UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Southeast Regional Office
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07/13/2021

F/SER31:DPO
SERO-2019-03622
https://doi.org/10.25923/59ak-yt96

Chief, Palm Beach Gardens Permits Section
Jacksonville District Corps of Engineers
Department of the Army
4400 PGA Boulevard, Suite 500
Palm Beach Gardens, Florida 33410

Ref: Fisherman's Pier Incorporated, Fisherman's Pier Repair, SAJ-2019-01492, Lauderdale-by-the-Sea, Broward County, Florida

Dear Sir or Madam:

The enclosed Biological Opinion (Opinion) was prepared by the National Marine Fisheries Service (NMFS), pursuant to Section 7(a)(2) of the Endangered Species Act. The Opinion considers the effects of a proposal by the United States Army Corps of Engineers (USACE) to authorize the removal and replacement of an existing fishing pier. We base this Opinion on project-specific information provided in the consultation package, NMFS's review of published literature, and the best available data. This Opinion analyzes the potential for the projects to affect the following: green sea turtle (North Atlantic and South Atlantic distinct population segments [DPSs]), Kemp's ridley sea turtle, loggerhead sea turtle (Northwest Atlantic DPS), hawksbill sea turtle, smalltooth sawfish (United States DPS), and giant manta ray.

We look forward to further cooperation with the USACE on other projects to ensure the conservation and recovery of our threatened and endangered marine species. This project has been assigned the tracking number SERO-2019-03622 in our NMFS Environmental Consultation Organizer (ECO). Please refer to the ECO number in all future inquiries regarding this consultation. If you have any questions regarding this consultation, please contact Daniel P. Owen, Consultation Biologist, by phone at 727-209-5961, or by email at Daniel.Owen@noaa.gov.

Sincerely,

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for Andrew J. Strelcheck
Acting Regional Administrator

Enclosure: Biological Opinion
File: 1514-22.f

Endangered Species Act - Section 7 Consultation
Biological Opinion

Action Agency: United States Army Corps of Engineers

Applicant: Spiro Marchelos, Fisherman's Pier Incorporated

Activity: Fisherman's Pier Repair

SAJ-2019-01492 (NW-KAE)

Consulting Agency: National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Regional Office, Protected Resources Division, St. Petersburg, Florida

Tracking Number: SERO-2019-03622
https://doi.org/10.25923/59ak-yt96

Approved by:

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for Andrew J. Strelcheck, Acting Regional Administrator
NMFS, Southeast Regional Office
St. Petersburg, Florida

Date Issued: 07/13/2021

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Acronyms and Abbreviations

ADA	Americans with Disabilities Act
CFR	Code of Federal Regulations
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CPUE	Catch per unit effort
CR	Conservation Recommendations
DDT	Dichlorodiphenyltrichloroethane
DO	Dissolved Oxygen
DPS	Distinct Population Segment
DWH	*Deepwater Horizon*
DTRU	Dry Tortugas Recovery Unit
ESA	Endangered Species Act
FGBNMS	Flower Garden Banks National Marine Sanctuary
MSFP	Fibropapillomatosis disease
FR	Federal Register
FWC	Florida Fish and Wildlife Conservation Commission
FWRI	Fish and Wildlife Research Institute
GADNR	Georgia Department of Natural Resources
GCRU	Greater Caribbean Recovery Unit
IPCC	Intergovernmental Panel on Climate Change
ISED	International Sawfish Encounter Database
ITS	Incidental Take Statement
LED	Light Emitting Diode
MHW	Mean High Water
MMF	Marine Megafauna Foundation
NA	North Atlantic
NCWRC	North Carolina Wildlife Resources Commission
NGMRU	Northern Gulf of Mexico Recovery Unit
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NRU	Northern Recovery Unit
NWA	Northwest Atlantic
Opinion	Biological Opinion
PCB	Polychlorinated Biphenyls
PFC	Perfluorinated Chemicals
PFRU	Peninsular Florida Recovery Unit
PRD	NMFS Protected Resources Division
PRM	Post-release mortality
RPMs	Reasonable and Prudent Measures

SA	South Atlantic
SCDNR	South Carolina Department of Natural Resources
SCL	Straight Carapace length
SERO	NMFS Southeast Regional Office
SSRIT	Smalltooth Sawfish Recovery Implementation Team
STSSN	Sea Turtle Stranding and Salvage Network
T&Cs	Terms and Conditions
TED	Turtle Exclusion Device
TEWG	Turtle Expert Working Group
U.S.	United States of America
USACE	United States Army Corps of Engineers
USFWS	United States Fish and Wildlife Service

Units of Measure

°C	Degrees Celsius
cm	Centimeter(s)
°F	Degrees Fahrenheit
ft	Foot/feet
g	Gram(s)
in	Inch(es)
kg	Kilogram(s)
lb	Pound(s)
m	Meter(s)
mm	Millimeter(s)
oz	Ounce(s)

Introduction

Section 7(a)(2) of the Endangered Species Act (ESA) of 1973, as amended (16 U.S.C. §1531 et seq.), requires that each federal agency ensure that any action authorized, funded, or carried out by the agency is not likely to jeopardize the continued existence of any endangered or threatened species or result in the destruction or adverse modification of critical habitat of those species. When the action of a federal agency may affect a protected species or its critical habitat, that agency is required to consult with either the National Marine Fisheries Service (NMFS) or the United States Fish and Wildlife Service (USFWS), depending upon the protected species or critical habitat that may be affected.

Consultations on most listed marine species and their designated critical habitat are conducted between the action agency and NMFS. Consultations are concluded after NMFS determines the action is not likely to adversely affect listed species or critical habitats, or issues a Biological Opinion (Opinion) that determines whether a proposed action is likely to jeopardize the continued existence of a federally listed species, or destroy or adversely modify federally designated critical habitat. The Opinion also states the amount or extent of listed species incidental take that may occur and develops nondiscretionary measures that the action agency must take to reduce the effects of the anticipated take. The Opinion may also recommend discretionary conservation measures. No incidental destruction or adverse modification of critical habitat may be authorized. The issuance of an Opinion detailing NMFS's findings concludes ESA Section 7 consultation.

This document represents NMFS's Opinion based on our review of effects associated with the United States Army Corps of Engineers (USACE) proposed action to permit the removal and replacement of the Fisherman's Pier in Broward County, Florida. This Opinion analyzes the proposed actions' effects on threatened and endangered species and designated critical habitat in accordance with Section 7 of the ESA. We based our Opinion on information provided by the USACE, the Sea Turtle Stranding and Salvage Network (STSSN), the Smalltooth Sawfish Recovery Implementation Team's (SSRIT) encounter database, the Marine Megafauna Foundation (MMF), and the published literature cited herein.

1. CONSULTATION HISTORY

The following is the consultation history for NMFS Environmental Consultation Organizer tracking number SERO-2019-03622 Fisherman's Pier.

On December 12, 2019, NMFS received a request for consultation under Section 7 of the ESA from USACE in a letter dated December 11, 2019.

On January 8, 2020, and November 14, 2020, NMFS requested additional information related to the construction details, pier usage, and description of the proposed action.

NMFS received USACE's complete response on November 26, 2020, and initiated consultation that day.

On May 27, June 18, and June 28, 2021, NMFS requested additional information during our internal review process. NMFS received final response on the June 30, 2021.

2. DESCRIPTION OF THE PROPOSED ACTION

2.1 Proposed Action

The applicant proposes to repair and replace the decking of the existing public fishing pier (also known as Anglin's Fishing Pier, but referred to as the Fisherman's Pier or the consultation pier in this Opinion) in the same location and of the same dimensions as the existing pier. The pier consists of a 22-foot (ft) by 750-ft (16,500-square ft [ft^2]) access walkway and a 30-ft by 90-ft (2700-ft^2) terminal platform. This project is necessary due to the age of the existing pier and the wear caused over time. The current pier was constructed in 1963, replacing an earlier pier that was built in 1941. Not all deck boards will be removed and replaced. In areas where the beams or pile caps need repair, areas of decking will be removed and reset to allow for access. Any deck boards that have been damaged during previous hurricanes will also be replaced as well. The pier is approximately 850-ft-long.

The decking will have a minimum one half inch spacing. The existing railing will be removed to allow for decking removal and reset or, if needed, replaced. All material replaced will be removed and disposed in an appropriate upland location. The dock is approximately 11.2 ft above the Mean High Water (MHW) line.

No new piles will be installed as part of this action. All existing concrete piles (90 in total) are to remain in place. The applicants estimate that 70 piles will be reinforced by chipping out the deteriorated concrete. The piles will then be encapsulated by installing basalt (non-corrosive rebar) reinforcement, forming the piles, and poring new concrete into a form. The cross-section of each piling is a 14–inches (in) by 14-in square. The encapsulated pilings will be round with a 22–in-diameter and poured using a Ecocrete additive. Pilings that the structural engineer deems necessary for repair will be encapsulated from sea floor to pile cap.

There are no plans to use work vessels as part of this action. All construction equipment and work will be conducted from either the shore or the deck of the pier. The applicant will install netting under the work area to catch falling debris. Divers will be used to retrieve debris that may fall through the netting and enter the water. Debris will be removed and disposed in an upland containment area.

All construction activities will occur during daylight hours only, and will have no seasonal restrictions. The entire project from start to finish will take approximately 3 years to complete because of the time that will be needed to repair the number of deteriorated concrete piles.

Upon completion, the Fisherman's Pier will be accessible to anglers both day and night. The pier will be open 365 days a year, 24 hours a day. The applicant estimates approximately between 35 to 45 anglers will use the pier per day. The pier will have an on-site pier attendant during operational hours (24 hours a day). The replacement pier will not include fish cleaning stations.

2.1.1 Construction Conditions

To minimize potential impacts to ESA-listed species, the applicant (or applicant's contractors) will be required to implement the following conditions during construction:

- Prior to the onset of construction activities, the applicant or designated agent will conduct a meeting with all construction staff to discuss identification of the sea turtles, sturgeon, giant manta rays, and marine mammals, their protected status, what to do if any are observed within the project area, and applicable penalties that may be imposed if State or Federal regulations are violated. All personnel shall be advised that there are civil and criminal penalties for harming, harassing, or killing ESA-listed species or marine mammals.

- The existing parking lot, or other upland, non-beach parcels will be used for construction staging. If areas other than the existing parking lot are needed for staging, the contractor will be responsible for identifying available areas and obtaining permission for use. The beach will not be used for project staging.

- The applicant will adhere to NMFS's *Sea Turtle and Smalltooth Sawfish Construction Conditions*,[1] including the use of turbidity curtains, and which requires construction to cease immediately if a sea turtle or smalltooth sawfish is seen within a 50-ft radius of the equipment. Activities will not resume until the protected species has departed the project area of its own volition. The applicant will extend these conditions to all ESA-listed species.

- The applicant will adhere to the Project Design Criteria (PDC) for In-Water Activities (AP.7 – AP.11 in the JAXBO).[2]

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[1] (NMFS, 2006)

[2] NMFS. 2017. Endangered Species Act - Section 7 Consultation Biological Opinion for the Authorization of Minor In-Water Activities throughout the Geographic Area of Jurisdiction of the U.S. Army Corps of Engineers Jacksonville District, including Florida and the U.S. Caribbean (JAXBO).

- Any injury to any ESA-listed species occurring during the construction shall be reported immediately to NMFS's Protected Resources Division (PRD) by phone at 1-727-824-5312 or by email at takereport.nmfsser@noaa.gov.

2.1.2 Best Management Practices

To minimize potential impacts to ESA-listed species, the USACE will include the following conditions to the permit for post-construction activities:

- The applicant will ensure that there will be an on-site pier attendant during pier operational hours (24 hours a day). The pier attendant will be able to assist with sea turtle recreational hook-and-line captures using large dip-nets and de-hooking equipment kept onsite.

- The applicant will put in place an agreement with the Florida Sea Turtle Stranding Coordinator to call, pick up, and assist with hooked, entangled, or stranded turtles. The Florida Stranding Coordinator's contact information can be found at the following web link: https://www.fisheries.noaa.gov/state-coordinators-sea-turtle-stranding-and-salvage-network

- Fishing line recycling receptacles will be placed along the pier in order to minimize gear from being disposed of in the ocean or on the beaches. Receptacles will be clearly marked and will be emptied frequently enough to ensure they do not overfill and that gear is disposed of properly.

- Upon completion of the pier, educational signs must be posted in a visible location(s), alerting users of listed species in the area. The applicant will post the "Save Dolphins, Sea Turtles, Sawfish and Manta Ray" sign, which is available for download at: https://www.fisheries.noaa.gov/southeast/consultations/protected-species-educational-signs

- The applicant will use sea turtle friendly pier lighting (i.e., long wavelength amber, orange, or red light-emitting diode lighting).

- The pier will undergo regular (e.g. annual) underwater cleanup in order to remove stranded line and tackle.

2.2 Proposed Action Area

The Fisherman's Pier is located at 2 East Commercial Boulevard, in Section 18, Township 49 South, Range 43 East, in Lauderdale-by-the-Sea, Broward County, Florida (Latitude: 26.189289, Longitude: -80.093414) on the Atlantic Ocean. The pier was constructed under a USACE permit issued in 1963 as a replacement of a pier that had been constructed under a Department of War permit issued in 1941.

Figure 1. Fisherman's Pier location (©Google 2019)

The action area is defined by regulation as all areas to be affected by the Federal action and not merely the immediate area involved in the action (50 CFR 402.02). The action area for the Fisherman’s Pier includes the old pier’s physical footprint, the new pier footprint, the surrounding water accessible to recreational anglers upon completion of the proposed action (i.e., casting distance or approximately 200-ft), which includes the radius of anticipated effects due to recreational fishing. The action area occurs within loggerhead sea turtle nearshore reproductive critical habitat (LOGG-N-19), loggerhead sea turtle Sargassum critical habitat (LOGG-S-01) (79 FR 39856), and Acropora Florida area critical habitat (73 FR 72210).

The water depth within the action area ranges from approximately 8 to 20-ft. The substrate consists primarily of unconsolidated, bare sand bottom. There are hard bottom resources located at the terminal end of the pier. A coral survey was conducted on October 28, 2019, from the hardbottom edge to 5 meters seaward of the end of the pier (a distance of approximately 90 m). No ESA-listed coral species were observed within the survey area. Coral species observed included *Montastraea cavernosa*, *Siderastrea* species, *Solenastrea bournoni*, *Pseudodiploria clivosa*, and *Porites astreoides*. Other benthic species observed included encrusting sponges, bryozoans, tunicates, barnacles, and *Millepora* species. The repaired pier will be the same height as the existing pier, approximately 11.2 ft above the MHW line.

3. STATUS OF THE SPECIES AND CRITICAL HABITAT

Table 1 provides the effect determinations for species the USACE and NMFS believe may be affected by the proposed action.

Table 1. Effects Determinations for ESA-Listed Species that May Be Affected by the Proposed Action

Species	ESA Listing Status[3]	Action Agency Effect Determination	NMFS Effect Determination
Sea Turtles			
Green (North Atlantic [NA] distinct population segment [DPS])	T	NLAA	LAA
Green (South Atlantic [SA] DPS)	T	NLAA	LAA
Kemp's ridley	E	NLAA	LAA
Leatherback	E	NLAA	NE
Loggerhead (Northwest Atlantic [NWA] DPS)	T	NLAA	LAA
Hawksbill	E	NLAA	LAA
Fish			
Smalltooth sawfish (U.S. DPS)	E	NLAA	LAA
Giant manta ray	T	NE	LAA

E = endangered; T = threatened; NLAA = may affect, not likely to adversely affect; LAA = likely to adversely affect; NE = no effect.

The Fisherman's Pier is located in the ocean-facing waters of Zone 26, a statistical subarea used when reporting commercial fishing data. Zone 26 extends from 26° to 27° North latitude along the east coast of Florida (Atlantic Ocean). To help determine which sea turtle species are likely to occur within the action area, we reviewed the STSSN offshore stranding data (i.e., stranding data for all areas outside of protected waters) for Zone 26 (Table 2). Based on the data, we believe green sea turtle (NA and SA DPSs), hawksbill sea turtle, Kemp's ridley sea turtle, and loggerhead sea turtle (NWA DPS) may be affected by construction effects as well as recreational fishing that will occur at the pier upon completion of the proposed action (Table 2). While the leatherback sea turtle is represented in the data, we do not believe this species will be in the action area or caught on or entangled in recreational hook and line gear used at the pier. The STSSN records of leatherback sea turtles are due to vessel strike (4 records), predation (2 records), and unknown activities (11 records); that is, no leatherback sea turtle records show evidence of recreational fishing interactions. Further, leatherback sea turtles tend to be pelagic feeders, feeding on jellyfish and not baits typically fished from piers.

Table 2. Summary of STSSN Offshore Data for Zone 26 (2007-2016)

Species	Number of Sea Known Turtles Stranded or Salvaged (All Activities)	Number of Known Gear Entanglements	Number of Known Recreational Hook-and-line Captures
Green sea turtle	716	73	33
Hawksbill sea turtle	85	9	1
Kemp's ridley sea turtle	24	3	1
Leatherback sea turtle	17	0	0
Loggerhead sea turtle	376	10	9
Unidentified	17	0	0
Total	**1,235**	**95**	**44**

Table 3 provides the effects determinations for designated critical habitat occurring within the action area that the USACE and NMFS believe may be affected by the proposed action. The project is located within the boundary of LOGG-N-19, constricted migratory habitat). The following essential features/primary constituent elements (PCEs) are present in LOGG-N-19: (1) Constricted continental shelf area relative to nearby continental shelf waters that concentrate migratory pathways; and (2) Passage conditions to allow for migration to and from nesting, breeding, and/or foraging areas. The proposed action is the repair of an existing pier in the same pier footprint with reinforcement of the supporting piles, which will increase the footprint of the piles from 14-in by 14 in to round piles with 22-in diameter. We do not believe any of the essential features/primary constituent elements (PCEs) will be affected by the proposed action and, therefore, there will be no effect to LOGG-N-19, constricted migratory habitat.

The project is located within the boundary of LOGG-N-19, breeding habitat. The following essential features/primary constituent elements (PCEs) are present in LOGG-N-19:
(1) High densities of reproductive male and female loggerheads; (2) Proximity to primary Florida migratory corridor; and (3) Proximity to Florida nesting grounds. The proposed action is the repair of an existing pier in the same pier footprint with reinforcement of the supporting piles. We do not believe any of the essential features/primary constituent elements (PCEs) will be affected by the proposed action and, therefore, there will be no effect to LOGG-N-19, breeding habitat.

The project is located within the boundary of LOGG-N-19, nearshore reproductive habitat. The following essential features/primary constituent elements (PCEs) are present in LOGG-N-19: (1) Nearshore waters directly off the highest density nesting beaches and their adjacent beaches as identified in 50 C.F.R. §17.95(c) to 1.6 km (1 mile) offshore; (2) Waters sufficiently free of obstructions or artificial lighting to allow transit through the surf zone and outward toward open water; and (3) Waters with minimal manmade structures that could promote predators (i.e., nearshore predator concentration caused by submerged and emergent offshore structures), disrupt wave patterns necessary for orientation, and/or create excessive longshore currents. The proposed action is the repair of an existing pier in the same pier footprint with reinforcement of the supporting piles. We do not believe any of the essential features/primary constituent elements

(PCEs) will be affected by the proposed action and, therefore, there will be no effect to LOGG-N-19, nearshore reproductive habitat.

The project is located within the boundary of critical habitat for elkhorn (*Acropora palmata*) and staghorn (*A. cervicornis*) corals, Subarea A of the Florida Area. The physical feature essential to the conservation of elkhorn and staghorn corals is: substrate of suitable quality and availability to support larval settlement and recruitment, and reattachment and recruitment of asexual fragments. "Substrate of suitable quality and availability" is defined as natural consolidated hard substrate or dead coral skeleton that is free from fleshy or turf macroalgae cover and sediment cover. The proposed action is the repair of an existing pier in the same pier footprint, with an approximate increase of 89 ft^2 to account for the additional pile reinforcement area. The applicant states that the existing pilings are exclusively within and adjacent to sandy substrate, and expanding the piles will not disturb existing hard bottom substrate within the project area. Additionally, existing structures, such as the consultation pier, are not included in the critical habitat designation of Subarea A of the Florida Area (50 C.F.R. § 266.216(c)(2)). Therefore, we do not believe the critical habitat will be affected by the proposed action.

Table 3. Effects Determinations for Designated Critical Habitat that May Be Affected by the Proposed Action

Species	Units	Action Agency Effect Determination	NMFS Effect Determination
Loggerhead sea turtle	LOGG-N-19	May affect, not likely to adversely affect	No effect
Elkhorn and staghorn coral	Subarea A of Florida Area	No effect	No effect

3.1 Potential Routes of Effect Not Likely To Adversely Affect ESA-Listed Species

Green, Kemp's ridley, hawksbill, loggerhead sea turtles, smalltooth sawfish, and giant manta ray may be injured if struck by equipment or materials during construction activities. However, we believe that such route of effect is extremely unlikely to occur. These species are expected to exhibit avoidance behavior by moving away from physical disturbances. In addition, the applicant will implement NMFS's *Sea Turtle and Smalltooth Sawfish Construction Conditions* and extend these conditions to giant manta ray. This will further reduce the risk of injury to these species during construction activities. If at any point, a sea turtle species, smalltooth sawfish, or giant manta ray is observed within 50 ft of the work site, all construction or operation of any mechanical equipment will cease until the animal has departed the project area on its own volition.

Green, Kemp's ridley, hawksbill, loggerhead sea turtles, smalltooth sawfish, and giant manta ray may also be injured due to entanglement in improperly discarded fishing gear upon completion of the proposed actions. We believe this route of effect is extremely unlikely to occur. The applicant will maintain fishing line recycling receptacles and trash cans to keep debris out of the water when the public fishing structures are open for use by the public, and we expect that anglers will appropriately dispose of fishing gear using these bins in the future. The receptacles will be clearly marked and will continue to be emptied regularly to ensure they are not overfilled and that fishing lines are disposed of properly. The applicant will also post signage that instructs anglers not to dispose of fishing line or debris in the water. Additionally, the applicants will conduct annual underwater clean-ups to remove stranded tackle and line that may cause potential entanglement.

The action area contains habitat that may be used by Green, Kemp's ridley, hawksbill, loggerhead sea turtles, smalltooth sawfish, and giant manta ray. These species may be affected by their inability to access the action area due to their avoidance of construction activities and physical exclusion from the project area due to blockage by turbidity curtains. We believe the effect of temporary loss of habitat access will be insignificant, given the availability of similar habitat nearby, the abundance of habitat outside of the action area.

The NMFS educational signs "Save Dolphins, Sea Turtles, Sawfish and Manta Ray", "Report a Sturgeon", and the "Help Protect North Atlantic Right Whales" will be installed in visible locations at Fisherman's Pier upon completions of the proposed actions. We believe the placement of educational signs is a beneficial effect to Green, Kemp's ridley, hawksbill, loggerhead sea turtles, smalltooth sawfish, and giant manta ray. The signs will provide information to the public on how to avoid and minimize encounters with these species as well as proper handling techniques. The signs will also encourage anglers to report sightings and interactions, thus providing valuable distribution and abundance data to researchers and resource managers. Accurate distribution and abundance data allows management to evaluate the status of the species and refine conservation and recovery measures.

3.2 Potential Route of Effect Likely To Adversely Affect ESA-Listed Species

NMFS determined that recreational hook-and-line interactions from the completed pier are likely to adversely affect green sea turtle (NA and SA DPSs), Kemp's ridley sea turtle, loggerhead sea turtle (NWA DPS), and hawksbill sea turtle, smalltooth sawfish, and giant manta ray. We provide greater detail on the potential effects of entanglement, hooking, and trailing line to sea turtles, smalltooth sawfish, and giant manta ray in the Effects of the Action below (Section 5.1)

3.3 Status of Sea Turtles

Section 3.3.1 addresses the general threats that confront all sea turtle species. Sections 3.3.2 – 3.3.5 address information on the distribution, life history, population structure, abundance, population trends, and unique threats to each species of sea turtle likely to be adversely affected by the proposed action.

3.3.1 General Threats Faced by All Sea Turtle Species

Sea turtles face numerous natural and man-made threats that shape their status and affect their ability to recover. Many of the threats are either the same or similar in nature for all listed sea turtle species. The threats identified in this section are discussed in a general sense for all sea turtles. Threat information specific to a particular species are then discussed in the corresponding status sections where appropriate.

Fisheries

Incidental bycatch in commercial fisheries is identified as a major contributor to past declines, and threat to future recovery, for all of the sea turtle species (NMFS & USFWS, 1991, 1992, 1993, 2008; NMFS, USFWS, & SEMARNAT, 2011b). Domestic fisheries often capture, injure, and kill sea turtles at various life stages. Sea turtles in the pelagic environment are exposed to U.S. Atlantic pelagic longline fisheries. Sea turtles in the benthic environment in waters off the coastal United States are exposed to a suite of other fisheries in federal and state waters. These fishing methods include trawls, gillnets, purse seines, hook-and-line gear (including bottom longlines and vertical lines [e.g., bandit gear, handlines, and rod-reel]), pound nets, and trap fisheries. Refer to the Environmental Baseline section of this Opinion for more specific information regarding federal and state managed fisheries affecting sea turtles within the action area). The Southeast U.S. shrimp fisheries have historically been the largest fishery threat to benthic sea turtles in the southeastern United States, and continue to interact with and kill large numbers of sea turtles each year.

In addition to domestic fisheries, sea turtles are subject to direct as well as incidental capture in numerous foreign fisheries, further impeding the ability of sea turtles to survive and recover on a global scale. For example, pelagic stage sea turtles, especially loggerheads and leatherbacks, circumnavigating the Atlantic are susceptible to international longline fisheries including the Azorean, Spanish, and various other fleets (Aguilar, Mas, & Pastor, 1994; A. B. Bolten, Bjorndal, & Martins, 1994). Bottom longlines and gillnet fishing is known to occur in many foreign waters, including (but not limited to) the northwest Atlantic, western Mediterranean, South America, West Africa, Central America, and the Caribbean. Shrimp trawl fisheries are also occurring off the shores of numerous foreign countries and pose a significant threat to sea turtles similar to the impacts seen in U.S. waters. Many unreported takes or incomplete records by foreign fleets make it difficult to characterize the total impact that international fishing pressure is having on listed sea turtles. Nevertheless, international fisheries represent a continuing threat to sea turtle survival and recovery throughout their respective ranges.

Non-Fishery In-Water Activities

There are also many non-fishery impacts affecting the status of sea turtle species, both in the ocean and on land. In nearshore waters of the United States, the construction and maintenance of federal navigation channels has been identified as a source of sea turtle mortality. Hopper dredges, which are frequently used in ocean bar channels and sometimes in harbor channels and offshore borrow areas, move relatively rapidly and can entrain and kill sea turtles (NMFS, 1997). Sea turtles entering coastal or inshore areas have also been affected by entrainment in the cooling-water systems of electrical generating plants. Other nearshore threats include harassment and/or injury resulting from private and commercial vessel operations, military detonations and training exercises, in-water construction activities, and scientific research activities.

Coastal Development and Erosion Control

Coastal development can deter or interfere with nesting, affect nesting success, and degrade nesting habitats for sea turtles. Structural impacts to nesting habitat include the construction of buildings and pilings, beach armoring and renourishment, and sand extraction (Bouchard et al., 1998; Lutcavage, Plotkin, Witherington, & Lutz, 1997). These factors may decrease the amount of nesting area available to females and change the natural behaviors of both adults and hatchlings, directly or indirectly, through loss of beach habitat or changing thermal profiles and increasing erosion, respectively (Ackerman, 1997; Blair Witherington, Hirama, & Moiser, 2003, 2007). In addition, coastal development is usually accompanied by artificial lighting which can alter the behavior of nesting adults (Blair E. Witherington, 1992) and is often fatal to emerging hatchlings that are drawn away from the water (B. E. Witherington & Bjorndal, 1991). In-water erosion control structures such as breakwaters, groins, and jetties can impact nesting females and hatchlings as they approach and leave the surf zone or head out to sea by creating physical blockage, concentrating predators, creating longshore currents, and disrupting of wave patterns.

Environmental Contamination

Multiple municipal, industrial, and household sources, as well as atmospheric transport, introduce various pollutants such as pesticides, hydrocarbons, organochlorides (e.g., dichlorodiphenyltrichloroethane [DDT], polychlorinated biphenyls [PCB], and perfluorinated chemicals [PFC]), and others that may cause adverse health effects to sea turtles (Garrett, 2004; Grant & Ross, 2002; Hartwell, 2004; Iwata, Tanabe, Sakai, & Tatsukawa, 1993). Acute exposure to hydrocarbons from petroleum products released into the environment via oil spills and other discharges may directly injure individuals through skin contact with oils (Geraci, 1990), inhalation at the water's surface and ingesting compounds while feeding (Matkin & Saulitis, 1997). Hydrocarbons also have the potential to impact prey populations, and therefore may affect listed species indirectly by reducing food availability in the action area.

The April 20, 2010, explosion of the Deepwater Horizon oil rig affected sea turtles in the Gulf of Mexico. An assessment has been completed on the injury to Gulf of Mexico marine life, including sea turtles, resulting from the spill (DWH Trustees, 2015a). Following the spill, juvenile Kemp's ridley, green, and loggerhead sea turtles were found in *Sargassum* algae mats in the convergence zones, where currents meet and oil collected. Sea turtles found in these areas were often coated in oil and/or had ingested oil. The spill resulted in the direct mortality of many sea turtles and may have had sublethal effects or caused environmental damage that will impact other sea turtles into the future. Information on the spill impacts to individual sea turtle species is presented in the Status of the Species sections for each species.

Marine debris is a continuing problem for sea turtles. Sea turtles living in the pelagic environment commonly eat or become entangled in marine debris (e.g., tar balls, plastic bags/pellets, balloons, and ghost fishing gear) as they feed along oceanographic fronts where debris and their natural food items converge. This is especially problematic for sea turtles that spend all or significant portions of their life cycle in the pelagic environment (i.e., leatherbacks, juvenile loggerheads, and juvenile green turtles).

Climate Change

There is a large and growing body of literature on past, present, and future impacts of global climate change, exacerbated and accelerated by human activities. Some of the likely effects commonly mentioned are sea level rise, increased frequency of severe weather events, and change in air and water temperatures. NOAA's climate information portal provides basic background information on these and other measured or anticipated effects (see http://www.climate.gov).

Climate change impacts on sea turtles currently cannot be predicted with any degree of certainty; however, significant impacts to the hatchling sex ratios of sea turtles may result (NMFS & USFWS, 2007c). In sea turtles, sex is determined by the ambient sand temperature (during the middle third of incubation) with female offspring produced at higher temperatures and males at lower temperatures within a thermal tolerance range of 25°-35°C (Ackerman, 1997). Increases in global temperature could potentially skew future sex ratios toward higher numbers of females (NMFS & USFWS, 2007c).

The effects from increased temperatures may be intensified on developed nesting beaches where shoreline armoring and construction have denuded vegetation. Erosion control structures could potentially result in the permanent loss of nesting beach habitat or deter nesting females (NRC, 1990). These impacts will be exacerbated by sea level rise. If females nest on the seaward side of the erosion control structures, nests may be exposed to repeated tidal overwash (NMFS & USFWS, 2007d). Sea level rise from global climate change is also a potential problem for areas with low-lying beaches where sand depth is a limiting factor, as the sea may inundate nesting sites and decrease available nesting habitat (Baker, Littnan, & Johnston, 2006; Daniels, White, & Chapman, 1993; Fish et al., 2005). The loss of habitat as a result of climate change could be accelerated due to a combination of other environmental and oceanographic changes such as an increase in the frequency of storms and/or changes in prevailing currents, both of which could lead to increased beach loss via erosion (Antonelis, Baker, Johanos, Braun, & Harting, 2006; Baker et al., 2006).

Other changes in the marine ecosystem caused by global climate change (e.g., ocean acidification, salinity, oceanic currents, dissolved oxygen levels, nutrient distribution, etc.) could influence the distribution and abundance of lower trophic levels (e.g., phytoplankton, zooplankton, submerged aquatic vegetation, crustaceans, mollusks, forage fish, etc.) which could ultimately affect the primary foraging areas of sea turtles.

Other Threats

Predation by various land predators is a threat to developing nests and emerging hatchlings. The major natural predators of sea turtle nests are mammals, including raccoons, dogs, pigs, skunks, and badgers. Emergent hatchlings are preyed upon by these mammals as well as ghost crabs, laughing gulls, and the exotic South American fire ant (*Solenopsis invicta*). In addition to natural predation, direct harvest of eggs and adults from beaches in foreign countries continues to be a problem for various sea turtle species throughout their ranges (NMFS & USFWS, 2008).

Diseases, toxic blooms from algae and other microorganisms, and cold stunning events are additional sources of mortality that can range from local and limited to wide-scale and impacting hundreds or thousands of animals.

3.3.2 Status of Green Sea Turtle – North Atlantic and South Atlantic DPSs

The green sea turtle was originally listed as threatened under the ESA on July 28, 1978, except for the Florida and Pacific coast of Mexico breeding populations, which were listed as endangered. On April 6, 2016, the original listing was replaced with the listing of 11 distinct population segments (DPSs) (81 FR 20057, 2016) (Figure 2). The Mediterranean, Central West Pacific, and Central South Pacific DPSs were listed as endangered. The North Atlantic, South Atlantic, Southwest Indian, North Indian, East Indian-West Pacific, Southwest Pacific, Central North Pacific, and East Pacific DPSs were listed as threatened. For the purposes of this consultation, only the South Atlantic DPS (SA DPS) and North Atlantic DPS (NA DPS) will be considered, as they are the only two DPSs with individuals occurring in the Atlantic and Gulf of Mexico waters of the United States.

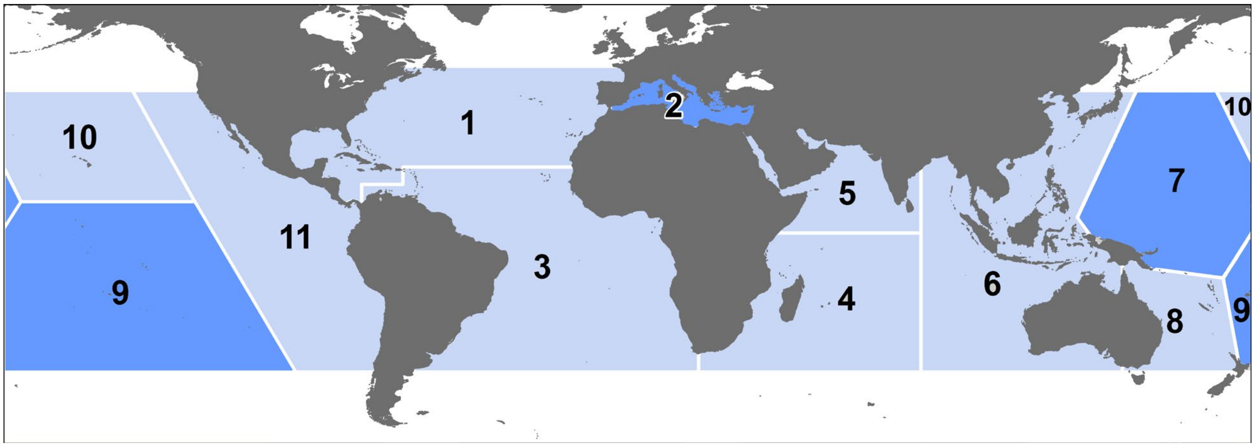

Figure 2. Threatened (light) and endangered (dark) green turtle DPSs: 1. North Atlantic, 2. Mediterranean, 3. South Atlantic, 4. Southwest Indian, 5. North Indian, 6. East Indian-West Pacific, 7. Central West Pacific, 8. Southwest Pacific, 9. Central South Pacific, 9. Central South Pacific, 10. Central North Pacific, and 11. East Pacific.

Species Description and Distribution

The green sea turtle is the largest of the hardshell marine turtles, growing to a weight of 350 lb (159 kg) with a straight carapace length of greater than 3.3 ft (1 m). Green sea turtles have a smooth carapace with 4 pairs of lateral (or costal) scutes and a single pair of elongated prefrontal scales between the eyes. They typically have a black dorsal surface and a white ventral surface, although the carapace of green sea turtles in the Atlantic Ocean has been known to change in color from solid black to a variety of shades of grey, green, or brown and black in starburst or irregular patterns (Lagueux, 2001).

With the exception of post-hatchlings, green sea turtles live in nearshore tropical and subtropical waters where they generally feed on marine algae and seagrasses. They have specific foraging grounds and may make large migrations between these forage sites and natal beaches for nesting

(Hays et al., 2001). Green sea turtles nest on sandy beaches of mainland shores, barrier islands, coral islands, and volcanic islands in more than 80 countries worldwide (Hirth, 1997). The 2 largest nesting populations are found at Tortuguero, on the Caribbean coast of Costa Rica (part of the NA DPS), and Raine Island, on the Pacific coast of Australia along the Great Barrier Reef.

Differences in mitochondrial DNA properties of green sea turtles from different nesting regions indicate there are genetic subpopulations (Brian W. Bowen et al., 1992; FitzSimmons, Farrington, McCann, Limpus, & Moritz, 2006). Despite the genetic differences, sea turtles from separate nesting origins are commonly found mixed together on foraging grounds throughout the species' range. Within U.S. waters individuals from both the NA and SA DPSs can be found on foraging grounds. While there are currently no in-depth studies available to determine the percent of NA and SA DPS individuals in any given location, two small-scale studies provide an insight into the degree of mixing on the foraging grounds. An analysis of cold-stunned green turtles in St. Joseph Bay, Florida (northern Gulf of Mexico) found approximately 4% of individuals came from nesting stocks in the SA DPS (specifically Suriname, Aves Island, Brazil, Ascension Island, and Guinea Bissau) (Foley et al., 2007). On the Atlantic coast of Florida, a study on the foraging grounds off Hutchinson Island found that approximately 5% of the turtles sampled came from the Aves Island/Suriname nesting assemblage, which is part of the SA DPS (Bass & Witzell, 2000). All of the individuals in both studies were benthic juveniles. Available information on green turtle migratory behavior indicates that long distance dispersal is only seen for juvenile turtles. This suggests that larger adult-sized turtles return to forage within the region of their natal rookeries, thereby limiting the potential for gene flow across larger scales (Monzón-Argüello et al., 2010). While all of the mainland U.S. nesting individuals are part of the NA DPS, the U.S. Caribbean nesting assemblages are split between the NA and SA DPS. Nesters in Puerto Rico are part of the NA DPS, while those in the U.S. Virgin Islands are part of the SA DPS. We do not currently have information on what percent of individuals on the U.S. Caribbean foraging grounds come from which DPS.

North Atlantic DPS Distribution

The NA DPS boundary is illustrated in Figure 1. Four regions support nesting concentrations of particular interest in the NA DPS: Costa Rica (Tortuguero), Mexico (Campeche, Yucatan, and Quintana Roo), U.S. (Florida), and Cuba. By far the most important nesting concentration for green turtles in this DPS is Tortuguero, Costa Rica. Nesting also occurs in the Bahamas, Belize, Cayman Islands, Dominican Republic, Haiti, Honduras, Jamaica, Nicaragua, Panama, Puerto Rico, Turks and Caicos Islands, and North Carolina, South Carolina, Georgia, and Texas, U.S.A. In the eastern North Atlantic, nesting has been reported in Mauritania (Fretey, 2001).

The complete nesting range of NA DPS green sea turtles within the southeastern United States includes sandy beaches between Texas and North Carolina, as well as Puerto Rico (Dow, Eckert, Palmer, & Kramer, 2007; NMFS & USFWS, 1991). The vast majority of green sea turtle nesting within the southeastern United States occurs in Florida (Johnson & Ehrhart, 1994; A. B. Meylan, Schroeder, & Mosier, 1995). Principal U.S. nesting areas for green sea turtles are in eastern Florida, predominantly Brevard south through Broward Counties.

In U.S. Atlantic and Gulf of Mexico waters, green sea turtles are distributed throughout inshore and nearshore waters from Texas to Massachusetts. Principal benthic foraging areas in the southeastern United States include Aransas Bay, Matagorda Bay, Laguna Madre, and the Gulf inlets of Texas (Doughty, 1984; H.H. Hildebrand, 1982; Shaver, 1994), the Gulf of Mexico off Florida from Yankeetown to Tarpon Springs (D. K. Caldwell & Carr, 1957), Florida Bay and the Florida Keys (Schroeder & Foley, 1995), the Indian River Lagoon system in Florida (Ehrhart, 1983), and the Atlantic Ocean off Florida from Brevard through Broward Counties (Guseman & Ehrhart, 1992; Wershoven & Wershoven, 1992). The summer developmental habitat for green sea turtles also encompasses estuarine and coastal waters from North Carolina to as far north as Long Island Sound (J. A. Musick & Limpus, 1997). Additional important foraging areas in the western Atlantic include the Culebra archipelago and other Puerto Rico coastal waters, the south coast of Cuba, the Mosquito Coast of Nicaragua, the Caribbean coast of Panama, scattered areas along Colombia and Brazil (Hirth, 1971), and the northwestern coast of the Yucatán Peninsula.

South Atlantic DPS Distribution

The SA DPS boundary is shown in Figure 1, and includes the U.S. Virgin Islands in the Caribbean. The SA DPS nesting sites can be roughly divided into four regions: western Africa, Ascension Island, Brazil, and the South Atlantic Caribbean (including Colombia, the Guianas, and Aves Island in addition to the numerous small, island nesting sites).

The in-water range of the SA DPS is widespread. In the eastern South Atlantic, significant sea turtle habitats have been identified, including green turtle feeding grounds in Corisco Bay, Equatorial Guinea/Gabon (Formia, 1999); Congo; Mussulo Bay, Angola (T. Carr & Carr, 1991); as well as Principe Island. Juvenile and adult green turtles utilize foraging areas throughout the Caribbean areas of the South Atlantic, often resulting in interactions with fisheries occurring in those same waters (Dow et al., 2007). Juvenile green turtles from multiple rookeries also frequently utilize the nearshore waters off Brazil as foraging grounds as evidenced from the frequent captures by fisheries (Lima, Melo, & Barata, 2010; López-Barrera, Longo, & Monteiro-Filho, 2012; Marcovaldi, Gifforni, Becker, Fiedler, & Sales, 2009). Genetic analysis of green turtles on the foraging grounds off Ubatuba and Almofala, Brazil show mixed stocks coming primarily from Ascension, Suriname and Trindade as a secondary source, but also Aves, and even sometimes Costa Rica (North Atlantic DPS)(Naro-Maciel, Becker, Lima, Marcovaldi, & DeSalle, 2007; Naro-Maciel et al., 2012). While no nesting occurs as far south as Uruguay and Argentina, both have important foraging grounds for South Atlantic green turtles (Gonzalez Carman et al., 2011; Lezama, 2009; López-Mendilaharsu, Estrades, Caraccio, Hernández, & Quirici, 2006; Prosdocimi, González Carman, Albareda, & Remis, 2012; Rivas-Zinno, 2012).

Life History Information

Green sea turtles reproduce sexually, and mating occurs in the waters off nesting beaches and along migratory routes. Mature females return to their natal beaches (i.e., the same beaches where they were born) to lay eggs (G. H. Balazs, 1982; Frazer & Ehrhart, 1985) every 2-4 years while males are known to reproduce every year (G. H. Balazs, 1983). In the southeastern United States, females generally nest between June and September, and peak nesting occurs in June and July (B. E. Witherington & Ehrhart, 1989b). During the nesting season, females nest at approximately 2-week intervals, laying an average of 3-4 clutches (Johnson & Ehrhart, 1996).

Clutch size often varies among subpopulations, but mean clutch size is approximately 110-115 eggs. In Florida, green sea turtle nests contain an average of 136 eggs (B. E. Witherington & Ehrhart, 1989b). Eggs incubate for approximately 2 months before hatching. Hatchling green sea turtles are approximately 2 inches (5 cm) in length and weigh approximately 0.9 ounces (25 grams). Survivorship at any particular nesting site is greatly influenced by the level of man-made stressors, with the more pristine and less disturbed nesting sites (e.g., along the Great Barrier Reef in Australia) showing higher survivorship values than nesting sites known to be highly disturbed (e.g., Nicaragua) (Campell & Lagueux, 2005; M. Chaloupka & Limpus, 2005).

After emerging from the nest, hatchlings swim to offshore areas and go through a post-hatchling pelagic stage where they are believed to live for several years. During this life stage, green sea turtles feed close to the surface on a variety of marine algae and other life associated with drift lines and debris. This early oceanic phase remains one of the most poorly understood aspects of green sea turtle life history (NMFS & USFWS, 2007a). Green sea turtles exhibit particularly slow growth rates of about 0.4-2 inches (1-5 cm) per year (Green, 1993), which may be attributed to their largely herbivorous, low-net energy diet (Bjorndal, 1982). At approximately 8-10 inches (20-25 cm) carapace length, juveniles leave the pelagic environment and enter nearshore developmental habitats such as protected lagoons and open coastal areas rich in sea grass and marine algae. Growth studies using skeletochronology indicate that green sea turtles in the western Atlantic shift from the oceanic phase to nearshore developmental habitats after approximately 5-6 years (Bresette, Scarpino, Singewald, & de Maye, 2006; Zug & Glor, 1998). Within the developmental habitats, juveniles begin the switch to a more herbivorous diet, and by adulthood feed almost exclusively on seagrasses and algae (Rebel, 1974), although some populations are known to also feed heavily on invertebrates (Carballo, Olabarria, & Osuna, 2002). Green sea turtles mature slowly, requiring 20-50 years to reach sexual maturity (M. Y. Chaloupka & Musick, 1997; Hirth, 1997).

While in coastal habitats, green sea turtles exhibit site fidelity to specific foraging and nesting grounds, and it is clear they are capable of “homing in” on these sites if displaced (McMichael, Carthy, & Seminoff, 2003). Reproductive migrations of Florida green sea turtles have been identified through flipper tagging and/or satellite telemetry. Based on these studies, the majority of adult female Florida green sea turtles are believed to reside in nearshore foraging areas throughout the Florida Keys and in the waters southwest of Cape Sable, and some post-nesting turtles also reside in Bahamian waters as well (NMFS & USFWS, 2007a).

Status and Population Dynamics

Accurate population estimates for marine turtles do not exist because of the difficulty in sampling turtles over their geographic ranges and within their marine environments. Nonetheless, researchers have used nesting data to study trends in reproducing sea turtles over time. A summary of nesting trends and nester abundance is provided in the most recent status review for the species (Seminoff et al., 2015), with information for each of the DPSs.

North Atlantic DPS

The NA DPS is the largest of the 11 green turtle DPSs, with an estimated nester abundance of over 167,000 adult females from 73 nesting sites. Overall this DPS is also the most data rich. Eight of the sites have high levels of abundance (i.e., <1000 nesters), located in Costa Rica, Cuba, Mexico, and Florida. All major nesting populations demonstrate long-term increases in abundance (Seminoff et al., 2015).

Quintana Roo, Mexico, accounts for approximately 11% of nesting for the DPS (Seminoff et al., 2015). In the early 1980s, approximately 875 nests/year were deposited, but by 2000 this increased to over 1,500 nests/year (NMFS and USFWS, 2007). By 2012, more than 26,000 nests were counted in Quintana Roo (J. Zurita, CIQROO, unpublished data, 2013, in Seminoff et al. 2015).

Tortuguero, Costa Rica is by far the predominant nesting site, accounting for an estimated 79% of nesting for the DPS (Seminoff et al., 2015). Nesting at Tortuguero appears to have been increasing since the 1970s, when monitoring began. For instance, from 1971-1975 there were approximately 41,250 average annual emergences documented and this number increased to an average of 72,200 emergences from 1992-1996 (Bjorndal, Wetherall, Bolten, & Mortimer, 1999). Troëng and Rankin (2005) collected nest counts from 1999-2003 and also reported increasing trends in the population consistent with the earlier studies, with nest count data suggesting 17,402-37,290 nesting females per year (NMFS & USFWS, 2007a). Modeling by M. Chaloupka, Work, Balazs, Murakawa, and Morris (2008) using data sets of 25 years or more resulted in an estimate of the Tortuguero, Costa Rica population's growing at 4.9% annually.

In the continental United States, green sea turtle nesting occurs along the Atlantic coast, primarily along the central and southeast coast of Florida (A. Meylan, Schroeder, & Mosier, 1994; J. F. Weishampel, Bagley, Ehrhart, & Rodenbeck, 2003). Occasional nesting has also been documented along the Gulf Coast of Florida (A. B. Meylan et al., 1995). Green sea turtle nesting is documented annually on beaches of North Carolina, South Carolina, and Georgia, though nesting is found in low quantities (up to tens of nests) (nesting databases maintained on www.seaturtle.org).

Florida accounts for approximately 5% of nesting for this DPS (Seminoff et al., 2015). In Florida, index beaches were established to standardize data collection methods and effort on key nesting beaches. Since establishment of the index beaches in 1989, the pattern of green sea turtle nesting has generally shown biennial peaks in abundance with a positive trend during the 10 years of regular monitoring (Figure 3). According to data collected from Florida's index nesting beach survey from 1989-2019, green sea turtle nest counts across Florida have increased dramatically, from a low of 267 in the early 1990s to a high of 40,911 in 2019. Two consecutive years of nesting declines in 2008 and 2009 caused some concern, but this was followed by increases in 2010 and 2011, and a return to the trend of biennial peaks in abundance thereafter (Figure 3). Modeling by M. Chaloupka et al. (2008) using data sets of 25 years or more resulted in an estimate of the Florida nesting stock at the Archie Carr National Wildlife Refuge growing at an annual rate of 13.9% at that time. Increases have been even more rapid in recent years.

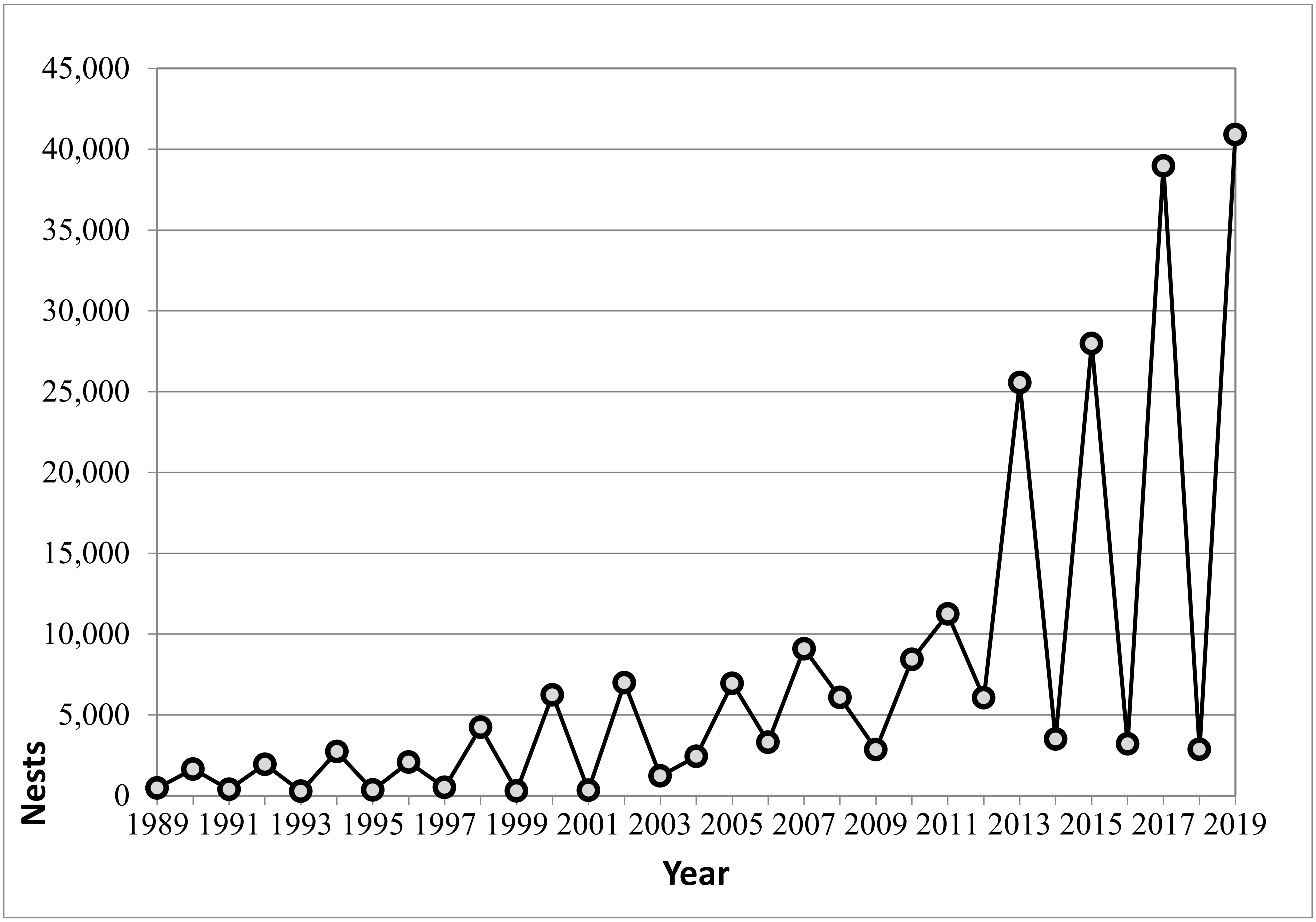

Figure 3. Green sea turtle nesting at Florida index beaches since 1989

Similar to the nesting trend found in Florida, in-water studies in Florida have also recorded increases in green turtle captures at the Indian River Lagoon site, with a 661 percent increase over 24 years (Ehrhart, Redfoot, & Bagley, 2007), and the St Lucie Power Plant site, with a significant increase in the annual rate of capture of immature green turtles (SCL<90 cm) from 1977 to 2002 or 26 years (3,557 green turtles total; M. Bressette, Inwater Research Group, unpubl. data; (B. Witherington, Bresette, & Herren, 2006).

South Atlantic DPS

The SA DPS is large, estimated at over 63,000 nesters, but data availability is poor. More than half of the 51 identified nesting sites (37) did not have sufficient data to estimate number of nesters or trends (Seminoff et al., 2015). This includes some sites, such as beaches in French Guiana, which are suspected to have large numbers of nesters. Therefore, while the estimated number of nesters may be substantially underestimated, we also do not know the population trends at those data-poor beaches. However, while the lack of data was a concern due to increased uncertainty, the overall trend of the SA DPS was not considered to be a major concern as some of the largest nesting beaches such as Ascension Island (United Kingdom), Aves Island (Venezuela), and Galibi (Suriname) appear to be increasing. Others such as Trindade (Brazil), Atol das Rocas (Brazil), and Poilão (Guinea-Bissau) and the rest of Guinea-Bissau seem to be stable or do not have sufficient data to make a determination. Bioko (Equatorial Guinea) appears to be in decline but has less nesting than the other primary sites (Seminoff et al., 2015).

In the U.S., nesting of SA DPS green turtles occurs on the beaches of the U.S. Virgin Islands, primarily on Buck Island. There is insufficient data to determine a trend for Buck Island nesting, and it is a smaller rookery, with approximately 63 total nesters utilizing the beach (Seminoff et al., 2015).

Threats

The principal cause of past declines and extirpations of green sea turtle assemblages has been the overexploitation of the species for food and other products. Although intentional take of green sea turtles and their eggs is not extensive within the southeastern United States, green sea turtles that nest and forage in the region may spend large portions of their life history outside the region and outside U.S. jurisdiction, where exploitation is still a threat. Green sea turtles also face many of the same threats as other sea turtle species, including destruction of nesting habitat from storm events, oceanic events such as cold-stunning, pollution (e.g., plastics, petroleum products, petrochemicals), ecosystem alterations (e.g., nesting beach development, beach nourishment and shoreline stabilization, vegetation changes), poaching, global climate change, fisheries interactions, natural predation, and disease. A discussion on general sea turtle threats can be found in Section 3.3.1.

In addition to general threats, green sea turtles are susceptible to natural mortality from Fibropapillomatosis (FP) disease. FP results in the growth of tumors on soft external tissues (flippers, neck, tail, etc.), the carapace, the eyes, the mouth, and internal organs (gastrointestinal tract, heart, lungs, etc.) of turtles (Aguirre, Balazs, Spraker, Murakawa, & Zimmerman, 2002; Herbst, 1994; Jacobson et al., 1989). These tumors range in size from 0.04 inches (0.1 cm) to greater than 11.81 inches (30 cm) in diameter and may affect swimming, vision, feeding, and organ function (Aguirre et al., 2002; Herbst, 1994; Jacobson et al., 1989). Presently, scientists are unsure of the exact mechanism causing this disease, though it is believed to be related to both an infectious agent, such as a virus (Herbst et al., 1995), and environmental conditions (e.g., habitat degradation, pollution, low wave energy, and shallow water (Foley, Schroeder, Redlow, Fick-Child, & Teas, 2005). FP is cosmopolitan, but it has been found to affect large numbers of animals in specific areas, including Hawaii and Florida (Herbst, 1994; Jacobson, 1990; Jacobson, Simpson Jr., & Sundberg, 1991).

Cold-stunning is another natural threat to green sea turtles. Although it is not considered a major source of mortality in most cases, as temperatures fall below 46.4°-50°F (8°-10°C) turtles may lose their ability to swim and dive, often floating to the surface. The rate of cooling that precipitates cold-stunning appears to be the primary threat, rather than the water temperature itself (Milton & Lutz, 2003). Sea turtles that overwinter in inshore waters are most susceptible to cold-stunning because temperature changes are most rapid in shallow water (B. E. Witherington & Ehrhart, 1989a). During January 2010, an unusually large cold-stunning event in the southeastern United States resulted in around 4,600 sea turtles, mostly greens, found cold-stunned, and hundreds found dead or dying. A large cold-stunning event occurred in the western Gulf of Mexico in February 2011, resulting in approximately 1,650 green sea turtles found cold-stunned in Texas. Of these, approximately 620 were found dead or died after stranding, while approximately 1,030 turtles were rehabilitated and released. During this same time frame, approximately 340 green sea turtles were found cold-stunned in Mexico, though approximately 300 of those were subsequently rehabilitated and released.

Whereas oil spill impacts are discussed generally for all species in Section 3.3.1, specific impacts of the DWH spill on green sea turtles are considered here. Impacts to green sea turtles occurred to offshore small juveniles only. A total of 154,000 small juvenile greens (36.6% of the total small juvenile sea turtle exposures to oil from the spill) were estimated to have been exposed to oil. A large number of small juveniles were removed from the population, as 57,300 small juveniles greens are estimated to have died as a result of the exposure. A total of 4 nests (580 eggs) were also translocated during response efforts, with 455 hatchlings released (the fate of which is unknown) (DWH Trustees, 2015b). Additional unquantified effects may have included inhalation of volatile compounds, disruption of foraging or migratory movements due to surface or subsurface oil, ingestion of prey species contaminated with oil and/or dispersants, and loss of foraging resources, which could lead to compromised growth and/or reproductive potential. There is no information currently available to determine the extent of those impacts, if they occurred.

While green turtles regularly use the northern Gulf of Mexico, they have a widespread distribution throughout the entire Gulf of Mexico, Caribbean, and Atlantic, and the proportion of the population using the northern Gulf of Mexico at any given time is relatively low. Although it is known that adverse impacts occurred and numbers of animals in the Gulf of Mexico were reduced as a result of the Deepwater Horizon oil spill of 2010 (DWH), the relative proportion of the population that is expected to have been exposed to and directly impacted by the DWH event, as well as the impacts being primarily to smaller juveniles (lower reproductive value than adults and large juveniles), reduces the impact to the overall population. It is unclear what impact these losses may have caused on a population level, but it is not expected to have had a large impact on the population trajectory moving forward. However, recovery of green turtle numbers equivalent to what was lost in the northern Gulf of Mexico as a result of the spill will likely take decades of sustained efforts to reduce the existing threats and enhance survivorship of multiple life stages (DWH Trustees, 2015b).

3.3.3 Status of Kemp’s Ridley Sea Turtle

The Kemp’s ridley sea turtle was listed as endangered on December 2, 1970, under the Endangered Species Conservation Act of 1969, a precursor to the ESA. Internationally, the Kemp’s ridley is considered the most endangered sea turtle (Groombridge, 1982; TEWG, 2000; Zwinenberg, 1977).

Species Description and Distribution

The Kemp’s ridley sea turtle is the smallest of all sea turtles. Adults generally weigh less than 100 lb (45 kg) and have a carapace length of around 2.1 ft (65 cm). Adult Kemp’s ridley shells are almost as wide as they are long. Coloration changes significantly during development from the grey-black dorsum and plastron of hatchlings, a grey-black dorsum with a yellowish-white plastron as post-pelagic juveniles, and then to the lighter grey-olive carapace and cream-white or yellowish plastron of adults. There are 2 pairs of prefrontal scales on the head, 5 vertebral scutes, usually 5 pairs of costal scutes, and generally 12 pairs of marginal scutes on the carapace. In each bridge adjoining the plastron to the carapace, there are 4 scutes, each of which is perforated by a pore.

Kemp's ridley habitat largely consists of sandy and muddy areas in shallow, nearshore waters less than 120 ft (37 m) deep, although they can also be found in deeper offshore waters. These areas support the primary prey species of the Kemp's ridley sea turtle, which consist of swimming crabs, but may also include fish, jellyfish, and an array of mollusks.

The primary range of Kemp's ridley sea turtles is within the Gulf of Mexico basin, though they also occur in coastal and offshore waters of the U.S. Atlantic Ocean. Juvenile Kemp's ridley sea turtles, possibly carried by oceanic currents, have been recorded as far north as Nova Scotia. Historic records indicate a nesting range from Mustang Island, Texas, in the north to Veracruz, Mexico, in the south. Kemp's ridley sea turtles have recently been nesting along the Atlantic Coast of the United States, with nests recorded from beaches in Florida, Georgia, and the Carolinas. In 2012, the first Kemp's ridley sea turtle nest was recorded in Virginia. The Kemp's ridley nesting population had been exponentially increasing prior to the recent low nesting years, which may indicate that the population had been experiencing a similar increase. Additional nesting data in the coming years will be required to determine what the recent nesting decline means for the population trajectory.

Life History Information

Kemp's ridley sea turtles share a general life history pattern similar to other sea turtles. Females lay their eggs on coastal beaches where the eggs incubate in sandy nests. After 45-58 days of embryonic development, the hatchlings emerge and swim offshore into deeper, ocean water where they feed and grow until returning at a larger size. Hatchlings generally range from 1.65-1.89 in (42-48 mm) straight carapace length (SCL), 1.26-1.73 in (32-44 mm) in width, and 0.3-0.4 lb (15-20 g) in weight. Their return to nearshore coastal habitats typically occurs around 2 years of age (Ogren, 1989), although the time spent in the oceanic zone may vary from 1-4 years or perhaps more (TEWG 2000). Juvenile Kemp's ridley sea turtles use these nearshore coastal habitats from April through November, but they move towards more suitable overwintering habitat in deeper offshore waters (or more southern waters along the Atlantic coast) as water temperature drops.

The average rates of growth may vary by location, but generally fall within 2.2-2.9 ± 2.4 in per year (5.5-7.5 ± 6.2 cm/year) (Schmid & Barichivich, 2006; Schmid & Woodhead, 2000). Age to sexual maturity ranges greatly from 5-16 years, though NMFS et al. (2011b) determined the best estimate of age to maturity for Kemp's ridley sea turtles was 12 years. It is unlikely that most adults grow very much after maturity. While some sea turtles nest annually, the weighted mean remigration rate for Kemp's ridley sea turtles is approximately 2 years. Nesting generally occurs from April to July. Females lay approximately 2.5 nests per season with each nest containing approximately 100 eggs (Márquez M., 1994).

Population Dynamics

Of the 7 species of sea turtles in the world, the Kemp's ridley has declined to the lowest population level. Most of the population of adult females nest on the beaches of Rancho Nuevo, Mexico (Pritchard, 1969). When nesting aggregations at Rancho Nuevo were discovered in 1947, adult female populations were estimated to be in excess of 40,000 individuals (H. H. Hildebrand, 1963). By the mid-1980s, however, nesting numbers from Rancho Nuevo and adjacent Mexican beaches were below 1,000, with a low of 702 nests in 1985. Yet, nesting steadily increased through the 1990s, and then accelerated during the first decade of the twenty-first century (Figure 4), which indicates the species is recovering.

It is worth noting that when the Bi-National Kemp's Ridley Sea Turtle Population Restoration Project was initiated in 1978, only Rancho Nuevo nests were recorded. In 1988, nesting data from southern beaches at Playa Dos and Barra del Tordo were added. In 1989, data from the northern beaches of Barra Ostionales and Tepehuajes were added, and most recently in 1996, data from La Pesca and Altamira beaches were recorded. Currently, nesting at Rancho Nuevo accounts for just over 81% of all recorded Kemp's ridley nests in Mexico. Following a significant, unexplained 1-year decline in 2010, Kemp's ridley nests in Mexico increased to 21,797 in 2012 (Gladys Porter Zoo, 2013). From 2013 through 2014, there was a second significant decline, as only 16,385 and 11,279 nests were recorded, respectively. More recent data, however, indicated an increase in nesting. In 2015 there were 14,006 recorded nests, and in 2016 overall numbers increased to 18,354 recorded nests (Gladys Porter Zoo 2016). There was a record high nesting season in 2017, with 24,570 nests recorded (J. Pena, pers. comm., August 31, 2017), but nesting for 2018 declined to 17,945, with another steep drop to 11,090 nests in 2019 (Gladys Porter Zoo data, 2019). At this time, it is unclear whether the increases and declines in nesting seen over the past decade represents a population oscillating around an equilibrium point or if nesting will decline or increase in the future.

A small nesting population is also emerging in the United States, primarily in Texas, rising from 6 nests in 1996 to 42 in 2004, to a record high of 353 nests in 2017 (National Park Service data). It is worth noting that nesting in Texas has paralleled the trends observed in Mexico, characterized by a significant decline in 2010, followed by a second decline in 2013-2014, but with a rebound in 2015, the record nesting in 2017, and then a drop back down to 190 nests in 2019 (National Park Service data).

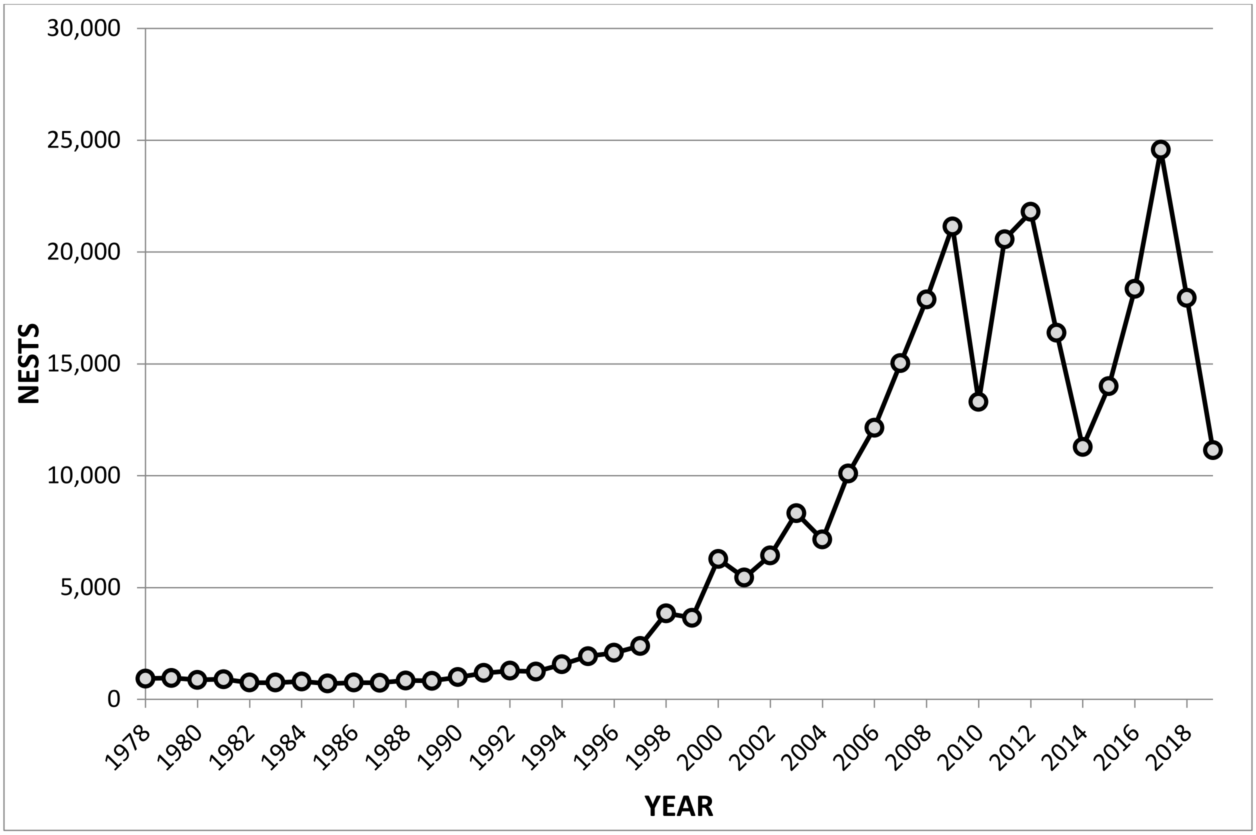

Figure 4. Kemp's ridley nest totals from Mexican beaches (Gladys Porter Zoo nesting database 2019)

Through modelling, Heppell et al. (2005) predicted the population is expected to increase at least 12-16% per year and could reach at least 10,000 females nesting on Mexico beaches by 2015. NMFS et al. (2011b) produced an updated model that predicted the population to increase 19% per year and to attain at least 10,000 females nesting on Mexico beaches by 2011. Approximately 25,000 nests would be needed for an estimate of 10,000 nesters on the beach, based on an average 2.5 nests/nesting female. While counts did not reach 25,000 nests by 2015, it is clear that the population has increased over the long term. The increases in Kemp's ridley sea turtle nesting over the last 2 decades is likely due to a combination of management measures including elimination of direct harvest, nest protection, the use of TEDs, reduced trawling effort in Mexico and the United States, and possibly other changes in vital rates (TEWG, 1998a, 2000). While these results are encouraging, the species' limited range as well as low global abundance makes it particularly vulnerable to new sources of mortality as well as demographic and environmental randomness, all factors which are often difficult to predict with any certainty. Additionally, the significant nesting declines observed in 2010 and 2013-2014 potentially indicate a serious population-level impact, and there is cause for concern regarding the ongoing recovery trajectory.

Threats

Kemp's ridley sea turtles face many of the same threats as other sea turtle species, including destruction of nesting habitat from storm events, oceanic events such as cold-stunning, pollution (plastics, petroleum products, petrochemicals, etc.), ecosystem alterations (nesting beach development, beach nourishment and shoreline stabilization, vegetation changes, etc.), poaching, global climate change, fisheries interactions, natural predation, and disease. A discussion on general sea turtle threats can be found in Section 3.3.1; the remainder of this section will expand on a few of the aforementioned threats and how they may specifically impact Kemp's ridley sea turtles.

As Kemp's ridley sea turtles continue to recover and nesting *arribadas*[4] are increasingly established, bacterial and fungal pathogens in nests are also likely to increase. Bacterial and fungal pathogen impacts have been well documented in the large arribadas of the olive ridley at Nancite in Costa Rica (Mo, 1988). In some years, and on some sections of the beach, the hatching success can be as low as 5% (Mo, 1988). As the Kemp's ridley nest density at Rancho Nuevo and adjacent beaches continues to increase, appropriate monitoring of emergence success will be necessary to determine if there are any density-dependent effects.

Since 2010, we have documented (via the Sea Turtle Stranding and Salvage Network data, https://www.fisheries.noaa.gov/national/marine-life-distress/sea-turtle-stranding-and-salvage-network) elevated sea turtle strandings in the northern Gulf of Mexico, particularly throughout the Mississippi Sound area. For example, in the first 3 weeks of June 2010, over 120 sea turtle strandings were reported from Mississippi and Alabama waters, none of which exhibited any signs of external oiling to indicate effects associated with the DWH oil spill event. A total of 644 sea turtle strandings were reported in 2010 from Louisiana, Mississippi, and Alabama waters, 561 (87%) of which were Kemp's ridley sea turtles. During March through May of 2011, 267 sea turtle strandings were reported from Mississippi and Alabama waters alone. A total of 525 sea turtle strandings were reported in 2011 from Louisiana, Mississippi, and Alabama waters, with the majority (455) having occurred from March through July, 390 (86%) of which were Kemp's ridley sea turtles. During 2012, a total of 384 sea turtles were reported from Louisiana, Mississippi, and Alabama waters. Of these reported strandings, 343 (89%) were Kemp's ridley sea turtles. During 2014, a total of 285 sea turtles were reported from Louisiana, Mississippi, and Alabama waters, though the data is incomplete. Of these reported strandings, 229 (80%) were Kemp's ridley sea turtles. These stranding numbers are significantly greater than reported in past years; Louisiana, Mississippi, and Alabama waters reported 42 and 73 sea turtle strandings for 2008 and 2009, respectively. It should be noted that stranding coverage has increased considerably due to the DWH oil spill event.

Nonetheless, considering that strandings typically represent only a small fraction of actual mortality, these stranding events potentially represent a serious impact to the recovery and survival of the local sea turtle populations. While a definitive cause for these strandings has not been identified, necropsy results indicate a significant number of stranded turtles from these events likely perished due to forced submergence, which is commonly associated with fishery interactions (B. Stacy, NMFS, pers. comm. to M. Barnette, NMFS PRD, March 2012). Yet, available information indicates fishery effort was extremely limited during the stranding events. The fact that 80% or more of all Louisiana, Mississippi, and Alabama stranded sea turtles in the past 5 years were Kemp's ridleys is notable; however, this could simply be a function of the

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[4] *Arribada* is the Spanish word for "arrival" and is the term used for massive synchronized nesting within the genus *Lepidochelys.*

species' preference for shallow, inshore waters coupled with increased population abundance, as reflected in recent Kemp's ridley nesting increases.

In response to these strandings, and due to speculation that fishery interactions may be the cause, fishery observer effort was shifted to evaluate the inshore skimmer trawl fisheries beginning in 2012. During May-July of that year, observers reported 24 sea turtle interactions in the skimmer trawl fisheries. All but a single sea turtle were identified as Kemp's ridleys (1 sea turtle was an unidentified hardshell turtle). Encountered sea turtles were all very small juvenile specimens, ranging from 7.6-19.0 in (19.4-48.3 cm) curved carapace length (CCL). Subsequent years of observation noted additional captures in the skimmer trawl fisheries, including some mortalities. The small average size of encountered Kemp's ridleys introduces a potential conservation issue, as over 50% of these reported sea turtles could potentially pass through the maximum 4-in bar spacing of TEDs currently required in the shrimp fisheries. Due to this issue, a proposed 2012 rule to require 4-in bar spacing TEDs in the skimmer trawl fisheries (77 FR 27411) was not implemented. Following additional gear testing, however, we proposed a new rule in 2016 (81 FR 91097) to require TEDs with 3-inch (in) bar spacing for all vessels using skimmer trawls, pusher-head trawls, or wing nets. Ultimately, we published a final rule on December 20, 2019 (84 FR 70048), that requires all skimmer trawl vessels 40 feet and greater in length to use TEDs designed to exclude small sea turtles in their nets effective April 1, 2021. Given the nesting trends and habitat utilization of Kemp's ridley sea turtles, it is likely that fishery interactions in the northern Gulf of Mexico may continue to be an issue of concern for the species, and one that may potentially slow the rate of recovery for Kemp's ridley sea turtles.

While oil spill impacts are discussed generally for all species in Section 3.3.1, specific impacts of the DWH oil spill event on Kemp's ridley sea turtles are considered here. Kemp's ridleys experienced the greatest negative impact stemming from the DWH oil spill event of any sea turtle species. Impacts to Kemp's ridley sea turtles occurred to offshore small juveniles, as well as large juveniles and adults. Loss of hatchling production resulting from injury to adult turtles was also estimated for this species. Injuries to adult turtles of other species, such as loggerheads, certainly would have resulted in unrealized nests and hatchlings to those species as well. Yet, the calculation of unrealized nests and hatchlings was limited to Kemp's ridleys for several reasons. All Kemp's ridleys in the Gulf belong to the same population (NMFS et al., 2011b), so total population abundance could be calculated based on numbers of hatchlings because all individuals that enter the population could reasonably be expected to inhabit the northern Gulf of Mexico throughout their lives (DWH Trustees 2016).

A total of 217,000 small juvenile Kemp's ridleys (51.5% of the total small juvenile sea turtle exposures to oil from the spill) were estimated to have been exposed to oil. That means approximately half of all small juvenile Kemp's ridleys from the total population estimate of 430,000 oceanic small juveniles were exposed to oil. Furthermore, a large number of small juveniles were removed from the population, as up to 90,300 small juveniles Kemp's ridleys are estimated to have died as a direct result of the exposure. Therefore, as much as 20% of the small oceanic juveniles of this species were killed during that year. Impacts to large juveniles (>3 years old) and adults were also high. An estimated 21,990 such individuals were exposed to oil (about 22% of the total estimated population for those age classes); of those, 3,110 mortalities were estimated (or 3% of the population for those age classes). The loss of near-reproductive and reproductive-stage females would have contributed to some extent to the decline in total nesting abundance observed between 2011 and 2014. The estimated number of unrealized Kemp's ridley nests is between 1,300 and 2,000, which translates to between approximately 65,000 and 95,000 unrealized hatchlings (DWH Trustees 2016). This is a minimum estimate, however, because the sublethal effects of the DWH oil spill event on turtles, their prey, and their habitats might have delayed or reduced reproduction in subsequent years, which may have contributed substantially to additional nesting deficits observed following the DWH oil spill event. These sublethal effects could have slowed growth and maturation rates, increased remigration intervals, and decreased clutch frequency (number of nests per female per nesting season). The nature of the DWH oil spill event effect on reduced Kemp's ridley nesting abundance and associated hatchling production after 2010 requires further evaluation. It is clear that the DWH oil spill event resulted in large losses to the Kemp's ridley population across various age classes, and likely had an important population-level effect on the species. Still, we do not have a clear understanding of those impacts on the population trajectory for the species into the future.

3.3.4 Status of Loggerhead Sea Turtle – Northwest Atlantic DPS

The loggerhead sea turtle was listed as a threatened species throughout its global range on July 28, 1978. NMFS and USFWS published a final rule which designated 9 DPSs for loggerhead sea turtles (76 FR 58868, September 22, 2011, and effective October 24, 2011). This rule listed the following DPSs: (1) Northwest Atlantic Ocean (threatened), (2) Northeast Atlantic Ocean (endangered), (3) South Atlantic Ocean (threatened), (4) Mediterranean Sea (endangered), (5) North Pacific Ocean (endangered), (6) South Pacific Ocean (endangered), (7) North Indian Ocean (endangered), (8) Southeast Indo-Pacific Ocean (endangered), and (9) Southwest Indian Ocean (threatened). The Northwest Atlantic (NWA) DPS is the only one that occurs within the action area, and therefore it is the only one considered in this Opinion.

Species Description and Distribution

Loggerheads are large sea turtles. Adults in the southeast United States average about 3 ft (92 cm) long, measured as a straight carapace length (SCL), and weigh approximately 255 lb (116 kg) (Ehrhart & Yoder, 1978). Adult and subadult loggerhead sea turtles typically have a light yellow plastron and a reddish brown carapace covered by non-overlapping scutes that meet along seam lines. They typically have 11 or 12 pairs of marginal scutes, 5 pairs of costals, 5 vertebrals, and a nuchal (precentral) scute that is in contact with the first pair of costal scutes (Dodd Jr., 1988).

The loggerhead sea turtle inhabits continental shelf and estuarine environments throughout the temperate and tropical regions of the Atlantic, Pacific, and Indian Oceans (Dodd Jr., 1988). Habitat uses within these areas vary by life stage. Juveniles are omnivorous and forage on crabs, mollusks, jellyfish, and vegetation at or near the surface (Dodd Jr., 1988). Subadult and adult loggerheads are primarily found in coastal waters and eat benthic invertebrates such as mollusks and decapod crustaceans in hard bottom habitats.

The majority of loggerhead nesting occurs at the western rims of the Atlantic and Indian Oceans concentrated in the north and south temperate zones and subtropics (NRC, 1990). For the NWA

DPS, most nesting occurs along the coast of the United States, from southern Virginia to Alabama. Additional nesting beaches for this DPS are found along the northern and western Gulf of Mexico, eastern Yucatán Peninsula, at Cay Sal Bank in the eastern Bahamas (Addison, 1997; Addison & Morford, 1996), off the southwestern coast of Cuba (Moncada Gavilan, 2001), and along the coasts of Central America, Colombia, Venezuela, and the eastern Caribbean Islands.

Non-nesting, adult female loggerheads are reported throughout the U.S. Atlantic, Gulf of Mexico, and Caribbean Sea. Little is known about the distribution of adult males who are seasonally abundant near nesting beaches. Aerial surveys suggest that loggerheads as a whole are distributed in U.S. waters as follows: 54% off the southeast U.S. coast, 29% off the northeast U.S. coast, 12% in the eastern Gulf of Mexico, and 5% in the western Gulf of Mexico (TEWG, 1998a).

Within the NWA DPS, most loggerhead sea turtles nest from North Carolina to Florida and along the Gulf Coast of Florida. Previous Section 7 analyses have recognized at least 5 western Atlantic subpopulations, divided geographically as follows: (1) a Northern nesting subpopulation, occurring from North Carolina to northeast Florida at about 29ºN; (2) a South Florida nesting subpopulation, occurring from 29°N on the east coast of the state to Sarasota on the west coast; (3) a Florida Panhandle nesting subpopulation, occurring at Eglin Air Force Base and the beaches near Panama City, Florida; (4) a Yucatán nesting subpopulation, occurring on the eastern Yucatán Peninsula, Mexico (Márquez M., 1990; TEWG, 2000); and (5) a Dry Tortugas nesting subpopulation, occurring in the islands of the Dry Tortugas, near Key West, Florida (NMFS, 2001).

The recovery plan for the Northwest Atlantic population of loggerhead sea turtles concluded that there is no genetic distinction between loggerheads nesting on adjacent beaches along the Florida Peninsula. It also concluded that specific boundaries for subpopulations could not be designated based on genetic differences alone. Thus, the recovery plan uses a combination of geographic distribution of nesting densities, geographic separation, and geopolitical boundaries, in addition to genetic differences, to identify recovery units. The recovery units are as follows: (1) the Northern Recovery Unit (Florida/Georgia border north through southern Virginia), (2) the Peninsular Florida Recovery Unit (Florida/Georgia border through Pinellas County, Florida), (3) the Dry Tortugas Recovery Unit (islands located west of Key West, Florida), (4) the Northern Gulf of Mexico Recovery Unit (Franklin County, Florida, through Texas), and (5) the Greater Caribbean Recovery Unit (Mexico through French Guiana, the Bahamas, Lesser Antilles, and Greater Antilles) (NMFS & USFWS, 2008). The recovery plan concluded that all recovery units are essential to the recovery of the species. Although the recovery plan was written prior to the listing of the NWA DPS, the recovery units for what was then termed the Northwest Atlantic population apply to the NWA DPS.

Life History Information

The Northwest Atlantic Loggerhead Recovery Team defined the following 8 life stages for the loggerhead life cycle, which include the ecosystems those stages generally use: (1) egg (terrestrial zone), (2) hatchling stage (terrestrial zone), (3) hatchling swim frenzy and transitional stage (neritic zone[5]), (4) juvenile stage (oceanic zone), (5) juvenile stage (neritic zone), (6) adult stage (oceanic zone), (7) adult stage (neritic zone), and (8) nesting female (terrestrial zone) (NMFS & USFWS, 2008). Loggerheads are long-lived animals. They reach sexual maturity between 20-38 years of age, although age of maturity varies widely among populations (Frazer & Ehrhart, 1985; NMFS, 2001). The annual mating season occurs from late March to early June, and female turtles lay eggs throughout the summer months. Females deposit an average of 4.1 nests within a nesting season (Murphy & Hopkins, 1984), but an individual female only nests every 3.7 years on average (Tucker, 2010). Each nest contains an average of 100-126 eggs (Dodd Jr., 1988) which incubate for 42-75 days before hatching (NMFS & USFWS, 2008). Loggerhead hatchlings are 1.5-2 inches long and weigh about 0.7 oz (20 g).

As post-hatchlings, loggerheads hatched on U.S. beaches enter the "oceanic juvenile" life stage, migrating offshore and becoming associated with *Sargassum* habitats, driftlines, and other convergence zones (A. F. Carr, 1986; Conant et al., 2009; B. E. Witherington, 2002). Oceanic juveniles grow at rates of 1-2 inches (2.9-5.4 cm) per year (Bjorndal, Bolten, Dellinger, Delgado, & Martins, 2003; Snover, 2002) over a period as long as 7-12 years (Alan B. Bolten et al., 1998) before moving to more coastal habitats. Studies have suggested that not all loggerhead sea turtles follow the model of circumnavigating the North Atlantic Gyre as pelagic juveniles, followed by permanent settlement into benthic environments (A. Bolten & Witherington, 2003; Laurent et al., 1998). These studies suggest some turtles may either remain in the oceanic habitat in the North Atlantic longer than hypothesized, or they move back and forth between oceanic and coastal habitats interchangeably (Witzell, 2002). Stranding records indicate that when immature loggerheads reach 15-24 in (40-60 cm) SCL, they begin to reside in coastal inshore waters of the continental shelf throughout the U.S. Atlantic and Gulf of Mexico (Witzell, 2002).

After departing the oceanic zone, neritic juvenile loggerheads in the Northwest Atlantic inhabit continental shelf waters from Cape Cod Bay, Massachusetts, south through Florida, the Bahamas, Cuba, and the Gulf of Mexico. Estuarine waters of the United States, including areas such as Long Island Sound, Chesapeake Bay, Pamlico and Core Sounds, Mosquito and Indian River Lagoons, Biscayne Bay, Florida Bay, as well as numerous embayments fringing the Gulf of Mexico, comprise important inshore habitat. Along the Atlantic and Gulf of Mexico shoreline, essentially all shelf waters are inhabited by loggerheads (Conant et al., 2009).

Like juveniles, non-nesting adult loggerheads also use the neritic zone. However, these adult loggerheads do not use the relatively enclosed shallow-water estuarine habitats with limited ocean access as frequently as juveniles. Areas such as Pamlico Sound, North Carolina, and Indian River Lagoon, Florida, are regularly used by juveniles but not by adult loggerheads. Adult loggerheads do tend to use estuarine areas with more open ocean access, such as the Chesapeake Bay in the U.S. mid-Atlantic. Shallow-water habitats with large expanses of open ocean access, such as Florida Bay, provide year-round resident foraging areas for significant numbers of male and female adult loggerheads (Conant et al., 2009).

Offshore, adults primarily inhabit continental shelf waters, from New York south through Florida, the Bahamas, Cuba, and the Gulf of Mexico. Seasonal use of mid-Atlantic shelf waters,

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[5] Neritic refers to the nearshore marine environment from the surface to the sea floor where water depths do not exceed 200 meters.

especially offshore New Jersey, Delaware, and Virginia during summer months, and offshore shelf waters, such as Onslow Bay (off the North Carolina coast), during winter months has also been documented (Hawkes, Broderick, Godfrey, & Godley, 2007) Georgia Department of Natural Resources [GADNR], unpublished data; South Carolina Department of Natural Resources [SCDNR], unpublished data). Satellite telemetry has identified the shelf waters along the west Florida coast, the Bahamas, Cuba, and the Yucatán Peninsula as important resident areas for adult female loggerheads that nest in Florida (Foley, Schroeder, & MacPherson, 2008; Girard, Tucker, & Calmettes, 2009; Hart, Lamont, Fujisaki, Tucker, & Carthy, 2012). The southern edge of the Grand Bahama Bank is important habitat for loggerheads nesting on the Cay Sal Bank in the Bahamas, but nesting females are also resident in the bights of Eleuthera, Long Island, and Ragged Islands. They also reside in Florida Bay in the United States, and along the north coast of Cuba (A. Bolten and K. Bjorndal, University of Florida, unpublished data). Moncada et al. (2010) report the recapture of 5 adult female loggerheads in Cuban waters originally flipper-tagged in Quintana Roo, Mexico, which indicates that Cuban shelf waters likely also provide foraging habitat for adult females that nest in Mexico.

Status and Population Dynamics

A number of stock assessments and similar reviews (Conant et al., 2009; Heppell, Crowder, Crouse, Epperly, & Frazer, 2003; NMFS-SEFSC, 2009; NMFS, 2001; NMFS & USFWS, 2008; TEWG, 1998a, 2000, 2009) have examined the stock status of loggerheads in the Atlantic Ocean, but none have been able to develop a reliable estimate of absolute population size.

Numbers of nests and nesting females can vary widely from year to year. Nesting beach surveys, though, can provide a reliable assessment of trends in the adult female population, due to the strong nest site fidelity of female loggerhead sea turtles, as long as such studies are sufficiently long and survey effort and methods are standardized (e.g., (NMFS & USFWS, 2008). NMFS and USFWS (2008) concluded that the lack of change in 2 important demographic parameters of loggerheads, remigration interval and clutch frequency, indicate that time series on numbers of nests can provide reliable information on trends in the female population.

Peninsular Florida Recovery Unit

The Peninsular Florida Recovery Unit (PFRU) 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 an average of 64,513 loggerhead nests per year, representing approximately 15,735 nesting females per year (NMFS & USFWS, 2008). The statewide estimated total for 2017 was 96,912 nests (FWRI nesting database).

In addition to the total nest count estimates, the Florida Fish and Wildlife Research Institute (FWRI) uses an index nesting beach survey method. The index survey uses standardized data-collection criteria to measure seasonal nesting and allow accurate comparisons between beaches and between years. This provides a better tool for understanding the nesting trends (Figure 5). FWRI performed a detailed analysis of the long-term loggerhead index nesting data (1989-2017; http://myfwc.com/research/wildlife/sea-turtles/nesting/loggerhead-trend/). Over that time period, 3 distinct trends were identified. From 1989-1998, there was a 24% increase that was followed by a sharp decline over the subsequent 9 years. A large increase in loggerhead nesting has occurred since, as indicated by the 71% increase in nesting over the 10-year period from 2007 and 2016. Nesting in 2016 also represented a new record for loggerheads on the core index beaches. FWRI examined the trend from the 1998 nesting high through 2016 and found that the decade-long post-1998 decline was replaced with a slight but nonsignificant increasing trend. Looking at the data from 1989 through 2016, FWRI concluded that there was an overall positive change in the nest counts although it was not statistically significant due to the wide variability between 2012-2016 resulting in widening confidence intervals. Nesting at the core index beaches declined in 2017 to 48,033, and rose slightly again to 48,983 in 2018 and then 53,507 in 2019, which is the 3rd highest total since 2001. However, it is important to note that with the wide confidence intervals and uncertainty around the variability in nesting parameters (changes and variability in nests/female, nesting intervals, etc.) it is unclear whether the nesting trend equates to an increase in the population or nesting females over that time frame (Ceriani, et al. 2019).

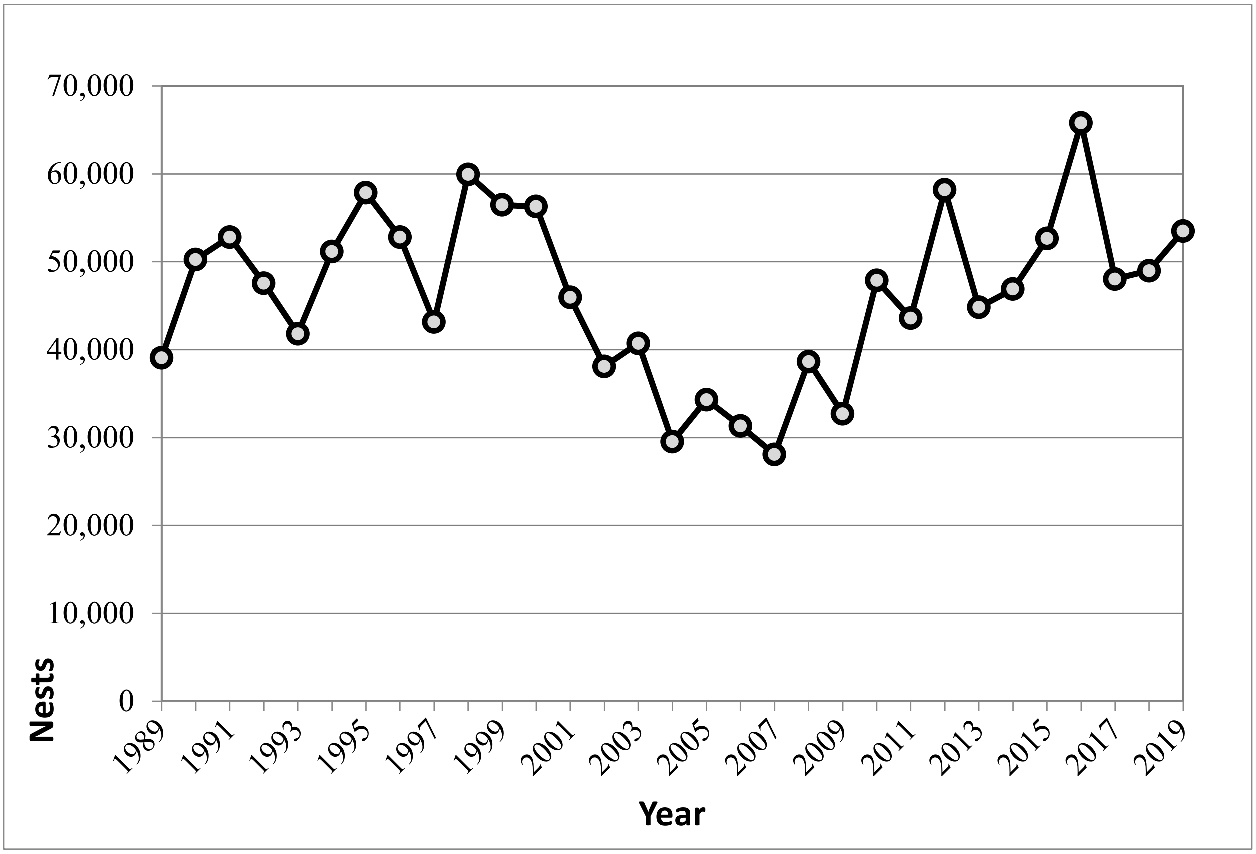

Figure 5. Loggerhead sea turtle nesting at Florida index beaches since 1989

Northern Recovery Unit

Annual nest totals from beaches within the Northern Recovery Unit (NRU) averaged 5,215 nests from 1989-2008, a period of near-complete surveys of NRU nesting beaches (GADNR unpublished data, North Carolina Wildlife Resources Commission [NCWRC] unpublished data, SCDNR unpublished data), and represent approximately 1,272 nesting females per year, assuming 4.1 nests per female (Murphy & Hopkins, 1984). The loggerhead nesting trend from daily beach surveys showed a significant decline of 1.3% annually from 1989-2008. Nest totals from aerial surveys conducted by SCDNR showed a 1.9% annual decline in nesting in South Carolina from 1980-2008. Overall, there are strong statistical data to suggest the NRU had experienced a long-term decline over that period of time.

Data since that analysis (Table 4) are showing improved nesting numbers and a departure from the declining trend. Georgia nesting has rebounded to show the first statistically significant increasing trend since comprehensive nesting surveys began in 1989 (Mark Dodd, GADNR press release, http://www.georgiawildlife.com/node/3139). South Carolina and North Carolina nesting have also begun to shift away from the past declining trend. Loggerhead nesting in Georgia, South Carolina, and North Carolina all broke records in 2015 and then topped those records again in 2016. Nesting in 2017 and 2018 declined relative to 2016, back to levels seen in 2013 to 2015, but then bounced back in 2019, breaking records for each of the three states and the overall recovery unit.

Table 4. Total Number of NRU Loggerhead Nests (GADNR, SCDNR, and NCWRC nesting datasets compiled at Seaturtle.org)

	Nests Recorded			
Year	**Georgia**	**South Carolina**	**North Carolina**	**Totals**
2008	1,649	4,500	841	**6,990**
2009	998	2,182	302	**3,472**
2010	1,760	3,141	856	**5,757**
2011	1,992	4,015	950	**6,957**
2012	2,241	4,615	1,074	**7,930**
2013	2,289	5,193	1,260	**8,742**
2014	1,196	2,083	542	**3,821**
2015	2,319	5,104	1,254	**8,677**
2016	3,265	6,443	1,612	**11,320**
2017	2,155	5,232	1,195	**8,582**
2018	1,735	2,762	765	**5,262**
2019	3,945	8,774	2,291	**15,010**

South Carolina also conducts an index beach nesting survey similar to the one described for Florida. Although the survey only includes a subset of nesting, the standardized effort and locations allow for a better representation of the nesting trend over time. Increases in nesting were seen for the period from 2009-2013, with a subsequent steep drop in 2014. Nesting then rebounded in 2015 and 2016, setting new highs each of those years. Nesting in 2017 dropped back down from the 2016 high, but was still the second highest on record (Figure 6).

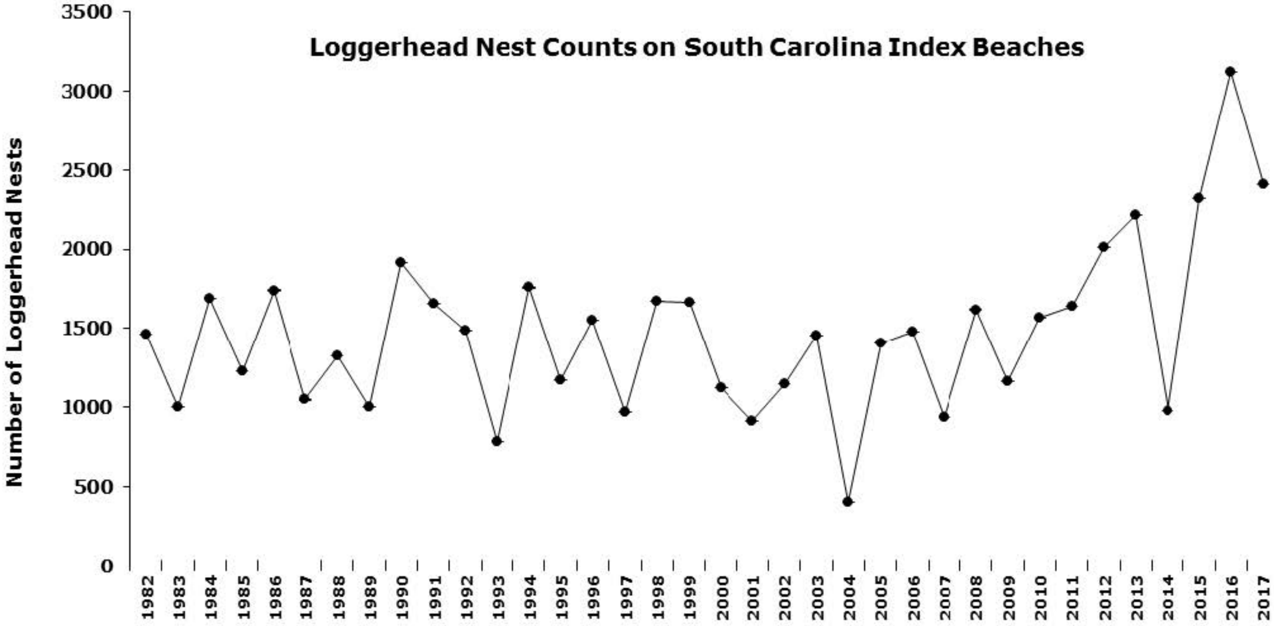

Figure 6. South Carolina index nesting beach counts for loggerhead sea turtles (from the SCDNR website: http://www.dnr.sc.gov/seaturtle/nest.htm)

Other Northwest Atlantic DPS Recovery Units

The remaining 3 recovery units—Dry Tortugas (DTRU), Northern Gulf of Mexico (NGMRU), and Greater Caribbean (GCRU)—are much smaller nesting assemblages, but they are still considered essential to the continued existence of the species. Nesting surveys for the DTRU are conducted as part of Florida's statewide survey program. Survey effort was relatively stable during the 9-year period from 1995-2004, although the 2002 year was missed. Nest counts ranged from 168-270, with a mean of 246, but there was no detectable trend during this period (NMFS & USFWS, 2008). Nest counts for the NGMRU are focused on index beaches rather than all beaches where nesting occurs. Analysis of the 12-year dataset (1997-2008) of index nesting beaches in the area shows a statistically significant declining trend of 4.7% annually. Nesting on the Florida Panhandle index beaches, which represents the majority of NGMRU nesting, had shown a large increase in 2008, but then declined again in 2009 and 2010 before rising back to a level similar to the 2003-2007 average in 2011. Nesting survey effort has been inconsistent among the GCRU nesting beaches, and no trend can be determined for this subpopulation (NMFS & USFWS, 2008). Zurita et al. (2003) found a statistically significant increase in the number of nests on 7 of the beaches on Quintana Roo, Mexico, from 1987-2001, where survey effort was consistent during the period. Nonetheless, nesting has declined since 2001, and the previously reported increasing trend appears to not have been sustained (NMFS & USFWS, 2008).

In-water Trends

Nesting data are the best current indicator of sea turtle population trends, but in-water data also provide some insight. In-water research suggests the abundance of neritic juvenile loggerheads is steady or increasing. Although Ehrhart et al. (2007) found no significant regression-line trend in a long-term dataset, researchers have observed notable increases in catch per unit effort (CPUE) (Arendt et al., 2009; Ehrhart et al., 2007; Epperly, Braun-McNeill, & Richards, 2007). Researchers believe that this increase in CPUE is likely linked to an increase in juvenile abundance, although it is unclear whether this increase in abundance represents a true population increase among juveniles or merely a shift in spatial occurrence. Bjorndal, Bolten, and Chaloupka (2005), cited in NMFS and USFWS (2008), caution about extrapolating localized in-water trends to the broader population and relating localized trends in neritic sites to population trends at nesting beaches. The apparent overall increase in the abundance of neritic loggerheads in the southeastern United States may be due to increased abundance of the largest oceanic/neritic juveniles (historically referred to as small benthic juveniles), which could indicate a relatively large number of individuals around the same age may mature in the near future (TEWG, 2009). In-water studies throughout the eastern United States, however, indicate a substantial decrease in the abundance of the smallest oceanic/neritic juvenile loggerheads, a pattern corroborated by stranding data (TEWG, 2009).

Population Estimate

The NMFS Southeast Fisheries Science Center developed a preliminary stage/age demographic model to help determine the estimated impacts of mortality reductions on loggerhead sea turtle population dynamics (NMFS-SEFSC, 2009). The model uses the range of published information for the various parameters including mortality by stage, stage duration (years in a stage), and fecundity parameters such as eggs per nest, nests per nesting female, hatchling emergence success, sex ratio, and remigration interval. Resulting trajectories of model runs for each individual recovery unit, and the western North Atlantic population as a whole, were found to be very similar. The model run estimates from the adult female population size for the western North Atlantic (from the 2004-2008 time frame), suggest the adult female population size is approximately 20,000-40,000 individuals, with a low likelihood of females' numbering up to 70,000 (NMFS-SEFSC, 2009). A less robust estimate for total benthic females in the western North Atlantic was also obtained, yielding approximately 30,000-300,000 individuals, up to less than 1 million (NMFS-SEFSC, 2009). A preliminary regional abundance survey of loggerheads within the northwestern Atlantic continental shelf for positively identified loggerhead in all strata estimated about 588,000 loggerheads (interquartile range of 382,000-817,000). When correcting for unidentified turtles in proportion to the ratio of identified turtles, the estimate increased to about 801,000 loggerheads (interquartile range of 521,000-1,111,000) (NMFS-NEFSC, 2011).

Threats (Specific to Loggerhead Sea Turtles)

The threats faced by loggerhead sea turtles are well summarized in the general discussion of threats in Section 3.3.1. Yet the impact of fishery interactions is a point of further emphasis for this species. The joint NMFS and USFWS Loggerhead Biological Review Team determined that the greatest threats to the NWA DPS of loggerheads result from cumulative fishery bycatch in neritic and oceanic habitats (Conant et al., 2009).

Regarding the impacts of pollution, loggerheads may be particularly affected by organochlorine contaminants; they have the highest organochlorine concentrations (Storelli, Barone, Storelli, & Marcotrigiano, 2008) and metal loads (D'Ilio, Mattei, Blasi, Alimonti, & Bogialli, 2011) in sampled tissues among the sea turtle species. It is thought that dietary preferences were likely to be the main differentiating factor among sea turtle species. Storelli et al. (2008) analyzed tissues from stranded loggerhead sea turtles and found that mercury accumulates in sea turtle livers while cadmium accumulates in their kidneys, as has been reported for other marine organisms like dolphins, seals, and porpoises (Law et al., 1991).

While oil spill impacts are discussed generally for all species in Section 3.3.1, specific impacts of the DWH oil spill event on loggerhead sea turtles are considered here. Impacts to loggerhead sea turtles occurred to offshore small juveniles as well as large juveniles and adults. A total of 30,800 small juvenile loggerheads (7.3% of the total small juvenile sea turtle exposures to oil from the spill) were estimated to have been exposed to oil. Of those exposed, 10,700 small juveniles are estimated to have died as a result of the exposure. In contrast to small juveniles, loggerheads represented a large proportion of the adults and large juveniles exposed to and killed by the oil. There were 30,000 exposures (almost 52% of all exposures for those age/size classes) and 3,600 estimated mortalities. A total of 265 nests (27,618 eggs) were also translocated during response efforts, with 14,216 hatchlings released, the fate of which is unknown (DWH Trustees, 2015b). Additional unquantified effects may have included inhalation of volatile compounds, disruption of foraging or migratory movements due to surface or subsurface oil, ingestion of prey species contaminated with oil and/or dispersants, and loss of foraging resources which could lead to compromised growth and/or reproductive potential. There is no information currently available to determine the extent of those impacts, if they occurred.

Unlike Kemp’s ridleys, the majority of nesting for the NWA DPS occurs on the Atlantic coast and, thus, loggerheads were impacted to a relatively lesser degree. However, it is likely that impacts to the NGMRU of the NWA DPS would be proportionally much greater than the impacts occurring to other recovery units. Impacts to nesting and oiling effects on a large proportion of the NGMRU recovery unit, especially mating and nesting adults likely had an impact on the NGMRU. Based on the response injury evaluations for Florida Panhandle and Alabama nesting beaches (which fall under the NFMRU), the DWH Trustees (2016) estimated that approximately 20,000 loggerhead hatchlings were lost due to DWH oil spill response activities on nesting beaches. Although the long-term effects remain unknown, the DWH oil spill event impacts to the Northern Gulf of Mexico Recovery Unit may result in some nesting declines in the future due to a large reduction of oceanic age classes during the DWH oil spill event. Although adverse impacts occurred to loggerheads, the proportion of the population that is expected to have been exposed to and directly impacted by the DWH oil spill event is relatively low. Thus we do not believe a population-level impact occurred due to the widespread distribution and nesting location outside of the Gulf of Mexico for this species.

Specific information regarding potential climate change impacts on loggerheads is also available. Modeling suggests an increase of 2°C in air temperature would result in a sex ratio of over 80% female offspring for loggerheads nesting near Southport, North Carolina. The same increase in air temperatures at nesting beaches in Cape Canaveral, Florida, would result in close to 100% female offspring. Such highly skewed sex ratios could undermine the reproductive capacity of the species. More ominously, an air temperature increase of 3°C is likely to exceed the thermal threshold of most nests, leading to egg mortality (Hawkes et al., 2007). Warmer sea surface temperatures have also been correlated with an earlier onset of loggerhead nesting in the spring (Hawkes et al., 2007; John F. Weishampel, Bagley, & Ehrhart, 2004), short inter-nesting intervals (Hays et al., 2002), and shorter nesting seasons (Pike, Antworth, & Stiner, 2006).

3.3.5 Status of Hawksbill Sea Turtle

The hawksbill sea turtle was listed as endangered throughout its entire range on June 2, 1970 (35 FR 8491), under the Endangered Species Conservation Act of 1969, a precursor to the ESA. Critical habitat was designated on June 2, 1998, in coastal waters surrounding Mona and Monito Islands in Puerto Rico (63 FR 46693).

Species Description and Distribution

Hawksbill sea turtles are small- to medium-sized (99-150 lb on average [45-68 kg]) although females nesting in the Caribbean are known to weigh up to 176 lb (80 kg) (Pritchard et al., 1983). The carapace is usually serrated and has a “tortoise-shell” coloring, ranging from dark to golden brown, with streaks of orange, red, and/or black. The plastron of a hawksbill turtle is typically yellow. The head is elongated and tapers to a point, with a beak-like mouth that gives the species its name. The shape of the mouth allows the hawksbill turtle to reach into holes and crevices of coral reefs to find sponges, their primary adult food source, and other invertebrates. The shells of hatchlings are 1.7 in (42 mm) long, are mostly brown, and are somewhat heart-shaped (K. L. Eckert, 1995; Hillis & Mackay, 1989; R. van Dam & Sarti, 1989).

Hawksbill sea turtles have a circumtropical distribution and usually occur between latitudes 30°N and 30°S in the Atlantic, Pacific, and Indian Oceans. In the western Atlantic, hawksbills are widely distributed throughout the Caribbean Sea, off the coasts of Florida and Texas in the continental United States, in the Greater and Lesser Antilles, and along the mainland of Central America south to Brazil (Amos, 1989; Groombridge & Luxmoore, 1989; Lund, 1985; A. Meylan & Donnelly, 1999; NMFS & USFWS, 1998; P. Plotkin & Amos, 1990; P. T. Plotkin & Amos, 1988). They are highly migratory and use a wide range of habitats during their lifetimes (J. A. Musick & Limpus, 1997; P. T. Plotkin, 2003). Adult hawksbill sea turtles are capable of migrating long distances between nesting beaches and foraging areas. For instance, a female hawksbill sea turtle tagged at Buck Island Reef National Monument (BIRNM) in St. Croix was later identified 1,160 miles (1,866 km) away in the Miskito Cays in Nicaragua (Spotila, 2004).

Hawksbill sea turtles nest on sandy beaches throughout the tropics and subtropics. Nesting occurs in at least 70 countries, although much of it now only occurs at low densities compared to that of other sea turtle species (NMFS and USFWS 2007b). A. Meylan and Donnelly (1999) believe that the widely dispersed nesting areas and low nest densities is likely a result of overexploitation of previously large colonies that have since been depleted over time. The most significant nesting within the United States occurs in Puerto Rico and the U.S. Virgin Islands, specifically on Mona Island and BIRNM, respectively. Although nesting within the continental United States is typically rare, it can occur along the southeast coast of Florida and the Florida Keys. The largest hawksbill nesting population in the western Atlantic occurs in the Yucatán

Peninsula of Mexico, where several thousand nests are recorded annually in the states of Campeche, Yucatán, and Quintana Roo (Garduño-Andrade, Guzmán, Miranda, Briseño-Dueñas, & Abreu-Grobois, 1999; Spotila, 2004). In the U.S. Pacific, hawksbills nest on main island beaches in Hawaii, primarily along the east coast of the island. Hawksbill nesting has also been documented in American Samoa and Guam. More information on nesting in other ocean basins may be found in the 5-year status review for the species (NMFS & USFWS, 2007b).

Mitochondrial DNA studies show that reproductive populations are effectively isolated over ecological time scales (Bass et al., 1996). Substantial efforts have been made to determine the nesting population origins of hawksbill sea turtles assembled in foraging grounds, and genetic research has shown that hawksbills of multiple nesting origins commonly mix in foraging areas (B. W. Bowen & Witzell, 1996). Since hawksbill sea turtles nest primarily on the beaches where they were born, if a nesting population is decimated, it might not be replenished by sea turtles from other nesting rookeries (Bass et al., 1996).

Life History Information

Hawksbill sea turtles exhibit slow growth rates although they are known to vary within and among populations from a low of 0.4-1.2 in (1-3 cm) per year, measured in the Indo-Pacific (M. Y. Chaloupka & Limpus, 1997; J. A. Mortimer et al., 2003; J. A. Mortimer, Day, & Broderick, 2002; Whiting, 2000), to a high of 2 in (5 cm) or more per year, measured at some sites in the Caribbean (Carlos E. Diez & Van Dam, 2002; León & Diez, 1999). Differences in growth rates are likely due to differences in diet and/or density of sea turtles at foraging sites and overall time spent foraging (Bjorndal & Bolten, 2002; Milani Chaloupka, Limpus, & Miller, 2004). Consistent with slow growth, age to maturity for the species is also long, taking between 20 and 40 years, depending on the region (M. Y. Chaloupka & Musick, 1997; Colin J. Limpus & Miller, 2000). Hawksbills in the western Atlantic are known to mature faster (i.e., 20 or more years) than sea turtles found in the Indo-Pacific (i.e., 30-40 years) (Boulan, 1983; Boulon Jr., 1994; Carlos E. Diez & Van Dam, 2002; Colin J. Limpus & Miller, 2000). Males are typically mature when their length reaches 27 in (69 cm), while females are typically mature at 30 in (75 cm) (Karen L. Eckert, Overing, & Lettsome, 1992; C. J. Limpus, 1992).

Female hawksbills return to the beaches where they were born (natal beaches) every 2-3 years to nest (R. Van Dam, Sarti M., & Pares J., 1991; Witzell, 1983) and generally lay 3-5 nests per season (Richardson, Bell, & Richardson, 1999). Compared with other sea turtles, the number of eggs per nest (clutch) for hawksbills can be quite high. The largest clutches recorded for any sea turtle belong to hawksbills (approximately 250 eggs per nest) ((Hirth & Latif, 1980), though nests in the U.S. Caribbean and Florida more typically contain approximately 140 eggs (USFWS hawksbill fact sheet, http://www.fws.gov/northflorida/SeaTurtles/Turtle%20Factsheets/hawksbill-sea-turtle.htm). Eggs incubate for approximately 60 days before hatching (USFWS hawksbill fact sheet). Hatchling hawksbill sea turtles typically measure 1-2 in (2.5-5 cm) in length and weigh approximately 0.5 oz (15 g).

Hawksbills may undertake developmental migrations (migrations as immatures) and reproductive migrations that involve travel over many tens to thousands of miles (A. B. Meylan, 1999a). Post-hatchlings (oceanic stage juveniles) are believed to live in the open ocean, taking shelter in floating algal mats and drift lines of flotsam and jetsam in the Atlantic and Pacific oceans (J. A. Musick & Limpus, 1997) before returning to more coastal foraging grounds. In the Caribbean, hawksbills are known to almost exclusively feed on sponges (A. Meylan, 1988; R. P. Van Dam & Diez, 1997), although at times they have been seen foraging on other food items, notably corallimorphs and zooanthids (León & Diez, 2000; Mayor, Phillips, & Hillis-Starr, 1998; R. P. Van Dam & Diez, 1997).

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

Status and Population Dynamics

There are currently no reliable estimates of population abundance and trends for non-nesting hawksbills at the time of this consultation; therefore, nesting beach data is currently the primary information source for evaluating trends in global abundance. Most hawksbill populations around the globe are either declining, depleted, and/or remnants of larger aggregations (NMFS & USFWS, 2007b). The largest nesting population of hawksbills occurs in Australia where approximately 2,000 hawksbills nest off the northwest coast and about 6,000-8,000 nest off the Great Barrier Reef each year (Spotila, 2004). Additionally, about 2,000 hawksbills nest each year in Indonesia and 1,000 nest in the Republic of Seychelles (Spotila, 2004). In the United States, hawksbills typically laid about 500-1,000 nests on Mona Island, Puerto Rico in the past (Carlos E. Diez & Van Dam, 2007), but the numbers appear to be increasing, as the Puerto Rico Department of Natural and Environmental Resources counted nearly 1,600 nests in 2010 (PRDNER nesting data). Another 56-150 nests are typically laid on Buck Island off St. Croix (A. B. Meylan, 1999b; Jeanne A. Mortimer & Donnelly, 2008). Nesting also occurs to a lesser extent on beaches on Culebra Island and Vieques Island in Puerto Rico, the mainland of Puerto Rico, and additional beaches on St. Croix, St. John, and St. Thomas, U.S. Virgin Islands.

Mortimer and Donnelly (2008) reviewed nesting data for 83 nesting concentrations organized among 10 different ocean regions (i.e., Insular Caribbean, Western Caribbean Mainland, Southwestern Atlantic Ocean, Eastern Atlantic Ocean, Southwestern Indian Ocean, Northwestern Indian Ocean, Central Indian Ocean, Eastern Indian Ocean, Western Pacific Ocean, Central Pacific Ocean, and Eastern Pacific Ocean). They determined historic trends (i.e., 20-100 years ago) for 58 of the 83 sites, and also determined recent abundance trends (i.e., within the past 20 years) for 42 of the 83 sites. Among the 58 sites where historic trends could be determined, all showed a declining trend during the long-term period. Among the 42 sites where recent (past 20 years) trend data were available, 10 appeared to be increasing, 3 appeared to be stable, and 29 appeared to be decreasing. With respect to regional trends, nesting populations in the Atlantic (especially in the Insular Caribbean and Western Caribbean Mainland) are generally doing better than those in the Indo-Pacific regions. For instance, 9 of the 10 sites that showed recent increases are located in the Caribbean. Buck Island and St. Croix's East End beaches support 2 remnant populations of between 17-30 nesting females per season (Hillis & Mackay, 1989; Mackay, 2006). While the proportion of hawksbills nesting on Buck Island represents a small proportion of the total hawksbill nesting occurring in the greater Caribbean region, Mortimer and Donnelly (2008) report an increasing trend in nesting at that site based on data collected from 2001-2006. The conservation measures implemented when BIRNM was expanded in 2001 most likely explains this increase.

Nesting concentrations in the Pacific Ocean appear to be performing the worst of all regions despite the fact that the region currently supports more nesting hawksbills than either the Atlantic or Indian Oceans (Jeanne A. Mortimer & Donnelly, 2008). While still critically low in numbers, sightings of hawksbills in the eastern Pacific appear to have been increasing since 2007, though some of that increase may be attributable to better observations (Gaos et al. 2010). More information about site-specific trends can be found in the most recent 5-year status review for the species (NMFS & USFWS, 2007b).

Threats

Hawksbills are currently subjected to the same suite of threats on both nesting beaches and in the marine environment that affect other sea turtles (e.g., interaction with federal and state fisheries, coastal construction, oil spills, climate change affecting sex ratios) as discussed in Section 3.3.1. There are also specific threats that are of special emphasis, or are unique, for hawksbill sea turtles discussed in further detail below.

While oil spill impacts are discussed generally for all species in Section 3.3.1, specific impacts of the DWH spill on hawksbill turtles have been estimated. Hawksbills made up 2.2% (8,850) of small juvenile sea turtle (of those that could be identified to species) exposures to oil in offshore areas, with an estimate of 615 to 3,090 individuals dying as a result of the direct exposure (DWH Trustees, 2015b). No quantification of large benthic juveniles or adults was made. Additional unquantified effects may have included inhalation of volatile compounds, disruption of foraging or migratory movements due to surface or subsurface oil, ingestion of prey species contaminated with oil and/or dispersants, and loss of foraging resources which could lead to compromised growth and/or reproductive potential. There is no information currently available to determine the extent of those impacts, if they occurred. Although adverse impacts occurred to hawksbills, the relative proportion of the population that is expected to have been exposed to and directly impacted by the DWH event is relatively low, and thus a population-level impact is not believed to have occurred due to the widespread distribution and nesting location outside of the Gulf of Mexico for this species.

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

The continuing demand for the hawksbills' shells as well as other products derived from the species (e.g., leather, oil, perfume, and cosmetics) represents an ongoing threat to its recovery. The British Virgin Islands, Cayman Islands, Cuba, Haiti, and the Turks and Caicos Islands (United Kingdom) all permit some form of legal take of hawksbill sea turtles. In the northern Caribbean, hawksbills continue to be harvested for their shells, which are often carved into hair clips, combs, jewelry, and other trinkets (Márquez M., 1990; Stapleton & Stapleton, 2006). Additionally, hawksbills are harvested for their eggs and meat, while whole, stuffed sea turtles are sold as curios in the tourist trade. Hawksbill sea turtle products are openly available in the Dominican Republic and Jamaica, despite a prohibition on harvesting hawksbills and their eggs (Fleming, 2001). Up to 500 hawksbills per year from 2 harvest sites within Cuba were legally captured each year until 2008 when the Cuban government placed a voluntary moratorium on the sea-turtle fishery (Carillo, Webb, & Manolis, 1999; Jeanne A. Mortimer & Donnelly, 2008). While current nesting trends are unknown, the number of nesting females is suspected to be declining in some areas (Carillo et al., 1999; Moncada, Carrillo, Saenz, & Nodarse, 1999). International trade in the shell of this species is prohibited between countries that have signed the Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES), but illegal trade still occurs and remains an ongoing threat to hawksbill survival and recovery throughout its range.

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

3.4 Status of Smalltooth Sawfish

The U.S. DPS of smalltooth sawfish was listed as endangered under the ESA effective May 1, 2003 (68 FR 15674; April 1, 2003).

Species Description and Distribution

The smalltooth sawfish is a tropical marine and estuarine elasmobranch. It is a batoid with a long, narrow, flattened, rostral blade (rostrum) lined with a series of transverse teeth along either edge. In general, smalltooth sawfish inhabit shallow coastal waters of the Atlantic Ocean (Dulvy et al., 2016) and feed on a variety of fish (e.g., mullet, jacks, and ladyfish)(G. R. Poulakis et al., 2017; Colin A. Simpfendorfer, 2001).

Although this species is reported throughout the tropical Atlantic, NMFS identified smalltooth sawfish from the Southeast United States as a distinct population segment (DPS), due to the physical isolation of this population from others, the differences in international management of the species, and the significance of the U.S. population in relation to the global range of the species (see 68 FR15674). Within the United States, smalltooth sawfish have historically been captured in estuarine and coastal waters from North Carolina southward through Texas, although peninsular Florida has been the region of the United States with the largest number of recorded captures (NMFS, 2018). Recent records indicate there is a resident reproducing population of smalltooth sawfish in south and southwest Florida from Charlotte Harbor through the Florida Keys, which is also the last U.S. stronghold for the species (Gregg R. Poulakis & Seitz, 2004; Seitz & Poulakis, 2002; Colin A. Simpfendorfer & Wiley, 2005). Water temperatures (no lower than 8-12°C) and the availability of appropriate coastal habitat (shallow, euryhaline waters and red mangroves) are the major environmental constraints limiting the northern movements of smalltooth sawfish in the western North Atlantic. Most specimens captured along the Atlantic coast north of Florida are large juveniles or adults (over 10 ft) that likely represent seasonal migrants, wanderers, or colonizers from a historical Florida core population to the south, rather than being members of a continuous, even-density population (Bigelow & Schroeder, 1953).

Life History Information

Smalltooth sawfish mate in the spring and early summer (Grubbs unpubl. data; Poulakis unpubl. data). Fertilization is internal and females give birth to live young. Evidence suggests a gestation period of approximately 12 months and females produce litters of 7-14 young (Feldheim, Fields, Chapman, Scharer, & Poulakis, 2017)(Gelsleichter unpub. data). Females have a biennial reproductive cycle (Feldheim et al., 2017) and parturition (act of giving birth) occurs nearly year round though peaking in spring and early summer (March – July) (G. Poulakis, Stevens, A. Timmers, R. Wiley, & Simpfendorfer, 2011)(Carlson unpubl. data). Smalltooth sawfish are approximately 26-31 in (64-80 cm) at birth (Dana M. Bethea, Smith, & Carlson, 2012; G. Poulakis et al., 2011) and may grow to a maximum length of approximately 16 ft (500 cm) (Grubbs unpubl. data (Brame et al., 2019). C. Simpfendorfer, Poulakis, M. O'Donnell, and R. Wiley (2008) report rapid juvenile growth for smalltooth sawfish for the first 2 years after birth, with stretched total length increasing by an average of 25-33 in (65-85 cm) in the first year and an average of 19-27 in (48-68 cm) in the second year. Uncertainty remains in estimating post-juvenile growth rates and age at maturity; yet, recent advances indicate maturity at 7-11 years (John K. Carlson & Simpfendorfer, 2015) at lengths of approximately 340 cm for males and 350-370 cm for females (Gelsleichter unpub data).

There are distinct differences in habitat use based on life history stage as the species shifts use through ontogeny. Juvenile smalltooth sawfish less than 220 cm, inhabit the shallow euryhaline waters (i.e., variable salinity) of estuaries and can be found in sheltered bays, dredged canals, along banks and sandbars, and in rivers (NMFS, 2000). These juveniles are often closely associated with muddy or sandy substrates, and shorelines containing red mangroves, *Rhizophora mangle* (Lisa D. Hollensead, Grubbs, Carlson, & Bethea, 2016; L. D. Hollensead, Grubbs, Carlson, & Bethea, 2018; G. Poulakis et al., 2011; Gregg R. Poulakis, Stevens, Timmers, Stafford, & Simpfendorfer, 2013; Colin A. Simpfendorfer, 2001; C.A. Simpfendorfer, 2003; Colin A. Simpfendorfer, Wiley, & Yeiser, 2010). (Colin A. Simpfendorfer et al., 2010) indicated the smallest juveniles (young-of-the-year juveniles measuring < 100 cm in length) generally used the shallowest water (depths less than 0.5 m (1.64 ft)), had small home ranges (4,264-4,557 m^2), and exhibited high levels of site fidelity. Although small juveniles exhibit high levels of site fidelity for specific nursery habitats for periods of time lasting up to 3 months (Wiley & Simpfendorfer, 2007), they do undergo small movements coinciding with changing tidal stages. These movements often involve moving from shallow sandbars at low tide to within red mangrove prop roots at higher tides (Colin A. Simpfendorfer et al., 2010)—behavior likely to reduce the risk of predation (C. A. Simpfendorfer, 2006). As juveniles increase in size, they begin to expand their home ranges (Colin A. Simpfendorfer et al., 2010; Colin A. Simpfendorfer et al., 2011), eventually moving to more offshore habitats where they likely feed on larger prey as they continue to mature.

Researchers have identified several areas within the Charlotte Harbor Estuary that are disproportionately more important to juvenile smalltooth sawfish, based on intra- or inter-annual (within or between year) capture rates during random sampling events within the estuary (G. Poulakis et al., 2011; Gregg R. Poulakis, 2012). These high-use areas were termed “hotspots” and also correspond with areas where public encounters are most frequently reported. Use of these “hotspots” can vary within and among years based on the amount and timing of freshwater inflow. Juvenile smalltooth sawfish use hotspots further upriver during high salinity conditions (drought) and areas closer to the mouth of the Caloosahatchee River during times of high freshwater inflow (G. Poulakis et al., 2011). At this time, researchers are unsure what specific biotic or abiotic factors influence this habitat use, but they believe a variety of conditions in addition to salinity, such as temperature, dissolved oxygen, water depth, shoreline vegetation, and food availability, may influence habitat selection (G. Poulakis et al., 2011).

The juvenile “hotspots” may be of further significance following the findings of female philopatry (Feldheim et al., 2017). More specifically, Feldheim et al. (2017) found that female sawfish return to the same parturition (birthing) sites over multiple years (parturition site fidelity). NMFS expects that these parturition sites align closely with the juvenile “hotspots” given the high fidelity shown by the smallest size/age classes of sawfish to specific nursery areas. Therefore, disturbance of these nursery areas could have wide-ranging effects on the sawfish population if it were to disrupt future parturition.

While adult smalltooth sawfish may also use the estuarine habitats used by juveniles, they are commonly observed in deeper waters along the coasts. Gregg R. Poulakis and Seitz (2004) noted that nearly half of the encounters with adult-sized smalltooth sawfish in Florida Bay and the Florida Keys occurred in depths from 200-400 ft (70-122 m) of water. Similarly, Colin A. Simpfendorfer and Wiley (2005) reported encounters in deeper waters off the Florida Keys, and observations from both commercial longline fishing vessels and fishery-independent sampling in the Florida Straits report large smalltooth sawfish in depths up to 130 ft (~40 m)(ISED, 2014). Yet, current field studies show adult smalltooth sawfish also use shallow estuarine habitats within Florida Bay and the Everglades (Grubbs unpub. data). Further, NMFS expects that females return to shallow estuaries during parturition (when adult females return to shallow estuaries to give birth).

Status and Population Dynamics

Based on the contraction of the species' geographic range, we expect that the population to be a fraction of its historical size. However, few long-term abundance data exist for the smalltooth sawfish, making it very difficult to estimate the current population size. Despite the lack of scientific data, recent encounters with young-of-the-year, older juveniles, and sexually mature smalltooth sawfish indicate that the U.S. population is currently reproducing (Feldheim et al., 2017; Seitz & Poulakis, 2002; C.A. Simpfendorfer, 2003). The abundance of juveniles publically encountered by anglers and boaters, including very small individuals, suggests that the population remains viable (Colin A. Simpfendorfer & Wiley, 2004), and data analyzed from Everglades National Park as part of an established fisheries-dependent monitoring program (angler interviews) indicated a slightly increasing trend in juvenile abundance within the Park over the past decade (J. K. Carlson & Osborne, 2012; John K. Carlson, Osborne, & Schmidt, 2007). Similarly, preliminary results of juvenile smalltooth sawfish sampling programs in both ENP and Charlotte Harbor indicate the juvenile population is at least stable and possibly increasing (Poulakis unpubl. data, Carlson unpubl. data).

Using a demographic approach and life history data for smalltooth sawfish and similar species from the literature, (Colin A. Simpfendorfer, 2000) estimated intrinsic rates of natural population increase for the species at 0.08-0.13 per year and population doubling times from 5.4-8.5 years. These low intrinsic rates[6] of population increase, suggest that the species is particularly vulnerable to excessive mortality and rapid population declines, after which recovery may take decades. John K. Carlson and Simpfendorfer (2015) constructed an age-structured Leslie matrix model for the U.S. population of smalltooth sawfish, using updated life history information, to determine the species' ability to recover under scenarios of variable life history inputs and the effects of bycatch mortality and catastrophes. As expected, population growth was highest (λ=1.237 yr-1) when age-at-maturity was 7 yr and decreased to 1.150 yr-1 when age-at-maturity was 11 yr. Despite a high level of variability throughout the model runs, in the absence of fishing mortality or catastrophic climate effects, the population grew at a relatively rapid rate approaching carrying capacity in 40 years when the initial population was set at 2250 females or 50 years with an initial population of 600 females. John K. Carlson and Simpfendorfer (2015) concluded that smalltooth sawfish in U.S. waters appear to have the ability to recover within the foreseeable future based on a model relying upon optimistic estimates of population size, lower age-at-maturity and the lower level of fisheries-related mortality. Another analysis was less optimistic based on lower estimates of breeding females in the Caloosahatchee River nursery (Chapman unpubl. data). Assuming similar numbers of females among the 5 known nurseries, that study would suggest an initial breeding population of only 140-390 females, essentially half of the initial population considered by John K. Carlson and Simpfendorfer (2015). A smaller initial breeding population would extend the time to reach carrying capacity.

Threats

Past literature indicates smalltooth sawfish were once abundant along both coasts of Florida and quite common along the shores of Texas and the northern Gulf coast (NMFS, 2010 and citations therein). Based on recent comparisons with these historical reports, the U.S. DPS of smalltooth sawfish has declined over the past century(Colin A. Simpfendorfer, 2001, 2002). The decline in

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[6] The rate at which a population increases in size if there are no density-dependent forces regulating the population

smalltooth sawfish abundance has been attributed to several factors including bycatch mortality in fisheries, habitat loss, and life history limitations of the species (NMFS, 2010).

Bycatch Mortality

Bycatch mortality is cited as the primary cause for the decline in smalltooth sawfish in the United States (NMFS, 2010). While there has never been a large-scale directed fishery, smalltooth sawfish easily become entangled in fishing gears (gill nets, otter trawls, trammel nets, and seines) directed at other commercial species, often resulting in serious injury or death (NMFS, 2009). This has historically been reported in Florida (Snelson & Williams, 1981), Louisiana (Colin A. Simpfendorfer, 2002), and Texas (Baughman, 1943). For instance, one fisherman interviewed by Evermann and Bean (1897) reported taking an estimated 300 smalltooth sawfish in just one netting season in the Indian River Lagoon, Florida. In another example, smalltooth sawfish landings data gathered by Louisiana shrimp trawlers from 1945-1978, which contained both landings data and crude information on effort (number of vessels, vessel tonnage, number of gear units), indicated declines in smalltooth sawfish landings from a high of 34,900 lbs in 1949 to less than 1,500 lbs in most years after 1967. The Florida net ban passed in 1995 has led to a reduction in the number of smalltooth sawfish incidentally captured, "…by prohibiting the use of gill and other entangling nets in all Florida waters, and prohibiting the use of other nets larger than 500 square feet in mesh area in nearshore and inshore Florida waters"[7] (FLA. CONST. art. X, § 16). However, the threat of bycatch currently remains in commercial fisheries (e.g., South Atlantic shrimp fishery, Gulf of Mexico shrimp fishery, federal shark fisheries of the South Atlantic, and the Gulf of Mexico reef fish fishery), though anecdotal information collected by NMFS port agents suggest smalltooth sawfish captures are now rare.

In addition to incidental bycatch in commercial fisheries, smalltooth sawfish have historically been and continue to be captured by recreational anglers. Encounter data (ISED, 2014) and past research (S. Caldwell, 1990) document that rostra are sometimes removed from smalltooth sawfish caught by recreational anglers, thereby reducing their chances of survival. While the current threat of mortality associated with recreational fisheries is expected to be low given that possession of the species in Florida has been prohibited since 1992, bycatch in recreational fisheries remains a potential threat to the species.

Habitat Loss

Modification and loss of smalltooth sawfish habitat, especially nursery habitat, is another contributing factor in the decline of the species. Activities such as agricultural and urban development, commercial activities, dredge-and-fill operations, boating, erosion, and diversions of freshwater runoff contribute to these losses (SAFMC, 1998). Large areas of coastal habitat were modified or lost between the mid-1970s and mid-1980s within the United States (Dahl & Johnson, 1991). Since then, rates of loss have decreased, but habitat loss continues. From 1998-2004, approximately 64,560 acres of coastal wetlands were lost along the Atlantic and Gulf coasts of the United States, of which approximately 2,450 acres were intertidal wetlands

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[7] "nearshore and inshore Florida waters" means all Florida waters inside a line 3 mi seaward of the coastline along the Gulf of Mexico and inside a line 1 mi seaward of the coastline along the Atlantic Ocean.

consisting of mangroves or other estuarine shrubs (Steadman & Dahl, 2008). Further, Orlando et al. (1994) analyzed 18 major southeastern estuaries and recorded over 703 mi of navigation channels and 9,844 mi of shoreline with modifications. In Florida, coastal development often involves the removal of mangroves and the armoring of shorelines through seawall construction. Changes to the natural freshwater flows into estuarine and marine waters through construction of canals and other water control devices have had other impacts: altered the temperature, salinity, and nutrient regimes; reduced both wetlands and submerged aquatic vegetation; and degraded vast areas of coastal habitat utilized by smalltooth sawfish (Gilmore, 1995; Reddering, 1988; Whitfield & Bruton, 1989). While these modifications of habitat are not the primary reason for the decline of smalltooth sawfish abundance, it is likely a contributing factor and almost certainly hampers the recovery of the species. Juvenile sawfish and their nursery habitats are particularly likely to be affected by these kinds of habitat losses or alternations, due to their affinity for shallow, estuarine systems. Prohaska et al. (2018) showed that juvenile smalltooth sawfish within the anthropogenically altered Charlotte Harbor estuary have higher metabolic stress compared to those collected from more pristine nurseries in the Everglades. Although many forms of habitat modification are currently regulated, some permitted direct and/or indirect damage to habitat from increased urbanization still occurs and is expected to continue to threaten survival and recovery of the species in the future.

Life History Limitations

The smalltooth sawfish is also limited by its life history characteristics as a relatively slow-growing, late-maturing, and long-lived species. Animals using this life history strategy are usually successful in maintaining small, persistent population sizes in constant environments, but are particularly vulnerable to increases in mortality or rapid environmental change (NMFS, 2000). The combined characteristics of this life history strategy result in a very low intrinsic rate of population increase (John A. Musick, 1999) that make it slow to recover from any significant population decline (Colin A. Simpfendorfer, 2000).

Stochastic Events

Although stochastic events such as aperiodic extreme weather and harmful algal blooms are expected to affect smalltooth, we are currently unsure of their impact. A strong and prolonged cold weather event in January 2010 resulted in the mortality of at least 15 juvenile and 1 adult sawfish (G. Poulakis et al., 2011; Scharer, Patterson III, Carlson, & Poulakis, 2012), and led to far fewer catches in directed research throughout the remainder of the year (D. M. Bethea, Smith, Hollensead, & Carlson, 2011). Another less severe cold front in 2011 did not result in any known mortality but did alter the typical habitat use patterns of juvenile sawfish within the Caloosahatchee River. Since surveys began, 2 hurricanes have made direct landfall within the core range of U.S. sawfish. While these storms denuded mangroves along the shoreline and created hypoxic water conditions, we are unaware of any direct effects to sawfish. Just prior to the passage of the most recent hurricane (Hurricane Irma), acoustically tagged sawfish moved away from their normal shallow nurseries and then returned within a few days (Poulakis unpubl. data; Carlson unpubl. data). Harmful algal blooms have occurred within the core range of smalltooth sawfish and affected a variety of fauna including sea turtles, fish, and marine mammals, but to date no sawfish mortalities have been reported.

Current Threats

The 3 major factors that led to the current status of the U.S. DPS of smalltooth sawfish – bycatch mortality, habitat loss, and life history limitations – continue to be the greatest threats today. All the same, other threats such as the illegal commercial trade of smalltooth sawfish or their body parts, predation, and marine pollution and debris may also affect the population and recovery of smalltooth sawfish on smaller scales (NMFS, 2010). We anticipate that all of these threats will continue to affect the rate of recovery for the U.S. DPS of smalltooth sawfish.

In addition to the anthropogenic effects mentioned previously, changes to the global climate are likely to be a threat to smalltooth sawfish and the habitats they use. The Intergovernmental Panel on Climate Change has stated that global climate change is unequivocal and its impacts to coastal resources may be significant (IPCC, 2007, 2013). Some of the likely effects commonly mentioned are sea level rise, increased frequency of severe weather events, changes in the amount and timing of precipitation, and changes in air and water temperatures (EPA, 2012; NOAA, 2012). The impacts to smalltooth sawfish cannot, for the most part, currently be predicted with any degree of certainty, but we can project some effects to the coastal habitats where they reside. Red mangroves and shallow, euryhaline waters will be directly impacted by climate change through sea level rise, which is expected to increase 0.45 to 0.75 m by 2100 (IPCC, 2013). Sea level rise will impact mangrove resources, as sediment surface elevations for mangroves will not keep pace with conservative projected rates of elevation in sea level (Gilman, Ellison, Duke, & Field, 2008). Sea level increases will also affect the amount of shallow water available for juvenile smalltooth sawfish nursery habitat, especially in areas where there is shoreline armoring (e.g., seawalls). Further, the changes in precipitation coupled with sea level rise may also alter salinities of coastal habitats, reducing the amount of available smalltooth sawfish nursery habitat.

3.5 Status of Giant Manta Ray

NMFS listed the giant manta ray (*Manta birostris*) as threatened under the ESA (83 FR 2916, Publication Date January 22, 2018) and determined that the designation of critical habitat is not prudent on (84 FR 66652, Publication Date December 5, 2019). On December 4, 2019, NMFS published a recovery outline for the giant manta ray (NMFS, 2019), which serves as an interim guidance to direct recovery efforts for giant manta ray.

Species Description and Distribution

The giant manta ray is the largest living ray, with a wingspan reaching a width of up to 7 m (23 ft), and an average size between 4-5 m (15-16.5 ft). The giant manta ray is recognized by its large diamond-shaped body with elongated wing-like pectoral fins, ventrally placed gill slits, laterally placed eyes, and wide terminal mouth. In front of the mouth, it has 2 structures called cephalic lobes that extend and help to introduce water into the mouth for feeding activities (making them the only vertebrate animals with 3 paired appendages). Giant manta rays have 2 distinct color types: chevron (mostly black back dorsal side and white ventral side) and black (almost completely black on both ventral and dorsal sides). Most of the chevron variants have a black dorsal surface and a white ventral surface with distinct patterns on the underside that can be used to identify individuals (Miller & Klimovich, 2017). There are bright white shoulder markings on the dorsal side that form 2 mirror image right-angle triangles, creating a T-shape on the upper shoulders.

The giant manta ray is found worldwide in tropical and subtropical oceans and in productive coastal areas. They also occasionally occur within estuaries (e.g., lagoons and bays) and Intracostal Waterways (ICWW). In terms of range, within the Northern Hemisphere, the species has been documented as far north as southern California and New Jersey on the United States west and east coasts, respectively, and Mutsu Bay, Aomori, Japan, the Sinai Peninsula and Arabian Sea, Egypt, and the Azores Islands (CITES, 2013; Gudger, 1922; Kashiwagi, Ito, & Sato, 2010; Moore, 2012). In the Southern Hemisphere, the species occurs as far south as Peru, Uruguay, South Africa, New Zealand and French Polynesia (CITES, 2013; Mourier, 2012). Within its range, the giant manta ray inhabits tropical, subtropical, and temperate bodies of water and is commonly found offshore, in oceanic waters, and near productive coastlines (Figure 7) (Kashiwagi, Marshall, Bennett, & Ovenden, 2011; A. D. Marshall, Compagno, & Bennett, 2009).

Figure 7. The Extent of Occurrence (dark blue) and Area of Occupancy (light blue) based on species distribution (J. M. Lawson et al., 2017).

Life History Information

Giant manta rays make seasonal long-distance migrations, aggregate in certain areas and remain resident, or aggregate seasonally (Dewar et al., 2008; Girondot et al., 2015; R. T. Graham et al., 2012; Stewart, Hoyos-Padilla, Kumli, & Rubin, 2016). The giant manta ray is a seasonal visitor along productive coastlines with regular upwelling, in oceanic island groups, and at offshore pinnacles and seamounts. The timing of these visits varies by region and seems to correspond with the movement of zooplankton, current circulation and tidal patterns, seasonal upwelling, seawater temperature, and possibly mating behavior. They have also been observed in estuarine waters and inlets, with use of these waters as potential nursery grounds (Adams & Amesbury, 1998; Medeiros, Luiz, & Domit, 2015; Milessi & Oddone, 2003).

Giant manta rays are known to aggregate in various locations around the world in groups usually ranging from 100-1,000 (R. T. Graham et al., 2012; Notarbartolo di Sciara & Hillyer, 1989; Venables, 2013). These sites function as feeding sites, cleaning stations, or sites where courtship interactions take place (R. T. Graham et al., 2012; Heinrichs, O'Malley, Medd, & Hilton, 2011; Venables, 2013). The appearance of giant manta rays in these locations is generally predictable. For example, food availability due to high productivity events tends to play a significant role in feeding site aggregations (Heinrichs et al., 2011; Notarbartolo di Sciara & Hillyer, 1989). Giant manta rays have also been shown to return to a preferred site of feeding or cleaning over extended periods of time (Dewar et al., 2008; R. T. Graham et al., 2012; Medeiros et al., 2015). In addition, giant and reef manta rays in Keauhou and Ho"ona Bays in Hawaii, appear to exhibit learned behavior. These manta rays learned to associate artificial lighting with high plankton concentration (primary food source) and shifted foraging strategies to include sites that had artificial lighting at night (Clark, 2010). While little is known about giant manta ray aggregation sites, the Flower Garden Banks National Marine Sanctuary and the surrounding region might represent the first documented nursery habitat for giant manta ray (Stewart, Nuttall, Hickerson, & Johnston, 2018). Stewart et al. (2018) found that the Flower Garden Banks National Marine Sanctuary provides nursery habitat for juvenile giant manta rays because small age classes have been observed consistently across years at both the population and individual level. The Flower Garden Banks National Marine Sanctuary may be an optimal nursery ground because of its location near the edge of the continental shelf and proximity to abundant pelagic food resources. In addition, small juveniles are frequently observed along a portion of Florida's east coast, indicating that this area may also function as a nursery ground for juvenile giant manta rays. Since directed visual surveys began in 2016, juvenile giant manta rays are regularly observed in the shallow waters (less than 5 m depth) from Jupiter Inlet to Boynton Beach Inlet (J Pate, Florida Manta Project, unpublished data). However, the extent of this purported nursery ground is unknown as the survey area is limited to a relatively narrow geographic area along Florida's southeast coast.

The giant manta ray appears to exhibit a high degree of plasticity in terms of its use of depths within its habitat. Tagging studies have shown that the giant manta rays conduct night descents from 200-450m depths (Rubin, Kumli, & Chilcott, 2008; Stewart et al., 2016) and are capable of diving to depths exceeding 1,000 m (A. Marshall et al. unpublished data 2011, cited in Marshall et al. (2011)). Stewart et al. (2016) found diving behavior may be influenced by season, and more specifically, shifts in prey location associated with the thermocline, with tagged giant manta rays (n=4) observed spending a greater proportion of time at the surface from April to June and in deeper waters from August to September. Overall, studies indicate that giant manta rays have a more complex depth profile of their foraging habitat than previously thought, and may actually be supplementing their diet with the observed opportunistic feeding in near-surface waters (Burgess et al., 2016; Couturier et al., 2013).

Giant manta rays primarily feed on planktonic organisms such as euphausiids, copepods, mysids, decapod larvae and shrimp, but some studies have noted their consumption of small and moderately sized fishes (Miller & Klimovich, 2017). While it was previously assumed, based on field observations, that giant manta rays feed predominantly during the day on surface zooplankton, results from recent studies (Burgess et al., 2016; Couturier et al., 2013) indicate that these feeding events are not an important source of the dietary intake. When feeding, giant manta rays hold their cephalic lobes in an "O" shape and open their mouth wide, which creates a funnel that pushes water and prey through their mouth and over their gill rakers. They use many different types of feeding strategies, such as barrel rolling (doing somersaults repeatedly) and creating feeding chains with other mantas to maximize prey intake.

The giant manta ray is viviparous (i.e., gives birth to live young). They are slow to mature and have very low fecundity and typically give birth to only one pup every 2 to 3 years. Gestation lasts approximately 10-14 months. Females are only able to produce between 5 and 15 pups in a lifetime (CITES, 2013; Miller & Klimovich, 2017). The giant manta ray has one of the lowest maximum population growth rates of all elasmobranchs (Dulvy, Pardo, Simpfendorfer, & Carlson, 2014; Miller & Klimovich, 2017). The giant manta rays generation time (based on *M. alfredi* life history parameters) is estimated to be 25 years (Miller & Klimovich, 2017).

Although giant manta rays have been reported to live at least 40 years, not much is known about their growth and development. Maturity is thought to occur between 8-10 years of age (Miller & Klimovich, 2017). Males are estimated to mature at around 3.8 m disc width (slightly smaller than females) and females at 4.5 m disc width (Rambahiniarison et al., 2018).

Status and Population Dynamics

There are no current or historical estimates of global abundance of giant manta rays, with most estimates of subpopulations based on anecdotal observations. The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES, 2013) found that only ten populations of giant manta rays had been actively studied, 25 other aggregations have been anecdotally identified, all other sightings are rare, and the total global population may be small. Subpopulation abundance estimates range between 42 and 1,500 individuals, but are anecdotal and subject to bias (Miller & Klimovich, 2017). The largest subpopulations and records of individuals come from the Indo-Pacific and eastern Pacific. Ecuador is thought to be home to the largest identified population (n=1,500) of giant manta rays in the world, with large aggregation sites within the waters of the Machalilla National Park and the Galapagos Marine Reserve (Hearn et al., 2014). Within the Indian Ocean, numbers of giant manta rays identified through citizen science in Thailand's waters (primarily on the west coast, off Khao Lak and Koh Lanta) was 288 in 2016. These numbers reportedly surpass the estimate of identified giant mantas in Mozambique (n=254), possibly indicating that Thailand may be home to the largest aggregation of giant manta rays within the Indian Ocean (MantaMatcher, 2016). Miller and Klimovich (2017) concluded that giant manta rays are at risk throughout a significant portion of their range, due in large part to the observed declines in the Indo-Pacific. There have been decreases in landings of up to 95% in the Indo-Pacific, although similar declines have not been observed in areas with other subpopulations, such as Mozambique and Ecuador. In the U.S. Atlantic and Caribbean, giant manta ray sightings are concentrated along the east coast as far north as New Jersey, within the Gulf of Mexico, and off the coasts of the U.S. Virgin Islands and Puerto Rico. Because most sightings of the species have been opportunistic during other surveys, researchers are still unsure what attracts giant manta rays to certain areas and not others and where they go for the remainder of the time (84 FR 66652; Publication Date December 5, 2019).

The available sightings data indicate that giant manta rays occur regularly along Florida's east coast. In 2010, Georgia Aquarium began conducting aerial surveys for giant manta rays. The surveys are conducted in spring and summer and run from the beach parallel to the shoreline (0 to 2.5 nautical miles), from St. Augustine Beach Pier to Flagler Beach Pier, Florida. The numbers, location, and peak timing of the manta rays to this area varies by year (H. Webb unpublished data). In addition, juvenile giant manta rays have also been regularly observed inshore off the southeast Florida. Since 2016, researchers with the MMF have been conducting annual surveys along a small transect off Palm Beach, Florida, between Jupiter Inlet and Boynton Beach Inlet (~44 km, 24 nautical miles) (J. Pate, MMF, pers. comm. to M. Miller, NMFS OPR, 2018). Results from these surveys indicate that juvenile manta rays are present in these waters for the majority of the year (observations span from May to December), with re-sightings data that suggest some manta rays may remain in the area for extended periods of time or return in subsequent years (J. Pate unpublished data). In the Gulf of Mexico, within the Flower Garden Banks National Marine Sanctuary, 95 unique individuals have been recorded between 1982 and 2017 (Stewart et al., 2018).

Threats

The giant manta ray faces many threats, including fisheries interactions, environmental contaminants (microplastics, marine debris, petroleum products, etc.), vessel strikes, entanglement, and global climate change. Overall, the predictable nature of their appearances, combined with slow swimming speed, large size, and lack of fear towards humans, may increase their vulnerability to threats (Convention on Migratory Species, 2014; O'Malley, Lee-Brooks, & Medd, 2013). The ESA status review determined that the greatest threat to the species results from fisheries related mortality (Miller & Klimovich, 2017); (83 FR 2916, Publication Date January 22, 2018).

Commercial Harvest and Fisheries Bycatch

Commercial harvest and incidental bycatch in fisheries is cited as the primary cause for the decline in the giant manta ray and threat to future recovery (Miller & Klimovich, 2017). We anticipate that these threats will continue to affect the rate of recovery of the giant manta ray. Worldwide giant manta ray catches have been recorded in at least 30 large and small-scale fisheries covering 25 countries (Julia M. Lawson et al., 2016). Demand for the gills of giant manta rays and other mobula rays has risen dramatically in Asian markets. With this expansion of the international gill raker market and increasing demand for manta ray products, estimated harvest of giant manta rays, particularly in many portions of the Indo-Pacific, frequently exceeds numbers of identified individuals in those areas and are accompanied by observed declines in sightings and landings of the species of up to 95% (Miller & Klimovich, 2017). In the Indian Ocean, manta rays (primarily giant manta rays) are mainly caught as bycatch in purse seine and gillnet fisheries (Oliver, Braccini, Newman, & Harvey, 2015). In the western Indian Ocean, data from the pelagic tuna purse seine fishery suggests that giant manta and mobula rays, together, are an insignificant portion of the bycatch, comprising less than 1% of the total non-tuna bycatch per year (Chassot, Amandè, Pierre, Pianet, & Dédo, 2008; Romanov, 2002). In the U.S., bycatch of giant manta rays has been recorded in the coastal migratory pelagic gillnet, Gulf reef fish bottom longline, Atlantic shark gillnet, pelagic longline, pelagic bottom longline, and trawl fisheries. Incidental capture of giant manta ray is also a rare occurrence in the elasmobranch catch within U.S. Atlantic and Gulf of Mexico, with the majority that are caught released alive. In addition to directed harvest and bycatch in commercial fisheries, the giant manta ray is incidentally captured by recreational fishers using vertical line (i.e., handline, bandit gear, and rod-and-reel).

Researchers frequently report giant manta rays having evidence of recreational gear interactions along the east coast of Florida (i.e., manta rays have embedded fishing hooks with attached trailing monofilament line) (J. Pate, Florida Manta Project, unpublished data). Internet searches also document recreational interactions with giant manta rays. For example, recreational fishers will search for giant manta rays while targeting cobia, as cobia often accompany giant manta rays (anglers will cast at manta rays in an effort to hook cobia). In addition, giant manta rays are commonly observed swimming near or underneath public fishing piers where they may become foul-hooked. The current threat of mortality associated with recreational fisheries is expected to be low, given that we have no reports of recreational fishers retaining giant manta ray. However, bycatch in recreational fisheries remains a potential threat to the species.

Vessel Strike

Vessel strikes can injure or kill giant manta rays, decreasing fitness or contributing to non-natural mortality (Couturier et al., 2012; Deakos, Baker, & Bejder, 2011). Giant manta rays do not surface to breath, but they can spend considerable time in surface waters, while basking and feeding, where they are more susceptible to vessel strikes (McGregor et al., 2019). They show little fear toward vessels which can also make them extremely vulnerable to vessel strikes (Deakos, 2010). Five giant manta rays were reported to have been struck by vessels from 2016 through 2018; individuals had injuries (i.e., fresh or healed dorsal surface propeller scars) consistent with a vessel strike. These interactions were observed by researchers conducting surveys from Boynton Beach to Jupiter, Florida (J. Pate, Florida Manta Project, unpublished data). The giant manta ray is frequently observed in nearshore coastal waters and feeding within and around inlets. As vessel traffic is concentrated in and around inlets and nearshore waters, this overlap exposes the giant manta ray in these locations to an increased likelihood of potential vessel strike. Yet, few instances of confirmed or suspected mortalities of giant manta ray attributed to vessel strike injury (e.g., via strandings) have been documented. This lack of documented mortalities could also be the result of other factors that influence carcass detection (i.e., wind, currents, scavenging, decomposition etc.). In addition, manta rays appear to be able to heal from wounds very quickly, while high wound healing capacity is likely to be beneficial for their long-term survival, the fitness cost of injuries and number vessel strikes occurring may be masked (McGregory et al., 2019).

Microplastics

Filter-feeding megafauna are particularly susceptible to high levels of microplastic ingestion and exposure to associated toxins due to their feeding strategies, target prey, and, for most, habitat overlap with microplastic pollution hotspots (Germanov et al., 2019). Giant manta rays are filter feeders, and, therefore can ingest microplastics directly from polluted water or indirectly through-contaminated planktonic prey (Miller & Klimovich, 2017). The effects of ingesting indigestible particles include blocking adequate nutrient absorption and causing mechanical damage to the digestive tract. Microplastics can also harbor high levels of toxins and persistent organic pollutants, and introduce these toxins to organisms via ingestion. These toxins can bioaccumulate over decades in long-lived filter feeders, leading to a disruption of biological processes (e.g., endocrine disruption), and potentially altering reproductive fitness (Germanov et al., 2019). Jambeck et al. (2015) found that the Western and Indo- Pacific regions are responsible for the majority of plastic waste. These areas also happen to overlap with some of the largest known aggregations of giant manta rays. For example, in Thailand, where recent sightings data have identified over 288 giant manta rays (MantaMatcher, 2016), mismanaged plastic waste is estimated to be on the order of 1.03 million tonnes annually, with up to 40% of this entering the marine environment (Jambeck et al., 2015). Approximately 1.6 million tonnes of mismanaged plastic waste is being disposed of in Sri Lanka, again with up to 40% entering the marine environment (Jambeck et al., 2015), potentially polluting the habitat used by the nearby Maldives aggregation of manta rays. While the ingestion of plastics is likely to negatively affect the health of the species, the levels of microplastics in manta ray feeding grounds and frequency of ingestion are presently being studied to evaluate the impact on these species (Germanov et al., 2019).

Mooring and Anchor Lines

Mooring and boat anchor line entanglement may also wound giant manta rays or cause them to drown (Deakos et al., 2011; Heinrichs et al., 2011). There are numerous anecdotal reports of giant manta rays becoming entangled in mooring and anchor lines (C. Horn, NMFS, unpublished data), as well as documented interactions encountered by other species of manta rays (C. Horn, NMFS, unpublished data). For example, although a rare occurrence, reef manta rays on occasion entangle themselves in anchor and mooring lines. Deakos (2010) suggested that manta rays become entangled when the line makes contact with the front of the head between the cephalic lobes, the animal's reflex response is to close the cephalic lobes, thereby trapping the rope between the cephalic lobes, entangling the manta ray as the animal begins to roll in an attempt to free itself. In Hawaii, on at least 2 occasions, a reef manta ray was reported to have died after entangling in a mooring line (A. Cummins, pers. comm. 2007, K. Osada, pers. comm. 2009; cited in Deakos (2011)). In Maui, Hawaii, Deakos et al. (2011) observed that 1 out of 10 reef manta rays had an amputated or disfigured non-functioning cephalic lobe, likely a result of line entanglement. Mobulid researchers indicate that entanglements may significantly affect the manta rays fitness (Braun, Skomal, Thorrold, & Berumen, 2015; Convention on Migratory Species, 2014; Couturier et al., 2012; Deakos et al., 2011; Germanov & Marshall, 2014; Heinrichs et al., 2011). However, there is very little quantitative information on the frequency of these occurrences and no information on the impact of these injuries on the overall health of the species.

Climate Change Effects

Because giant manta rays are migratory and considered ecologically flexible (e.g., low habitat specificity), they may be less vulnerable to the impacts of climate change compared to other sharks and rays (Chin, Kyne, Walker, & McAuley, 2010). However, as giant manta rays frequently rely on coral reef habitat for important life history functions (e.g., feeding, cleaning) and depend on planktonic food resources for nourishment, both of which are highly sensitive to environmental changes (Brainard et al., 2011; Guinder & Molinero, 2013), climate change is likely to have an impact on their distribution and behavior. Coral reef degradation from anthropogenic causes, particularly climate change, is projected to increase through the future. Specifically, annual, globally averaged surface ocean temperatures are projected to increase by approximately 0.7 °C by 2030 and 1.4 °C by 2060 compared to the 1986-2005 average

(Intergovernmental Panel on Climate Change, 2013), with the latest climate models predicting annual coral bleaching for almost all reefs by 2050 (Heron, Eakin, Maynard, & van Hooidonk, 2016). Declines in coral cover have been shown to result in changes in coral reef fish communities (Jones, McCormick, Srinivasan, & Eagle, 2004) (N. A. J. Graham et al., 2008). Therefore, the projected increase in coral habitat degradation may potentially lead to a decrease in the abundance of fish that clean giant manta rays (e.g., *Labroides* spp., *Thalassoma* spp., and *Chaetodon* spp.) and an overall reduction in the number of cleaning stations available to manta rays within these habitats. Decreased access to cleaning stations may negatively affect the fitness of giant manta rays by hindering their ability to reduce parasitic loads and dead tissue, which could lead to increases in diseases and declines in reproductive fitness and survival rates.

Changes in climate and oceanographic conditions, such as acidification, are also known to affect zooplankton structure (size, composition, and diversity), phenology, and distribution (Guinder & Molinero, 2013). As such, the migration paths and locations of both resident and seasonal aggregations of giant manta rays, which depend on these animals for food, may similarly be altered (Couturier et al., 2012). As research to understand the exact impacts of climate change on marine phytoplankton and zooplankton communities is still ongoing, the severity of this threat has yet to be fully determined (Miller & Klimovich, 2017).

4. ENVIRONMENTAL BASELINE

By regulation (50 CFR 402.02), the environmental baseline for an Opinion refers to the condition of the listed species in the action area, without the consequences to the listed species or designated critical habitat caused by the proposed action. 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. The consequences to the listed species from ongoing agency activities or existing agency facilities that are not within the agency's discretion to modify are part of the environmental baseline.

Focusing on the impacts of the activities in the action area specifically allows us to assess the prior experience and state (or condition) of the endangered and threatened individuals. This consideration is important because in some states or life history stages, or areas of their ranges, listed individuals will commonly exhibit, or be more susceptible to, adverse responses to stressors than they would be in other states, stages, or areas within their distributions. These localized stress responses or stressed baseline conditions may increase the severity of the adverse effects expected from the proposed action.

4.1 Status of Species within the Action Area

There have been 3 reported recreational hook-and-line captures of sea turtles at the Fisherman's Pier according to STSSN data for the years 2007-2016. Based on the best available species life history data and the STSSN recreational hook-and-line capture and entanglement data (Table 2), we believe green sea turtle (NA and SA DPSs), Kemp's ridley sea turtle, loggerhead sea turtle (NWA DPS), and hawksbill sea turtle may be in the action area and adversely affected by recreational hook-and-line fishing that will occur at the pier upon completion of the proposed action. All of these sea turtle species are migratory, traveling to forage grounds or for reproduction purposes. The Atlantic Ocean waters within the action area are likely used by these species of sea turtle for nearshore reproductive, developmental, and foraging habitat. NMFS believes that no individual sea turtle is likely to be a permanent resident of the action area, although some individuals may be present at any given time. These same individuals will migrate into offshore waters of the Gulf of Mexico, Caribbean Sea, and other areas of the North Atlantic Ocean at certain times of the year, and thus may be affected by activities occurring there. Therefore, the status of the sea turtles species in the action area are considered the same as those discussed in Sections 3.3.1 - 3.3.5.

Smalltooth sawfish are documented throughout the state of Florida. According to a review of the available SSRIT data since the species was listed (2003-2017), there have been 3 documented reports of smalltooth sawfish in Broward County, FL. Of those reports, 2 are captures due to recreational fishing from ocean-facing fishing piers. There has been 1 reported recreational hook-and-line capture of a smalltooth sawfish at the Fisherman’s Pier. NMFS believes that no individual smalltooth sawfish is likely to be a permanent resident of the action area, although some individuals may be present at any given time and may be adversely affected by recreational fishing that will occur at the pier. These same individuals will migrate into coastal and offshore waters of the Gulf of Mexico and potentially areas of the North Atlantic Ocean, and thus may be affected by activities occurring there. Therefore, the status of smalltooth sawfish in the action area is considered to be the same as those discussed in Section 3.4.

NMFS is not aware of any reported recreational hook-and-line captures of a giant manta ray at the Fisherman’s Pier. Giant manta ray have been observed in estuarine waters of Florida near oceanic inlets, with use of these waters as potential nursery grounds. They are also commonly observed swimming near or underneath public fishing piers where they may become foul-hooked. Due to the pier’s position on an ocean-facing beach, we believe giant manta ray may be adversely affected by recreational fishing that will occur at the pier upon completion of the proposed action. NMFS believes that no individual giant manta ray is likely to be a permanent resident of the action area, although some individuals may be present at any given time. These same individuals will migrate into coastal and offshore waters of the Gulf of Mexico and the North Atlantic Ocean, and thus may be affected by activities occurring there. Therefore, the status of giant manta ray in the action area, including the threats, are the same as those discussed in Section 3.5.

4.2 Factors Affecting Species within the Action Area

4.2.1 Federal Actions

Other than the proposed action, no other federally permitted projects are known to have occurred within the action area or undergone Section 7 consultation, as per a review of the NMFS SERO PRD’s completed ESA Section 7 consultation database by the consulting biologist on April 19, 2021.

4.2.2 State or Private Actions

4.2.2.1 Recreational Fishing

Recreational fishing as regulated by the State of Florida can affect green sea turtle (NA and SA DPSs), Kemp's ridley sea turtle, loggerhead sea turtle (NWA DPS), hawksbill sea turtle, smalltooth sawfish, and giant manta ray within the action area. Pressure from recreational fishing in and adjacent to the action area is likely to continue.

The Fisherman's Pier (also known as Anglin's Fishing Pier) was originally built in 1941 and reconstructed to its current footprint in 1963. When operational, the pier will be open 24-hours a day, year-round. Use of the pier by anglers and is dependent on weather, tide, and fishing conditions. The estimated number of anglers per day can range from 35 to 40.

As stated above, the 10-year STSSN dataset (2007-2016) for offshore Zone 26 contains 3 reported recreational hook-and-line captures of sea turtles from the Fisherman's Pier. The SSRIT data (2003-2017) contains 1 reported hook-and-line capture of a smalltooth sawfish at Fisherman's Pier. NMFS is not aware of any giant manta ray captures at the Fisherman's Pier. We have no way of knowing how many unreported captures of these species may have occurred at the pier in the past. Observations of state recreational fisheries have shown that loggerhead sea turtles are known to bite baited hooks and frequently ingest the hooks. Overall, hooked sea turtles have been reported to the STSSN by the public fishing from boats, piers, and beach, banks, and jetties and from commercial anglers fishing for reef fish and for sharks with both single rigs and bottom longlines (NMFS 2001). Additionally, lost fishing gear such as line cut after snagging on rocks, or discarded hooks and line, can also pose an entanglement threat to sea turtles in the area. A detailed summary of the known impacts of hook-and-line incidental captures to Kemp's ridley and loggerhead sea turtles can be found in the Turtle Expert Working Group (TEWG) reports (1998; 2000).

Though anglers are not targeting smalltooth sawfish, but instead capturing them incidentally, recreational fishing is currently a major activity that directly interacts with smalltooth sawfish throughout most of its range, including Tampa Bay. Smalltooth sawfish occur as bycatch in the recreational hook-and-line fishery, mostly by shark, red drum (*Sciaenops ocellatus*), snook (*Centropomus undecimalis*), and tarpon (*Megalops atlanticus*) fishers (Wiley & Simpfendorfer, 2010), which may operate within the action area.

Giant manta ray is incidentally captured by recreational fishers using vertical line (i.e., handline, bandit gear, and rod-and-reel). Researchers frequently report giant manta rays having evidence of recreational gear interactions along the east coast of Florida (i.e., manta rays have embedded fishing hooks with attached trailing fishing line) (J. Pate, Florida Manta Project, unpublished data). Internet searches also document recreational interactions with giant manta rays. For example, recreational fishers will search for giant manta rays while targeting cobia, as cobia often accompany giant manta rays. Giant manta rays are commonly observed swimming near or underneath public fishing piers where they may become foul-hooked.

4.2.3 Marine Debris and Acoustic Impacts

A number of activities that may affect green sea turtle (NA and SA DPSs), Kemp's ridley sea turtle, loggerhead sea turtle (NWA DPS), hawksbill sea turtle, smalltooth sawfish, and giant manta ray in the action area include anthropogenic marine debris and acoustic effects. The effects from these activities are difficult to measure. Where possible, conservation actions are being implemented to monitor or study the effects to these species from these sources.

4.2.4 Marine Pollution and Environmental Contamination

Sources of pollutants along the coast that may affect green sea turtle (NA and SA DPSs), Kemp's ridley sea turtle, loggerhead sea turtle (NWA DPS), hawksbill sea turtle, smalltooth sawfish, and giant manta ray include PCB loading, stormwater runoff from coastal towns and cities into rivers and canals emptying into bays and the ocean, and groundwater and other discharges (Vargo, Lutz, Odell, Vleet, & Bossart, 1986). Although pathological effects of oil spills have been documented in laboratory studies of marine mammals and sea turtles (Vargo et al., 1986), the impacts of those and many other anthropogenic toxins have not been investigated in smalltooth sawfish or giant manta ray.

4.2.5 Stochastic Events

Stochastic (i.e., random) events, such as hurricanes or cold snaps, occur in Florida and can affect green sea turtle (NA and SA DPSs), Kemp's ridley sea turtle, loggerhead sea turtle (NWA DPS), hawksbill sea turtle, smalltooth sawfish, and giant manta in the action area. These events are unpredictable and their effect on the recovery of these ESA-listed species is unknown; yet, they have the potential to directly impede recovery if animals die as a result or indirectly if important habitats are damaged.

5. EFFECTS OF THE ACTION ON ESA-LISTED SPECIES

Effects of the action are all consequences to listed species or critical habitat that are caused by the proposed action, including the consequences of other activities that are caused by the proposed action. A consequence is caused by the proposed action if it would not occur but for the proposed action and it is reasonably certain to occur. Effects of the action may occur later in time and may include consequences occurring outside the immediate area involved in the action (50 CFR 402.02).

As discussed above in Section 3.2, we believe hook-and-line gear commonly used by recreational anglers fishing from the Fisherman's Pier may adversely affect green sea turtle (NA and SA DPSs), Kemp's ridley sea turtle, loggerhead sea turtle (NWA DPS), hawksbill sea turtle, smalltooth sawfish, and giant manta ray. In Sections 5.1.1 - 5.1.3, we provide more detail on the potential effects of entanglement, hooking, and trailing line to these species from hook-and-line gear. Section 5.2 addresses how we estimate future captures of sea turtles. Section 5.3 addresses how we estimate future captures of smalltooth sawfish. Section 5.4 addresses how we estimate future captures of giant manta ray.

5.1 Effects of the Action on the Species

5.1.1 Entanglement

Sea turtles are particularly prone to entanglement as a result of their body configuration and behavior. Records of stranded or entangled sea turtles reveal that hook-and-line gear can wrap around the neck, flipper, or body of a sea turtle and severely restrict swimming or feeding. If the sea turtle is entangled when young, the fishing line becomes tighter and more constricting as the sea turtle grows, cutting off blood flow and causing deep gashes, some severe enough to remove an appendage. Sea turtles have been found entangled in many different types of hook-and-line gear. Entangling gear can interfere with a sea turtle's ability to swim or impair its feeding, breeding, or migration. Entanglement may even prevent surfacing and cause drowning.

Due to their toothed rostra, smalltooth sawfish can become entangled in fishing gears such as gill nets, otter trawls, trammel nets, cast nets and seines that are directed at other species (NMFS, 2009). Entanglement in recreational fishing line can cause effects to smalltooth sawfish including injury to fins and rostra (FWC unpublished data).

Fishing line entanglement can cause effects to giant manta ray, including injury to cephalic fins (Deakos et al. 2011), stress, deep lacerations to the body (Gallagher et al. 2014), and impaired feeding or swimming (Marshal et al. 2008).

5.1.2 Hooking

Sea turtles are also injured and killed by being hooked. Hooking can occur as a result of a variety of scenarios, some depending on the foraging strategies and diving and swimming behavior of the various species of sea turtles. Sea turtles are either hooked externally in the flippers, head, shoulders, armpits, or beak, or internally inside the mouth or when the animal has swallowed the bait (George H. Balazs, Pooley, & Murakawa, 1995). Swallowed hooks are the greatest threat. A sea turtle's esophagus (throat) is lined with strong conical papillae directed towards the stomach (White, 1994). The presence of these papillae in combination with an S-shaped bend in the esophagus make it difficult to see hooks when looking through a sea turtle's mouth, especially if the hooks have been deeply ingested. Because of a sea turtle's digestive structure, deeply ingested hooks are also very difficult to remove without seriously injuring the turtle. A sea turtle's esophagus is also firmly attached to underlying tissue; thus, if a sea turtle swallows a hook and tries to free itself or is hauled on board a vessel, the hook can pierce the sea turtle's esophagus or stomach and can pull organs from its connective tissue. These injuries can cause the sea turtle to bleed internally or can result in infections, both of which can kill the sea turtle. If an ingested hook does not lodge into, or pierce, a sea turtle's digestive organs, it can pass through the digestive system entirely (Aguilar, Mas, & Pastor, 1995; George H. Balazs et al., 1995) with little damage (Work, 2000). For example, a study of loggerheads deeply hooked by the Spanish Mediterranean pelagic longline fleet found ingested hooks could be expelled after 53 to 285 days (average 118 days) (Aguilar et al., 1995). If a hook passes through a sea turtle's digestive tract without getting lodged, the hook probably has not harmed the turtle.

At present, the SSRIT contains several recreational hook-and-line captures of smalltooth sawfish from fishing structures (A. Brame, NOAA NMFS SERO PRD, pers. comm. to consulting biologist on May 15, 2020). Based on this data, smalltooth sawfish do not appear to be actively attracted to recreational fishing structures or to habituate near recreational fishing structures as a forage source. We believe smalltooth sawfish captures are largely a function of co-occurrence in space and time rather than triggered by the presence of a recreational fishing structure. While hooking interactions within the recreational fishery are numerous, the level of mortality is likely low when smalltooth sawfish are handled and released properly. Further, the threat of mortality associated with recreational fisheries in Florida is expected to be low given that possession of the species in Florida has been prohibited since 1992. Longer fights on recreational hook-and-line gear as opposed to commercial bottom longlines may elevate lactate and HCO_3 levels (Prohaska et al. (2018)); however, smalltooth sawfish appear resilient and, when considered in conjunction with information from ongoing tagging and telemetry studies, post-release survival is expected to be high (Brame et al., 2019).

Hook-and-line gear commonly used by recreational anglers fishing from fishing piers can adversely affect giant manta ray via foul-hooking (i.e., a method that catches a fish using hooks without having the fish take the bait in its mouth). While foul-hooking will cause injury, it is considered sub-lethal to giant manta ray at this time. The effects from hooking and entanglement are considered sub-lethal to giant manta ray because they do not immediately result in death, with documented evidence that manta rays can recover and survive post-injury (Pate and Marshall (2020)).

5.1.3 Trailing Line

Trailing line (i.e., line left on a sea turtle after it has been captured and released) poses a serious risk to sea turtles. Line trailing from a swallowed hook is also likely to be swallowed, which may irritate the lining of the digestive system. The line may cause the intestine to twist upon itself until it twists closed, creating a blockage, or may cause a part of the intestine to slide into another part of intestine like a telescopic rod which also leads to blockage. In both cases, death is a likely outcome (Watson, Epperly, Shah, & Foster, 2005). The line may also prevent or hamper foraging, eventually leading to death. Trailing line may also become snagged on a floating or fixed object, further entangling a turtle and potentially slicing its appendages and affecting its ability to swim, feed, avoid predators, or reproduce. Sea turtles have been found trailing gear that has been snagged on the sea floor, or has the potential to snag, thus anchoring them in place (George H. Balazs, 1985). Long lengths of trailing gear are more likely to entangle the sea turtle, eventually leading to impaired movement, constriction wounds, and potentially death.

The effects to smalltooth sawfish and giant manta ray from trailing line are the same as those discussed above under Entanglements.

5.2 Sea Turtles

5.2.1 Estimating Captures of Sea Turtles

5.2.1.1 Estimating Reported Captures of Sea Turtles

We believe the best available data to estimate future reported recreational hook-and-line captures of sea turtles at public fishing structures comes from the historic reported captures at similar structures obtained from STSSN data, and any additional information regarding captures at the structure under consultation. We believe that using this dataset, which includes available data for the pier included in this consultation, is a more accurate representation of the likely range of future interactions in the action area than the smaller subset of data of historical reported captures at the consultation pier only, given the rarity of expected interactions and variability in species presence and angler behavior. The STSSN data contains number and location of sea turtle recreational hook-and-line captures that were reported to the STSSN; it does not provide the total number of potential public fishing structures available in a particular zone, and NMFS does not have that information. Below, we provide additional discussion regarding why this is the best available information to estimate the expected annual number of reported recreational hook-and-line captures of sea turtles at the Fisherman's Pier in the future.

As previously stated, the Fisherman's Pier is located on the ocean-facing waters of Zone 26. In the 10-year STSSN dataset (2007-2016), there are 44 total reported captures of sea turtles at 6 similar public fishing structures in Zone 26 (including the 3 reported captures at the Fisherman's Pier). Because these 6 fishing structures are in a similar habitat and location as the Fisherman's Pier (i.e., ocean-facing, Zone 26), we assume sea turtle behavior, density, and species composition are comparable all 6 locations. Because all 6 fishing structures are of a similar size, they likely have comparable angler effort. Further, we assume anglers fishing from all 6 of these structures use similar baits, equipment, and fishing techniques. Therefore, even though the historic reported hook-and-line captures are different between these 6 structures, the potential for interactions with sea turtles is likely comparable at all locations.

Whether interactions with sea turtles are reported varies depending on a number of factors, including whether there are educational signs encouraging reporting and angler behavior; sometimes anglers do not report encounters with ESA-listed species due to concerns over their personal liability or public perception at the time of the capture even if there are posted signs. Given this variability, it is difficult to estimate reporting behavior. However, we assume that similar fishing structures within the same statistical fishing zone (in this case, Zone 26) would have similar reporting rates. Because piers in the same reporting zone are in similar geographic locations, we assume public perception about reporting and angler reporting behavior is likely the same. Therefore, even though the historic reported hook-and-line captures are different between these 6 structures, the potential for reported captures is the same at all locations.

Thus, we believe the best available data to estimate the number of future reported recreational hook-and-line captures of sea turtles at the Fisherman's Pier is the average of the historic reported recreational hook-and-line captures at the similar fishing structures in the offshore Zone 26 STSSN dataset. Averaging the Zone 26 data helps smooth variability in both the potential for interactions (i.e., number and species composition) and in reporting behavior among the locations and over time, providing for a more accurate overall estimate of future reported captures at the consultation pier. There is no additional information that can be used to estimate potential reported interactions.

To calculate the average number of reported hook-and-line captures at these similar fishing structures in the offshore waters of Zone 26, we use available STSSN data and the following equation:

$$\begin{aligned}&\mathit{Average\ Reported\ Captures\ Per\ Structure\ in}\ 10\ \mathit{years}\\&= \mathit{Sum\ of\ Reported\ Captures\ in}\ 10\ \mathit{years} \div 6\ \mathit{Locations}\\&= (11 + 12 + 12 + 4 + 3 + 2\ ) \div 6\\&= 7.333\ \mathit{per\ structure\ in}\ 10\ \mathit{years}\end{aligned}$$

To calculate the estimated expected annual number of reported recreational hook-and-line captures of sea turtles at the Fisherman's Pier, we refer to the information above and use the following equation:

$$\begin{aligned}&\mathit{Expected\ Annual\ Reported\ Captures}\\&= \mathit{Average\ Reported\ Captures\ Per\ Structure\ in}\ 10\ \mathit{years} \div 10\ \mathit{years}\\&= 7.3333 \div 10\\&= 0.7333\ \mathit{per\ year}\ \text{(Table 5,}\ \mathit{Line}\ \text{1)}\end{aligned}$$

5.2.1.2 Estimating Unreported Captures of Sea Turtles

While we believe the best available information for estimating expected reported captures at the consultation pier is the reported captures at similar public fishing structures in the surrounding area, we also recognize the need to account for unreported captures. In the following section, we use the best available data to estimate the number of unreported recreational hook-and-line-captures that may occur. To the best of our knowledge, only 2 fishing pier surveys aimed at collecting data regarding unreported recreational hook-and-line captures of ESA-listed species have been conducted in the Southeast. One is from Charlotte Harbor, Florida, and the other is from Mississippi.

The fishing pier survey in Charlotte Harbor, Florida, was conducted at 26 fishing piers in smalltooth sawfish critical habitat (Hill, 2013). During the survey, 93 anglers were asked a series of open-ended questions regarding captures of sea turtles, smalltooth sawfish, and dolphins, including whether or not they knew these encounters were required to be reported and if they did report encounters. The interviewer also noted conditions about the pier including if educational signs regarding reporting of hook-and-line captures were present at the pier. Hill (2013) found that only 8% of anglers would have reported a sea turtle hook-and-line capture (i.e., 92% of anglers would not have reported a sea turtle capture).

NMFS conducted the fishing pier survey in Mississippi that interviewed 382 anglers. This survey indicated that approximately 60% of anglers who incidentally caught a sea turtle on hook-and-line reported it (i.e., 40% of anglers who incidentally caught a sea turtle did not report it) (Cook et al., 2014). It is important to note that in 2012 educational signs were installed at all fishing piers in Mississippi, alerting anglers to report accidental hook-and-line captures of sea turtles. After the signs were installed, there was a dramatic increase in the number of reported sea turtle hook-and-line captures. Though this increase in reported captures may not solely be related to outreach efforts, it does highlight the importance of educational signs on fishing piers. The STSSN in Mississippi indicated that inconsistency in reporting of captures may also be due to anglers' concerns over their personal liability, public perception at the time of the capture, or other consequences from turtle captures (M. Cook, STSSN, pers. comm. to N. Bonine, NMFS

SERO PRD, April 17, 2015). Anglers often do not admit the incidental capture for fear of liability.

We believe it is most appropriate to use the unreported rate in the Hill (2013) fishing pier study to estimate the future unreported captures at the Fisherman's Pier. Because the study was in Florida, it is a reasonable proxy for reporting behavior at the Fisherman's Pier. In addition, in the absence of additional information on factors that might affect angler reporting behavior, such as similarity of outreach and education, signage, or culture, we will err on the side of the species and assume fewer interactions were reported, as this will result in a higher total expected interactions. Therefore, we will address unreported captures by assuming that the expected annual reported captures of 0.7333 sea turtles per year at the Fisherman's Pier represents 8% of the actual captures and 92% of sea turtle captures will be unreported. Reinitiation may be required if information reveals changes in reporting behavior.

$$\begin{aligned}&Expected\ Annual\ Unreported\ Captures\\&= (Expected\ Annual\ Reported\ Captures \div 8\%) \times 92\%\\&= (0.7333\ \div 0.08) \times 0.92\\&= \ 8.4333\ per\ year\ (\text{Table } 5, Line\ 2)\end{aligned}$$

5.2.1.3 Calculating Total Captures of Sea Turtles

The number of captures in any given year can be influenced by sea temperatures, species abundances, fluctuating salinity levels in estuarine habitats where piers may be located, and other factors that cannot be predicted. For these reasons, we believe basing our future capture estimate on a 1-year estimated capture is largely impractical. Using our experience monitoring other fisheries, a 3-year time period is appropriate for meaningful evaluation of future impacts and monitoring. The triennial takes are set as 3-year running sums (i.e., 2021-2023, 2022-2024, 2023-2025, and so on) and not for static 3-year periods (i.e., 2021-2023, 2024-2026, 2026-2028, and so on). This approach reduces the likelihood of reinitiation of the formal consultation process because of inherent variability in captures, while still allowing for an accurate assessment of how the proposed action is performing versus our expectations. Table 5 shows the projected total sea turtle captures at the consultation pier for any 3-year consecutive period based on the expected annual reported and unreported captures.

Table 5. Summary of Expected Captures of Sea Turtles

Captures	Total
1. Expected Annual Reported	0.7333
2. Expected Annual Unreported	8.4333
Annual Total	9.1667
Triennial (3-year) Total	27.5000

5.2.2 Estimating Total Post Release Mortality of Sea Turtles

5.2.2.1 Estimating Post Release Mortality for Reported Captures of Sea Turtles

Almost all sea turtles that are captured, landed, and reported to the STSSN are evaluated by a trained veterinarian to determine if they can be immediately released alive or require a rehabilitation facility; exceptions may happen if the sea turtle breaks free before help can arrive. Sea turtles that are captured and reported to the STSSN may die onsite, may be evaluated, released alive, and subsequently suffer post-release mortality (PRM) later, or may be evaluated and taken to a rehabilitation facility. Those taken to a rehabilitation facility may be released alive at later date or be kept in rehabilitation indefinitely (either due to serious injury or death). We consider those that are never returned to the wild population to have suffered PRM because they will never again contribute to the population. The risk of PRM to sea turtles from reported hook-and-line captures will depend on numerous factors, including how deeply the hook is embedded, whether or not the hook was swallowed, whether the sea turtle was released with trailing line, how soon and how effectively the hooked sea turtle was de-hooked or otherwise cut loose and released.

We believe the 10-year STSSN dataset for offshore recreational hook and line captures and entanglements in Zone 26 is the most accurate representation of PRM for reported captures of sea turtles in the action area because this dataset pertains specifically to Florida where future reported captures are anticipated to occur. Table 6 provides a breakdown of final disposition of the 139 sea turtles caught or entangled in recreational hook-and-line gear in the STSSN dataset for offshore Zone 26.

Table 6. Final Disposition of Sea Turtles from Reported Recreational Hook-and-Line Captures and Gear Entanglements in Offshore Zone 26, 2007-2016 (n=139)

	Dead or Died Onsite	Released Alive Immediately (Not Evaluated)	Released Alive, Immediately (Evaluated)	Taken to Rehab, Released Alive Later	Taken to Rehab, Kept or Died in Rehab
Number of Records	54	1	3	54	27
Percentage	38.85	0.72	2.16	38.85	19.42

Of the 139 sea turtles reported captured on recreational hook-and-line or entangled in gear in offshore Zone 26, 58.27% were removed from the wild population either through death or being unable to be released from the rehabilitation facility (i.e., lethal captures, 38.85 + 19.42) and 41.73% were released alive back into the wild population (i.e., non-lethal captures, 0.72 + 2.16 + 38.85).

To calculate the annual estimated lethal captures of reported sea turtles at the consultation pier, we use the following equation:

$$\begin{aligned}
&Annual\ Lethal\ Reported\ Captures \\
&= Expected\ Annual\ Reported\ Captures\ [\text{Table 5}, Line\ 1] \\
&\qquad\qquad \times Lethal\ Captures\ [calculated\ from\ \text{Table 5}] \\
&= 0.7333 \times 58.27\% \\
&= 0.4273\ per\ year\ (\text{Table 10}, Line\ 1A)
\end{aligned}$$

To calculate the estimated annual non-lethal captures of reported sea turtles at the consultation pier, we use the following equation:

$$
\begin{aligned}
&Annual\ Non - lethal\ Reported\ Captures\\
&= Expected\ Annual\ Reported\ Captures\ [\text{Table } 5, Line\ 1] \times Non\\
&\qquad\qquad - lethal\ Captures\ [calculated\ from\ Table\ 5]\\
&= 0.7333 \times 41.73\%\\
&= 0.3060\ per\ year\ (\text{Table } 10, Line\ 1B)
\end{aligned}
$$

5.2.2.2 Estimating Post-Release Mortality for Unreported Captures of Sea Turtles

Sea turtles that are captured and not reported to the STSSN may be released alive and subsequently suffer PRM. The risk of PRM to sea turtles from hook-and-line captures will depend on numerous factors, including how deeply the hook is embedded, whether or not the hook was swallowed, whether the sea turtle was released with trailing line, how soon and how effectively the hooked sea turtle was de-hooked or otherwise cut loose and released, and other factors which are discussed in more detail below. While the preferred method to release a hooked sea turtle safely is to bring it ashore and de-hook/disentangle it there and release it immediately, that cannot always be accomplished. The next preferred technique is to cut the line as close as possible to the sea turtle's mouth or hooking site rather than attempt to pull the sea turtle up to the pier. Some incidentally captured sea turtles are likely to break free on their own and escape with embedded/ingested hooks and/or trailing line. Because of considerations such as the tide, weather, and the weight and size of a hooked captured sea turtle, some will not be able to be de-hooked, and will be cut free by anglers and intentionally released. These sea turtles will escape with embedded or swallowed hooks, or trailing varying amounts of fishing line, which may cause post-release injury or death.

In January 2004, NMFS convened a workshop of experts to develop criteria for estimating PRM of sea turtles caught in the pelagic longline fishery based on the severity of injury. In 2006, those criteria were revised and finalized (Ryder, Conant, & Schroeder, 2006). In February 2012, the Southeast Fisheries Science Center updated the criteria again by adding 3 additional hooking scenarios, bringing the total to 6 categories of injury (NMFS2012a). Table 7 describes injury categories for hardshell sea turtles captured on hook-and-line gear and the associated PRM estimates for sea turtles released with hook and trailing line greater than or equal to half the length of the carapace (i.e., Release Condition B as defined in (NMFS, 2012). We use these criteria when estimating the PRM for unreported captures of sea turtles because it accounts for the expected differences in handling and care of reported versus unreported sea turtles.

Table 7. Estimated Post Release Mortality Based on Injury Category for Hardshell Sea Turtles Captured via Commercial Pelagic Longline and Released in Release Condition B (NMFS, 2012).

Injury Category	Description	Post-release Mortality
I	Hooked externally with or without entanglement	20%
II	Hooked in upper or lower jaw with or without entanglement—includes ramphotheca (i.e., beak), but not any other jaw/mouth tissue parts	30%
III	Hooked in cervical esophagus, glottis, jaw joint, soft palate, tongue, and/or other jaw/mouth tissue parts not categorized elsewhere, with or without entanglement—includes all events where the insertion point of the hook is visible when viewed through the mouth.	45%
IV	Hooked in esophagus at or below level of the heart with or without entanglement—includes all events where the insertion point of the hook is not visible when viewed through the mouth	60%
V	Entangled only, no hook involved	50%*
VI	Comatose/Resuscitated	60%**

*There is no PRM estimate of Release Condition B for Injury Category V. For Injury Category V, we believe it is prudent to use the PRM for Release Condition A (Released Entangled) because we know the sea turtle was released entangled without a hook, but we do not know how much line was remaining.

**For Injury Category 6, we believe it is prudent to use the PRM Release Condition D (Released with All Gear Removed) because we believe that if a fisher took the time to resuscitate the sea turtle, then it is likely the fisher also took the time to disentangle the animal completely before releasing it back into the wild

PRM varies based on the initial injury the animal sustained and the amount of gear left on the animal at the time of release. Again, we will rely on the STSSN dataset we used in Table 6 because this data includes on what part of the body the sea turtle was hooked for 132 of the 139 interactions (Table 8).

Table 8. Category of Injury of Sea Turtles from Reported Recreational Hook-and-Line Captures and Gear Entanglements in Zone 26, 2007-2016 (n=132)

Injury Category*	I	II	III	IV	V	VI
Number	33	0	32	14	53	0
Percentage	25.00	0	24.24	10.61	40.15	0

*SERO PRD assigned an Injury Category of 0 to all records with unknown hooking and entanglement locations. We exclude Injury Category 0 from the calculation because we are unsure of the location and therefore cannot assign a corresponding PRM. In this case, there are 7 interactions with an unknown hooking/entanglement location in the dataset.

As above, we assume that 8% of the sea turtles captured at the pier will be reported, and that reported turtles will be sent to rehabilitation if needed. To estimate the fate of the 92% of sea turtles expected to go unreported at the consultation pier, and therefore un-evaluated or rehabilitated, we use the estimated PRM for the injury categories in Table 7 along with the percentage of captures in each injury category in Table 8 to calculate the weighted PRM for each injury category. We then sum the weighted PRMs across all injury categories to determine the overall PRM for sea turtles (Table 9). This overall rate helps us account for the varying severity of future injuries and varying PRM associated with these injuries. Based on the assumptions we have made about the percentage of sea turtles that will be released alive without rehabilitation, the hooking location, and the amount of fishing gear likely to remain on an animal released immediately at the pier, we estimate a total weighted PRM of 42.35% for the 92% of sea turtles captured, unreported, and released immediately at the consultation pier.

Table 9. Estimated Weighted and Overall Post Release Mortality for Sea Turtles Captured, Unreported, and Released Immediately

Injury Category	PRM (%) [from Table 6]	Percentage [from Table 7]	% Weighted PRM*
I	20	25.00	5.0
II	30	0	0
III	45	24.24	10.91
IV	60	10.61	6.36
V	50	40.15	20.08
VI	60	0	0
		Total % Weighted PRM	42.35

*% Weighted PRM = % PRM × % Captures for each category

To calculate the estimated annual lethal captures of unreported sea turtles at the consultation pier, we use the following equation:

$$
\begin{aligned}
&Annual\ Unreported\ Lethal\ Captures\\
&= \ Annual\ Unreported\ Captures\ [\text{Table 5}, Line\ 2] \times Total\ Weighted\ PRM\ [\text{Table 9}]\\
&= 8.4333\ \times 42.35\%\\
&= 3.5714\ per\ year\ (\text{Table 10}, Line\ 2A)
\end{aligned}
$$

If the equation for calculating annual lethal captures of unreported sea turtles multiplies the annual unreported captures by the total weighted PRM of 42.35%, then the equation for calculating annual non-lethal captures of unreported sea turtles would multiply the annual unreported captures by 57.65% (100% – 42.35%). Therefore, to calculate the estimated annual non-lethal captures of unreported sea turtles at the consultation pier, we use the following equation:

$$
\begin{aligned}
&Annual\ Unreported\ Non-lethal\ Captures\\
&= Annual\ Unreported\ Captures\ [\text{Table 5}, Line\ 2] \times 50.9\%\\
&= 8.4333 \times 57.65\%\\
&= 4.8619\ per\ year\ (\text{Table 10}, Line\ 2B)
\end{aligned}
$$

5.2.2.3 Calculating Total Post Release Mortality of Sea Turtles

As we discussed above, we use a 3-year running total to evaluate future impacts to sea turtles due to PRM. Table 10 shows the total sea turtle captures at the consultation pier for any 3-year consecutive period based on the expected annual lethal and non-lethal reported and unreported captures.

Table 10. Summary of Post Release Mortality of Sea Turtles

Captures	A. Lethal	B. Non-lethal
1. Annual Reported Captures	0.4273	0.3060
2. Annual Unreported Captures	3.5714	4.8619
Annual Total	3.9987	5.1679
Triennial (3-year) Total	11.9962	15.5038

5.2.3 Estimating Captures of Sea Turtles by Species

Of the sea turtles in the STSSN Zone 26 offshore (ocean-facing) data identifiable to species and which may be adversely affected by the proposed action (n=139), 76.26% were green (n=106), 2.88% were Kemp's ridley (n=4), 13.67% were loggerhead (n=19), and 7.19% were hawksbill sea turtles (n= 10) (Table 2). We will assume this is the same potential species composition for future captures at the consultation pier because this is the best available data regarding the relative abundance of sea turtle species that may be affected by hook and line gear in the action area. Table 11 estimates the number of lethal and non-lethal captures by sea turtles species for any consecutive 3-year period based on our calculations from Sections 5.2.2.1 and 5.2.2.2. To be conservative to the individual species, numbers of captures are rounded up to the nearest whole number. While this results in an increase in the total number of sea turtles, compared to what is presented in the non-species-specific total estimates in Table 5 and Table 10, this approach is most conservative to the species, ensures that we are adequately analyzing the effects of the proposed action on whole animals, and that impacts from the proposed action can be more easily tracked. The impacts of future captures to the individual green sea turtle DPSs are discussed in the Jeopardy Analysis (Section 7) and presented in the Incidental Take Statement (Section 9).

Table 11. Estimated Captures of Sea Turtle Species for Any Consecutive 3-Year Period

Species	Lethal Captures	Non-lethal Captures	Total Captures
Green sea turtle (NA or SA DPS)	10 (11.9962 × 0.7626 = 9.1482)	12 (15.5038 × 0.7626 = 1.5753)	22
Kemp's ridley sea turtle	1 (11.9962 × 0.0288 = 0.3452)	1 (15.5038 × 0.0288 = 1.2889)	2
Loggerhead sea turtle (NWA DPS)	2 (11.9962 × 0.1367 = 1.6398)	3 (15.5038 × 0.1367 = 2.7210)	5
Hawksbill sea turtle	1 (11.9962 × 0.0719 = 0.8630)	2 (15.5038 × 0.0719 = 1.1154)	3

5.3 Smalltooth Sawfish

5.3.1 Estimating Reported Captures of Smalltooth Sawfish

We believe the best available data to estimate future reported recreational hook-and-line captures of smalltooth sawfish at public fishing structures comes from the historic reported captures at similar structures obtained from SSRIT data, and any additional information regarding captures at the structure under consultation. The SSRIT data contains number and location of smalltooth sawfish recreational hook-and-line captures that were reported; it does not provide the total number of potential public fishing structures available in a particular zone, and NMFS does not have that information. Below, we discuss why this is the best available information to estimate the expected annual number of reported recreational hook-and-line captures of smalltooth sawfish at the Fisherman's Pier in the future.

As previously stated, the Fisherman's Pier is located in Broward County, Florida. The SSRIT data for Broward County since the species was listed contains 1 reported capture of smalltooth sawfish at the Fisherman's Pier (years 2003-2017). There was also 1 reported recreational hook-and-line capture of smalltooth sawfish at 1 similar ocean-facing, public fishing structure in Broward County during this period. Because this fishing structures is in a similar habitat and location as the Fisherman's Pier (i.e., ocean-facing, coastal Broward County), we assume smalltooth sawfish behavior and density is the same at both locations. Because the fishing structures are of a similar size, they likely have similar angler effort. Further, we assume anglers fishing at these structures use similar baits, equipment, and fishing techniques. Therefore, the potential for interactions with smalltooth sawfish is likely the same at both locations.

Whether those interactions with smalltooth sawfish are reported varies depending on a number of factors, including whether there are educational signs encouraging reporting and angler behavior; sometimes anglers do not report encounters with ESA-listed species due to concerns over their personal liability or public perception at the time of the capture even if there are posted signs. Given this variability, it is difficult to estimate reporting behavior. However, we assume that similar fishing structures within the same area (in this case, ocean-facing, coastal Broward County) would have similar reporting rates. Because they are in similar geographic locations, we assume public perception about reporting and angler reporting behavior is likely the same. Therefore, even though the historic reported hook-and-line captures are different between these structures, the potential for reported captures is the same at both locations.

Thus, we believe the best available data to estimate the number of future reported recreational hook-and-line captures of smalltooth sawfish at the Fisherman's Pier can be determined by taking the average of the historic reported recreational hook-and-line captures at the similar fishing structures in the ocean-facing, coastal Broward County SSRIT dataset. Averaging the data in this way helps smooth variability in both the potential for interactions and in reporting behavior among the locations and over time, providing for a more accurate overall estimate of future reported captures at the consultation pier. There is no additional information that can be used to estimate potential reported interactions.

To calculate the average number of reported hook-and-line captures at these similar fishing structures in ocean-facing, coastal Broward County, we use available SSRIT data and the following equation:

$$Average\ Reported\ Captures\ Per\ Structure\ in\ 15\ years$$
$= Sum\ of\ Reported\ Captures\ in\ 15\ years \div 2\ Locations$
$= 2 \div 2$
$= 1.0\ per\ structure\ in\ 15\ years$

To calculate the estimated expected annual number of reported recreational hook-and-line captures of smalltooth sawfish at the Fisherman's Pier, we refer to the information on the similar structures above and use the following equation:

$Expected\ Annual\ Reported\ Captures$
$= Average\ Reported\ Captures\ Per\ Structure\ in\ 15\ years \div 15\ years$
$= 1.0 \div 15$
$= 0.0667\ per\ structure\ per\ year$ (Table 12, $Line$ 1)

5.3.2 Estimating Unreported Captures of Smalltooth Sawfish

While we believe the best available information for estimating expected reported captures at the Fisherman's Pier is the average of the historic reported recreational hook-and-line captures at the similar fishing structures in the ocean-facing, coastal Broward County SSRIT dataset, we also recognize the need to account for unreported captures. As previously discussed, only 2 fishing pier surveys aimed at collecting data regarding unreported recreational hook-and-line captures of ESA-listed species have been conducted in the Southeast. Like above, we will use the unreported rate from Hill (2013). Hill (2013) found that only 12% of anglers would have reported a smalltooth sawfish hook-and-line capture (i.e., 88% of anglers would not have reported a smalltooth sawfish capture).

Below, we will address unreported captures by assuming that the expected annual reported captures of 0.0667 smalltooth sawfish per year represents 12% of the actual captures and 88% of captures will be unreported. We believe it is most conservative to use the unreported rate in the Hill (2013) fishing pier study to estimate the future unreported captures. The study was located in Florida, and is a reasonable proxy for reporting behavior at the Fisherman's Pier. In addition, in the absence of additional information on factors that might affect angler reporting behavior, such as similarity of outreach and education, signage, or culture, we will err on the side of the species and assume fewer interactions were reported, as this will result in a higher total expected interactions. Reinitiation may be required if information reveals changes in reporting behavior.

Therefore, to calculate the expected annual number of unreported recreational hook-and-line captures of smalltooth sawfish, we use the equation:

$Expected\ Annual\ Unreported\ Captures$
$= (Expected\ Annual\ Reported\ Captures \div 12\%) \times 88\%$
$= (0.0667 \div 0.12) \times 0.88$
$= 0.5333\ per\ structre\ per\ year$ (Table 12, $Line$ 2)

5.3.3 Calculating Total Captures of Smalltooth Sawfish

As previously discussed, we believe using a 3-year period is appropriate for meaningful monitoring. Table 12 presents the estimated smalltooth sawfish captures at the Fisherman's Pier for any 3-year consecutive period based on the expected annual reported and unreported captures calculated above.

Table 12. Summary of Expected Captures of Smalltooth Sawfish

Captures	Total
1. Expected Annual Reported	0.0667
2. Expected Annual Unreported	0.5333
Annual Total	0.600
Triennial (3-year) Total	1.800

We round 1.8 up to 2 to account for the capture of whole animals in our Jeopardy analysis. Therefore, we estimate that up to 2 smalltooth sawfish could be caught at the Fisherman's Pier during any consecutive 3-year period. As previously stated, we believe that all captures of smalltooth sawfish will be non-lethal with no associated PRM

5.4 Giant Manta Ray

The MMF conducts annual visual surveys between Jupiter Inlet and Boynton Beach Inlet, Florida. This is a known area of high abundance for juvenile giant manta ray. From 2016-2019, MMF documented 59 unique giant manta ray in the survey area, of which 16 were entangled in fishing line or foul-hooked (J. Pate, MMF, unpublished data). In the absence of better data, we assume that all giant manta ray observed entangled or foul-hooked were due to recreational fishing interactions from fishing piers. There are 4 public fishing piers between Jupiter Inlet and Boynton Beach Inlet, Florida. Because these piers are similar in size and location (i.e., relatively large, public ocean-facing or inlet piers), they likely have similar angler effort. We also assume anglers fishing from these piers use similar baits, equipment, and fishing techniques. Therefore, if we believe that the potential for interactions with giant manta ray is likely the same at all 4 piers in the survey area, then approximately 4 animals were entangled or foul-hooked per pier (16 unique animals observed entangled or foul-hooked in 4 years ÷ 4 piers in survey area). This equates to 1 recreational fishing interaction per pier per year in the survey area. This analysis is likely an overestimation of giant manta ray interactions that may occur at the consultation pier because the survey occurred in a known area of high abundance; however, it is the best available data we have and most conservative to the species. As discussed above, we believe using a 3-year period is appropriate for meaningful monitoring. Therefore, up to 3 interactions with giant manta ray at the consultation pier may occur in any consecutive 3-year period. As previously stated, we believe that all captures of giant manta ray will be non-lethal with no associated PRM.

6 CUMULATIVE EFFECTS

ESA Section 7 regulations require NMFS to consider cumulative effects in formulating its Opinions (50 CFR 402.14). Cumulative effects include the effects of future state, tribal, local, or private actions that are reasonably certain to occur in the action area considered in this Opinion (50 CFR 402.02).

At this time, we are not aware of any non-federal actions, beyond those discussed in the Environmental Baseline section, being planned or under development in the action area which would have effects to green sea turtle (NA and SA DPSs), Kemp's ridley sea turtle, loggerhead sea turtle (NWA DPS), hawksbill sea turtle, smalltooth sawfish, or giant manta ray. Within the action area, major future changes are not anticipated in these ongoing human activities. The present, major human uses of the action area are expected to continue at the present levels of intensity in the near future.

Many threats to green sea turtle (NA and SA DPSs), Kemp's ridley sea turtle, loggerhead sea turtle (NWA DPS), hawksbill sea turtle, smalltooth sawfish, and giant manta ray are expected to be exacerbated by the effects of global climate change. These threats are the same as those previously discussed in Section 3.3, 3.4, and 3.5.

7 JEOPARDY ANALYSIS

The analyses conducted in the previous sections of this Opinion serve to provide a basis to determine whether the proposed action is likely to jeopardize the continued existence of green sea turtle (NA and SA DPS), Kemp's ridley sea turtle, loggerhead sea turtle (NWA DPS), hawksbill sea turtle, smalltooth sawfish (U.S. DPS), and giant manta ray. In the Effects of the Action, we outlined how the proposed action would affect these species at the individual level and the extent of those effects in terms of the number of associated interactions, captures, and mortalities of each species to the extent possible based on the best available data. Now we assess each of these species' responses to this impact, in terms of overall population effects, and whether those effects of the proposed actions, when considered in the context of the Status of the Species, the Environmental Baseline, and the Cumulative Effects, are likely to jeopardize the continued existence of ESA-listed species in the wild. To "jeopardize the continued existence of" means to "engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and the recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species" (50 CFR 402.02). Thus, in making this determination for each species, we must look at whether the proposed actions directly or indirectly reduce the reproduction, numbers, or distribution of a listed species. Then, if there is a reduction in 1 or more of these elements, we evaluate whether it would be expected to cause an appreciable reduction in the likelihood of both the survival and the recovery of the species.

The NMFS and USFWS's ESA Section 7 Handbook (USFWS and NMFS, 1998) defines survival and recovery, as they apply to the ESA's jeopardy standard. Survival means "the species' persistence . . . beyond the conditions leading to its endangerment, with sufficient resilience to allow recovery from endangerment." Survival is the condition in which a species continues to exist into the future while retaining the potential for recovery. This condition is characterized by a sufficiently large population, represented by all necessary age classes, genetic heterogeneity, and number of sexually mature individuals producing viable offspring, which exists in an environment providing all requirements for completion of the species' entire life cycle, including reproduction, sustenance, and shelter. Recovery means "improvement in the status of a listed species to the point at which listing is no longer appropriate under the criteria set out in Section 4(a)(1) of the Act." Recovery is the process by which species' ecosystems are restored and/or threats to the species are removed so self-sustaining and self-regulating populations of listed species can be supported as persistent members of native biotic communities.

The status of each listed species likely to be adversely affected by the proposed action is reviewed in the Status of the Species. For any species listed globally, a jeopardy determination must find that the proposed actions will appreciably reduce the likelihood of survival and recovery at the global species range (i.e., in the wild). For any species listed as DPSs, a jeopardy determination must find that the proposed actions will appreciably reduce the likelihood of survival and recovery of that DPS.

7.1 Green Sea Turtles (NA and SA DPSs)

Within U.S. waters, individuals from both the NA and SA DPS of green sea turtle can be found on foraging grounds. While there are currently no in-depth studies available to determine the percent of NA and SA DPS individuals in any given location, On the Atlantic coast of Florida, a study on the foraging grounds off Hutchinson Island found that approximately 5% of the turtles sampled came from the Aves Island/Suriname nesting assemblage, which is part of the SA DPS (Bass & Witzell, 2000). This information suggests that the vast majority of the anticipated captures in the southern Atlantic Ocean are likely to come from the NA DPS. However, it is possible that animals from the SA DPS could be captured during the proposed action. For these reasons, we will act conservatively and conduct 2 jeopardy analyses (1 for each DPS). The NA DPS analysis will assume based on Bass and Witzell (2000) that 95% of animals adversely affected during the proposed actions are from that DPS. The SA DPS analysis will assume that 5% of the green sea turtles adversely affected by the proposed action are from that DPS.

In Section 5.2.2.1, we presented the breakdown of the final disposition of the 139 sea turtles reported caught or entangled in recreational hook-and-line gear in the STSSN dataset for offshore Zone 26. We then estimated that 58.27% of those sea turtles were removed from the wild population either through death or being unable to be released from the rehabilitation facility (Table 5). Applying that same percentage here to estimate lethal captures of green sea turtles during any 3-year consecutive period at the consultation pier, we estimate the following:

- Up to 21 green sea turtles will come from the NA DPS, of which 13 will be lethal captures (58.27% of 21 is 12.24, rounded up to 13) and 8 will be non-lethal captures, and
- Up to 2 green sea turtles will come from the SA DPS, of which both will be lethal captures (58.27% of 2 is 1.17, rounded up to 2).

We note that rounding when splitting the take into lethal and non-lethal captures results in a higher estimate of lethal take than the 3-year total (i.e., 15 instead of 10). This approach provides a conservative estimate for lethal and non-lethal captures at the consultation pier. While we use the higher numbers for purposes of analyzing the likelihood of jeopardy to the DPSs (Section

7.1.1 and 7.1.2), we do not expect more than 10 lethal green sea turtle captures at the consultation pier during any consecutive 3-year period.

7.1.1 NA DPS of Green Sea Turtle

7.1.1.1 Survival

The proposed action is expected to result in capture of up to 21 green sea turtles (13 lethal, 8 non-lethal) from the NA DPS over any consecutive 3-year period. Any potential non-lethal capture during any consecutive 3-year period are not expected to have a measurable impact on the reproduction, numbers, or distribution of the species. The individual suffering non-lethal injuries or stresses is expected to fully recover such that no reductions in reproduction or numbers of green sea turtles are anticipated. The non-lethal captures will occur in the action area, which encompass a small portion of the overall range or distribution of green sea turtles within the NA DPS. Any incidentally caught animals would be released within the general area where caught and no change in the distribution of NA DPS green sea turtles would be anticipated. The potential lethal captures during any consecutive 3-year period would reduce the number of NA DPS green sea turtles, compared to their numbers in the absence of the proposed action, assuming all other variables remained the same. A lethal capture would also result in a reduction in future reproduction, assuming the individual was female and would have survived otherwise to reproduce. For example, as discussed in this Opinion, an adult green sea turtle can lay up to 7 clutches (usually 3-4) of eggs every 2-4 years, with a mean clutch size of 110-115 eggs per nest, of which a small percentage is expected to survive to sexual maturity. The potential lethal captures are expected to occur in a small, discrete area and green sea turtles in the NA DPS generally have large ranges; thus, no reduction in the distribution is expected from the take of these individuals.

Whether the reductions in numbers and reproduction of this species would appreciably reduce the species likelihood of survival depends on the probable effect the changes in numbers and reproduction would have relative to current population sizes and trends. In the Status of Species, we presented the status of the NA DPS, outlined threats, and discussed information on estimates of the number of nesting females and nesting trends at primary nesting beaches. In the Environmental Baseline, we outlined the past and present impacts of all state, federal, or private actions and other human activities in or having effects in the action area that have affected and continue to affect the NA DPS. In the Cumulative Effects, we discussed the effects of future state, tribal, local, or private actions that are reasonably certain to occur within the action area.

In Section 3.3.2, we summarized the available information on number of green sea turtle nesters and nesting trends at NA DPS beaches; all major nesting populations demonstrate long-term increases in abundance (Seminoff et al., 2015). Therefore, nesting at the primary nesting beaches has been increasing over the course of the decades, against the background of the past and ongoing human and natural factors that have contributed to the Status of the Species. We believe these nesting trends are indicative of a species with a high number of sexually mature individuals. In the absence of any total population estimates, nesting trends are the best proxy for estimating population changes. Since the nesting abundance trend information for the NA DPS of green sea turtle is clearly increasing against the background of the past and ongoing human and natural factors that have contributed to the current status of the species, including fishing at the Fisherman's pier, we believe the combined potential lethal take of up to 13 green sea turtles from the NA DPS during any consecutive 3-year period attributed to the continued fishing at the repaired pier will not have any measurable effect on that trend. After analyzing the magnitude of the effects, in combination with the past, present, and future expected impacts to the DPS discussed in this Opinion, we believe that recreational fishing from the consultation pier is not reasonably expected to cause an appreciable reduction in the likelihood of survival of the green sea turtle NA DPS in the wild.

7.1.1.2 Recovery

The NA DPS of green sea turtles does not have a separate recovery plan at this time. However, an Atlantic Recovery Plan for the population of Atlantic green sea turtles (NMFS and USFWS, 1991) does exist. Since the animals within the NA DPS all occur in the Atlantic Ocean and would have been subject to the recovery actions described in that plan, we believe it is appropriate to continue using that Recovery Plan as a guide until a new plan, specific to the NA DPS, is developed. The Atlantic Recovery Plan lists the following relevant recovery objectives over a period of 25 continuous years:

- The level of nesting in Florida has increased to an average of 5,000 nests per year for at least 6 years.
- A reduction in stage class mortality is reflected in higher counts of individuals on foraging grounds.

According to data collected from Florida's index nesting beach survey from 1989-2019, green sea turtle nest counts across Florida index beaches have increased substantially from a low of approximately 267 in the early 1990s to a high of almost 41,000 in 2019 (See Figure 3), and indicate that the first listed recovery objective is being met. There are currently no estimates available specifically addressing changes in abundance of individuals on foraging grounds. Given the clear increases in nesting, however, it is likely that numbers on foraging grounds have increased, which is consistent with the criteria of the second listed recovery objective.

The potential lethal captures of up to 13 green sea turtles from the NA DPS during any consecutive 3-year period will result in a reduction in numbers; however, it is unlikely to have any detectable influence on the recovery objectives and trends noted above, even when considered in the context of the of the Status of the Species, the Environmental Baseline, and Cumulative Effects discussed in this Opinion. Any non-lethal captures would not affect the adult female nesting population or number of nests per nesting season. Thus, the proposed action will not impede achieving the recovery objectives above and will not result in an appreciable reduction in the likelihood of NA DPS green sea turtles' recovery in the wild.

7.1.1.3 Conclusion

The combined potential lethal and non-lethal capture of up to 21 green sea turtles from the NA DPS during any consecutive 3-year period of green sea turtles from the NA DPS associated with the proposed action is not expected to cause an appreciable reduction in the likelihood of either the survival or recovery of the NA DPS of green sea turtle in the wild.

7.1.2 SA DPS of Green Sea Turtle

7.1.2.1 Survival

The proposed action is expected to result in the capture of up to 2 green sea turtles, both of which will be lethal, from the SA DPS over any consecutive 3-year period. The potential lethal captures during any consecutive 3-year period would reduce the number of SA DPS green sea turtles, compared to their numbers in the absence of the proposed action, assuming all other variables remained the same. A lethal capture would also result in a reduction in future reproduction, assuming the individual was female and would have survived otherwise to reproduce. For example, as discussed in this Opinion, an adult green sea turtle can lay up to 7 clutches (usually 3-4) of eggs every 2-4 years, with a mean clutch size of 110-115 eggs/nest, of which a small percentage is expected to survive to sexual maturity. All potential lethal captures are expected to occur in a small, discrete area and green sea turtles in the SA DPS generally have large ranges; thus, no reduction in the distribution is expected from the take of these individuals.

Whether the reductions in numbers and reproduction of this species would appreciably reduce its likelihood of survival depends on the probable effect the changes in numbers and reproduction would have relative to current population sizes and trends. In the Status of Species, we presented the status of the DPS, outlined threats, and discussed information on estimates of the number of nesting females and nesting trends at primary nesting beaches. In the Environmental Baseline, we considered the past and present impacts of all state, federal, or private actions and other human activities in, or having effects in, the action area(s) that have affected and continue to affect this DPS. In the Cumulative Effects, we considered the effects of future state, tribal, local, or private actions that are reasonably certain to occur within the action area(s).

In Section 3.3.2, we summarized available information on number of green sea turtle nesters and nesting trends at SA DPS beaches; some of the largest nesting beaches such as Ascension Island, Aves Island (Venezuela), and Galibi (Suriname) appear to be increasing. Therefore, is likely that nesting at the primary nesting beaches has been increasing over the course of the decades, against the background of the past and ongoing human and natural factors that have contributed to the status of the species. We believe these nesting trends are indicative of a species with a high number of sexually mature individuals. Since the nesting abundance trend information for green sea turtles appears to be increasing against the background of the past and ongoing human and natural factors that have contributed to the current status of the species, including fishing at the Fisherman's pier, we believe lethal capture of up to 2 green sea turtles from the SA DPS during any consecutive 3-year period attributed to continued recreational fishing at the consultation pier will not have any measurable effect on that trend. After analyzing the magnitude of the effects, in combination with the past, present, and future expected impacts to the DPS discussed in this Opinion, we believe that recreational fishing from the consultation pier is not reasonably expected to cause an appreciable reduction in the likelihood of survival of the SA DPS of green sea turtle in the wild.

7.1.2.2 Recovery

Like the NA DPS, the SA DPS of green sea turtles does not have a separate recovery plan in place at this time. However, an Atlantic Recovery Plan for the population of Atlantic green sea turtles (NMFS and USFWS, 1991) does exist. Since the animals within the SA DPS all occur in the Atlantic Ocean and would have been subject to the recovery actions described in that plan, we believe it is appropriate to continue using that Recovery Plan as a guide until a new plan, specific to the SA DPS, is developed. In our analysis for the NA DPS, we stated that the Atlantic Recovery Plan lists the following relevant recovery objectives over a period of 25 continuous years:

- The level of nesting in Florida has increased to an average of 5,000 nests per year for at least 6 years.
- A reduction in stage class mortality is reflected in higher counts of individuals on foraging grounds.

Because the first objective listed above is specific to nesting in Florida, it is specific to the NA DPS, but demonstrates the importance of increases in nesting to recovery. As previously stated, nesting at the primary SA DPS nesting beaches appears to have been increasing over the course of the decades. There are currently no estimates available specifically addressing changes in abundance of individuals on foraging grounds. Given the likely increases in nesting, and likely correlation between increased nesting and increased overall population, it is likely that numbers on foraging grounds also have increased.

The potential lethal capture of up to 2 green sea turtle from the SA DPS during any consecutive 3-year period will result in a reduction in numbers; however, it is unlikely to have any detectable influence on the trends noted above, even when considered in context with the Status of the Species, the Environmental Baseline, and Cumulative Effects discussed in this Opinion. Any non-lethal captures would not affect the adult female nesting population or number of nests per nesting season. Thus, the continued recreational fishing from the consultation pier will not impede achieving the recovery objectives above and will not result in an appreciable reduction in the likelihood of the SA DPS of green sea turtles' recovery in the wild.

7.1.2.3 Conclusion

The potential lethal capture of 2 green sea turtles from the SA DPS during any consecutive 3-year period of green sea turtles associated with the proposed action is not expected to cause an appreciable reduction in the likelihood of either the survival or recovery of the SA DPS of green sea turtle in the wild.

7.2 Kemp's Ridley Sea Turtle

7.2.1 Survival

The proposed action is expected to result in the capture of up to 2 Kemp's ridley sea turtles (1 lethal, 1 non-lethal) during any consecutive 3-year period. Any potential non-lethal capture is not expected to have any measurable impact on the reproduction, numbers, or distribution of the species. The individual suffering non-lethal injuries or stresses are expected to fully recover such that no reductions in reproduction or numbers of Kemp's ridley sea turtles are anticipated. A non-lethal capture will occur in the action area, which encompasses a small portion of this species overall range/distribution. Any incidentally caught animal would be released within the general area where caught and no change in the distribution of Kemp's ridley sea turtles would be anticipated. The potential lethal captures during any consecutive 3-year period would reduce the species' population compared to the number that would have been present in the absence of the proposed actions, assuming all other variables remained the same. The Turtle Expert Working Group (TEWG, 1998b) estimates age at maturity from 7-15 years for this species. Females return to their nesting beach about every 2 years (TEWG, 1998b). The mean clutch size for Kemp's ridley sea turtle is 100 eggs per nest, with an average of 2.5 nests per female per season. A lethal capture could also result in a potential reduction in future reproduction, assuming at least one of these individuals would be female and would have survived to reproduce in the future. The loss could preclude the production of thousands of eggs and hatchlings, of which a fractional percentage would be expected to survive to sexual maturity. Thus, the death of any females would eliminate their contribution to future generations, and result in a reduction in sea turtle reproduction. However, the potential lethal take during any consecutive 3-year period is expected to occur in a small, discrete area and Kemp's ridley sea turtle generally have large ranges; thus, no reduction in the distribution is expected from the take of these individuals.

Whether the reductions in numbers and reproduction of this species would appreciably reduce its likelihood of survival depends on the probable effect the changes in numbers and reproduction would have relative to current population sizes and trends. In the Status of Species, we presented the status of the Kemp's ridley sea turtle, outlined threats, and discussed information on estimates of the number of nesting females and nesting trends at primary nesting beaches. In the Environmental Baseline, we considered the past and present impacts of all state, federal, or private actions and other human activities in, or having effects in, the action area(s) that have affected and continue to affect this DPS. In the Cumulative Effects, we considered the effects of future state, tribal, local, or private actions that are reasonably certain to occur within the action area(s).

In the absence of any total population estimates, nesting trends are the best proxy for estimating population changes. It is important to remember that with significant inter-annual variation in nesting data, sea turtle population trends necessarily are measured over decades and the long-term trend line better reflects the population trend. In Section 3.3.3, we summarized available information on number of Kemp's ridley sea turtle nesters and nesting trends. At this time, it is unclear whether the increases and declines in Kemp's ridley nesting seen over the past decade at nesting beaches in Mexico, or the similar trend with the emerging Texas population, represents a population oscillating around an equilibrium point or if nesting will decline or increase in the future. With the recent period of increases in nesting (2015-17) bookended by recent periods of declining numbers of nests (2013-14 and 2018-19), it is too early to tell whether the long-term trend line is affected; however, there may be cause for concern. Nonetheless, the full data set from 1990 to present continues to support the conclusion that Kemp's ridley sea turtles are increasing in population size. We believe these nesting trends are indicative of a species with a high number of sexually mature individuals. Since the nesting trend information is increasing against the background of the past and ongoing human and natural factors that have contributed to the current status of the species, including fishing at the Fisherman's pier, we believe the potential lethal capture of 1 Kemp's ridley sea turtle during any consecutive 3-year period will not have any measurable effect on that trend. After analyzing the magnitude of the effects, in combination with the past, present, and future expected impacts to the DPS discussed in this Opinion, we believe that continued recreational fishing from the proposed pier is not reasonably expected to cause an appreciable reduction in the likelihood of survival of Kemp's ridley sea turtle in the wild.

7.2.2 Recovery

As to whether the consultation pier will appreciably reduce the species' likelihood of recovery, the recovery plan for the Kemp's ridley sea turtle (NMFS, USFWS, & SEMARNAT, 2011a) lists the following relevant recovery objective:

- A population of at least 10,000 nesting females in a season (as measured by clutch frequency per female per season) distributed at the primary nesting beaches (Rancho Nuevo, Tepehuajes, and Playa Dos) in Mexico is attained. Methodology and capacity to implement and ensure accurate nesting female counts have been developed.

The recovery plan states the average number of nests per female is 2.5; it sets a recovery goal of 10,000 nesting females associated with 25,000 nests. The 2012 nesting season recorded approximately 22,000 nests in Mexico. Yet, in 2013 through 2014, there was a significant decline, with only 16,385 and 11,279 nests recorded, respectively, which would equate to 6,554 nesting females in 2013 (16,385 ÷ 2.5) and 4,512 in 2014 (11,279 ÷ 2.5). Nest counts increased 2015-2017, they did not reach 25,000 by 2017, and they decreased 2018-2019; however, it is clear that the population has increased over the last 2 decades. The increase in Kemp's ridley sea turtle nesting is likely due to a combination of management measures including elimination of direct harvest, nest protection, the use of TEDs, reduced trawling effort in Mexico and the U.S., and possibly other changes in vital rates (TEWG, 1998a, 2000).

The potential lethal capture of 1 Kemp's ridely sea turtle during any consecutive 3-year period by recreational fishing at the pier will result in a reduction in numbers and reproduction; however, it is unlikely to have any detectable influence on the nesting trends. Given annual nesting numbers are in the thousands, the projected loss is not expected to have any discernable impact to the species. Any non-lethal capture would not affect the adult female nesting population. Thus, continued recreational fishing at the pier will not impede achieving the recovery objectives above and will not result in an appreciable reduction in the likelihood of the Kemp's ridley sea turtles' recovery in the wild.

7.2.3 Conclusion

The combined potential lethal and non-lethal capture of up to 2 Kemp's ridely sea turtles during any consecutive 3-year period of Kemp's ridley sea turtles associated with the proposed action is not expected to cause an appreciable reduction in the likelihood of either the survival or recovery of Kemp's ridley sea turtle in the wild.

7.3 NWA DPS of Loggerhead Sea Turtle

7.3.1 Survival

The proposed action is expected to result in the capture of up to 5 loggerhead sea turtles (2 lethal, 3 non-lethal) from the NWA DPS during any consecutive 3-year period. Any potential non-lethal captures during any consecutive 3-year period are not expected to have a measurable impact on the reproduction, numbers, or distribution of the species. The individual suffering non-lethal injuries or stresses is expected to fully recover such that no reductions in reproduction or numbers of green sea turtles are anticipated. All non-lethal captures will occur in the action area, which encompass a small portion of the overall range or distribution of loggerhead sea turtles within the NWA DPS. Any incidentally caught animals would be released within the general area where caught and no change in the distribution of NWA DPS of loggerhead sea turtles would be anticipated.

The potential lethal captures during any consecutive 3-year period would reduce the number of NWA logerhead sea turtles, compared to their numbers in the absence of the proposed action, assuming all other variables remained the same. Potential lethal captures would also result in a reduction in future reproduction, assuming the individual was female and would have survived otherwise to reproduce. For example, an adult female loggerhead sea turtle can lay approximately 4 clutches of eggs every 3-4 years, with 100-126 eggs per clutch. Thus, the loss of adult females could preclude the production of thousands of eggs and hatchlings of which a small percentage would be expected to survive to sexual maturity. However, the potential lethal take of 2 loggerhead sea turtles during any consecutive 3-year period is expected to occur in a small, discrete area and loggerhead sea turtle generally have large ranges; thus, no reduction in the distribution is expected from the take of these individuals.

Whether the reductions in numbers and reproduction of this species would appreciably reduce its likelihood of survival depends on the probable effect the changes in numbers and reproduction would have relative to current population sizes and trends. In the Status of Species, we presented the status of the DPS, outlined threats, and discussed information on estimates of the number of nesting females and nesting trends at primary nesting beaches. In the Environmental Baseline, we considered the past and present impacts of all state, federal, or private actions and other human activities in, or having effects in, the action area that have affected and continue to affect this DPS. In the Cumulative Effects, we considered the effects of future state, tribal, local, or private actions that are reasonably certain to occur within the action area.

In the absence of any total population estimates, nesting trends are the best proxy for estimating population changes. Abundance estimates in the western North Atlantic indicate the population is large (i.e., several hundred thousand individuals). In Section 3.3.4, we summarized available information on number of loggerhead sea turtle nesters and nesting trends. Nesting trends across all of the recovery units have been steady or increasing over several years against the background of the past and ongoing human and natural factors that have contributed to the current status of the species, including fishing at the Fisherman's pier. Additionally, in-water research suggests the abundance of neritic juvenile loggerheads is steady or increasing.

While the potential lethal capture of 2 loggerhead sea turtles during any consecutive 3-year period will affect the population, in the context of the overall population's size and current trend, we do not expect this loss to result in a detectable change to the population numbers or increasing trend. After analyzing the magnitude of the effects, in combination with the past, present, and future expected impacts to the DPS discussed in this Opinion, we believe the continued fishing at the consultation pier is not reasonably expected to cause an appreciable reduction in the likelihood of survival of the NWA DPS of loggerhead sea turtle in the wild.

7.3.2 Recovery

The recovery plan for the for the Northwest Atlantic population of loggerhead sea turtles (NMFS and USFWS, 2009) was written prior to the loggerhead sea turtle DPS listings. However, this plan deals with the populations that comprise the current NWA DPS and is therefore, the best information on recovery criteria and goals for the DPS. It lists the following recovery objectives that are relevant to the effects of the proposed actions:

- Ensure that the number of nests in each recovery unit is increasing and that this increase corresponds to an increase in the number of nesting females
- Ensure the in-water abundance of juveniles in both neritic and oceanic habitats is increasing and is increasing at a greater rate than strandings of similar age classes

Recovery is the process of removing threats so self-sustaining populations persist in the wild. The proposed actions would not impede progress on carrying out any aspect of the recovery program or achieving the overall recovery strategy. The recovery plan estimates that the population will reach recovery in 50-150 years following implementation of recovery actions. The minimum end of the range assumes a rapid reversal of the current declining trends; the higher end assumes that additional time will be needed for recovery actions to bring about population growth.

Nesting trends have been significantly increasing over several years. The potential lethal capture of up to 2 loggerhead sea turtles during any consecutive 3-year period is so small in relation to the overall population, even when considered in the context of the Status of the Species, the Environmental Baseline, and Cumulative Effects discussed in this Opinion. We believe this is true for both nesting and juvenile in-water populations. The potential non-lethal from the NWA DPS would not affect the adult female nesting population, number of nests per nesting season, or juvenile in-water populations. Thus, continued recreational fishing at the proposed pier will not impede achieving the recovery objectives above and will not result in an appreciable reduction in the likelihood of NWA DPS of loggerhead sea turtles' recovery in the wild.

7.3.3 Conclusion

The combined lethal and non-lethal capture of up to 5 loggerhead sea turtles during any consecutive 3-year period of loggerhead sea turtles associated with the proposed action is not expected to cause an appreciable reduction in the likelihood of either the survival or recovery of the NWA DPS of the loggerhead sea turtle in the wild.

7.4 Hawksbill Sea Turtle

The proposed action may result in the capture of up to 3 hawksbill sea turtles (1 lethal, 2 non-lethal) over any consecutive 3-year period. The potential non-lethal capture of hawksbill sea turtles is not expected to have any measurable impact on the reproduction, numbers, or distribution of the species. The individuals suffering non-lethal injuries or stresses are expected to fully recover such that no reductions in reproduction or numbers of hawksbill sea turtles are anticipated. The captures may occur anywhere in the action area, which encompasses only a tiny portion of hawksbill sea turtles' overall range/distribution. Any incidentally caught animal would be released within the general area where caught and no change in the distribution of hawksbill sea turtles would be anticipated.

Survival

The lethal capture of 1 hawksbill sea turtle during any 3-year consecutive period would reduce the number of hawksbill sea turtles, compared to the number that would have been present in the absence of the proposed action, assuming all other variables remained the same. The potential lethal interaction could also result in a reduction in future reproduction, assuming the individual would be a female and would have survived to reproduce in the future. For example, an adult hawksbill sea turtle can lay 3-5 clutches of eggs every few years (A. Meylan & Donnelly, 1999; Richardson et al., 1999) with up to 250 eggs/nest (Hirth & Latif, 1980). Thus, the loss of a female could preclude the production of thousands of eggs and hatchlings, of which a fraction would otherwise survive to sexual maturity and contribute to future generations. Sea turtles generally have large ranges in which they disperse; thus, no reduction in the distribution of hawksbill sea turtles is expected from this take.

In the absence of any total population estimates for hawksbill sea turtles, nesting trends are the best proxy we have for estimating population changes. The 5-year status review estimated between 21,000 and 28,000 adult females existed in the Atlantic basin at the time of its writing in 2007 (NMFS & USFWS, 2007b); this estimate does not include juveniles of either sex or mature males. Hawksbill nesting trends also indicate an increase over the last 20 years. A survey of historical nesting trends (i.e., 20-100 years ago) for the 33 nesting sites in the Caribbean found declines at 25 of those sites; data were not available for the remaining 8 sites. However, in the last 20 years, nesting trends have been increasing. Of those 33 sites, 9 sites now show an increase in nesting, 11 sites showed a decrease, and data for the remaining 13 were not available (NMFS & USFWS, 2007b). Because of the small impact we believe the proposed action may have on the hawksbill population from the loss of 1 hawksbill sea turtle in any 3-year period and because we believe increases in nesting indicate improving population numbers against the background of the past and ongoing human and natural factors that have contributed to the current status of the species, including fishing at the Fisherman's pier, we do not anticipate the potential loss will have any detectable effect on the total population of hawksbill sea turtles.

Additionally, we do not anticipate the proposed action will have any measurable effect on genetic diversity. Based on the sex ratio of hawksbill sea turtles, there is only a 50% chance that a female would be captured. Furthermore, we have no reason to believe that the proposed action would disproportionately affect females from one rookery over another. This is noteworthy because, regardless of the size of these rookeries, each contributes to species' genetic diversity. Because we believe only 1 lethal take may occur over any consecutive 3-year period, and that take could be from any 1 of these rookeries, we do not believe the proposed action will have a measurable effect on the species' overall genetic diversity. Nor do we believe the anticipated lethal take of 1 hawksbill sea turtle during any 3-year consecutive period will have any noticeable effect on the number of sexually mature individuals that produce viable offspring.

We do not anticipate the proposed action will have any noticeable impact of the population overall, and the action will not cause the population to lose genetic diversity, or the capacity to successfully reproduce. Therefore, we do not believe the proposed action will cause an appreciable reduction in the likelihood of survival of the hawksbill sea turtle in the wild.

Recovery

The Recovery Plan for the population of the hawksbill sea turtles (NMFS & USFWS, 1993) lists the following relevant recovery objectives over a period of 25 continuous years:

Objective: The adult female population is increasing, as evidenced by a statistically significant trend in the annual number of nests at 5 index beaches, including Mona Island and Buck Island Reef National Monument.

- Of the rookeries regularly monitored—Jumby Bay (Antigua/Barbuda), Barbados, Mona Island, and Buck Island Reef National Monument— all show increasing trends in the annual number of nests (NMFS & USFWS, 2007b).

Objective: The numbers of adults, subadults, and juveniles are increasing, as evidenced by a statistically significant trend on at least 5 key foraging areas within Puerto Rico, USVI, and Florida.

- In-water research projects at Mona Island, Puerto Rico, and Marquesas, Florida, which involve the observation and capture of juvenile hawksbill turtles, are underway. Although there are 15 years of data for the Mona Island project, abundance indices have not yet been incorporated into a rigorous analysis or a published trend assessment. The time series for the Marquesas project is not long enough to detect a trend (NMFS & USFWS, 2007b).

Objective: The recovery plan lists 6 major actions that are needed to achieve recovery, including:

- Provide long-term protection to important nesting beaches
- Ensure at least 75% hatching success rate on major nesting beaches
- Determine distribution and seasonal movements of turtles in all life stages in the marine environment
- Minimize threat from illegal exploitation
- End international trade in hawksbill products
- Ensure long-term protection of important foraging habitats

The proposed action could cause the loss of 1 hawksbill sea turtle over any consecutive 3-year period, and that animal may or may not be an adult and may or may not be a female. Compared to the adult female populations at index beaches, which are showing increasing trends in the annual number of nests, we do not believe the potential lethal take associated with the proposed action would have any detectable influence on the magnitude of the trends noted above. Similarly, we do not believe the potential lethal take of 1 hawksbill sea turtle over any consecutive 3-year period will have any detectable influence over the numbers of adults, subadults, and juveniles occurring at 5 key foraging areas. Unlike for other sea turtle species, none of the major actions specified for recovery are specific to fishery bycatch. While incidental capture in commercial and recreational fisheries is listed as one of the threats to the species, the only related action, “Monitor and reduce mortality from incidental capture in fisheries,” is ranked as a Priority 3. The potential effects on hawksbill sea turtles from the proposed action are not likely to reduce overall population numbers over time due to current population sizes and expected recruitment. Thus, we believe the proposed action is not likely to impede the recovery objectives above and will not result in an appreciable reduction in the likelihood of hawksbill sea turtles’ recovery in the wild.

Conclusion

The combined potential lethal and nonlethal capture of up to 3 hawksbill sea turtles associated with the proposed action is not expected to cause an appreciable reduction in the likelihood of either the survival or recovery of hawksbill sea turtles in the wild.

7.5 U.S. DPS of Smalltooth Sawfish

The proposed action is expected to result in the capture of up to 2 smalltooth sawfish over any consecutive 3-year period. We expect all captures to be non-lethal with no associated PRM.

7.5.1 Survival

The potential non-lethal capture of up to 2 smalltooth sawfish over any consecutive 3-year period is not expected to have any measurable impact on the reproduction, numbers, or distribution of this species. The individuals captured are expected to fully recover such that no reductions in reproduction or numbers of this species are anticipated. Since these captures may occur in the small, discrete action area and would be released within the general area where caught, no change in the distribution of smalltooth sawfish is anticipated.

7.5.2 Recovery

The following analysis considers the effects of non-lethal capture on the likelihood of recovery in the wild. The recovery plan for the smalltooth sawfish (NMFS, 2009) lists 3 main objectives as recovery criteria for the species. The 2 objectives and the associated sub-objectives relevant to the proposed action are:

Objective - Minimize Human Interactions and Associated Injury and Mortality

Sub-objective:

- Minimize human interactions and resulting injury and mortality of smalltooth sawfish through public education and outreach targeted at groups that are most likely to interact with sawfish (e.g., fishermen, divers, boaters).
- Develop and seek adoption of guidelines for safe handling and release of smalltooth sawfish to reduce injury and mortality associated with fishing.
- Minimize injury and mortality in all commercial and recreational fisheries.

Objective - Ensure Smalltooth Sawfish Abundance Increases Substantially and the Species Reoccupies Areas from which it had Previously Been Extirpated
Sub-objective:

- Sufficient numbers of juvenile smalltooth sawfish inhabit several nursery areas across a diverse geographic area to ensure survivorship and growth and to protect against the negative effects of stochastic events within parts of their range.
- Adult smalltooth sawfish (> 340 cm) are distributed throughout the historic core of the species' range (both the Gulf of Mexico and Atlantic coasts of Florida). Numbers of adult smalltooth sawfish in both the Atlantic Ocean and Gulf of Mexico are sufficiently large that there is no significant risk of extirpation (i.e., local extinction) on either coast.
- Historic occurrence and/or seasonal migration of adult smalltooth sawfish are reestablished or maintained both along the Florida peninsula into the South-Atlantic Bight, and west of Florida into the northern and/or western Gulf of Mexico.

NMFS is currently funding several actions identified in the Recovery Plan for smalltooth sawfish: adult satellite tagging studies, the ISED, and monitoring take in commercial fisheries to name a few. Additionally, NMFS has developed safe-handling guidelines for the species. Despite the ongoing threats from recreational fishing, we have seen a stable or slightly increasing trend in the population of this species. Thus, the proposed action is not likely to impede the recovery objectives above and will not result in an appreciable reduction in the likelihood of the U.S. DPS of smalltooth sawfish's recovery in the wild. NMFS must continue to monitor the status of the population to ensure the species continues to recover.

The potential non-lethal capture of up to 2 smalltooth sawfish will not affect the population of reproductive adult females. Thus, the recreational fishing effects from the consultation pier will not result in an appreciable reduction in the likelihood of smalltooth sawfish recovery in the wild.

7.5.3 Conclusion

The potential non-lethal capture of up to 2 smalltooth sawfish over any consecutive 3-year period associated with propose action is not expected to cause an appreciable reduction in the likelihood of either the survival or recovery of the U.S. DPS of smalltooth sawfish in the wild.

7.6 Giant Manta Ray

The proposed action is expected to result in the capture of 3 giant manta rays over any consecutive 3-year period. We expect all captures to be non-lethal with no associated PRM.

7.6.1 Survival

The non-lethal capture of giant manta ray over any consecutive 3-year period is not expected to have any measurable impact on the reproduction, numbers, or distribution of this species. The individuals captured are expected to fully recover such that no reductions in reproduction or numbers of this species are anticipated. Since these captures may occur in the small, discrete action area and would be released within the general area where caught, no change in the distribution of giant manta ray is anticipated.

7.6.2 Recovery

A recovery plan for giant manta ray has not yet been developed; however, NMFS published a recovery outline for the giant manta ray (NMFS, 2019). The recovery outline serves as an interim guidance to direct recovery efforts for giant manta ray. The recovery outline identifies two primary interim goals:

1) Stabilize population trends through reduction of threats, such that the species is no longer declining throughout a significant portion of its range; and
2) Gather additional information through research and monitoring on the species' current distribution and abundance, movement and habitat use of adult and juveniles, mortality rates in commercial fisheries (including at-vessel and PRM), and other potential threats that may contribute to the species' decline.

The major threats affecting the giant manta ray were summarized in the final listing rule (83 FR 2619, Publication Date January 22, 2018). The most significant threats to the giant manta ray are overutilization by foreign commercial and artisanal fisheries in the Indo-Pacific and Eastern Pacific and inadequate regulatory mechanisms in foreign nations to protect this species from the heavy fishing pressure and related mortality in these waters outside of U.S. jurisdiction. Other threats that potentially contribute to long-term risk of the species include: (micro) plastic ingestion rates, increased parasitic loads as a result of climate change effects, and potential disruption of important life history functions as a result of increased tourism. However, due to the significant data gaps, the likelihood and impact of these threats on the status of the species is highly uncertain. Recreational fishing interactions are not considered a major threat to this species and we do not believe the proposed action will appreciably reduce the recovery of giant manta ray, by significantly exacerbating effects of any of the major threats identified in the final listing rule.

The individuals suffering non-lethal capture are expected to fully recover such that no reductions in reproduction or numbers of giant manta rays are anticipated. The non-lethal capture will occur at in a discrete location and the action area encompasses only a portion of the overall range or distribution of giant manta rays. Any incidentally caught animal would be released within the general area where caught and no change in the distribution of giant manta rays would be anticipated. Therefore, the non-lethal capture of giant manta rays associated with the proposed action are not expected to cause an appreciable reduction in the likelihood of recovery of the giant manta rays in the wild.

7.6.3 Conclusion

The potential non-lethal capture of 3 giant manta ray over any consecutive 3-year period associated with the proposed action is not expected to cause an appreciable reduction in the likelihood of either the survival or recovery of giant manta ray in the wild.

8 CONCLUSION

After reviewing the Status of the Species, the Environmental Baseline, the Effects of the Action, and the Cumulative Effects using the best available data, it is NMFS's Opinion that the proposed action are not likely to jeopardize the continued existence of the NA or SA DPS of green sea turtle, Kemp's ridley sea turtle, the NWA DPS of loggerhead sea turtle, hawksbill sea turtle, the U.S. DPS of smalltooth sawfish, or giant manta ray.

9 INCIDENTAL TAKE STATEMENT

Section 9 of the ESA and protective regulations issued 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 attempt to engage in any such conduct. *Incidental take* is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of Section 7(b)(4) and Section 7(o)(2), taking that would otherwise be considered prohibited under Section 9 or Section 4(d), but which is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the ESA, provided that such taking is in compliance with the reasonable and prudent measures and the terms and conditions of the Incidental Take Statement (ITS) of the Opinion.

9.1 Anticipated Amount or Extent of Incidental Take

The take limits prescribed in this Opinion that will trigger the requirement to reinitiate consultation are based on the amount of take that we expect *to be reported* as it is not possible to directly monitor the incidents that go unreported. The best available information for estimating the amount of future take of the NA and SA DPS of green sea turtle, Kemp's ridley sea turtle, the NWA DPS of loggerhead sea turtle, hawksbill sea turtle, smalltooth sawfish, and giant manta ray that will be reported at the Fisherman's Pier is described in Section 5. Based on the data collected from the Hill (2013) fishing pier study, we anticipate 92% of sea turtle take and 88% of smalltooth sawfish take will go unreported. The anticipated, unreported takes are not directly monitored but can be estimated from reported takes using the process described in Section 5.2.2.2 (sea turtles) and Section 5.3.2 (smalltooth sawfish).

The take limits shown in Table 13 are our best estimates of the amount of take expected to be reported over any consecutive 3-year period. In Section 5.2.1, we developed an estimate of the total number of sea turtle captures expected to be reported annually (0.7333; Table 5, Line 1). We take that number and multiply by 3 to get the 3-year total estimate of reported sea turtle captures (0.7333 × 3 = 2.1999). We then apply that number to the species breakdown reported in the STSSN inshore data for recreational hook-and-line captures and gear entanglement in Zone 26 (described in Section 5.2) to obtain the 3-year total estimate of reported take of each species of sea turtle. For those estimates that come out to be less than 1, we round up to 1 to reach a whole number that can be used as the take limit. In Section 5.3, we developed an estimate of the total number of smalltooth sawfish captures expected to be reported annually (0.0667; Table 12, Line 1). We take that number and multiply by 3 to get the 3-year total estimate of reported smalltooth sawfish captures (0.0667 × 3 = 0.2001). We round 0.2001 to 1 to reach a whole number that can be used as the take limit. Section 5.4 describes how we calculate the take limit for giant manta ray in the absence of annual reporting data.

Table 13. Incidental Take Limits by Species for Any Consecutive 3-Year Period

Species	Total Estimated Reported Captures	Incidental Take Limits that will Trigger Reinitiation
Green sea turtle (NA or SA DPS)	2.1999 × 0.7626 = 1.6777, rounded up to 2	No more than 2 reported capture*
Kemp's ridley sea turtle	2.1999 × 0.0288 = 0.0633, rounded up to 1	No more than 1 reported capture per year
Loggerhead sea turtle (NWA DPS)	2.1999 × 0.1367 = 0.3007, rounded up to 1	No more than 1 reported capture
Hawksbill sea turtle	2.1999 × 0.0719 = 0.1583, rounded up to 1	No more than 1 reported capture
Smalltooth sawfish (U.S. DPS)	0.0667 × 3 = 0.2001, rounded up to 1	No more than 1 reported capture
Giant manta ray	N/A	No more than 3 reported captures

*We do not expect, and do not authorize, more than 2 green sea turtle take during any consecutive 3-year time period, which may come from either the NA or the SA DPS.

It is important to note that the mortality rates estimated in Section 5.2.2 for sea turtles are not likely to be detected in the initial reporting of captures, as most sea turtles are expected to live for some period following capture. Some of these individuals may be sent to rehabilitation facilities and later die in those facilities, or may be released and die in the wild from undetected injuries, as discussed in our PRM analysis. While it is also possible that some sea turtles may die immediately from severe injuries related to hook and line capture or entanglement (which will be included in the annual reports discussed below [Terms & Conditions (T&Cs)], we do not expect that result. At the time of the interaction, we expect sea turtle take in the above ITS to be non-lethal. As previously discussed in Section 5.2.2.1, up to 58.27% of the reported interactions could result in a mortality, and reports of such PRM are consistent with the analysis in this Opinion and this ITS. Likewise, we expect PRM of the unreported sea turtle interactions, as described in Section 5.2.2.2. Again, we expect all interactions with smalltooth sawfish and giant manta ray (reported and unreported) to be non-lethal with no associated PRM.

9.2 Effect of Take

NMFS has determined that the anticipated incidental take is not likely to jeopardize the continued existence of the green sea turtle (NA and SA DPS), Kemp's ridley sea turtle, loggerhead sea turtle (NWA DPS), hawksbill sea turtle, smalltooth sawfish (U.S. DPS), or giant manta ray.

9.3 Reasonable and Prudent Measures

Section 7(b)(4) of the ESA requires NMFS to issue a statement specifying the impact of any incidental take on a ESA-listed species, which results from an agency action otherwise found to comply with Section 7(a)(2) of the ESA. It also states that the Reasonable and Prudent Measures (RPMs) necessary to minimize the impacts of take and the T&Cs to implement those measures must be provided and must be followed to minimize those impacts. Only incidental taking by the federal action agency or applicant that complies with the specified T&Cs is authorized.

The RPMs and T&Cs are specified as required by 50 CFR 402.14(i)(1)(ii) and (iv) to document the incidental take by the proposed action and to minimize the impact of that take ESA-listed species. These RPMs and T&C are nondiscretionary, and must be implemented by the federal action agency in order for the protection of Section 7(o)(2) to apply. If the applicant fails to adhere to the T&Cs of this ITS through enforceable terms, and/or fails to retain oversight to ensure compliance with these T&Cs, the protective coverage of Section 7(o)(2) may lapse. To monitor the impact of the incidental take, the applicant must report the progress of the action and its impact on the species to NMFS as specified in this ITS [50 CFR 402.14(i)(3)].

NMFS has determined that the following RPMs and associated T&Cs are necessary and appropriate to minimize impacts of the incidental take of ESA-listed species related to the proposed action:

1. The federal action agency must ensure that the applicant provides take reports regarding all interactions with ESA-listed species at the fishing pier(s).
2. The federal action agency must ensure that the applicant minimizes the likelihood of injury or mortality to ESA-listed species resulting from hook-and-line capture or entanglement by activities at the fishing pier(s).
3. The federal action agency must ensure that the applicant reduces the impacts to incidentally captured ESA-listed species.
4. The federal action agency must ensure that the applicant coordinates periodic fishing line removal (i.e., cleanup) events with non-governmental or other local organizations.

9.4 Terms and Conditions

The following T&Cs implement the above RPMs:

1. To implement RPM 1, the federal action agency must ensure that the applicant reports all known angler-reported hook-and-line captures of ESA-listed species and any other takes of ESA-listed species to the NMFS SERO PRD.
    a. If and when the applicant becomes aware of any known reported capture, entanglement, stranding, or other take, the applicant must notify NMFS SERO PRD by email: takereport.nmfsser@noaa.gov.
        i. Emails must reference this Opinion by the NMFS tracking number (SERO-2019-03622 Fisherman's Pier Repair) and date of issuance.
        ii. The email must state the species, date and time of the incident, general location and activity resulting in capture (e.g., fishing from the pier by hook-and-line), condition of the species (i.e., alive, dead, sent to rehabilitation), size of the individual, behavior, identifying features (i.e., presence of tags, scars, or distinguishing marks), and any photos that may have been taken.
    b. Every year, the applicant must submit a summary report of capture, entanglement, stranding, or other take of ESA-listed species to NMFS SERO PRD by email: nmfs.ser.esa.consultations@noaa.gov.
        i. Emails and reports must reference this Opinion by the NMFS tracking number (SERO-2019-03622 Fisherman's Pier Repair) and date of issuance.
        ii. The report will contain the following information: the total number of ESA-listed species captures, entanglements, strandings, or other take that was reported at or adjacent to the piers included in this Opinion.
        iii. The report will contain all information for any sea turtles taken to a rehabilitation facility holding an appropriate USFWS Native Endangered and Threatened Species Recovery permit. This information can be obtained from the appropriate State Coordinator for the STSSN (https://www.fisheries.noaa.gov/state-coordinators-sea-turtle-stranding-and-salvage-network)
        iv. The first report will be submitted by January 31, of the first year of operation post construction. The second report will be submitted by January 31, the following year, and will cover the previous calendar year and the information in the first report. The third report will be submitted by January 31, the next consecutive year, and will cover the prior two calendar years and the information from the first report. The next report will be submitted by January 31, the following year and will cover the prior three calendar years. Thereafter, reports will be prepared every year, covering the prior rolling three-year time period, and emailed no later than January 31 of any year.
        v. Reports will include current photographs of signs and bins required in T&Cs 2, below, and records of the clean-ups required in T&C 3 below.

2. To implement RPMs 2 and 3, the federal action agency must ensure that the applicant must:
    a. Install and maintain the following NMFS Protected Species Educational Sign: 'Save Dolphins, Sea Turtles, Sawfish, and Manta Ray.'
        i. Signs will be posted at least at the entrance to and terminal end of the pier.

        ii. Signs will be installed prior to opening the pier for public use.
        iii. Photographs of the installed signs will be emailed to NMFS's Southeast Regional Office (nmfs.ser.esa.consultations@noaa.gov) with the NMFS tracking number (SERO-2019-03622 Fisherman's Pier Repair) and date of issuance.
        iv. Sign designs and installation methods are provided at the following website: https://www.fisheries.noaa.gov/southeast/consultations/protected-species-educational-signs.
        v. Current photographs of the signs will be included in each report required by T&C 1, above.
    b. Install and maintain monofilament recycling bins and trash receptacles at the piers to reduce the probability of trash and debris entering the water.
        i. Monofilament recycling bins and trash receptacles will be installed prior to opening the pier for public use.
        ii. Photographs of the installed bins will be emailed to NMFS's Southeast Regional Office by email (nmfs.ser.esa.consultations@noaa.gov) with the NMFS tracking number for this Opinion (SERO-2019-03622 Fisherman's Pier Repair) and date of issuance.
        iii. The applicant must regularly empty the bins and trash receptacles and make sure they are functional and upright.
        iv. Additionally, current photographs of the bins will be included in each report required by T&C 1, above.

3. To implement RPMs 2, 3, and 4, the federal action agency must ensure that the applicant must:
    a. Perform at least 1 annual underwater cleanup to remove derelict fishing line and associated gear from around the pier structure.
    b. Submit a record of each cleaning event in the report required by T&C 1 above.

10 CONSERVATION RECOMMENDATIONS

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

NMFS believes the following CRs further the conservation of the listed species that will be affected by the proposed action. NMFS strongly recommends that these measures be considered and implemented by the federal action agency:

Sea Turtles:

- Conduct or fund research that investigates ways to reduce and minimize mortality of sea turtles in the recreational hook-and-line fishery.
- Conduct or fund outreach designed to increase the public's knowledge and awareness of ESA-listed sea turtle species.

Smalltooth sawfish:

- Conduct or fund outreach designed to increase the public's knowledge and awareness of smalltooth sawfish.

Giant manta ray:

- Conduct or fund outreach designed to increase the public's knowledge and awareness of giant manta ray.

In order for NMFS to be kept informed of actions minimizing or avoiding adverse effects or benefiting listed species or their habitats, NMFS requests notification of the implementation of any of these or additional conservation recommendations.

11 REINITIATION OF CONSULTATION

As provided in 50 CFR Section 402.16, reinitiation of formal consultation is required where discretionary federal agency involvement or control over the action has been retained (or is authorized by law) and if (1) the amount or extent of take specified in the ITS is exceeded, (2) new information reveals effects of the action that may affect listed species or critical habitat in a manner or to an extent not previously considered, (3) the identified action is subsequently modified in a manner that causes an effect to listed species or critical habitat that was not considered in the Opinion, or (4) a new species is listed or critical habitat designated that may be affected by the identified action.

12 LITERATURE CITED

81 FR 20057. (2016). Endangered and Threatened Wildlife and Plants; Final Rule To List Eleven Distinct Population Segments of the Green Sea Turtle (*Chelonia mydas*) as Endangered or Threatened and Revision of Current Listings Under the Endangered Species Act. Final Rule. *Federal Register, 81*(66), 20057 -20090.

Ackerman, R. A. (1997). The nest environment and the embryonic development of sea turtles. In P. L. Lutz & J. A. Musick (Eds.), *The Biology of Sea Turtles* (pp. 83-106). Boca Raton, Florida: CRC Press.

Adams, D. H., & Amesbury, E. (1998). Occurrence of the manta ray, *Manta birostris*, in the Indian River Lagoon, Florida. *Florida Scientist, 61*(1), 7-9.

Addison, D. (1997). Sea turtle nesting on Cay Sal, Bahamas, recorded June 2-4, 1996. *Bahamas Journal of Science, 5*(1), 34-35.

Addison, D., & Morford, B. (1996). Sea turtle nesting activity on the Cay Sal Bank, Bahamas. *Bahamas Journal of Science, 3*(3), 31-36.

Aguilar, R., Mas, J., & Pastor, X. (1994). *Impact of Spanish swordfish longline fisheries on the loggerhead sea turtle Caretta caretta population in the western Mediterranean*. Paper presented at the Proceedings of the 12th Annual Workshop on Sea Turtle Biology and Conservation, Jekyll Island, Georgia.

Aguilar, R., Mas, J., & Pastor, X. (1995, February 25-29, 1992). *Impact of Spanish swordfish longline fisheries on the loggerhead sea turtle, Caretta caretta, population in the western*

Mediterranean. Paper presented at the 12th Annual Workshop on Sea Turtle Biology and Conservation, Jekyll Island, Georgia.

Aguirre, A., Balazs, G., Spraker, T., Murakawa, S. K. K., & Zimmerman, B. (2002). Pathology of oropharyngeal fibropapillomatosis in green turtles *Chelonia mydas*. *Journal of Aquatic Animal Health, 14*, 298-304.

Amos, A. F. (1989). *The occurrence of Hawksbills (Eretmochelys imbricata) along the Texas Coast*. Paper presented at the Ninth Annual Workshop on Sea Turtle Conservation and Biology.

Antonelis, G. A., Baker, J. D., Johanos, T. C., Braun, R. C., & Harting, A. L. (2006). Hawaiian monk seal (*Monachus schauinslandi*): Status and conservation issues. *Atoll Research Bulletin, 543*, 75-101.

Arendt, M., Byrd, J., Segars, A., Maier, P., Schwenter, J., D. Burgess, J. B., . . . Blanvillain, G. (2009). *Examination of local movement and migratory behavior of sea turtles during spring and summer along the Atlantic coast off the southeastern United States*. Retrieved from

Baker, J., Littnan, C., & Johnston, D. (2006). *Potential effecfs of sea-level rise on terrestrial habitat and biota of the northwestern Hawaiian Islands*. Paper presented at the Twentieth Annual Meeting Society for Conservation Biology Conference, San Jose, California.

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

Balazs, G. H. (1983). *Recovery records of adult green turtles observed or originally tagged at French Frigate Shoals, Northwestern Hawaiian Islands* (NOAA-TM-NMFS-SWFC-36). Retrieved from

Balazs, G. H. (1985, November 27-29, 1984). *Impact of ocean debris on marine turtles: entanglement and ingestion.* Paper presented at the Proceedings of the workshop on the fate and impact of marine debris, Honolulu, HI.

Balazs, G. H., Pooley, S. G., & Murakawa, S. K. (1995). *Guidelines for handling marine turtles hooked or entangled in the Hawaii longline fishery: Results of an expert workshop held in Honolulu, Hawaii March 15-17,1995*. Retrieved from Honolulu:

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

Bass, A. L., & Witzell, W. N. (2000). Demographic composition of immature green turtles (*Chelonia mydas*) from the east central Florida coast: Evidence from mtDNA markers. *Herpetologica, 56*(3), 357-367. Retrieved from <Go to ISI>://000089615900008

Baughman, J. L. (1943). Notes on sawfish, *Pristis perotteti* Müller and Henle, not previously reported from the waters of the United States. *Copeia, 1943*(1), 43-48. Retrieved from http://www.jstor.org/stable/1437880

Bethea, D. M., Smith, K. L., & Carlson, J. K. (2012). *Relative abundance and essential fish habitat studies for smalltooth sawfish, Prisits pectinata, in southwest Florida, USA*. Retrieved from Panama City, FL:

Bethea, D. M., Smith, K. L., Hollensead, L. D., & Carlson, J. K. (2011). *Relative abundance and essential fish habitat studies for smalltooth sawfish, Pristis pectinata, in southwest Florida, USA.* Retrieved from Panama City, FL:

Bigelow, S. F., & Schroeder, W. C. (1953). Sharks, sawfishes, guitarfishes, skates, rays, and chimaeroids. In J. Tee-Van, C. M. Breder, F. F. Hildebrand, A. E. Parr, & W. E. Schroeder (Eds.), *Fishes of the Western North Atlantic, Part 2* (pp. 1-514). New Haven, CT: Sears Foundation of Marine Research, Yale University.

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

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

Bjorndal, K. A., & Bolten, A. B. (2002). *Proceedings of a workshop on assessing abundance and trends for in-water sea turtle populations* (NMFS-SEFSC-445). Retrieved from

Bjorndal, K. A., Bolten, A. B., & Chaloupka, M. Y. (2005). Evaluating trends in abundance of immature green turtles, *Chelonia mydas*, in the greater Caribbean. *Ecological Applications, 15*(1), 304-314.

Bjorndal, K. A., Bolten, A. B., Dellinger, T., Delgado, C., & Martins, H. R. (2003). Compensatory growth in oceanic loggerhead sea turtles: Response to a stochastic environment. *Ecology, 84*(5), 1237-1249. Retrieved from <Go to ISI>://000184120500017

http://www.esajournals.org/doi/abs/10.1890/0012-9658%282003%29084%5B1237%3ACGIOLS%5D2.0.CO%3B2

Bjorndal, K. A., Wetherall, J. A., Bolten, A. B., & Mortimer, J. A. (1999). Twenty-six years of green turtle nesting at Tortuguero, Costa-Rica: An encouraging trend. *Conservation Biology, 13*(1), 126-134.

Bolten, A., & Witherington, B. (2003). *Loggerhead Sea Turtles*. Washington, D. C.: Smithsonian Books.

Bolten, A. B., Bjorndal, K. A., & Martins, H. R. (1994). Life history model for the loggerhead sea turtle (*Caretta caretta*) populations in the Atlantic: Potential impacts of a longline fishery. In G. J. Balazs & S. G. Pooley (Eds.), *Research Plan to Assess Marine Turtle Hooking Mortality* (Vol. Technical Memorandum NMFS-SEFSC-201, pp. 48-55): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Science Center.

Bolten, A. B., Bjorndal, K. A., Martins, H. R., Dellinger, T., Biscoito, M. J., Encalada, S. E., & Bowen, B. W. (1998). Transatlantic developmental migrations of loggerhead sea turtles demonstrated by mtDNA sequence analysis. *Ecological Applications, 8*(1), 1-7.

Bouchard, S., Moran, K., Tiwari, M., Wood, D., Bolten, A., Eliazar, P., & Bjorndal, K. (1998). Effects of exposed pilings on sea turtle nesting activity at Melbourne Beach, Florida. *Journal of Coastal Research, 14*(4), 1343-1347. Retrieved from http://www.jstor.org/stable/4298895

Boulan, R. H., Jr. (1983). *Some notes on the population biology of green (Chelonia mydas) and hawksbill (Eretmochelys imbricata) turtles in the northern U.S. Virgin Islands: 1981-1983*. Retrieved from

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

Bowen, B. W., Meylan, A. B., Ross, J. P., Limpus, C. J., Balazs, G. H., & Avise, J. C. (1992). Global population structure and natural history of the green turtle (*Chelonia mydas*) in terms of matriarchal phylogeny. *Evolution, 46*(4), 865-881.

Bowen, B. W., & Witzell, W. N. (1996). *Proceedings of the International Symposium on Sea Turtle Conservation Genetics* (NMFS-SEFSC-396). Retrieved from

Brainard, R. E., Birkeland, C., Eakin, C. M., McElhany, P., Miller, M. W., Patterson, M., & Piniak, G. A. (2011). *Status review report of 82 candidate coral species petitioned under the U.S. Endangered Species Act* (NOAA Technical Memorandum NMFS-PIFSC-27). Retrieved from Honolulu, HI: http://www.pifsc.noaa.gov/library/pubs/tech/NOAA_Tech_Memo_PIFSC_27.pdf

Brame, A. B., Wiley, T. R., Carlson, J. K., Fordham, S. V., Grubbs, R. D., Osborne, J., . . . Poulakis, G. R. (2019). Biology, ecology, and status of the smalltooth sawfish Pristis pectinata in the USA. *Endangered Species Research, 39*, 9-23. Retrieved from https://www.int-res.com/abstracts/esr/v39/p9-23/

Braun, C. D., Skomal, G. B., Thorrold, S. R., & Berumen, M. L. (2015). Movements of the reef manta ray (*Manta alfred*i) in the Red Sea using satellite and acoustic telemetry. *Marine Biology, 162*(12), 2351-2362. doi:10.1007/s00227-015-2760-3

Brautigam, A., & Eckert, K. L. (2006). *Turning the tide: Exploitation, trade and management of marine turtles in the Lesser Antilles, Central America, Columbia and Venezuela*. Retrieved from Cambridge, United Kingdom:

Bresette, M., Scarpino, R. A., Singewald, D. A., & de Maye, E. P. (2006). *Recruitment of post-pelagic green turtles (Chelonia mydas) to nearshore reefs on Florida's southeast coast*. Paper presented at the Twenty-Sixth Annual Symposium on Sea Turtle Biology and Conservation, Athens, Greece.

Burgess, K. B., Couturier, L. I., Marshall, A. D., Richardson, A. J., Weeks, S. J., & Bennett, M. B. (2016). Manta birostris, predator of the deep? Insight into the diet of the giant manta ray through stable isotope analysis. *Royal Society Open Science, 3*(11), 160717. doi:10.1098/rsos.160717

Caldwell, D. K., & Carr, A. (1957). *Status of the sea turtle fishery in Florida*. Paper presented at the Twenty-Second North American Wildlife Conference, Statler Hotel, Washington, D. C.

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

Campell, C. L., & Lagueux, C. J. (2005). Survival probability estimates for large juvenile and adult green turtles (*Chelonia mydas*) exposed to an artisanal marine turtle fishery in the western Caribbean. *Herpetologica, 61*(2), 91-103. Retrieved from <Go to ISI>://000229100000002

Carballo, J. L., Olabarria, C., & Osuna, T. G. (2002). Analysis of four macroalgal assemblages along the Pacific Mexican coast during and after the 1997-98 El Niño. *Ecosystems, 5*(8), 749-760.

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

Carlson, J. K., & Osborne, J. (2012). *Relative abundance of smalltooth sawfish (Pristis pectinata) based on the Everglades National Park Creel Survey* (NMFS-SEFSC-626). Retrieved from Panama City, FL:

Carlson, J. K., Osborne, J., & Schmidt, T. W. (2007). Monitoring the recovery of smalltooth sawfish, *Pristis pectinata*, using standardized relative indices of abundance. *Biological Conservation, 136*(2), 195-202. doi:10.1016/j.biocon.2006.11.013

Carlson, J. K., & Simpfendorfer, C. A. (2015). Recovery potential of smalltooth sawfish, Pristis pectinata, in the United States determined using population viability models. *Aquatic Conservation: Marine and Freshwater Ecosystems, 25*(2), 187-200. doi:10.1002/aqc.2434

Carr, A. F. (1986). *New perspectives on the pelagic stage of sea turtle development*. Retrieved from

Carr, T., & Carr, N. (1991). Surveys of the sea turtles of Angola. *Biological Conservation, 58*(1), 19-29.

Chaloupka, M., & Limpus, C. (2005). Estimates of sex- and age-class-specific survival probabilities for a southern Great Barrier Reef green sea turtle population. *Marine Biology, 146*(6), 1251-1261. doi:10.1007/s00227-004-1512-6

Chaloupka, M., Limpus, C., & Miller, J. (2004). Green turtle somatic growth dynamics in a spatially disjunct Great Barrier Reef metapopulation. *Coral Reefs, 23*(3), 325-335. Retrieved from http://dx.doi.org/10.1007/s00338-004-0387-9

Chaloupka, M., Work, T. M., Balazs, G. H., Murakawa, S. K. K., & Morris, R. (2008). Cause-specific temporal and spatial trends in green sea turtle strandings in the Hawaiian Archipelago (1982-2003). *Marine Biology, 154*(5), 887-898. doi:10.1007/s00227-008-0981-4

Chaloupka, M. Y., & Limpus, C. J. (1997). Robust statistical modelling of hawksbill sea turtle growth rates (southern Great Barrier Reef). *Marine Ecology Progress Series, 146*(1-3), 1-8. Retrieved from <Go to ISI>://A1997WL39000001

Chaloupka, M. Y., & Musick, J. A. (1997). Age growth and population dynamics. In P. L. Lutz & J. A. Musick (Eds.), *The Biology of Sea Turtles* (pp. 233-276). Boca Raton, Florida: CRC Press.

Chassot, E., Amandè, M., Pierre, C., Pianet, R., & Dédo, R. (2008). Some preliminary results on tuna discards and bycatch in the French purse seine fishery of the eastern Atlantic Ocean. *Collective Volume Of Scientific Papers, 64*.

Chin, A., Kyne, P., Walker, T., & McAuley, R. (2010). An integrated risk assessment for climate change: Analysing the vulnerability of sharks and rays on Australia's Great Barrier Reef. *Global Change Biology, 16*, 1936-1953. doi:10.1111/j.1365-2486.2009.02128.x

CITES. (2013). *Consideration of proposals for amendment of Appendices I and II: Manta Rays* (CoP16 Prop. 46 (Rev. 2)). Retrieved from Bangkok, Thailand:

Clark, T. B. (2010). *Abundance, home range, and movement patterns of manta rays (Manta alfredi, M. birostris) in Hawai'i.* (Doctor of Philosophy Dissertation). Univeristy of Hawai'i at Mānoa, Honolulu, HI.

Coles, R. J. (1916). Natural history notes on the devil-fish, *Manta birostris* (Walbaum) and *Mobula olfersi* (Muller). *Bulletin of the American Museum of Natural History, 35*(33), 649-657. Retrieved from http://hdl.handle.net/2246/1930

Conant, T. A., Dutton, P. H., Eguchi, T., Epperly, S. P., Fahy, C. C., Godfrey, M. H., . . . Witherington, B. E. (2009). *Loggerhead sea turtle (Caretta caretta) 2009 status review under the U.S. Endangered Species Act*. Retrieved from

Convention on Migratory Species. (2014). *Proposal for the inclusion of the reef manta ray (Manta alfredi) in CMS Appendix I and II* (UNEP/CMS/ScC18/Doc.7.2.9). Retrieved from Bonn, Germany:

Cook, M. C., Coleman, A., Shannon, D., Dunch, V., Carmon, B., Klaus, J., & Howard, V. (2014). Hooked on Kemp's - Preliminary Results of Mississippi's Angler Survey. In *International Sea Turtle Symposium-2014*. New Orleans, LA.

Couturier, L. I. E., Marshall, A. D., Jaine, F. R. A., Kashiwagi, T., Pierce, S. J., Townsend, K. A., . . . Richardson, A. J. (2012). Biology, ecology and conservation of the Mobulidae. *Journal of Fish Biology, 80*(5), 1075-1119. doi:10.1111/j.1095-8649.2012.03264.x

Couturier, L. I. E., Rohner, C. A., Richardson, A. J., Marshall, A. D., Jaine, F. R. A., Bennett, M. B., . . . Nichols, P. D. (2013). Stable isotope and signature fatty acid analyses suggest reef manta rays feed on demersal zooplankton. *PLOS ONE, 8*(10), e77152. doi:10.1371/journal.pone.0077152

Crabbe, M. J. (2008). Climate change, global warming and coral reefs: modelling the effects of temperature. *Computational Biology and Chemistry, 32*(5), 311-314. doi:S1476-9271(08)00045-5 [pii]

10.1016/j.compbiolchem.2008.04.001

D'Ilio, S., Mattei, D., Blasi, M. F., Alimonti, A., & Bogialli, S. (2011). The occurrence of chemical elements and POPs in loggerhead turtles (*Caretta caretta*): An overview. *Marine Pollution Bulletin, 62*(8), 1606-1615.

Dahl, T. E., & Johnson, C. E. (1991). *Status and trends of wetlands in the conterminous United States, mid-1970s to mid-1980s*. Retrieved from Washington, D.C.:

Daniels, R. C., White, T. W., & Chapman, K. K. (1993). Sea-level rise - destruction of threatened and endangered species habitat in South Carolina. *Environmental Management, 17*(3), 373-385. Retrieved from <Go to ISI>://A1993KY77700010

Deakos, M. H. (2010). *Ecology and social behavior of a resident manta ray (Manta alfredi) population of Maui, Hawai'i.* (Doctor of Philosophy Dissertation). Univeristy of Hawai'i at Mānoa, Honolulu, HI.

Deakos, M. H., Baker, J. D., & Bejder, L. (2011). Characteristics of a manta ray *Manta alfredi* population off Maui, Hawaii, and implications for management. *Marine Ecology Progress Series, 429*, 245-260. doi:10.3354/meps09085

Dewar, H., Mous, P., Domeier, M. L., Muljadi, A., Pet, J., & Whitty, J. (2008). Movements and site fidelity of the giant manta ray, *Manta birostris*, in the Komodo Marine Park, Indonesia. *Marine Biology, 155*(2), 121-133. doi:10.1007/s00227-008-0988-x

Diez, C. E., & Van Dam, R. P. (2002). Habitat effect on hawksbill turtle growth rates on feeding grounds at Mona and Monito Islands, Puerto Rico. *Marine Ecology Progress Series, 234*, 301-309. doi:10.3354/meps234301

Diez, C. E., & Van Dam, R. P. (2007). *In-water surveys for marine turtles at foraging grounds of Culebra Archipelago, Puerto Rico* Retrieved from

Dodd Jr., C. K. (1988). *Synopsis of the biological data on the loggerhead sea turtle Caretta caretta (Linnaeus 1758)* (88(14)). Retrieved from

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

Dow, W., Eckert, K., Palmer, M., & Kramer, P. (2007). *An atlas of sea turtle nesting habitat for the wider Caribbean region*. Retrieved from Beaufort, North Carolina:

Dulvy, N. K., Davidson, L. N. K., Kyne, P. M., Simpfendorfer, C. A., Harrison, L. R., Carlson, J. K., & Fordham, S. V. (2016). Ghosts of the coast: global extinction risk and conservation of sawfishes. *Aquatic Conservation: Marine and Freshwater Ecosystems, 26*(1), 134-153. doi:10.1002/aqc.2525

Dulvy, N. K., Pardo, S. A., Simpfendorfer, C. A., & Carlson, J. K. (2014). Diagnosing the dangerous demography of manta rays using life history theory. *PeerJ Preprints, 2*. doi:10.7717/peerj.400

DWH Trustees. (2015a). *Deepwater Horizon Oil Spill: Draft Programmatic Damage Assessment and Restoration Plan and Draft Programmatic Environmental Impact Statement. Retrieved from http://www.gulfspillrestoration.noaa.gov/restoration-planning/gulf-plan/*. Retrieved from http://www.gulfspillrestoration.noaa.gov/restoration-planning/gulf-plan/

DWH Trustees. (2015b). *DWH Trustees (Deepwater Horizon Natural Resource Damage Assessment Trustees). 2015. Deepwater Horizon Oil Spill: Draft Programmatic Damage Assessment and Restoration Plan and Draft Programmatic Environmental Impact Statement. Retrieved from http://www.gulfspillrestoration.noaa.gov/restoration-planning/gulf-plan/*. Retrieved from http://www.gulfspillrestoration.noaa.gov/restoration-planning/gulf-plan/

Eckert, K. L. (1995). Hawksbill sea turtle (*Eretmochelys imbricata*). In *National Marine Fisheries Service and U.S. Fish and Wildlife Service Status Reviews for Sea Turtles Listed under the Endangered Species Act of 1973* (pp. 76-108). Silver Springs, Maryland: National Oceanic and Atmospheric Administration, National Marine Fisheries Service.

Eckert, K. L., Overing, J. A., & Lettsome, B. B. (1992). *Sea turtle recovery action plan for the British Virgin Islands*. Retrieved from Kingston, Jamaica:

Ehrhart, L. M. (1983). Marine turtles of the Indian River Lagoon System. *Florida Scientist, 46*(3/4), 337-346.

Ehrhart, L. M., Redfoot, W. E., & Bagley, D. A. (2007). Marine turtles of the central region of the Indian River Lagoon System, Florida. *Florida Scientist, 70*(4), 415-434.

Ehrhart, L. M., & Yoder, R. G. (1978). Marine turtles of Merritt Island National Wildlife Refuge, Kennedy Space Centre, Florida. *Florida Marine Research Publications, 33*, 25-30.

EPA. (2012, 4 November 2015). Climate Change. Retrieved from www.epa.gov/climatechange/index.html

Epperly, S. P., Braun-McNeill, J., & Richards, P. M. (2007). Trends in catch rates of sea turtles in North Carolina, USA. *Endangered Species Research, 3*(3), 283-293. doi:10.3354/esr00054

Evermann, B. W., & Bean, B. A. (1897). *Report on the Fisheries of Indian River, Florida*. Retrieved from Washington D.C.:

Feldheim, K. A., Fields, A. T., Chapman, D. D., Scharer, R. M., & Poulakis, G. R. (2017). Insights into reproduction and behavior of the smalltooth sawfish Pristis pectinata. *Endangered Species Research, 34*, 463-471. Retrieved from https://www.int-res.com/abstracts/esr/v34/p463-471/

Fish, M. R., Cote, I. M., Gill, J. A., Jones, A. P., Renshoff, S., & Watkinson, A. R. (2005). Predicting the Impact of Sea-Level Rise on Caribbean Sea Turtle Nesting Habitat. *Conservation Biology, 19*(2), 482-491. Retrieved from http://dx.doi.org/10.1111/j.1523-1739.2005.00146.x

FitzSimmons, N. N., Farrington, L. W., McCann, M. J., Limpus, C. J., & Moritz, C. (2006). *Green turtle populations in the Indo-Pacific: A (genetic) view from microsatellites*. Paper presented at the Twenty-Third Annual Symposium on Sea Turtle Biology and Conservation.

Fleming, E. H. (2001). *Swimming Against the Tide: Recent Surveys of Exploitation, Trade, And Management of Marine Turtles In the Northern Caribbean*. Retrieved from Washington, D.C., USA:

Foley, A. M., Schroeder, B. A., & MacPherson, S. L. (2008). *Post-nesting migrations and resident areas of Florida loggerheads (Caretta caretta)*. Paper presented at the Twenty-Fifth Annual Symposium on Sea Turtle Biology and Conservation, Savannah, Georgia.

Foley, A. M., Schroeder, B. A., Redlow, A. E., Fick-Child, K. J., & Teas, W. G. (2005). Fibropapillomatosis in stranded green turtles (*Chelonia mydas*) from the eastern United States (1980-98): Trends and associations with environmental factors. *Journal of Wildlife Diseases, 41*(1), 29-41.

Foley, A. M., Singel, K. E., Dutton, P. H., Summers, T. M., Redlow, A. E., & Lessman, J. (2007). Characteristics of a green turtle (*Chelonia mydas*) assemblage in northwestern Florida determined during a hypothermic stunning event. *Gulf of Mexico Science, 25*(2), 131-143. Retrieved from <Go to ISI>://BIOSIS:PREV200800689004

Formia, A. (1999). Les tortues marines de la Baie de Corisco. *Canopee, 14*, i-ii.

Frazer, N. B., & Ehrhart, L. M. (1985). Preliminary growth models for green, (*Chelonia mydas*) and loggerhead, (*Caretta caretta*), turtles in the wild. *Copeia, 1985*(1), 73-79.

Fretey, J. (2001). *Biogeography and conservation of marine turtles of the Atlantic Coast of Africa*. Retrieved from UNebraskaP/CMississippi Secretariat:

Garduño-Andrade, M., Guzmán, V., Miranda, E., Briseño-Dueñas, R., & Abreu-Grobois, F. A. (1999). Increases in hawksbill turtle (*Eretmochelys imbricata*) nestings in the Yucatán Peninsula, Mexico, 1977-1996: Data in support of successful conservation? *Chelonian Conservation and Biology, 3*(2), 286-295.

Garrett, C. (2004). *Priority Substances of Interest in the Georgia Basin - Profiles and background information on current toxics issues* (GBAP Publication No. EC/GB/04/79). Retrieved from

Geraci, J. R. (1990). Physiologic and toxic effects on cetaceans. In J. R. Geraci & D. J. S. Aubin (Eds.), *Sea Mammals and Oil: Confronting the Risks* (pp. 167-197). San Diego: Academic Press.

Germanov, E. S., & Marshall, A. D. (2014). Running the gauntlet: regional movement patterns of Manta alfredi through a complex of parks and fisheries. *PLOS ONE, 9*(10), e110071. doi:10.1371/journal.pone.0110071

Germanov, E. S., Marshall, A. D., Hendrawan, I. G., Admiraal, R., Rohner, C. A., Argeswara, J., . . . Loneragan, N. R. (2019). Microplastics on the menu: Plastics pollute Indonesian manta ray and whale shark feeding grounds. *Frontiers in Marine Science, 6*(679). doi:10.3389/fmars.2019.00679

Gilman, E. L., Ellison, J., Duke, N. C., & Field, C. (2008). Threats to mangroves from climate change and adaptation options: A review. *Aquatic Botany, 89*(2), 237-250. doi:doi: 10.1016/j.aquabot.2007.12.009

Gilmore, G. R. (1995). Environmental and Biogeographic Factors Influencing Ichthyofaunal Diversity: Indian River Lagoon. *Bulletin of Marine Science, 57*(1), 153-170. Retrieved from http://www.ingentaconnect.com/content/umrsmas/bullmar/1995/00000057/00000001/art00017

Girard, C., Tucker, A. D., & Calmettes, B. (2009). Post-nesting migrations of loggerhead sea turtles in the Gulf of Mexico: Dispersal in highly dynamic conditions. *Marine Biology, 156*(9), 1827-1839. doi:10.1007/s00227-009-1216-z

Girondot, M., Bédel, S., Delmoitiez, L., Russo, M., Chevalier, J., Guéry, L., . . . Jribi, I. (2015). Spatio-temporal distribution of *Manta birostris* in French Guiana waters. *Journal of the Marine Biological Association of the United Kingdom, 95*(1), 153-160. doi:10.1017/S0025315414001398

Gladys Porter Zoo. (2013). *Gladys Porter Zoo's Preliminary Annual Report on the Mexico/United States of America Population Restoration Project for the Kemp's Ridley Sea Turtle, Lepidochelys kempii, on the Coasts of Tamaulipas, Mexico 2013*. Retrieved from

Gonzalez Carman, V., Alvarez, K., Prosdocimi, L., Inchaurraga, M. C., Dellacasa, R., Faiella, A., . . . Albareda, D. (2011). Argentinian coastal waters: A temperate habitat for three species of threatened sea turtles. *Marine Biology Research, 7*, 500-508.

Graham, N. A. J., McClanahan, T. R., MacNeil, M. A., Wilson, S. K., Polunin, N. V. C., Jennings, S., . . . Sheppard, C. R. C. (2008). Climate Warming, Marine Protected Areas and the Ocean-Scale Integrity of Coral Reef Ecosystems. *PLOS ONE, 3*(8), e3039. doi:10.1371/journal.pone.0003039

Graham, R. T., Witt, M. J., Castellanos, D. W., Remolina, F., Maxwell, S., Godley, B. J., & Hawkes, L. A. (2012). Satellite tracking of manta rays highlights challenges to their conservation. *PLOS ONE, 7*(5). doi:10.1371/journal.pone.0036834

Grant, S. C. H., & Ross, P. S. (2002). *Southern Resident killer whales at risk: Toxic chemicals in the British Columbia and Washington environment*. Retrieved from Sidney, B.C.:

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

Groombridge, B. (1982). Kemp's ridley or Atlantic ridley, *Lepidochelys kempii* (Garman 1980). *The IUCN Amphibia, Reptilia Red Data Book*, 201-208.

Groombridge, B., & Luxmoore, R. (1989). *The Green Turtle and Hawksbill (Reptilia: Cheloniidae): World Status, Exploitation and Trade*. Lausanne, Switzerland: Secretariat of the Convention on International Trade in Endangered Species of Wild Fauna and Flora.

Gudger, E. W. (1922). The most northerly record of the capture in Atlantic waters of the United States of the giant ray, *Manta birostris*. *Science, 55*(1422), 338-340. doi:10.1126/science.55.1422.338

Guinder, V. A., & Molinero, J. C. (2013). Climate change effects on marine phytoplankton. In A. H. Arias & M. C. Menendez (Eds.), *Marine Ecology in a Changing World* (pp. 68-90). Boca Raton, FL: CRC Press.

Guseman, J. L., & Ehrhart, L. M. (1992). *Ecological geography of western Atlantic loggerheads and green turtles: Evidence from remote tag recoveries*. Paper presented at the Eleventh Annual Workshop on Sea Turtle Biology and Conservation, Jekyll Island, Georgia.

Hart, K. M., Lamont, M. M., Fujisaki, I., Tucker, A. D., & Carthy, R. R. (2012). Common coastal foraging areas for loggerheads in the Gulf of Mexico: Opportunities for marine conservation. *Biological Conservation, 145*, 185-194.

Hartwell, S. I. (2004). Distribution of DDT in sediments off the central California coast. *Marine Pollution Bulletin, 49*(4), 299-305.

Hawkes, L. A., Broderick, A. C., Godfrey, M. H., & Godley, B. J. (2007). Investigating the potential impacts of climate change on a marine turtle population. *Global Change Biology, 13*, 1-10.

Hays, G. C., Åkesson, S., Broderick, A. C., Glen, F., Godley, B. J., Luschi, P., . . . Papi, F. (2001). The diving behavior of green turtles undertaking oceanic migration to and from Ascension Island: Dive durations, dive profiles, and depth distribution. *Journal of Experimental Biology, 204*, 4093-4098.

Hays, G. C., Broderick, A. C., Glen, F., Godley, B. J., Houghton, J. D. R., & Metcalfe, J. D. (2002). Water temperature and internesting intervals for loggerhead (*Caretta caretta*) and green (*Chelonia mydas*) sea turtles. *Journal of Thermal Biology, 27*(5), 429-432. Retrieved from <Go to ISI>://WOS:000177739300014

Hearn, A. R., Acuña, D., Ketchum, J. T., Peñaherrera, C., Green, J., Marshall, A., . . . Shillinger, G. (2014). Elasmobranchs of the Galapagos Marine Reserve. In J. Denkinger & L. Vinueza (Eds.), *Social and Ecological Interactions in the Galapagos Island, The Galapagos Marine Reserve: A dynamic social-ecological system* (pp. 23-59). New York, NY: Springer.

Heinrichs, S., O'Malley, M., Medd, H., & Hilton, P. (2011). *Global Threat to Manta and Mobula Rays* (2011 Report).

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

Heppell, S. S., Crowder, L. B., Crouse, D. T., Epperly, S. P., & Frazer, N. B. (2003). Population models for Atlantic loggerheads: Past, present, and future. In A. Bolten & B. Witherington (Eds.), *Loggerhead Sea Turtles* (pp. 255-273). Washington, D. C.: Smithsonian Books.

Herbst, L. H. (1994). Fibropapillomatosis of marine turtles. *Annual Review of Fish Diseases, 4*, 389-425.

Herbst, L. H., Jacobson, E. R., Moretti, R., Brown, T., Sundberg, J. P., & Klein, P. A. (1995). An infectious etiology for green turtle fibropapillomatosis. *Proceedings of the American Association for Cancer Research Annual Meeting, 36*, 117.

Heron, S. F., Eakin, C. M., Maynard, J. A., & van Hooidonk, R. (2016). Impacts and effects of ocean warming on coral reefs. In D. Laffoley & J. M. Baxter (Eds.), *Explaining Ocean Warming: Causes, scale, effects and consequences* (pp. 177-197). Gland, Switzerland: IUCN.

Hildebrand, H. H. (1963). Hallazgo del area de anidacion de la tortuga marina "lora", *Lepidochelys kempi* (Garman), en la costa occidental del Golfo de Mexico (Rept., Chel.). *Ciencia, Mexico, 22*, 105-112.

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

Hill, A. (2013). *Rough Draft of Fishing Piers and Protected Species: An Asesment of the Presence and Effectiveness of Conservation Measures in Charlotte and Lee County, Florida*. Division of Marine Affairs and Policy. University of Miami, Rosenstiel School of Marine and Atmospheric Science.

Hillis, Z.-M., & Mackay, A. L. (1989). *Research report on nesting and tagging of hawksbill sea turtles Eretmocheys imbricata at Buck Island Reef National Monument, U.S. Virgin Islands, 1987-88*. Retrieved from

Hirth, H. F. (1971). *Synopsis of biological data on the green turtle Chelonia mydas (Linnaeus) 1758*. Retrieved from

Hirth, H. F. (1997). Synopsis of the biological data on the green turtle *Chelonia mydas* (Linnaeus 1758). *Biological Report, 91*(1), 120.

Hirth, H. F., & Latif, E. M. A. (1980). A nesting colony of the hawksbill turtle (*Eretmochelys imbricata*) on Seil Ada Kebir Island, Suakin Archipelago, Sudan. *Biological Conservation, 17*, 125-130.

Hollensead, L. D., Grubbs, R. D., Carlson, J. K., & Bethea, D. M. (2016). Analysis of fine-scale daily movement patterns of juvenile *Pristis pectinata* within a nursery habitat. *Aquatic Conservation: Marine and Freshwater Ecosystems, 26*(3), 492-505. doi:10.1002/aqc.2556

Hollensead, L. D., Grubbs, R. D., Carlson, J. K., & Bethea, D. M. (2018). Assessing residency time and habitat use of juvenile smalltooth sawfish using acoustic monitoring in a nursery habitat. *Endangered Species Research, 37*, 119-131. Retrieved from https://www.int-res.com/abstracts/esr/v37/p119-131/

Intergovernmental Panel on Climate Change. (2013). *Climate Change 2013: The physical science basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*. Retrieved from Cambridge, United Kingdom; New York, NY:

IPCC. (2007). Summary for Policymakers. In S. Solomon, D. Quin, M. Manning, Z. Chen, M. Marquis, K. B. Averyt, M. Tignor, & H. L. Miller (Eds.), *Climate Change 2007: the physical science basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* (pp. 18). Cambridge, UK and New York, NY: Cambridge University Press.

IPCC. (2013). Summary for Policymakers. In T. F. Stocker, D. Qin, G.-K. Plattner, M. Tignor, S. K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex, & P. M. Midgley (Eds.), *Climate Change 2013: the physical science basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* (pp. SPM-1 - 36). Retrieved from http://www.climatechange2013.org/

ISED. (2014). *International Sawfish Encounter Database*. Retrieved from: http://www.flmnh.ufl.edu/fish/sharks/sawfish/sawfishdatabase.html

Iwata, H., Tanabe, S., Sakai, N., & Tatsukawa, R. (1993). Distribution of persistent organochlorines in the oceanic air and surface seawater and the role of ocean on their global transport and fate. *Environmental Science and Technology, 27*(6), 1080-1098.

Jacobson, E. R. (1990). An update on green turtle fibropapilloma. *Marine Turtle Newsletter, 49*, 7-8.

Jacobson, E. R., Mansell, J. L., Sundberg, J. P., Hajjar, L., Reichmann, M. E., Ehrhart, L. M., . . . Murru, F. (1989). Cutaneous fibropapillomas of green turtles (*Chelonia mydas*). *Journal Comparative Pathology, 101*, 39-52.

Jacobson, E. R., Simpson Jr., S. B., & Sundberg, J. P. (1991). Fibropapillomas in green turtles. In G. H. Balazs & S. G. Pooley (Eds.), *Research Plan for Marine Turtle Fibropapilloma* (Vol. NOAA-TM-NMFS-SWFSC-156, pp. 99-100).

Jambeck, J. R., Geyer, R., Wilcox, C., Siegler, T. R., Perryman, M., Andrady, A., . . . Law, K. L. (2015). Plastic waste inputs from land into the ocean. *Science, 347*(6223), 768-771. doi:10.1126/science.1260352

Johnson, S. A., & Ehrhart, L. M. (1994). *Nest-site fidelity of the Florida green turtle*. Paper presented at the Thirteenth Annual Symposium on Sea Turtle Biology and Conservation.

Johnson, S. A., & Ehrhart, L. M. (1996). Reproductive ecology of the Florida green turtle: Clutch frequency. *Journal of Herpetology, 30*(3), 407-410. Retrieved from <Go to ISI>://A1996VH53900015

Jones, G. P., McCormick, M. I., Srinivasan, M., & Eagle, J. V. (2004). Coral decline threatens fish biodiversity in marine reserves. *Proc Natl Acad Sci U S A, 101*(21), 8251-8253. doi:10.1073/pnas.0401277101

Kashiwagi, T., Ito, T., & Sato, F. (2010). Occurences of reef manta ray, *Manta alfredi*, and giant manta ray, *M. birostris*, in Japan, examined by photographic records. *Japanese Society for Elasmobranch Studies, 46*, 20-27.

Kashiwagi, T., Marshall, A. D., Bennett, M. B., & Ovenden, J. R. (2011). Habitat segregation and mosaic sympatry of the two species of manta ray in the Indian and Pacific Oceans: *Manta alfredi* and *M. birostris*. *Marine Biodiversity Records, 4*, 1-8. doi:10.1017/S1755267211000479

Lagueux, C. J. (2001). *Status and distribution of the green turtle, Chelonia mydas, in the wider Caribbean region*. Paper presented at the Marine Turtle Conservation in the Wider Caribbean Region - A Dialogue for Effective Regional Management, Santo Domingo, Dominican Republic.

Laurent, L., Casale, P., Bradai, M. N., Godley, B. J., Gerosa, G., Broderick, A. C., . . . Gautier, C. H. (1998). Molecular resolution of marine turtle stock composition in fishery by-catch: A case study in the Mediterranean. *Molecular Ecology, 7*, 1529-1542.

Law, R. J., Fileman, C. F., Hopkins, A. D., Baker, J. R., Harwood, J., Jackson, D. B., . . . Morris, R. J. (1991). Concentrations of trace metals in the livers of marine mammals (seals, porpoises and dolphins) from waters around the British Isles. *Marine Pollution Bulletin, 22*(4), 183-191.

Lawson, J. M., Fordham, S. V., O'Malley, M. P., Davidson, L. N., Walls, R. H., Heupel, M. R., . . . Dulvy, N. K. (2017). Sympathy for the devil: a conservation strategy for devil and manta rays. *PeerJ, 5*, e3027. doi:10.7717/peerj.3027

Lawson, J. M., Walls, R. H. L., Fordham, S. V., O'Malley, M. P., Heupel, M. R., Stevens, G., . . . Dulvy, N. K. (2016). Sympathy for the devil: A conservation strategy for devil and manta rays. *PeerJ, 5*, e3027. doi:10.7287/peerj.preprints.1731v1

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

León, Y. M., & Diez, C. E. (2000). *Ecology and population biology of hawksbill turtles at a Caribbean feeding ground*. Paper presented at the Eighteenth International Sea Turtle Symposium, Mazatlán, Sinaloa, México.

Lezama, C. (2009). *impacto de la pesqueria artesanal sobre la tortoga verde (Chelonia mydas) en las costas del Rio de la Plata exterior*. Retrieved from

Lima, E. H. S. M., Melo, M. T. D., & Barata, P. C. R. (2010). Incidental capture of sea turtles by the lobster fishery off the Ceará Coast, Brazil. *Marine Turtle Newsletter, 128*, 16-19. Retrieved from http://www.seaturtle.org/mtn/archives/mtn128/mtn128p16.shtml

Limpus, C. J. (1992). The hawksbill turtle, *Eretmochelys imbricata*, in Queensland: Population struture within a southern Great Barrier Reef feeding ground. *Australian Wildlife Research, 19*, 489-506.

Limpus, C. J., & Miller, J. D. (2000). *Final report for Australian hawksbill turtle population dynamics project*. Retrieved from

López-Barrera, E. A., Longo, G. O., & Monteiro-Filho, E. L. A. (2012). Incidental capture of green turtle (*Chelonia mydas*) in gillnets of small-scale fisheries in the Paranaguá Bay, Southern Brazil. *Ocean and Coastal Management, 60*, 11-18. doi:10.1016/j.ocecoaman.2011.12.023

López-Mendilaharsu, M., Estrades, A., Caraccio, M. A. C., V., Hernández, M., & Quirici, V. (2006). *Biología, ecología yetología de las tortugas marinas en la zona costera uruguaya*. Retrieved from Montevideo, Uruguay: Vida Silvestre, Uruguay:

Lund, F. P. (1985). Hawksbill turtle (*Eretmochelys imbricata*) nesting on the East Coast of Florida. *Journal of Herpetology, 19*(1), 166-168.

Lutcavage, M., Plotkin, P., Witherington, B., & Lutz, P. (1997). Human impacts on sea turtle survival. In P. Lutz & J. A. Musick (Eds.), *The Biology of Sea Turtles* (Vol. 1, pp. 387–409). Boca Raton, Florida: CRC Press.

Mackay, A. L. (2006). *2005 sea turtle monitoring program the East End beaches (Jack's, Isaac's, and East End Bay) St. Croix, U.S. Virgin Islands*. Retrieved from

MantaMatcher. (2016). Manta Matcher - The Wildbook for Manta Rays. Retrieved from https://www.mantamatcher.org/

https://www.facebook.com/mantamatcher/

Marcovaldi, N., Gifforni, B. B., Becker, H., Fiedler, F. N., & Sales, G. (2009). *Sea Turtle Interactions in Coastal Net Fisheries in Brazil*. Retrieved from Gland, Switze, Honolulu, Hawaii, USA:

Márquez M., R. (1990). *Sea turtles of the world. An annotated and illustrated catalogue of sea turtle species known to date*. Retrieved from Rome: ftp://ftp.fao.org/docrep/fao/009/t0244e/t0244e00.pdf (March 2008)

Márquez M., R. (1994). *Synopsis of biological data on the Kemp's ridley sea turtle, Lepidochelys kempii (Garman, 1880)*. Retrieved from

Marshall, A., Bennett, M. B., Kodja, G., Hinojosa-Alvarez, S., Galvan-Magana, F., Harding, M., . . . Kashiwagi, T. (2011). *Manta birostris*. Retrieved from

Marshall, A. D., Compagno, L. J. V., & Bennett, M. B. (2009). Redescription of the genus Manta with resurrection of *Manta alfredi* (Krefft, 1868) (Chondrichthyes; Myliobatoidei; Mobulidae). *Zootaxa, 2301*, 1-28. doi:resurrection of Manta alfredi (Krefft, 1868) (Chondrichthyes; Myliobatoidei; Mobulidae). Zootaxa 2301: 1-28, DOI: 10.5281/zenodo.191734

Matkin, C. O., & Saulitis, E. (1997). *Restoration notebook: Killer whale (Orcinus orca)*. Retrieved from Anchorage, Alaska:

Mayor, P. A., Phillips, B., & Hillis-Starr, Z.-M. (1998). *Results of the stomach content analysis on the juvenile hawksbill turtles of Buck Island Reef National Monument, U.S.V.I.* Paper presented at the Seventeenth Annual Sea Turtle Symposium.

McMichael, E., Carthy, R. R., & Seminoff, J. A. (2003). *Evidence of homing behavior in juvenile green turtles in the northeastern Gulf of Mexico*. Paper presented at the Twenty-Second Annual Symposium on Sea Turtle Biology and Conservation.

Medeiros, A. M., Luiz, O. J., & Domit, C. (2015). Occurrence and use of an estuarine habitat by giant manta ray *Manta birostris*. *Journal of Fish Biology, 86*(6), 1830-1838. doi:10.1111/jfb.12667

Meylan, A. (1988). Spongivory in hawksbill turtles: A diet of glass. *Science, 239*(4838), 393-395.

Meylan, A., & Donnelly, M. (1999). Status justification for listing the hawksbill turtle (*Eretmochelys imbricata*) as critically endangered on the 1996 IUCN Red List of threatened animals. *Chelonian Conservation and Biology, 3*(2), 200-224.

Meylan, A., Schroeder, B., & Mosier, A. (1994). *Marine turtle nesting activity in the State of Florida, 1979-1992*. Paper presented at the Fourteenth Annual Symposium on Sea Turtle Biology and Conservation.

Meylan, A. B. (1999a). International movements of immature and adult hawksbill turtles (*Eretmochelys imbricata*) in the Caribbean region. *Chelonian Conservation and Biology, 3*(2), 189-194.

Meylan, A. B. (1999b). Status of the hawksbill turtle (*Eretmochelys imbricata*) in the Caribbean region. *Chelonian Conservation and Biology, 3*(2), 177-184.

Meylan, A. B., Schroeder, B. A., & Mosier, A. (1995). Sea turtle nesting activity in the State of Florida 1979-1992. *Florida Department of Environmental Protection*(52), 63.

Milessi, A. C., & Oddone, M. C. (2003). Primer registro de *Manta birostris* (Donndorff 1798) (Batoidea: Mobulidae) en el Rio de La Plata, Uruguay. *Gayana, 67*(1), 126-129. doi:10.4067/S0717-65382003000100017

Miller, M. H., & Klimovich, C. (2017). *Endangered Species Act status review report: Giant manta ray (Manta birostris) and reef manta ray (Manta alfredi)*. Retrieved from Silver Spring, MD:

Milliken, T., & Tokunaga, H. (1987). *The Japanese sea turtle trade 1970-1986*. Retrieved from Washington, D. C.:

Milton, S. L., & Lutz, P. L. (2003). Physiological and genetic responses to environmental stress. In P. L. Lutz, J. A. Musick, & J. Wyneken (Eds.), *The Biology of Sea Turtles* (Vol. II, pp. 163-197). Boca Raton, Florida: CRC Press.

Mo, C. L. (1988). *Effect of bacterial and fungal infection on hatching success of Olive Ridley sea turtle eggs*. Retrieved from

Moncada, F., Abreu-Grobois, A., Bagley, D., Bjorndal, K. A., Bolten, A. B., Caminas, J. A., . . . Hawkes, L. A. (2010). Movement patterns of loggerhead turtles *Caretta caretta* in Cuban waters inferred from flipper tag recaptures. *Endangered Species Research, 11*(1), 61-68.

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

Moncada Gavilan, F. (2001). *Status and distribution of the loggerhead turtle, Caretta caretta, in the wider Caribbean region*. Paper presented at the Marine Turtle Conservation in the Wider Caribbean Region - A Dialogue for Effective Regional Management, Santo Domingo, Dominican Republic.

Monzón-Argüello, C., López-Jurado, L. F., Rico, C., Marco, A., López, P., Hays, G. C., & Lee, P. L. M. (2010). Evidence from genetic and Lagrangian drifter data for transatlantic transport of small juvenile green turtles. *Journal of Biogeography, 37*(9), 1752-1766. doi:10.1111/j.1365-2699.2010.02326.x

Moore, A. B. M. (2012). Records of poorly known batoid fishes from the north-western Indian Ocean (Chondrichthyes: Rhynchobatidae, Rhinobatidae, Dasyatidae, Mobulidae). *African Journal of Marine Science, 34*(2), 297-301. doi:10.2989/1814232X.2012.675129

Mortimer, J. A., Collie, J., Jupiter, T., Chapman, R., Liljevik, A., & Betsy, B. (2003). *Growth rates of immature hawksbills (Eretmochelys imbricata) at Aldabra Atoll, Seychelles (Western Indian Ocean)*. Paper presented at the Twenty-Second Annual Symposium on Sea Turtle Biology and Conservation.

Mortimer, J. A., Day, M., & Broderick, D. (2002). *Sea turtle populations of the Chagos Archipelago, British Indian Ocean Territory*. Paper presented at the Twentieth Annual Symposium on Sea Turtle Biology and Conservation.

Mortimer, J. A., & Donnelly, M. (2008). *Hawksbill turtle (Eretmochelys imbricata)* Retrieved from

Mourier, J. (2012). Manta rays in the Marquesas Islands: First records of *Manta birostris* in French Polynesia and most easterly location of *Manta alfredi* in the Pacific Ocean, with notes on their distribution. *Journal of Fish Biology, 81*(6), 2053-2058. doi:10.1111/j.1095-8649.2012.03449.x

Murphy, T. M., & Hopkins, S. R. (1984). *Aerial and ground surveys of marine turtle nesting beaches in the southeast region*. Retrieved from

Musick, J. A. (1999). Ecology and conservation of long-lived marine animals. *American Fisheries Society Symposium, 23*, 1-10.

Musick, J. A., & Limpus, C. J. (1997). Habitat utilization and migration in juvenile sea turtles. In P. L. Lutz & J. A. Musick (Eds.), *The Biology of Sea Turtles* (pp. 137-163). New York, New York: CRC Press.

Naro-Maciel, E., Becker, J. H., Lima, E. H. S. M., Marcovaldi, M. A., & DeSalle, R. (2007). Testing dispersal hypotheses in foraging green sea turtles (*Chelonia mydas*) of Brazil. *Journal of Heredity, 98*(1), 29-39.

Naro-Maciel, E., Bondioli, A. C., Martin, M., de Padua Almeida, A., Baptistotte, C., Bellini, C., . . . Amato, G. (2012). The interplay of homing and dispersal in green turtles: A focus on the southwestern atlantic. *Journal of Heredity, 103*(6), 792-805. doi:10.1093/jhered/ess068

NMFS-NEFSC. (2011). *Preliminary summer 2010 regional abundance estimate of loggerhead turtles (Caretta caretta) in northwestern Atlantic Ocean continental shelf waters* (Reference Document 11-03). Retrieved from

NMFS-SEFSC. (2009). *An assessment of loggerhead sea turtles to estimate impacts of mortality on population dynamics* (PRD-08/09-14). Retrieved from

NMFS. (1997). *Endangered Species Act Section 7 Consultation - Biological Opinion on Navy activities off the southeastern United States along the Atlantic coast*. Retrieved from National Marine Fisheries Service, Office of Protected Resources and the Southeast Regional Office:

NMFS. (2000). *Status review of smalltooth sawfish, Pristis pectinata*. Retrieved from St. Petersburg, FL:

NMFS. (2001). *Stock assessments of loggerhead and leatherback sea turtles and an assessment of the impact of the pelagic longline fishery on the loggerhead and leatherback sea turtles of the western North Atlantic*. Retrieved from

NMFS. (2006). *Sea Turtle and Smalltooth Sawfish Construction Conditions revised March 23, 2006*. Retrieved from Saint Petersburg, Florida.

http://sero.nmfs.noaa.gov/protected_resources/section_7/guidance_docs/documents/sea_turtle_and_smalltooth_sawfish_construction_conditions_3-23-06.pdf, accessed June 2, 2017:

NMFS. (2009). *Smalltooth sawfish recovery plan (Pristis pectinata)*. Retrieved from Silver Spring, MD: http://www.nmfs.noaa.gov/pr/recovery/plans.htm

NMFS. (2010). *Smalltooth sawfish 5-year review: summary and evaluation*. Retrieved from St. Petersburg, FL:

NMFS. (2012). *Protocols for Categorizing Sea Turtles for Post-release Mortality Estimates. August 2001, revised February 2012. PRD Contribution: #PRD-2011-07*. Retrieved from Miami, Florida:

NMFS. (2018). *Smalltooth sawfish 5-year review: summary and evaluation*. Retrieved from St. Petersburg, FL:

NMFS. (2019). *Giant manta ray recovery outline*. Retrieved from Silver Spring, MD:

NMFS, & USFWS. (1991). *Recovery plan for U.S. population of the Atlantic green turtle (Chelonia mydas)*. Retrieved from Washington, D. C.:

NMFS, & USFWS. (1992). *Recovery plan for leatherback turtles Dermochelys coriacea in the U. S. Carribean, Atlantic and Gulf of Mexico*. Retrieved from Silver Spring, Maryland:

NMFS, & USFWS. (1993). *Recovery plan for the hawksbill turtle Eretmochelys imbricata in the U.S. Caribbean, Atlantic and Gulf of Mexico*. Retrieved from St. Petersburg, Florida:

NMFS, & USFWS. (1998). *Recovery plan for U. S. Pacific populations of the hawksbill turtle (Eretmochelys imbricata)*. Retrieved from Silver Spring, Maryland:

NMFS, & USFWS. (2007a). *Green Sea Turtle (Chelonia mydas) 5-year review: Summary and Evaluation*. Retrieved from Silver Spring, Maryland:

NMFS, & USFWS. (2007b). *Hawksbill sea turtle (Eretmochelys imbricata) 5-year review: Summary and evaluation* Retrieved from Silver Spring, Maryland:

NMFS, & USFWS. (2007c). *Kemp's ridley sea turtle (Lepidochelys kempii) 5-year review: Summary and evaluation*. Retrieved from Silver Spring, Maryland:

NMFS, & USFWS. (2007d). *Loggerhead sea turtle (Caretta caretta) 5-year review: Summary and evaluation*. Retrieved from Silver Spring, Maryland:

NMFS, & USFWS. (2008). *Recovery plan for the northwest Atlantic population of the loggerhead sea turtle (Caretta caretta), second revision.* Retrieved from Silver Spring, Maryland:

NMFS, USFWS, & SEMARNAT. (2011a). *Bi-National Recovery Plan for the Kemp's Ridley Sea Turtle (Lepidochelys kempii), Second Revision*. Retrieved from Silver Spring, Maryland:

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

NMFS and USFWS. (1991). *Recovery plan for U.S. Population of Atlantic Green Turtle (Chelonia mydas)*. Retrieved from Silver Spring, Maryland:

NMFS and USFWS. (2007). *Green Sea Turtle (Chelonia mydas) 5-year review: Summary and Evaluation*. Retrieved from Silver Spring, Maryland:

NMFS and USFWS. (2009). *Recovery plan for the northwest Atlantic population of the loggerhead sea turtle (Caretta caretta)*. Retrieved from Silver Spring, Maryland:

NOAA. (2012, November 2015). Understanding Climate. Retrieved from http://www.climate.gov/#understandingClimate

Notarbartolo di Sciara, G., & Hillyer, E. V. (1989). Mobulid rays off eastern Venezuela (Chondrichthyes, Mobulidae). *Copeia*(3), 607-614. doi:10.2307/1445487

NRC. (1990). *Decline of the sea turtles: Causes and prevention*. Retrieved from Washington, D. C.:

O'Malley, M. P., Lee-Brooks, K., & Medd, H. B. (2013). The global economic impact of manta ray watching tourism. *PLOS ONE, 8*(5), e65051. doi:10.1371/journal.pone.0065051

Ogren, L. H. (1989). *Distribution of juvenile and subadult Kemp's ridley sea turtles: Preliminary results from 1984-1987 surveys*. Paper presented at the First International Symposium on Kemp's Ridley Sea Turtle Biology, Conservation and Management, Galveston, Texas.

Oliver, S., Braccini, M., Newman, S. J., & Harvey, E. S. (2015). Global patterns in the bycatch of sharks and rays. *Marine Policy, 54*, 86-97. doi:10.1016/j.marpol.2014.12.017

Orlando, S. P., Jr. , P. H. Wendt, C. J. Klein, M. E. Patillo, K. C. Dennis, & Ward., H. G. (1994). *Salinity Characteristics of South Atlantic Estuaries*. Silver Spring, MD: NOAA, Office of Ocean Resources Conservation and Assessment.

Parsons, J. J. (1972). The hawksbill turtle and the tortoise shell trade. In *Études de Géographie Tropicale Offertes a Pierre Gourou* (pp. 45-60). Paris, France: Mouton.

Pate, J., & Marshall, A. (2020). Urban manta rays: potential manta ray nursery habitat along a highly developed Florida coastline. *Endangered Species Research, 43*. doi:10.3354/esr01054

Pike, D. A., Antworth, R. L., & Stiner, J. C. (2006). Earlier nesting contributes to shorter nesting seasons for the loggerhead seaturtle, *Caretta caretta*. *Journal of Herpetology, 40*(1), 91-94.

Plotkin, P., & Amos, A. F. (1990). *Effects of anthropogenic debris on sea turtles in the northwestern Gulf of Mexico*. Paper presented at the Proceedings of the Second Internntional Conference on Marine Debris. NOAA Technical Memorandum NMFS SWFSC-154, Honolulu, Hawaii.

Plotkin, P. T. (2003). Adult migrations and habitat use. In P. L. Lutz, J. A. Musick, & J. Wyneken (Eds.), *The Biology of Sea Turtles* (Vol. 2, pp. 225-241): CRC Press.

Plotkin, P. T., & Amos, A. F. (1988). Entanglement in and ingestion of marine debris by sea turtles stranded along the South Texas coast. In *Supplemental Deliverables under Entanglement-Debris Task No. 3. Debris, Entanglement and Possible Causes of Death in Stranded Sea Turtles (FY88)* (pp. 7).

Poulakis, G., Stevens, P., A. Timmers, A., R. Wiley, T., & Simpfendorfer, C. (2011). Abiotic affinities and spatiotemporal distribution of the endangered smalltooth sawfish, *Pristis pectinata*, in a south-western Florida nursery. *Marine and Freshwater Research, 62*, 1165-1177. doi:10.1071/MF11008

Poulakis, G. R. (2012). *Distribution, habitat use, and movements of juvenile smalltooth sawfish, Pristis pectinata, in the Charlotte Harbor estuarine system, Florida.* (Doctor of Philosophy Dissertation). Florida Institute of Technology, Melbourne, FL.

Poulakis, G. R., & Seitz, J. C. (2004). Recent occurrence of the smalltooth sawfish, *Pristis pectinata* (Elasmobranchiomorphi: Pristidae), in Florida Bay and the Florida Keys, with comments on sawfish ecology. *Florida Scientist, 67*(1), 27-35. Retrieved from http://www.jstor.org/stable/24321195

Poulakis, G. R., Stevens, P. W., Timmers, A. A., Stafford, C. J., & Simpfendorfer, C. A. (2013). Movements of juvenile endangered smalltooth sawfish, *Pristis pectinata*, in an estuarine river system: use of non-main-stem river habitats and lagged responses to freshwater inflow-related changes. *Environmental Biology of Fishes, 96*(6), 763-778. doi:10.1007/s10641-012-0070-x

Poulakis, G. R., Urakawa, H., Stevens, P. W., DeAngelo, J. A., Timmers, A. A., Grubbs, R. D., . . . Olin, J. A. (2017). Sympatric elasmobranchs and fecal samples provide insight into the trophic ecology of the smalltooth sawfish. *Endangered Species Research, 32*, 491-506. Retrieved from https://www.int-res.com/abstracts/esr/v32/p491-506/

Pritchard, P. C. H. (1969). The survival status of ridley sea-turtles in America. *Biological Conservation, 2*(1), 13-17.

Pritchard, P. C. H., Bacon, P., Berry, F. H., Carr, A., Feltemyer, J., Gallagher, R. M., . . . Witham, R. (1983). *Manual of sea turtle research and conservation techniques, Second ed*. Retrieved from Washington, D. C.:

Prohaska, B. K., Bethea, D. M., Poulakis, G. R., Scharer, R. M., Knotek, R., Carlson, J. K., & Grubbs, R. D. (2018). Physiological stress in the smalltooth sawfish: effects of ontogeny, capture method, and habitat quality. *Endangered Species Research, 36*, 121-135. Retrieved from https://www.int-res.com/abstracts/esr/v36/p121-135/

Prosdocimi, L., González Carman, V., Albareda, D. A., & Remis, M. I. (2012). Genetic composition of green turtle feeding grounds in coastal waters of Argentina based on mitochondrial DNA. *Journal of Experimental Marine Biology and Ecology, 412*, 37-45. doi:10.1016/j.jembe.2011.10.015

Rambahiniarison, J. M., Lamoste, M. J., Rohner, C. A., Murray, R., Snow, S., Labaja, J., . . . Ponzo, A. (2018). Life history, growth, and reproductive biology of four mobulid species in the Bohol Sea, Philippines. *Frontiers in Marine Science, 5*, 269. doi:10.3389/fmars.2018.00269

Rebel, T. P. (1974). *Sea Turtles and the Turtle Industry of the West Indies, Florida and the Gulf of Mexico*. Retrieved from Coral Gables, Florida:

Reddering, J. S. V. (1988). Prediction of the effects of reduced river discharge on estuaries of the south-eastern Cape Province, South Africa. *South African Journal of Science, 84*, 726-730.

Richardson, J. I., Bell, R., & Richardson, T. H. (1999). Population ecology and demographic implications drawn from an 11-year study of nesting hawksbill turtles, *Eretmochelys imbricata*, at Jumby Bay, Long Island, Antigua, West Indies. *Chelonian Conservation and Biology, 3*(2), 244-250.

Rivas-Zinno, F. (2012). *Captura incidental de tortugas marinas en Bajos del Solis, Uruguay*. Retrieved from

Romanov, E. V. (2002). Bycatch in the tuna purse-seine fisheries of the western Indian Ocean. *Fishery Bulletin, 100*(1), 90-105. Retrieved from <Go to ISI>://WOS:000173629300010

Rubin, R. D., Kumli, K. R., & Chilcott, G. (2008). *Dive characteristics and movement patterns of acoustic and satellite-tagged manta rays (Manta birostris) in the Revillagigedos Islands of Mexico*. Montreal, Canada: American Elasmobranch Society.

Ryder, C. E., Conant, T. A., & Schroeder, B. A. (2006). *Report of the Workshop on Marine Turtle Longline Post-Interaction Mortality*. Retrieved from

SAFMC. (1998). *Final habitat plan for the South Atlantic region: Essential fish habitat requirements for fishery management plans of the South Atlantic Fishery Management Council*. Retrieved from Charleston, South Carolina:

Scharer, R. M., Patterson III, W. F., Carlson, J. K., & Poulakis, G. R. (2012). Age and growth of endangered smalltooth sawfish (*Pristis pectinata*) verified with LA-ICP-MS analysis of vertebrae. *PloS one, 7*, e47850. doi:10.1371/journal.pone.0047850

Schmid, J. R., & Barichivich, J. A. (2006). *Lepidochelys kempii*–Kemp's ridley. In P. A. Meylan (Ed.), *Biology and conservation of Florida turtles. Chelonian Research Monographs* (Vol. 3, pp. 128-141).

Schmid, J. R., & Woodhead, A. (2000). *Von Bertalanffy growth models for wild Kemp's ridley turtles: analysis of the NMFS Miami Laboratory tagging database*. Retrieved from Miami, Florida:

Schroeder, B. A., & Foley, A. M. (1995). *Population studies of marine turtles in Florida Bay*. Paper presented at the Twelfth Annual Workshop on Sea Turtle Biology and Conservation.

Seitz, J. C., & Poulakis, G. R. (2002). Recent occurrence of sawfishes (Elasmobranchiomorphi: Pristidae) along the southwest coast of Florida (USA). *Florida Scientist, 65*(4), 256-266. Retrieved from http://www.jstor.org/stable/24321140

Seminoff, J. A., Allen, C. D., Balazs, G. H., Dutton, P. H., Eguchi, T., Haas, H. L., . . . Waples, R. S. (2015). *Status review of the green turtle (Chelonia Mydas) under the endangered species act. NOAA Technical Memorandum* (NMFS-SWFSC-539). Retrieved from

Shaver, D. J. (1994). Relative abundance, temporal patterns, and growth of sea turtles at the Mansfield Channel, Texas. *Journal of Herpetology, 28*(4), 491-497.

Simpfendorfer, C., Poulakis, G., M. O'Donnell, P., & R. Wiley, T. (2008). Growth rates of juvenile smalltooth sawfish *Pristis pectinata* Latham in the Western Atlantic. *Journal of Fish Biology, 72*, 711-723. doi:10.1111/j.1095-8649.2007.01764.x

Simpfendorfer, C. A. (2000). Predicting population recovery rates for endangered western Atlantic sawfishes using demographic analysis. *Environmental Biology of Fishes, 58*(4), 371-377. doi:10.1023/A:1007675111597

Simpfendorfer, C. A. (2001). *Essential habitat of the smalltooth sawfish, Pristis pectinata* (Technical Report 786). Retrieved from Sarasota, FL:

Simpfendorfer, C. A. (2002). Smalltooth sawfish: The USA's first endangered elasmobranch? *Endangered Species Update, 19*(3), 53-57.

Simpfendorfer, C. A. (2003). *Abundance, movement and habitat use of the smalltooth sawfish. Final Report* (Mote Technical Report No. 929). Retrieved from Sarasota, FL:

Simpfendorfer, C. A. (2006). *Movement and habitat use of smalltooth sawfish. Final Report* (Mote Marine Laboratory Technical Report 1070). Retrieved from Sarasota, FL:

Simpfendorfer, C. A., & Wiley, T. R. (2004). *Determination of the distribution of Florida's remnant sawfish population, and identification of areas critical to their conservation*. Retrieved from Sarasota, Florida:

Simpfendorfer, C. A., & Wiley, T. R. (2005). *Identification of priority areas for smalltooth sawfish conservation. Final report to the National Fish and Wildlife Foundation for Grant # 2003-0041-000.* Retrieved from

Simpfendorfer, C. A., Wiley, T. R., & Yeiser, B. G. (2010). Improving conservation planning for an endangered sawfish using data from acoustic telemetry. *Biological Conservation, 143*(6), 1460-1469. doi:https://doi.org/10.1016/j.biocon.2010.03.021

Simpfendorfer, C. A., Yeiser, B. G., Wiley, T. R., Poulakis, G. R., Stevens, P. W., & Heupel, M. R. (2011). Environmental influences on the spatial ecology of juvenile smalltooth sawfish

(*Pristis pectinata*): results from acoustic monitoring. *PloS one, 6*(2), e16918. doi:10.1371/journal.pone.0016918

Snelson, F., & Williams, S. (1981). Notes on the occurrence, distribution, and biology of *elasmobranch* fishes in the Indian River lagoon system, Florida. *Estuaries and Coasts, 4*(2), 110-120. doi:10.2307/1351673

Snover, M. L. (2002). *Growth and ontogeny of sea turtles using skeletochronology: Methods, validation and application to conservation.* (Ph.D.). Duke University,

Spotila, J. (2004). *Sea Turtles: A Complete Guide to their Biology, Behavior, and Conservation*. Baltimore, Maryland: Johns Hopkins University Press.

Stapleton, S., & Stapleton, C. (2006). *Tagging and nesting research on hawksbill turtles (Eretmochelys imbricata) at Jumby Bay, Long Island, Antigua, West Indies: 2005 annual report*. Retrieved from

Steadman, S., & Dahl, T. E. (2008). *Status and trends of wetlands in the coastal watersheds of the Eastern United States 1998 to 2004*.

Stewart, J. D., Hoyos-Padilla, E. M., Kumli, K. R., & Rubin, R. D. (2016). Deep-water feeding and behavioral plasticity in *Manta birostris* revealed by archival tags and submersible observations. *Zoology, 119*. doi:10.1016/j.zool.2016.05.010

Stewart, J. D., Nuttall, M., Hickerson, E. L., & Johnston, M. A. (2018). Important juvenile manta ray habitat at Flower Garden Banks National Marine Sanctuary in the northwestern Gulf of Mexico. *Marine Biology, 165*, 111. doi:10.1007/s00227-018-3364-5

Storelli, M. M., Barone, G., Storelli, A., & Marcotrigiano, G. O. (2008). Total and subcellular distribution of trace elements (Cd, Cu and Zn) in the liver and kidney of green turtles (*Chelonia mydas*) from the Mediterranean Sea. *Chemosphere, 70*(5), 908-913. Retrieved from <Go to ISI>://000253108800020

TEWG. (1998a). *An assessment of the Kemp's ridley (Lepidochelys kempii) and loggerhead (Caretta caretta) sea turtle populations in the Western North Atlantic*. Retrieved from

TEWG. (1998b). *An assessment of the Kemp's ridley (Lepidochelys kempii) and loggerhead (Caretta caretta) sea turtle populations in the western North Atlantic*. Retrieved from

TEWG. (2000). *Assessment update for the Kemp's ridley and loggerhead sea turtle populations in the western North Atlantic*. Retrieved from

TEWG. (2009). *An assessment of the loggerhead turtle population in the western North Atlantic ocean* (NMFS-SEFSC-575). Retrieved from

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

Tucker, A. D. (2010). Nest site fidelity and clutch frequency of loggerhead turtles are better elucidated by satellite telemetry than by nocturnal tagging efforts: Implications for stock estimation. *Journal of Experimental Marine Biology and Ecology, 383*(1), 48-55. doi:10.1016/j.jembe.2009.11.009

USFWS and NMFS. (1998). *Endangered Species Act consultation handbook. Procedures for Conducting Section 7 Consultations and Conferences*: U.S. Fish and Wildlife, National Marine Fisheries Service.

van Dam, R., & Sarti, L. (1989). *Sea turtle biology and conservation on Mona Island, Puerto Rico. Report for 1989*. Retrieved from

Van Dam, R., Sarti M., L., & Pares J., D. (1991). *The hawksbills of Mona Island, Puerto Rico: Report for 1990*. Retrieved from

Van Dam, R. P., & Diez, C. E. (1997). *Predation by hawksbill turtles on sponges at Mona Island, Puerto Rico*. Paper presented at the Eighth International Coral Reef Symposium.

Van Dam, R. P., & Diez, C. E. (1998). Home range of immature hawksbill turtles (*Eretmochelys imbricata* (Linnaeus)) at two Caribbean islands. *Journal of Experimental Marine Biology and Ecology, 220*, 15-24.

Vargo, S., Lutz, P., Odell, D., Vleet, E. V., & Bossart, G. (1986). *Study of the effects of oil on marine turtles*. Retrieved from Vienna, Virginia:

Venables, S. (2013). *Short term behavioural responses of manta rays, Manta alfredi, to tourism interactions in Coral Bay, Western Australia.* (Bachelor of Science Thesis). Murdoch University,

Watson, J. W., Epperly, S. P., Shah, A. K., & Foster, D. G. (2005). Fishing methods to reduce sea turtle mortality associated with pelagic longlines. *Canadian Journal of Fisheries and Aquatic Sciences, 62*(5), 965-981. doi:10.1139/f05-004

Weishampel, J. F., Bagley, D. A., & Ehrhart, L. M. (2004). Earlier nesting by loggerhead sea turtles following sea surface warming. *Global Change Biology, 10*, 1424-1427. doi:10.1111/j.1365-2486.2004.00817.x

Weishampel, J. F., Bagley, D. A., Ehrhart, L. M., & Rodenbeck, B. L. (2003). Spatiotemporal patterns of annual sea turtle nesting behaviors along an East Central Florida beach. *Biological Conservation, 110*(2), 295-303. Retrieved from <Go to ISI>://000180818400013

Wershoven, J. L., & Wershoven, R. W. (1992). *Juvenile green turtles in their nearshore habitat of Broward County, Florida: A five year review*. Paper presented at the Eleventh Annual Workshop on Sea Turtle Biology and Conservation.

White, F. N. (1994). *Swallowing dynamics of sea turtles*. Paper presented at the Research Plan to Assess Marine Turtle Hooking Mortality, Honolulu, Hawaii.

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

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

Wiley, T. R., & Simpfendorfer, C. A. (2007). *Site fidelity/residency patterns/habitat modeling. Final Report to the National Marine Fisheries Service, Grant number WC133F-06-SE-2976*. Retrieved from

Wiley, T. R., & Simpfendorfer, C. A. (2010). Using public encounter data to direct recovery efforts for the endangered smalltooth sawfish, Pristis pectinata. *Endangered Species Research, 12*, 179-191.

Wilkinson, C. (2004). *Status of Coral Reefs of the World: 2004* (ISSN 1447-6185). Retrieved from

Witherington, B., Bresette, M., & Herren, R. (2006). *Chelonia mydas* - Green turtle. *Chelonian Research Monographs, 3*, 90-104.

Witherington, B., Hirama, S., & Moiser, A. (2003). *Effects of beach armoring structures on marine turtle nesting*. Retrieved from

Witherington, B., Hirama, S., & Moiser, A. (2007). *Changes to armoring and other barriers to sea turtle nesting following severe hurricanes striking Florida beaches*. Retrieved from

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

Witherington, B. E. (2002). Ecology of neonate loggerhead turtles inhabiting lines of downwelling near a Gulf Stream front. *Marine Biology, 140*(4), 843-853. doi:10.1007/s00227-001-0737-x

Witherington, B. E., & Bjorndal, K. A. (1991). Influences of artificial lighting on the seaward orientation of hatchling loggerhead turtles *Caretta caretta*. *Biological Conservation, 55*(2), 139-149.

Witherington, B. E., & Ehrhart, L. M. (1989a). Hypothermic stunning and mortality of marine turtles in the Indian River Lagoon System, Florida. *Copeia, 1989*(3), 696-703.

Witherington, B. E., & Ehrhart, L. M. (1989b). *Status, and reproductive characteristics of green turtles (Chelonia mydas) nesting in Florida*. Paper presented at the Second Western Atlantic Turtle Symposium. .

Witzell, W. N. (1983). *Synopsis of biological data on the hawksbill sea turtle, Eretmochelys imbricata (Linnaeus, 1766)*. Retrieved from Rome:

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

Work, T. M. (2000). *Synopsis of necropsy findings of sea turtles caught by the Hawaii-based pelagic longline fishery*. Retrieved from

Zug, G. R., & Glor, R. E. (1998). Estimates of age and growth in a population of green sea turtles (*Chelonia mydas*) from the Indian River lagoon system, Florida: A skeletochronological analysis. *Canadian Journal of Zoology, 76*(8), 1497-1506.

Zurita, J. C., Herrera, R., Arenas, A., Torres, M. E., Calderón, C., Gómez, L., . . . Villavicencia, R. (2003). *Nesting loggerhead and green sea turtles in Quintana Roo, Mexico*. Paper presented at the Twenty-Second Annual Symposium on Sea Turtle Biology and Conservation, Miami, Florida.

Zwinenberg, A. J. (1977). Kemp's ridley, *Lepidochelys kempii* (Garman, 1880), undoubtedly the most endangered marine turtle today (with notes on the current status of *Lepidochelys olivacea*). *Bulletin Maryland Herpetological Society, 13*(3), 170-192.