Programmatic Biological Evaluation (NLAA) on the Effects of Transportation Activities and Projects Regularly Undertaken in North Carolina, South Carolina, and Georgia

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1. Executive Summary

Pursuant to Section 7(a)(2) of the Endangered Species Act (ESA) of 1973, as amended (16 U.S.C. §1531 *et seq*.), each federal agency is required to 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 listed species or its critical habitat, that agency is required to consult with the National Marine Fisheries Service (NMFS), who administers the ESA for most listed marine species, anadromous fish species, and their critical habitat.

The Federal Highway Administration (FHWA) aims to streamline consultation and improve conservation for listed species and critical habitat under the purview of NMFS in North Carolina (NC), South Carolina (SC), and Georgia (GA). As part of this effort, the FHWA has developed a programmatic biological evaluation (BE) for common types of transportation projects that State or local Departments of Transportation (DOTs) conduct with federal funding and/or approval. The purpose of the consultation is:

- to streamline the ESA consultation process that is required when these projects "may affect" federally listed species and critical habitats in NC, SC, and GA; and
- promote better conservation outcomes from these projects for all listed species and critical habitat.

This consultation does not cover all projects or project types the FHWA funds or approves. The BE defines the scope and criteria applicable to a subset of transportation projects that qualifies the project for coverage under the programmatic consultation. Separate section 7 consultation is required for projects that are outside the scope and criteria of the BE or to address newly-listed species and/or their critical habitat not covered by the BE. Projects that are likely to adversely affect listed species or critical habitat are not eligible to use the programmatic consultation.

For transportation projects that require other Federal approvals, such as U.S. Army Corps of Engineers (USACE) permits under the Clean Water Act, the FHWA will generally serve as the lead Federal agency for ESA consultation purposes. The FHWA may use this programmatic consultation, consult on a case-by-case basis, or use another applicable programmatic consultation for its projects.

Based on the analysis provided herein, we conclude that the subset of transportation activities and projects to be covered by this programmatic consultation:

- will result in no effect to listed species and critical habitat; or,
- may affect, but are not likely to adversely affect listed species and critical habitat.

2. Table of Contents

3. Background Statutory and Regulatory Information

Section 7(a)(1) requires Federal agencies, in consultation with NMFS, to utilize their authorities to further the purposes of the ESA by carrying out programs for the conservation of listed species. 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 insure, in consultation with NMFS, 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 listed species or its designated critical habitat, that agency is required to consult with either the National Marine Fisheries Service (NMFS) or the U.S. Fish and Wildlife Service (USFWS), or both, depending upon the species 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 concurs or determines the action is not likely to adversely affect listed species or critical habitat; or issues a Biological Opinion ("Opinion") that determines whether the action agency has insured the proposed action is not likely to jeopardize the continued existence of any federally listed species, or destroy or adversely modify designated critical habitat. If there is a "no jeopardy or adverse modification" finding the Opinion will include an Incidental Take Statement (ITS). The ITS states the amount or extent of incidental take anticipated and provides non-discretionary measures that the action agency must implement to minimize the impact of the anticipated/authorized take on the species. The Opinion may also recommend discretionary conservation measures. The issuance of an Opinion detailing NMFS's findings concludes ESA Section 7 consultation.

If an action agency determines that a proposed action "may affect" a listed species or critical habitat then formal consultation is required, unless the action agency determines, and NMFS concurs in writing, that the action is not likely to adversely affect any listed species or critical habitat. NMFS may conclude informal consultation when the effects of the proposed action are found to be discountable, insignificant, or entirely beneficial. "Entirely beneficial" means all effects are beneficial and there are no adverse effects. Determinations based on the net effect of a proposed action, where an action with beneficial effects also includes some adverse effects, is not the basis for a "not likely to adversely affect" determination. In such cases NMFS may be required to issue an Opinion. NMFS may conclude ESA Section 7 consultation with the issuance of a "concurrence letter."

This document represents the FHWA's Biological Evaluation of impacts associated with regularly occurring transportation projects and activities and request for informal programmatic concurrence on these projects and activities that would occur throughout the states of North Carolina, South Carolina, and Georgia.

These categories of activities and projects include:

<u>Activities (common to several project types)</u>

1. Installation, maintenance, and removal of temporary erosion, turbidity, and sedimentation control devices

2. Staging areas
3. Site preparation
4. Geotechnical drilling and hazardous waste sampling
5. Installation, maintenance, and removal of scientific survey devices
6. Temporary platforms, access fills, and cofferdams
7. Pile installation and removal
8. Blasting
9. Dredging/underwater excavation
10. Equipment

Project Types

1. New alignments/roadways and road widening (roadway construction)
2. New bridge, bridge replacement, and bridge widening; new and replacement piers
3. Bridge repair, maintenance, and retrofit; pier repair and maintenance
4. Culvert installation, replacement, repair, maintenance, and cleaning
5. Installation, maintenance, and removal of shoreline stabilization
6. Pavement preservation

We analyzed the effects from these 10 categories of activities and 6 categories of project types on the endangered (E) and threatened (T) species and critical habitat listed in Tables 1 and 2, in accordance with Section 7 of the ESA. The analysis begins with a description of the types of the activities and projects that would be undertaken, the action area(s) in which they can occur, the requirements they must meet to be undertaken, and how the activities will be reviewed. This is followed by the analysis of the effects of the proposed action on species likely to be affected. A discussion of aggregate effects precedes the status of listed species and critical habitat within the action area. The conclusions and effects determinations follow, which are based on the analysis of the effects of the action on the species and critical habitat that may be present in the action area.

Table 1. Listed Species Likely to Occur in or near the Action Area

Common Name	Scientific Name	ESA-Listed Status
Sea Turtles		
hawksbill sea turtle	*Eretmochelys imbricata*	Endangered
Kemp's ridley sea turtle	*Lepidochelys kempii*	Endangered
leatherback sea turtle	*Dermochelys coriacea*	Endangered

green sea turtle	*Chelonia mydas*[1]	Endangered/Threatened
loggerhead sea turtle	*Caretta caretta*[2]	Threatened
Fish		
shortnose sturgeon	*Acipenser brevirostrum*	Endangered
Atlantic sturgeon[3]	*Acipenser oxyrinchus oxyrinchus*	Endangered

Table 2. Designated Critical Habitat in or near the Action Area

Species	Unit
Atlantic sturgeon	82 FR 39160

Atlantic sturgeon critical habitat rivers in the Southeast U.S. are for the Carolina and South Atlantic DPS units.

Programmatic Informal Consultations

NMFS has developed a range of techniques to streamline the procedures and time involved in consultations for broad agency programs or numerous similar activities with well-understood predictable effects on listed species and critical habitat. Some of the more common of these techniques and the requirements for ensuring that streamlined consultation procedures comply with Section 7 of the ESA and its implementing regulations are discussed in the October 2002 joint Services memorandum, *Alternative Approaches for Streamlining Section 7 Consultation on Hazardous Fuels Treatment Projects* (http://www.fws.gov/endangered/pdfs/MemosLetters/streamlining.pdf; see also, 68 FR 1628 [January 13, 2003]). Provided below is a generalized discussion about Programmatic Consultations. The specific requirements set forth for this Programmatic evaluation are provided in the remainder of the document.

Programmatic informal consultations can be used to evaluate the expected effects of groups of related agency actions expected to be implemented in the future, where specifics of individual projects such as project location are not definitively known. It is important to note that the term "programmatic" is defined differently by NMFS when discussing a Programmatic Consultation or Programmatic Biological Opinion than it is by other Federal agencies (such as USACE when discussing a Programmatic General Permits). A Programmatic Informal Consultation must identify PDCs, or standards that will be applicable to all future projects implemented under the consultation document. PDCs serve to structure an action to avoid adverse effects to listed species and critical habitat at the individual project level and in aggregate from all projects implemented under the programmatic

[1] Green turtles are listed as threatened except for the Florida and Pacific coast of Mexico breeding populations, which are listed as endangered. On March 23, 2015, a proposed rule was published to list 11 DPSs of green sea turtles as threatened or endangered. The populations within Florida would be listed as part of the North Atlantic DPS and listed as threatened; thus, any animals potentially affected by the proposed action would be members of that proposed DPS.

[2] Northwest Atlantic Ocean (NWA) distinct population segment (DPS).

[3] Carolina and SA DPS of Atlantic Sturgeon.

consultation. Programmatic Informal Consultations allow for streamlined project-specific consultations because the suite of actions covered are pre-defined and the effects analysis is completed up front. At the project-specific consultation stage, a proposed project is reviewed to determine if it can be implemented consistent with the action as described (including all relevant PDCs). The following elements should be included in a Programmatic Informal Consultation to ensure its consistency with ESA Section 7 and its implementing regulations:

1. PDCs to prevent or limit future adverse effects on listed species and critical habitat such that the effects of projects, individually and in aggregate, are discountable, insignificant or entirely beneficial.

2. Description of the manner in which projects to be implemented under the Programmatic Informal Consultation may affect, but are not likely to adversely affect listed species and critical habitat.

3. Evaluation of the expected, aggregate, or net additive effects of all projects expected to be implemented under the Programmatic Informal Consultation. The analysis in the Programmatic Informal Consultation document must demonstrate that when the PDCs are applied to each project, the aggregate effect of all projects are not likely to adversely affect listed species or their critical habitat.

4. Procedures for streamlined project-specific consultation. As discussed above, if an approved Programmatic Informal Consultation document is sufficiently detailed, project-specific consultations ideally will consist of certifications and concurrences between the action agency and consulting agency. An action agency will provide a description of a proposed project, or batched projects, and a certification that the project(s) will be implemented in accordance with the proposed action, including PDCs. The action agency also provides a certification that these effects are consistent with those anticipated in the Programmatic Informal Consultation document. If a project is likely to adversely affect listed species or critical habitat, then it would not qualify for using the programmatic informal consultation and a separate, individual formal consultation would be necessary. The consulting agency biologist reviews the submission and provides verification, or identifies adjustments to the project(s) necessary to bring it (them) into compliance with the Programmatic Informal Consultation document. Finally, the project-specific consultation procedures must provide contingencies for proposed projects that cannot be implemented in accordance with the PDCs; full stand-alone consultations may be performed on these projects if they are too dissimilar in nature or in expected effects from those projected in the Programmatic Informal Consultation document.

5. Procedures for monitoring projects to ensure they are implemented as proposed.

6. Comprehensive review of the program, including compliance with the proposed action, generally conducted annually.

Actions that are likely to adversely affect listed species or designated critical habitat cannot be covered under this programmatic informal consultation and must undergo separate, formal consultation.

4. Proposed Action

The proposed action is the implementation of the projects funded or authorized by the FHWA (and carried out by State DOTs) in North Carolina, South Carolina, and Georgia and activities common to those projects, with relevant/applicable Project Design Criteria (PDCs) listed below. These three states also represent the *action area*, with projects concentrated in estuarine and freshwater environments. The FHWA and State DOTs conduct several kinds of routine and repetitive activities and projects that typically result in predictable effects. The Wilmington, Charleston, and Savannah Districts of the U.S. Army Corps of Engineers (USACE) regularly authorize these projects. The USACE uses several permitting authorities to permit these projects such as Nationwide Permits, Regional General Permits, Programmatic General Permits, and Individual Permits.

This section provides a description of:

- The 10 categories of activities and 6 categories of projects covered under this agreement and the PDCs needed to authorize the activities (Section 4.1).
- The project specific review (Section 4.4) and programmatic review (Section 4.5) requirements necessary to ensure that the FHWA adheres to the PDCs to authorize projects in NC, SC, and GA.
- An estimate of the number of activities that will rely upon this agreement as the Section 7 consultation analysis (Section 4.2)

FHWA provides stewardship over the construction, maintenance, and preservation of the Nation's highways, bridges, and tunnels. FHWA also conducts research and provides technical assistance to Federal, State, Tribes, and local agencies in an effort to improve safety, mobility, and livability, and to encourage innovation. FHWA strives to advance environmental stewardship and streamlining for FHWA-funded projects through the application of National Environmental Policy Act (NEPA) and related environmental laws and regulations.

The Federal-Aid Highway Program (FAHP), Federal Lands Highway Program (FLHP), and Federal Lands Access Program (FLAP) are three FHWA programs addressed in this BE. The FAHP provides the financial resources and mechanism to assist States and local public agencies (LPAs) in constructing, preserving, and improving transportation for the movement of people and goods. FAHP funds are authorized by Congress; tax dollars are allocated and distributed by FHWA directly to the State DOTs, as a direct recipient for Federal-aid projects or LPAs, as sub-recipients, for "eligible" activities.

The FLHP and FLAP provide financial resources and technical assistance to support a coordinated program of public roads that service the transportation needs of Federal and Tribal lands. Federal Land Management Agencies include: the Bureau of Indian Affairs, Bureau of Land Management, Bureau of Reclamation, Surface Deployment and Distribution Command, US Forest Service, US Fish and Wildlife Service, National Park Service, and USACE.

4.1 Activities and Projects Included in this Programmatic Consultation and Project Design Criteria

The proposed action includes multiple transportation actions. Some of those actions need no further consultation and some need additional consultation with NMFS Southeast Regional Office. Other transportation actions are not included in the proposed action. Projects are not included in the proposed action for various reasons, though the two primary reasons include: (1) there is no plausible route of effect (to species or critical habitat), or (2) the project may affect, and is likely to adversely affect listed species or critical habitat. For example, projects that do not involve any construction (e.g., bridge assessment) or are completely within existing road surface (e.g., road line painting) are not included in the proposed action.

- **Projects included in the proposed action are those that are undertaken in or within 0.5 miles of areas where sturgeon and sea turtles occur, and/or where Atlantic sturgeon critical habitat is present.**

This Biological Evaluation analyzes 10 categories of activities (common to several project types) and 6 project types that are funded or authorized by the FHWA, as described below. Every activity and project type includes Project Design Criteria (PDCs). PDCs are non-discretionary measures that must be incorporated into individual projects to avoid or reduce the potential effects of permitted activities on listed species and critical habitat such that remaining effects are discountable, insignificant, or entirely beneficial. Each activity and project type category below includes:

1. The PDCs required with an activity/project using the programmatic informal consultation.
2. A general description of how the activity/project is typically installed/constructed.

The PDCs were developed based on information from past projects and practices and review of consultations with similar activities. These PDCs are the typical requirements to protect ESA-listed species and critical habitat. The PDCs are provided in the following format:

1. General PDCs that apply to all projects.
2. Activity-specific PDCs for each category of activity/project.
3. Critical habitat-specific PDCs are provided at the end of each category when additional protections are required for a specific critical habitat unit.

Hot Spots: "Hot spots" are biologically significant areas of exceptional importance for the conservation of species that will not be included in this programmatic consultation. These include:

- Mouths[4]/inlets of spawning rivers/estuaries where sturgeon are known to migrate for spawning purposes.
- The Savannah River in Allendale County, SC and Screven County, GA, including 5 kilometers upstream and downstream of the US-301 Bridge.
- The Great Pee Dee River in Marlboro County, SC, including 2 kilometers upstream and downstream of the SC-34 (Cashua Ferry Rd) Bridge.
- Sea turtle nesting beaches and ocean waters occurring waterward of those beaches.

4.1.1 General PDCs Applicable to All Projects

Project sponsors implement standard measures as part of other environmental compliance processes (e.g., USACE wetland permitting), and many of these measures reduce potential effects on listed species and critical habitat in NC, SC, and GA. These include:

- Wetland avoidance/minimization/compensation

[4] Mouths of rivers/streams/creeks are generally where the lotic system (referring to moving waters such as rivers and streams) enters another system, such as a river, stream, bay, or harbor. In some instances, a mouth is also referred to as an inlet. Here, the mouth will be considered from a river/stream distance of 0.5 kilometer (0.31 miles), measured from the mouth (or inlet) and extending upstream.

- Clearly delineating vegetative clearing limits; maintaining riparian buffers/minimizing impacts to riparian buffers.
- Compliance with State water quality standards through Storm Water Pollution Prevention Plans (SWPPP), which include erosion and sediment control, spill control, runoff detention, and treatment (further described in AP4.)

In addition, specific PDCs will be implemented where applicable. PDCs included in the analysis, if adopted under appropriate circumstances, are expected to reduce potential impacts of the stressors. Impacts will be reduced to levels that are insignificant (the size of the impact should never reach the scale where take occurs) or discountable (extremely unlikely to occur); therefore, a may affect, not likely to adversely affect determination will be appropriate.

General PDCs applicable to all projects include:

AP1. All projects will adhere to the sea turtle measures in the most current version of NMFS's *Sea Turtle and Smalltooth Sawfish Construction Conditions*, when a project is located in areas where sea turtles occur. These conditions will also apply to projects located in areas where Atlantic and shortnose sturgeon occur (the Conditions include protections for listed species in general). This includes the requirement that construction stops temporarily if an ESA-listed species is sighted within 50 feet of mechanical construction equipment.

AP2. Vessel Traffic and Construction Equipment: All vessel operators will watch for and avoid collision with species protected under the ESA. Vessel operators will avoid potential interactions with protected species and operate in accordance with the following protective measures:

Construction Equipment:

AP2.1. All vessels associated with the construction project will operate at "Idle Speed/No Wake" at all times while operating in water depths where the draft of the vessel provides less than a 4-foot (ft) clearance from the bottom, and after a protected species has been observed in and has departed the area.

AP2.2. All vessels will follow marked channels and/or routes using the maximum water depth whenever possible.

AP2.3. Operation of any mechanical construction equipment, including vessels, will cease immediately if a listed species is observed within a 50-ft radius of construction equipment and cannot resume until the species has departed the area of its own volition.

All Vessels:

AP3.4. Sea turtles: Do not approach within 150 ft.

AP3. Turbidity Control Measures during Construction: Turbidity must be monitored and controlled. Prior to initiating any of the work covered under this programmatic consultation, the Permittee will install turbidity barriers (including fencing and curtains) as described below. In some instances, the use of turbidity curtains may be waived if the project is deemed too minimal to generate turbidity or if the current is too strong for the curtains to stay in place or if the water is too shallow for a curtain. Turbidity barrier specifications:

AP3.1. Use turbidity barriers throughout construction to control erosion and siltation and ensure that turbidity levels within the project area do not exceed background conditions (i.e., the normal water quality levels from natural turbidity).

AP3.2. Position turbidity barriers in a way that does not block species' entry to or exit from designated critical habitat.

AP3.3. Install floating turbidity curtains with weighted skirts around all work areas that are in, or adjacent to, surface waters. All turbidity curtains should extend to 1 ft. or less from the bottom (acceptable to lay on the bottom, especially at low tides).

AP3.4 Monitor and maintain turbidity barriers in place until the authorized work has been completed and the water quality in the project area has returned to background conditions.

AP4. Petroleum products, chemicals, live (uncured) concrete, or water contaminated by these will not be allowed to enter flowing waters.

AP4.1 To the maximum extent practicable, refueling of machinery will be done at least 250 feet from any water body and be outside of active stream channels, outside of any tidal areas, and away from ditches or channels that enter flowing waters; designated refueling sites in upland areas at least 250 feet away from receiving waters are preferred. Refueling of boats and heavy machinery such as cranes positioned atop temporary work platforms over the water will take all relevant precautions to avoid spills into waterbodies.

AP4.2 To the maximum extent practicable, concrete washout pits/pans/pools will be located at least 500 feet from any water body and be outside of active stream channels, outside of any tidal areas, and away from ditches or channels that enter flowing waters. Designated sites in upland areas at least 500 feet away from receiving waters are preferred.

AP4.3 A Spill Plan will be created, and the plan and all materials necessary to implement the plan shall be accessible on site.

AP5. Construction personnel will ensure all materials placed in the water, including sheet piles, concrete piles, and erosion control materials, will be free of sediments and/or contaminants.

AP6. Reporting of interactions with protected species:

AP6.1. Any collisions(s) and/or injuries to any sea turtle or sturgeon occurring during the construction of a project, will be reported immediately to NMFS's Protected Resources Division (PRD) at (1-727-824-5312) or by email to takereport.nmfsser@noaa.gov. Sea turtle stranding/rescue organizations' contact information is available by region at http://www.nmfs.noaa.gov/pr/health/networks/htm.

AP6.2. Dead sturgeon must be reported to 1-844-788-7491 or email nmfs.ser.sturgeonnetwork@noaa.gov

AP6.3. Stranded, injured, or dead sea turtles will be reported to 1-877-942-5343.

AP7 Entanglement: All turbidity curtains and other in-water equipment will be properly secured with materials that reduce the risk of entanglement of marine species (described below). Turbidity curtains likewise will be made of materials that reduce the risk of entanglement of marine species.

AP7.1. In-water lines (rope, chain, and cable, including the lines to secure turbidity curtains) will be stiff, taut, and non-looping. Examples of such lines are heavy metal chains or heavy cables that do not readily loop and tangle. Flexible in-water lines, such as nylon rope or any lines that could loop or tangle, will be enclosed in a plastic or rubber sleeve/tube to add rigidity and prevent the line from looping and tangling. In all instances, no excess line will be allowed in the water.

AP7.2. Turbidity curtains and other in-water equipment will be placed in a manner that does not entrap species within the construction area or block access for them to navigate around the construction area.

AP8. All projects will follow the PDCs defined in Section 5.2 ("Noise") and Appendix A. .

AP8.1. Projects will not result in noise in excess of the established thresholds for physical injury or behavioral modification (single strike and cumulative exposure) for ESA-listed sea turtles and sturgeon. FHWA/State DOTs will ensure all pile installation activities not exceed these thresholds, but may accomplish this using relevant best management practices and other methods to avoid and minimize hydroacoustic impacts. A series of pile types, sizes, and hammer types have been analyzed in Section 5.2 and Appendix A, for use as reference/models. Projects that adhere to these previously analyzed scenarios will not need further review. However, projects that do not conform to these previously analyzed scenarios must conduct project-specific hydroacoustic analyses and submit these analyses to NMFS as part of the programmatic submission document(s). This hydroacoustic information should be clearly marked in a separate section of submittal materials for ease of review.

AP8.2 From **January to May** and/or **August to November**, installation of piles and sheet piles in rivers where sturgeon are known to use for migration and spawning are limited to drilled-shafts or those activities labeled "A" in section 5.2 ("Noise"). Appropriate/specific timeframes for individual sturgeon migration and spawning rivers are found in Appendix H of the *FHWA/NMFS-SERO BMP Manual.*

AP9. Impacts (both temporary and permanent) to living submerged aquatic vegetation (SAV) are limited to 250 ft^2 for a single, complete project (to include all activities/aspects of projects, e.g., cofferdams, piles, and temporary work platforms).

AP10. All in-water work activities will be performed during daylight hours.

AP11. Construction on, or waterward of, beaches used by sea turtles for nesting will not occur.

AP12. All over-water structures will incorporate measures to maximize ambient light transmission and minimize shading. Such measures include, but are not limited to, maximizing the height of the structure and minimizing the width of the structure, minimizing the number of instream pilings/piers, and using grated decking material. The optimal height-width (HW) ratio of newly constructed (new or replacement) bridges, piers, multi-use paths, or docks is 0.7 or greater. This ratio is also recommended for temporary work structures such as trestle systems/work bridges.

AP13. Projects located near the mouths/inlets of spawning rivers/estuaries where sturgeon are known to migrate/spawn are not eligible to use this programmatic informal consultation.

AP14. All construction personnel are responsible for observing water-related activities to detect the presence of these species and avoid them.

NOTE: For projects that utilize NMFS construction conditions or other documents, FHWA shall ensure that State DOTs are using the current versions including any updates (e.g., NMFS's *Sea Turtle and Smalltooth Sawfish Construction Conditions*).

4.1.2 Activities Common to Several Project Types

Several project types include common construction practices and techniques that facilitate work, and avoid and minimize impacts to species and their habitats. Almost all projects require erosion and sediment control measures, and usually include staging areas and some form of site preparation. Many projects include geotechnical drilling, offsite use areas, use of temporary platforms, access fills, and cofferdams, pile installation and removal activities, and blasting. Numerous equipment types and incidental or miscellaneous construction practices and techniques are also common to several project types.

Activity #1 – Installation, Maintenance, and Removal of Temporary Erosion, Turbidity, and Sediment Control Devices

The installation of temporary erosion, turbidity, and sediment control measures is a necessary component of active construction sites. Prior to major construction activities, erosion and sediment control measures are typically installed on the perimeter of active construction sites (including off-site and staging areas) to prevent erosion and water pollution. Siltation control fence (SCF) is commonly used on the perimeter of sites, but typically requires small amounts of clearing and grubbing for installation. Construction work, typically beginning with site preparation, usually proceeds following the installation of perimeter SCF. Additional erosion and sediment control measures are routinely installed on the interior of active construction sites and may be used on the perimeter of sites in addition to, or to reinforce, SCF. Numerous measures are commonly used in NC, SC, and GA, and include berms, silt basins, dams, and ditches, rock filter dams, hay bales, fiber logs and mats, inlet filters, slope drains, temporary seeding, stabilization control entrances/exits, brush barriers, and sediment tubes.

Activity-specific PDCs for the installation, maintenance, and removal of erosion, turbidity, and sediment control devices:

A1.1 Temporary erosion, turbidity, and sediment control devices are required to be installed prior to any clearing and grubbing activities, to the maximum extent practicable. In areas where clearing and grubbing is necessary to provide access and area for the installation of temporary erosion, turbidity, and sediment control devices, those devices should be installed immediately following the minimal amount of clearing and grubbing that is necessary.

A1.2 Temporary erosion, turbidity, and sediment control devices are required on all project-related areas, including off-site use areas, staging areas, and in/around temporary access roads and other areas.

A1.3 All devices will be regularly inspected for effectiveness and promptly repaired or replaced if they have been damaged or are ineffective.

A1.4 All temporary devices designed to control erosion, turbidity, and sedimentation throughout the construction process will be removed immediately following project completion.

A1.5 Installation of silt/turbidity curtains will be shore-parallel (anchored on the shore at both ends) and may not exceed 550 feet in length; curtains must be securely anchored and will not impede or obstruct movement of listed species.

A1.6 Silt/turbidity curtains will not extend more than 10-feet waterward from the shoreline. In waterways 40-feet wide or less, silt/turbidity curtains will not encroach more than 25% from the Mean High Water Line (MHWL) in intertidal areas or Ordinary High Water Mark (OHWM) in rivers/streams.

A1.7 Silt/turbidity curtains will avoid impacts to submerged aquatic vegetation (i.e., seagrasses), to the maximum extent practicable; curtains will not enclose more than 100 ft^2 of submerged aquatic vegetation.

A1.8 Siltation control fence or other stationary measures will be placed parallel to the shoreline and may not be placed waterward of the MHWL or OHWM; measures will not impede or obstruct movement of listed species.

Critical Habitat-specific PDCs:

A1.9 Installation of erosion, turbidity, and sediment control devices will not occur in Atlantic Sturgeon critical habitat, where the following PBF is present:

- Suitable hard bottom substrate (e.g., rock, cobble, gravel, limestone, boulder, etc.) in low salinity waters (i.e., 0.0-0.5 parts per thousand range [ppt]) for settlement of fertilized eggs and refuge, growth, and development of early life stages.

A1.10 Silt/turbidity curtains will only extend waterward into depths no greater than 1.1 meters (3.6 ft) in main river channels; curtains will not impede/obstruct movement of sturgeon.

Activity #2 - Staging Areas

Staging areas are used for delivery and storage of construction materials and equipment, contractor office and storage trailers, and employee parking. These areas are typically contractor-selected and permitted, and are often fenced and located in close proximity to project construction. Temporary fencing prevents machinery and equipment, materials storage, and construction activity from intruding into adjacent properties, wetland and stream buffers, and shoreline areas. Office trailers, placed on temporary foundations, are often connected to available utilities including power, telephone, water, and sewer as needed. Connecting to these utilities may include installing poles for power lines and excavating trenches to place water and sewer pipelines. After construction is complete, staging areas are restored, if appropriate, and disconnected from any utilities.

Depending on site conditions, construction staging areas vary in size and may require vegetation clearing, grubbing, and grading or excavation to level the site and install drainage improvements.

Extensive alterations to establish a staging area, such as blasting, are extremely unlikely. Cleared vegetation is often hauled offsite, mulched and redistributed, or less commonly piled and burned onsite. Excess material (e.g., soil, rock, debris) is disposed of at offsite facilities or reused as appropriate in construction. Conveyance systems for the movement of stormwater from a collection point to an outfall can consist of drainage pipes and stormwater facilities (such as ponds, vaults, and catch basins), using gravity or pumps to move the stormwater. Temporary driveways and access roads may be established from staging areas to the existing roadway network. Some staging areas may also be equipped with wheel washes that clean truck tires to reduce tracking dirt and dust offsite. Additional dust control is provided via water trucks and street sweepers.

Staging, fueling, and storage areas are typically located in areas that minimize potential effects to sensitive areas. Specialized best management practices (BMPs) are employed around concrete- handling areas to prevent water contamination from uncured cement entering water bodies or stormwater facilities. Temporary erosion and sediment control measures are implemented prior to, or immediately following, ground disturbance on these sites. Examples include marking clearing limits, establishing construction access, controlling runoff flow rates (sediment ponds, check dams, etc.), installing sediment controls and soil stabilization (silt fence, coir blankets, temporary seeding), protecting slopes, protecting drain inlets, and preventing/containing contaminant spills.

Activity-specific PDCs for staging areas:

A2.1 Staging areas will be located in upland areas and have appropriate temporary erosion, turbidity, and sediment controls, including, but not limited to stabilized construction exists/entrances and sediment control fence.

A2.2 Staging areas will not be located in active channels (e.g., streams, tidal creek creeks, or rivers) or open water areas and will not be located in tidal areas (e.g., all staging areas will be located above MHWL); staging areas shall be setback a minimum of 15 feet from the OHWM and MHWL.

A2.3 Staging area activities will not impede or obstruct movement of listed species.

Critical Habitat-specific PDCs:

A2.4 Staging areas will not be located in Atlantic Sturgeon critical habitat, where the PBFs are present.

A2.5 Staging areas will be setback a minimum of 75 feet from the active channel (bankfull width) and MHWL in intertidal areas.

Activity #3 - Site Preparation

Site preparation begins with vegetation removal, which may be permanent or temporary. Permanent conversion of a vegetated area into a developed area includes clearing vegetation then grubbing out the roots, stumps, and other debris. Together, these are typically referred to as “clearing and grubbing” and are a sub-activity of earthwork. Temporary vegetative clearing includes cutting vegetation but maintaining the root mass to allow for regrowth. Removed vegetation is disposed of similarly to staging area vegetation clearing. Preliminary earthwork consists of stripping topsoil from an area and either removing earth or placing and compacting earth for roadway prism construction or slope construction. The earth may be moved from or to another section on the same project, or it may come from or be disposed off-site. Completed cut or fill prisms may then be covered by any number of treatments, such as rock base and pavement, rock stabilization and rip-rap, or mulch and seeding. Drainage and utility work often accompany excavation and embankment. Impacts to wetlands and other sensitive areas are first avoided and minimized as much as possible, then mitigated when unavoidable. Utility work includes excavation to install new utility poles or trench excavation to install underground utilities. This work can be completed in forested areas.

Temporary road construction is often necessary for equipment access and involves similar site preparation activities as conducted for permanent roads. However, these roads are often unpaved, either constructed by grading, laying fabric and quarry spalls, construction mats, or rock rip-rap. Compaction is minimized so the materials can be removed and the site restored and replanted following construction. A variety of temporary construction BMPs are used for site preparation, including silt fences, berms, fiber wattles, storm drain inlet protection, straw bale barriers, check dams, and detention or siltation ponds. Erosion control measures are installed and operational before commencement of ground- disturbing activities. Areas where vegetation should be preserved are clearly marked or fenced. If work is conducted at night, temporary lighting is utilized.

Activity-specific PDCs for site preparation activities:

A3.1 To the maximum extent practicable, site preparation (e.g., earthwork, obstruction removal, etc.) will begin following installation of temporary erosion, turbidity, and sedimentation control measures, including perimeter sediment control fence.

A3.2 Riparian and shoreline clearing, grading, and preparing that occurs in areas where ESA-listed species are present will be completed by hand or with construction machinery (e.g., mini-excavator or bobcat/skid-steer); whichever method best avoids and minimizes erosion, sedimentation, and turbidity. All appropriate precautions will be taken to avoid and minimize erosion, sedimentation, and turbidity.

A3.3 Construction machinery will not be located in an active channel or below the OHWM or MHWL for site preparation purposes; machinery may reach (e.g., mini-excavator arm with bucket) approximately 5 ft waterward and 5 ft below the OHWM or MHWL for site preparation purposes. Machinery may be placed atop work structures, such as work trestles, mats, or barges.

A3.4 In areas where ESA-listed species are present, riparian and shoreline vegetation will not be cleared, trimmed, or otherwise altered if the area is not essential for project construction or facilitation of construction.

A3.5 Site preparation will not impede or obstruct movement of listed species.

Critical Habitat-specific PDCs:

A3.6 Clearing will take place by hand or with construction machinery – whichever method best avoid and minimizes erosion, sedimentation, and turbidity - in Atlantic sturgeon critical habitat areas, where the PBFs are present.

A3.7 Construction machinery will not be located in an active channel or below the OHWM or MHWL in Atlantic sturgeon critical habitat, where the PBFs are present, for site preparation purposes; machinery may reach (e.g., mini-excavator arm with bucket) approximately 2 ft waterward and 2 ft below the OHWM or MHWL for site preparation purposes. Machinery may be placed atop work structures, such as work trestles, mats, or barges.

Activity #4 - Geotechnical Drilling and Hazardous Waste Sampling

Subsurface sampling and testing to determine soil characteristics is often an important step in the engineering design process. Such sampling and testing may be associated with all programs/categories described. Subsurface sampling is accomplished by drilling test holes up to 300 ft. deep or digging soil pits up to 8 ft. deep. A drill rig can be mounted on a variety of transportation vehicles including trucks, tractors, skids, drill rigs, and barges. The drill is typically 5 to 10 inches in diameter. The drill shaft is lubricated using a mixture of bentonite (a natural, inert clay material) and water. The fluid is filtered and recycled back through the drilling operation.

When drilling is done off the roadway, impacts are minimized as much as possible through the selection of an appropriate sized and mounted drill rig, and limited vegetation removal. Normally, herbaceous and woody vegetation is cut back as necessary for drill access and not grubbed, and trees are rarely removed. Subsurface sampling for hazardous materials may also be necessary for each program/category. It is very similar to subsurface sampling for geotechnical purposes. Durations will vary for these activities depending on number of bore holes and substrate composition. Typically, one to several bore holes can be drilled in a day and most sampling is accomplished within a week.

Activity-specific PDCs for geotechnical drilling and hazardous waste sampling activities:

A4.1 Bore holes for geotechnical drilling and hazardous waste sampling are limited to 13.54 inches in diameter (144 $inches^2$; 1 ft^2) and only the minimum amount of vegetation clearing required for access will occur.

A4.2 Drilling in aquatic, intertidal, or wetland areas will occur from existing structures (e.g., bridges, temporary work trestles), barges, vessels, or low ground bearing pressure tracked rigs.

A4.2.1 Barge grounding is not authorized and tracked rigs will not travel through more than 50 linear feet of seagrasses.

A4.3 All drilling will avoid submerged aquatic vegetation (i.e., seagrass beds).

A4.4 All areas will be restored to pre-drilling/pre-sampling conditions and elevations.

A4.5 Drilling and sampling will be timed to avoid the presence of sturgeon and sea turtles, to the extent practicable; drilling and sampling will not impede or obstruct movement of listed species.

Critical Habitat-specific PDCs:

A4.6 Geotechnical drilling and hazardous waste sampling will not occur in Atlantic sturgeon critical habitat, where the following PBF is present:

- Suitable hard bottom substrate (e.g., rock, cobble, gravel, limestone, boulder, etc.) in low salinity waters (i.e., 0.0-0.5 parts per thousand range [ppt]) for settlement of fertilized eggs and refuge, growth, and development of early life stages.

A4.7 Tracked rigs will not be used in critical habitat, where the PBFs are present, unless they are operating atop mats, barges, or other temporary work structures..

Activity #5 – Installation, Maintenance, and Removal of Scientific Survey Devices

Numerous scientific survey devices are installed in or near project sites to collect data on environmental conditions, processes, and impacts. These types of devices are typically removed in less than 24 months. Many survey devices are installed with anchored buoys, vinyl poles, or single piles installed by hand or jetted in place from a barge. The amount of impact from this category of activity typically varies from 1ft^2 to 50 ft^2. This type of installation can typically be completed in 1-2 days. These types of projects can include:

- Temporary buoys that contain current profilers to measure and record water temperatures and currents.
- Surface Elevation Tables (SETs)
- Time-laps cameras and passive data recorders affixed to PVC poles.
- Water quality monitoring buoys.

Activity-specific PDCs for installation, maintenance, and removal of scientific survey devices:

A5.1 The amount of impact from a single project will not exceed 25 ft^2 and impacts to seagrasses will not exceed 15 ft^2.

A5.2 The installation, maintenance, and removal of temporary devices are allowed if they are intended to measure and/or record scientific data in tidal and freshwater areas, such as staff gages, tide and current gages, biological observation devices, water quality testing and improvement devices, and similar instruments.

A5.3 Temporary structures will not block access of species to an area such as preventing movement in or out of a river or channel.

A5.4 No later than 24 months from initial installation, or upon completion of data acquisition, whichever comes first, the measuring device and any other structure or fill associated with that device (e.g., anchors, buoys, lines) will be removed and the site must be restored to pre-construction elevations.

A5.5 Projects are not authorized seaward of sea turtle nesting beaches or in estuarine inlets of sturgeon migration/spawning rivers.

Critical Habitat-specific PDCs:

A5.6 Installation of scientific survey devices will not occur in Atlantic Sturgeon critical habitat, where the following PBF is present:

- Suitable hard bottom substrate (e.g., rock, cobble, gravel, limestone, boulder, etc.) in low salinity waters (i.e., 0.0-0.5 parts per thousand range [ppt]) for settlement of fertilized eggs and refuge, growth, and development of early life stages.

A5.7 The amount of impact from a single project will not exceed 25 ft^2 in Atlantic sturgeon critical habitat, where the PBFs are present.

Activity #6 - Temporary Platforms, Access Fills (including rock/rip rap jetties), and Cofferdams

Temporary work platforms and fills (including rock riprap jetties and islands) may be required for new construction and to support maintenance activities (typically for bridges and causeways). Equipment typically includes the use of barges, cranes, pumps, boats, front-end loaders, and track hoes. Examples of temporary platforms and fills includes:

- Space-frame structures (i.e., truss-like, lightweight rigid structure constructed from interlocking struts in a geometric pattern) that provide high capacity working platforms which are capable of spanning large decks, including traversing along the length of a bridge; underslung girders and trusses
- Pontoons
- Work trestles (i.e., a rigid frame used as a support, especially referring to a bridge composed of a number of short spans supported by such frames)
- Temporary haul road fill (i.e., temporary roads of fill created in or adjacent to the waterbody to transport equipment and materials).
- Fill platforms (i.e., temporary islands or access roads of fill created to support equipment, including those composed of rock riprap).

Cofferdams are temporary steel or concrete boxes used to keep water out of work areas and are common to in-water work operations. Cofferdams can also include inflatable (typically made of geotextile) devices, where the walls are filled with water and the interior areas is pumped out; these types of cofferdams are typically used in areas where sheet piles cannot penetrate the bottom substrate. Cofferdams enclose work areas and reduce turbidity, sedimentation, and hydroacoustic impacts, while excluding organisms from areas where construction work is occurring. Cofferdams composed of steel sheet piles installed with vibratory hammers in a generally rectangular configuration are included in this evaluation. Cofferdams may also consist of large casings (hollow cylinders), known as isolation casings, installed with vibratory hammers. Cofferdam installation includes driving sheet piling into the substrate to a sufficient depth to cut off water flow. The proper penetration depth will vary based on soil conditions. The sheet piling must also be tall enough to isolate the work area. Once the cofferdam is established, the inside of the cofferdam is dewatered using pumps to create "dry" conditions. Once work within the cofferdam is completed, all sheet piling is removed with a vibratory hammer.

Activity-specific PDCs for temporary platforms, access fills, and cofferdam activities:

A6.1 All [water dependent] activities will be limited to a total of 120 days or less ("temporary" is defined as 120 days or less), except temporary work platforms/work trestles. Temporary work platforms/work trestles are limited to 24 months or less.

A6.2 Temporary platforms/work trestles will be installed/constructed following the PDCs outlined in Section 5.2 ("Noise") below and Appendix A.

A6.3 The combined temporary impacts from temporary platforms/access fills/cofferdams are limited to a total of 0.5 acres or less in waters of the U.S. (e.g., below OHWM or MHWL) for a single, complete project. Of the total 0.5 acres of temporary impacts, individual activity breakdowns are as follows:

A6.3.1 Temporary platforms are limited to those with substrate impacts (e.g., footprint of pilings equaling less than 500 ft^2 (0.011 acres).

A6.3.2 Temporary access fills are limited to 0.5 ac of clean fill (e.g., riprap free of debris) in waters of the U.S. (e.g., below OHWM or MHWL) at any given time.

A6.3.3 Individual temporary cofferdams are limited to:

A. 500 ft^2 (0.011 ac) or less in size and a maximum of 2 cofferdams (regardless of size) may be installed/in place at any given time; a maximum of 8 cofferdams (regardless of size) may be installed for a single, complete project.

or

B. 1000 ft^2 (0.023 ac) or less in size and a maximum of 1 cofferdam (regardless of size) may be installed/in place at any given time; a maximum of 4 cofferdams (regardless of size) may be installed for a single, complete project.

A6.4 Placement of geotextile barriers is required prior to placement of the platform/access fills to ensure that the fill will be removed completely at the end of construction.

A6.5 Temporary fill materials will be placed in a manner that will not be eroded by high water flows. Temporary fills will be removed in their entirety and the affected areas returned to pre-construction conditions/elevations.

A6.6 The navigability of the waterway will remain uninterrupted and freely open for species movement in/out of the area.

A6.6.1 Cofferdams and fills will be limited to no more than 50% of the width of a waterbody. In tidal areas (e.g., tidal creeks), the width of the water body should be considered/measured at mean low water (MLW).

A6.7 Projects will not appreciably impact surface water flow into or out of any waters of the U.S.

A6.8 Appropriate measures will be taken to maintain normal downstream flows and minimize flooding to the maximum extent practicable, when temporary structures, work and discharges, including cofferdams, are necessary for construction activities, access fills, or dewatering of the construction sites.

A6.9 Temporary steel sheet pile cofferdams will be installed/removed by vibratory hammers only.

A6.10 For temporary inflatable cofferdams, the footprints of the walls will be included into the overall impacts area.

A6.11 All activities will avoid impacts to submerged aquatic vegetation (i.e., seagrasses), to the maximum extent practicable; activities will not impact more than 100 ft^2 of submerged aquatic vegetation.

A6.12 Activities are not authorized at the mouths of rivers where sturgeon are known to migrate for spawning purposes.

Critical Habitat-specific PDCs:

A6.13 Temporary platforms/work trestles in Atlantic sturgeon critical habitat, where the following PBF is present, are limited to 24 months or less and those with total substrate impacts (e.g., footprint of pilings) of 250 ft^2 (0.005 acres) or less, do not impede or obstruct sturgeon movement, and will be installed outside of the spawning/migration season.

- Suitable hard bottom substrate (e.g., rock, cobble, gravel, limestone, boulder, etc.) in low salinity waters (i.e., 0.0-0.5 parts per thousand range [ppt]) for settlement of fertilized eggs and refuge, growth, and development of early life stages.

A6.14 Temporary access fills in Atlantic sturgeon critical habitat, where the following PBF is present, are limited to 0.25 acre of total temporary impacts or less, and will be installed and removed outside of the spawning/migration (moratoria) season(s):

- Suitable hard bottom substrate (e.g., rock, cobble, gravel, limestone, boulder, etc.) in low salinity waters (i.e., 0.0-0.5 parts per thousand range [ppt]) for settlement of fertilized eggs and refuge, growth, and development of early life stages.

A6.15 Temporary cofferdams in Atlantic sturgeon critical habitat, where the following PBF is present, are limited to 2000 ft^2 (0.04 acres) of total temporary impacts or less (must adhere to the same individual size restrictions as A6.3.3), and will be installed and removed outside of the spawning/migration (moratoria) season(s):

- Suitable hard bottom substrate (e.g., rock, cobble, gravel, limestone, boulder, etc.) in low salinity waters (i.e., 0.0-0.5 parts per thousand range [ppt]) for settlement of fertilized eggs and refuge, growth, and development of early life stages.

Activity #7 - Pile Installation and Removal

Substructures: Piles and Footings

Substructures include all parts of a bridge or pier supporting the superstructures (i.e., beams and deck) and include abutments, interior bents, end-bents, footings, and piles/columns. Bents support a vertical load and are placed transverse to the length of the structure. The vertical elements of a bent are columns or piles. Horizontal bent elements on top of piles are bent caps, while elements below the piles are foundations, which are categorized as shallow or deep. Shallow foundations, known as footings, are used when surface soils are sufficiently strong enough to support loads and are typically rectangular reinforced concrete structures near the surface. The bearing capacity of the soil largely determines the size of the footing.

Piles are typically made of steel, concrete, or wood (timber). Various types (e.g., pre-cast and pre-stressed, cast-in-place), shapes (e.g., cylindrical, H-piles, sheet piles), sizes and configurations of piles are used for transportation projects depending on need, site-specific conditions, and other factors. Piles are typically penetrated into the ground and are categorized as deep foundations. Piles provide support by transferring loads to deeper soil strata with higher bearing capacities. Some piles, such as metal sheet piles used for cofferdams and retaining walls, do not support a vertical load.

Pile Installation

Pile installation methods can be categorized as displacement or replacement. Displacement piles are driven or vibrated into the ground, displacing the surrounding soil. Replacement piles are placed or constructed within previously drilled boreholes, replacing the excavated soil. Various methods exist for displacement and replacement pile installation and a combination of methods are typically used.

Pile driving is a type of displacement method using mechanical force to drive piles into substrates. Impact hammers and vibratory hammers are the most common type of pile drivers. Impact hammers use a heavy ram weight raised hydraulically or mechanically above a pile, which is then dropped or propelled onto the head of a pile to move the pile into the substrate. Cushions are typically used between the ram and the pile in order to avoid physical breakdown. Numerous types of impact hammers exist, including simple drop/gravity hammers, single and double acting compressed air, steam, or hydraulic hammers, and diesel hammers (single or double acting). Impact pile hammers produce high-intensity impulsive sounds.

Vibratory hammers vibrate piles at frequencies, which move soil particles, significantly reducing friction around the pile shaft. Electrically or hydraulically produced vibrations are transmitted from the pile to the soil, allowing for penetration. Vibratory hammers are most effective in granular soils, but can also be effective in cohesive soils. Vibratory hammers produce non-impulsive sounds. For all pile drivers, pile diameter and hammer energy are correlated; with increased pile diameters, requiring increased hammer energy.

Jetting, or water jetting, is another type of displacement pile driving method. Jetting uses high-pressure water pumps to force a hole in the bottom substrate for the placement of piles. Jetting is typically used in association with impact and vibratory hammers; jetting is typically used to begin pile installation, then a hammer is used to complete the installation.

Cast-in-place (CIP) piles are the primary type of replacement pile installation method. CIP piles are reinforced concrete piles cast on-site in holes drilled to predetermined depths. CIP piles are commonly referred to as “drilled shafts.” For CIP piles in aquatic environments, steel casings are typically installed using a vibratory hammer, after which drilling takes place inside of the casing with an auger or other type of drilling equipment (e.g., drilling buckets) to the desired depth. After drilling is complete, a rebar cage is placed inside of the casing and concrete is poured into the casing; the casing is later removed. CIP piles generally produce less vibration and lower sound levels than driven piles.

Footings

Footings are constructed to support piles or columns, both of which are composed of reinforced concrete. In aquatic environments, cofferdams facilitate construction of footings (and below-water sections of piles or columns). Cofferdams are typically rectangular structures composed of steel sheet piles installed with a vibratory hammer. Once a cofferdam is in place, it is dewatered to create dry conditions and work proceeds as if on land: the soil is excavated and foundation is constructed with reinforced concrete. Piles/columns may also be constructed within the cofferdam, which is later removed

Pile and Footing Removal

Pile and footing removal takes place for various reasons, such as piles or footings are structurally deficient or functionally obsolete or piles are part of temporary structures. There are four general types of pile and footing removal:

Direct pull or clamshell method: Piles are typically grasped or held with an excavator bucket or clamshell bucket and are repeatedly moved or shaken until they are pulled directly out of the substrate. Piles may also break below the mudline using this method.

Pile hammer: Vibratory hammers are used to vibrate the pile in order to break the bonds between the pile and sediment and reduce friction of soil particles against the pile shaft. Piles are slowly pulled out of the substrate while being vibrated; soil will typically slough off during removal.

Cutting: Piles are cut off at, or just below, the mudline while the pile is supported from above the cut line. The portion of the pile below the mudline typically remains in the substrate.

Blasting: Described in the next section.

Activity-specific PDCs for pile installation and removal activities:

A7.1 All temporary and permanent piles will be installed/constructed following the PDCs outlined in Section 5.2 ("Noise") below and Appendix A.

A7.1.1 Pile installation/construction/removal activities will not produce noise to levels that are considered "injurious" to sturgeon or sea turtles.

A7.1.2 When necessary (when levels may be injurious or cause behavioral modification) noise attenuation devices will be used to decrease underwater noise to levels below those that are considered "injurious" or to cause behavioral modifications. Typical attenuation includes: (1) air bubble curtains; and, (2) isolation casings, which can be coordinated with NMFS.

A7.2 One of the following methods will be used to give any listed animals the opportunity to leave an area prior to full-force pile driving on each project. These procedures will be used for a minimum of 10 minutes prior to full-force pile driving:

- "Ramp up" method (i.e., pile driving starts at a very low force and gradually builds up to full force),
- "Dry firing" method (i.e., operating the pile hammer by dropping the hammer with no compression), or
- "Soft start" method (i.e., noise from hammers is initiated for 15 seconds, followed by a 1-minute waiting period – this sequence is repeated multiple times).

A7.3 Pile installation (both in-water and "in the dry" [behind cofferdam]), will take place only during daylight hours.

A7.4 Where appropriate, silt or turbidity curtains will be used to reduce the impact of suspended sediments and potential for siltation/sedimentation of adjacent habitats.

A7.5 Piles will be placed in a way that does not impede the navigability of the waterway for species movement in/out of an area.

A7.5.1 Pile placement in rivers, streams or tidal creeks (including at the mouths of rivers, streams or tidal creeks) is limited to no more than 50% of the width of the waterbody (combined or continuous width of piles/sheet piles may not exceed 50%). In tidal areas (e.g., tidal creeks), the width of the water body should be considered/measured at MLW.

A7.6 Water jetting will be avoided, to the maximum extent practicable, in areas with fine sediments to reduce turbidity plumes and the release of nutrients and contaminants. If jetting is necessary, silt curtains will be used.

A7.7 Vibratory hammers will be used to remove piles. Piles that cannot be removed with vibratory hammers will be cut off at or below the mud line.

A7.8 All holes left by removed piles will be filled with clean, native sediments.

A7.9 In intertidal areas, all piles will be installed/removed during low tide periods when sediments are exposed and work can proceed temporarily "in-the-dry"

A7.10 Follow "Equipment" PDCs, including, but not limited to, A10.8 and A10.8.1:

A10.8, the maximum speed equipment and items can be lowered into the water shall be no great than 60 feet/minute at times of the year when sturgeon or sea turtles may be present.

A10.8.1, extreme care will be taken when lowering equipment below the water line (and into/onto the bottom). Equipment and materials include, but are not limited to: excavator buckets, piles, spuds, casings, etc.

A7.11 Piles/columns/footings will avoid impacts to submerged aquatic vegetation (i.e., seagrasses) to the maximum extent practicable; piles will not impact more than 100 ft^2 of submerged aquatic vegetation.

A7.12 Pile/column/footing installation is not authorized at the mouths/inlets of rivers/estuaries where sturgeon are known to migrate to/from spawning grounds.

A7.13 Substrate impacts from pile/column/footing installations are limited to 200 ft^2 (0.004 acres), unless otherwise noted.

Critical Habitat-specific PDCs:

A7.13 Installation, construction or placement of piles/columns/footings in Atlantic sturgeon critical habitat is limited to 200 ft^2 (0.004 acres) or less; or 100 ft^2 (0.002 acres) or less where the following PBF is present:

- Suitable hard bottom substrate (e.g., rock, cobble, gravel, limestone, boulder, etc.) in low salinity waters (i.e., 0.0-0.5 parts per thousand range [ppt]) for settlement of fertilized eggs and refuge, growth, and development of early life stages.

Activity #8 - Blasting

Blasting involves using explosive charges to break-up or remove rock, reinforced concrete, or other structures for excavation, construction, or demolition purposes. Blasting charges use various explosive weights and time delays that generate high-energy impulsive sounds and pressure waves. For transportation projects, underwater blasting is typically employed to remove sub-structure components of old/existing bridges or excavate bottom sediments (e.g., rock) for the placement of new sub-structures. The most common type of blasting (above- or underwater) used in transportation projects is confined blasting, which consists of placing explosive charges into pre-drilled holes (blast holes) within a structure prior to detonation. Stemming is typically used with confined blasts and involves placing inert material into blast holes (to cover the charge) prior to detonation. Stemming material typically includes angular crushed stone or gravel. Confined blasts typically produce lower peak sound pressure levels than unconfined blasts, but surface and bottom boundaries can reflect pressure waves and create a complex series of positive and negative pressure peaks in shallow water conditions.

Blasting may also be required when expanding the transportation footprint or as part of the stabilization efforts to remove unstable material. The scale of blasting operations can vary from breaking up a boulder or trimming an unstable overhang, to large-scale removal operations that involve thousands of cubic yards of material. There are two general types of blasting: production and controlled. Production blasting uses widely-spaced, large explosive charges that are designed to fragment a large amount of burden (the rock that lies between the existing slope face and blasthole). Controlled blasting uses more tightly spaced and smaller explosive charges to remove smaller amounts of burden. This technique can remove material along the final slope face or it can be used prior to production blasting to create an artificial fracture along the final cut slope.

Blasting mats may be required to contain flying rock, especially when blasting occurs adjacent to sensitive areas such as aquatic systems. Containment can also include installing anchored wire mesh.

Activity-specific PDCs for Blasting activities:

A8.1 Only confined blasts with stemmed charges will be used; blast mats will be employed to contain "fly rock."

A8.2 Time delays that turn the overall blast into a series of lesser-charged explosions will be used: the minimum delay between individual charges will be at least 9 milliseconds to minimize hydroacoustic impacts to ESA-listed species.

A8.3 The maximum sized charge will be 5 lbs.

A8.4 A Danger Zone around the blast area will be determined based on the maximum explosive weight per delay. A buffer zone beyond the zone of influence will also be used (as a "heads-up" zone).

A8.5 Pre-blast meetings will be held to discuss all requirements, concerns, and procedures prior to the commencement of blasting activities. Blasting plans will be submitted to NMFS.

A8.6 Blasting is not authorized if ESA-listed species are present.

A8.6.1 Blasting will only occur during times of the year when species are absent from the project site; or,

A8.6.2 Are determined to be excluded or absent from the blasting area (danger zone + buffer zone).

A8.7 Blasting will not occur in freshwater rivers when sturgeon are migrating or spawning.

A8.8 Blasting will not occur at the mouths/inlets of rivers/estuaries where sturgeon are known to migrate to/from spawning grounds.

A8.9 In areas of rivers where sturgeon are known to migrate and spawn, typically extending from the salt front to the upper extent of sturgeon distribution (at or below the Fall Line), blasting will only occur between June 15 and July 15. In known migration/spawning rivers, sturgeon forage and shelter throughout all of the year in the lower half (1/2) to third (1/3) of the river (closest to, and encompassing, estuaries). Therefore, blasting will only occur in the upper ***one half (1/2) of spawning rivers from June 15 to July 15.***

Critical Habitat-specific PDCs:

A8.10 Activities will not occur in Atlantic Sturgeon critical habitat, where the following PBF is present:

- Suitable hard bottom substrate (e.g., rock, cobble, gravel, limestone, boulder, etc.) in low salinity waters (i.e., 0.0-0.5 parts per thousand range [ppt]) for settlement of fertilized eggs and refuge, growth, and development of early life stages.

A8.11 Blasting will only occur in Atlantic Sturgeon critical habitat (except for areas mentioned in A8.10) at times of the year when sturgeon will not be present.

Activity #9 – Dredging/underwater excavation

Dredging is defined as underwater excavation and involves removing bottom sediments from the aquatic environment. Dredging is typically done to create or maintain waterways to support navigation, vessel access to channels, ports, and marinas. Dredging can also consist of removing debris, sediments, or other obstructions from the aquatic environment. For transportation projects, dredging is typically used to gain access to project sites and remove sediments to place piles.

Mechanical Dredging

Mechanical dredges remove bottom sediments by direct application of mechanical force to dislodge and scoop the sediments from the bottom. Mechanical dredges are primarily used for smaller sites; clamshell dredges (buckets) and excavators are the most common mechanical dredges. Clamshell dredges employ a vertical loading grabber connected to wire rope, which is lowered in the open position into the sediment, closes around the sediment load, and is raised above the water to be deposited into a barge. Clamshell dredges operate from atop barges, which are moved or positioned using spuds. Barges are typically equipped with three spuds: two forward and one aft.

Excavator dredging involves a backhoe excavator that uses its bucket to remove sediments from beneath the water line, bring the sediments to the surface in the open bucket, and deposit the sediments, typically on the shoreline or in a barge or truck. This is a common method of dredging associated with transportation projects. Excavator dredging can occur from the shoreline or from atop barges. Barges used for excavator dredging are typically configured with spuds in the same way as clamshell dredges.

Hydraulic Dredging

Hydraulic dredges remove bottom sediments by suction force and the sediments are pumped away from the site in liquid slurry form. Hydraulic dredges are typically used for larger sites; cutterhead/pipeline and hopper (suction) are the two common hydraulic dredges. Cutterhead dredges are equipped with rotating cutter apparatuses that surround the intake end of a suction pipe. The rotation of the cutterhead breaks up bottom sediments and facilitates the pumping of the sediment water slurry through the pipe. The pipeline discharges dredged material directly to a disposal site, which enables continuous work. Cutterhead dredges are the most common dredge in the U.S.

Cutterhead dredges are typically held in position and advanced with spuds.

Suction or hopper dredges suck dredged material from the bottom through long intake pipes, called drag arms, and store it in hoppers. Hopper dredges are self-propelled ships with large hopper bins ("hoppers"; containment areas) that are fitted with powerful pumps to facilitate the suction process. Dredging stops when the hoppers are full and ships must dispose (in-water) of the dredged material. Hopper dredges are typically viewed as the dredging method with the highest potential to adversely affect species, including ESA-listed species. As a result of high rates of listed-species takes in the 1990s resulting from hopper dredging projects, NMFS developed a regional biological opinion concerning the use of hopper dredges in channels and borrow areas along the Southeast U.S. Atlantic coast (referred to as SARBO, 1997). The biological opinion includes a number of conservation recommendations to protect species. SARBO is currently used (applicable/precedent) for hopper dredging projects in the Southeast region.

Knockdown/Bed-leveling

Knockdowns employ an I-beam or similar equipment to redistribute shoaled sediment into deeper areas within dredging sites. This method is typically employed for smoothing the bottom after conventional dredging, and for managing localized mounds of sediment. Knockdowns are commonly used for shoaling in ports and marinas.

Disposal

Sediments that are removed from below the water surface during the dredging process must be transported and disposed of. Dredged material may be deposited in several location types, depending on purpose, need, permitting, and other factors. On-site disposal is typically used if dredged material is intended to be used as fill material; the use of off-site dredge disposal sites is also common. Beneficial use of dredged material is encouraged, provided the sediments meet certain physical, chemical and biological criteria.

Activity specific PDCs for dredging activities:

A9.1 Minor dredging for (1) work site access; (2) placement of erosion and scour control-measures or shoreline stabilization (usually required to embed geotextile fabric or riprap to avoid reducing the navigable depth of channels or waterways, or so the toe of the slope can be stabilized to allow smooth transition of the work to the natural surrounding elevation); (3) creation of "pilot holes" for pilings; and (4) to remove pilings/footers is allowed. Minor dredging is limited to -5.0 ft MLW and limited in size to 1000 ft^2.

A9.2 All spoil material will be placed in an approved upland disposal site, EPA-designated open water disposal site, USACE Dredged Material Management Area, or USACE approved beneficial use sites for mitigation or restoration and shall employ erosion control measures such as upland erosion control or in-water turbidity curtains. Return water from an upland contained dredged material disposal area is allowed provided the quality of the return water meets Section 401 certification. Beneficial use and ocean disposal sites must have undergone Section 7 consultation to determine the potential effects of disposal on ESA-listed species and critical habitat. Projects will not include placement of material on beaches within USACE jurisdiction (e.g., sand could be placed in the uplands beyond the jurisdiction of the USACE).

A9.3 Dredging will not occur in freshwater rivers when sturgeon are migrating or spawning.

A9.4 Dredging will not occur at the mouths/inlets of rivers/estuaries where sturgeon are known migrate to/from spawning grounds.

A9.5 Dredging will avoid impacts to submerged aquatic vegetation (i.e., seagrasses), to the maximum extent practicable; dredging will not impact more than 100 ft^2 of submerged aquatic vegetation.

A9.6 Hydraulic dredging will not occur.

Critical Habitat-specific PDCs:

A9.7 Activities will not occur in Atlantic Sturgeon critical habitat, where the following PBFs are present:

- Suitable hard bottom substrate (e.g., rock, cobble, gravel, limestone, boulder, etc.) in low salinity waters (i.e., 0.0-0.5 parts per thousand range [ppt]) for settlement of fertilized eggs and refuge, growth, and development of early life stages.
- Water of appropriate depth and absent physical barriers to passage (e.g., locks, dams, reservoirs, gear, etc.) between the river mouth and spawning sites necessary to support: (i) unimpeded movement of adults to and from spawning sites; (ii) seasonal and physiologically dependent movement of juvenile Atlantic sturgeon to appropriate salinity zones within the river estuary; and (iii) staging, resting, or holding of subadults or spawning condition adults - water depths in main river channels must also be deep enough (at least 1.2 m) to ensure continuous flow in the main channel at all times when any sturgeon life stage would be in the river.

A9.8 Minor dredging is limited to -5.0 ft MLW and limited in size to 500 ft^2 (0.01 acres) in Atlantic Sturgeon critical habitat, provided projects adhere to A9.7.

Activity #10 - Equipment

General equipment associated with roadway construction includes, but is not limited to, pick-up trucks, dump trucks, front-end loaders, cranes, asphalt grinders, paving machines, compaction rollers, bulldozers, chainsaws, vibratory and impact pile drivers, barges, vessels (boats), explosives, excavators, hoe rams, rock crusher (if blasting is used for on-site fill) track or pneumatic drills, graders, jack hammers, stingers, wire saws, air compressors, traffic control devices, generators, and other heavy equipment.

Activity-specific PDCs for equipment:

A10.1 Equipment will only be used for its primary/intended purpose.

A10.2 All equipment will be checked daily for leaks; all projects will have, at a minimum, 1 spill kit readily available at all times.

A10.3 Equipment will not be used until leaks, or other maintenance issues, are repaired or new equipment is brought in for replacement.

A10.4 To the maximum extent practicable, all equipment maintenance and other work that may release pollutants/toxicants will occur in contained maintenance areas at least 500 feet (preferred) from any water body and be outside of active stream channels, outside of any tidal areas, and away from ditches or channels that enter flowing waters.

A10.5 Heavy equipment such as excavators, cranes, and bulldozers will not be located in the water to conduct work; buckets or extensions may reach into the water from atop the bank/platform/trestle to conduct work.

A10.6 Drilling equipment, such as low ground bearing pressure tracked rigs, may be used in-water, but not in the main channel of streams, creeks, or rivers, and must be in-water for the least amount of time necessary to complete work.

A10.7 Vessels shall operate at "no wake/idle" speeds.

A10.8 The maximum speed equipment and items can be lowered into the water will be no great than 60 feet/minute at times of the year when sturgeon or sea turtles may be present.

A10.8.1 Extreme care will be taken to avoid striking individuals when lowering equipment below the water line (and into/onto the bottom). Equipment and materials include, but are not limited to: excavator buckets, piles, spuds, casings, etc.

A10.9 Spudding will occur, provided all other PDCs are adhered to.

Critical Habitat-specific PDCs:

A10.10 Heavy equipment or drilling equipment is not authorized in (below the water line) Atlantic Sturgeon critical habitat, where the PBFs are present. Equipment shall only be positioned on barges, temporary fill (rip rap pads), temporary work trestles, existing bridges, or in other upland areas.

A10.11 To the maximum extent practicable, barge grounding will be avoided in all Atlantic Sturgeon critical habitat areas and will be limited to 30 days for a given location. Barge grounding is not authorized in Atlantic Sturgeon critical habitat, where the following PBFs are present:

- Suitable hard bottom substrate (e.g., rock, cobble, gravel, limestone, boulder, etc.) in low salinity waters (i.e., 0.0-0.5 parts per thousand range [ppt]) for settlement of fertilized eggs and refuge, growth, and development of early life stages.

4.1.2 Specific Transportation Project Types

Project Type #1 - New Alignments/Roadways and Road Widening (Roadway Construction)

Roadway construction activities generally include installation of the roadway itself, and associated facilities such as retaining walls, noise walls, and stormwater treatment. Roadways are generally constructed by first creating embankments, or raised areas of fill, onto a prepared site. The construction of roadway embankment consists of building up soil or rock to create a new ground surface at the elevation needed for the new roadway or structure. Roadway embankments slope outward; therefore, the higher the embankment, the wider the surface area needed at the base. To avoid future settlement, rollers and hauling equipment thoroughly compact each layer of soil or rock. Retaining walls are used to support the embankment fill area where other constraints may exist along the alignment. Once final grading is achieved, the roadway is paved, striped, and signed. Guardrails may also be installed if applicable. These activities may also include constructing new bicycle/pedestrian/multi-use facilities.

Retaining walls are used to minimize the footprint width of the roadway cut or fill. Because retaining walls can be nearly vertical, they allow for a much smaller footprint than an earth slope. They can be used to support the roadway when the roadway is higher than the surrounding ground and can also be used in situations where the road is lower than the surrounding ground. In this case, the retaining wall supports the adjacent soil and prevents soil from slumping onto the roadway. Retaining walls are also used in areas where there is a high possibility of erosion such as near a bridge abutment or water. The walls must have an area of free drainage between the retained soil and the back of the retaining wall to prevent water pressure from developing and adding to the soil loads. The drainage is usually provided by placing a layer of clean gravel and drainage pipes against the back of the retaining wall. There is a variety of wall types (soldier pile, mechanically stabilized earth [MSE], soil nail, etc.); the type used depends on the structure it supports, the ground slope being retained, and available area.

Noise walls are mitigation measures designed to reduce noise impacts on sensitive receivers. They are typically precast panels or cast-in-place walls. They can be cast in a wide variety of patterns to improve their aesthetics. On bridges, noise walls may be cast into the traffic barrier. Noise walls are constructed to withstand the forces of wind and seismic loads.

Stormwater facilities are typically constructed to collect and treat stormwater runoff from impervious surfaces such as roads and bridges. The type of facility constructed will depend on the topography, profile of the road or bridge segment, availability of land, and availability and proximity of an outfall site for collected and treated water. A variety of approaches are utilized, such open ditches and pipes to convey water, bioswales, constructed stormwater wetlands and ponds, vaults, and where possible, infiltration and dispersion basins.

Primary project objectives for new alignment/roadway or road widening projects may include mobility and/or safety improvements. Example projects range between construction with large project footprints, such as new interchanges, new general purpose lanes, realignments, new road corridors, and bypass routes to smaller footprints such as reconstructing existing interchanges, minor realignments, adding shoulders or increasing shoulder widths, bicycle/pedestrian facilities, and new sidewalks.

New alignments/roadways include constructing roadways in new locations, where there is little or no existing infrastructure. Road widening consists of expanding existing roadways, typically to add additional travel lanes or shoulder width. Activities for new alignments/roadways and road widening may consist of placing permanent fill material into waters where necessary for the construction of new road surface. Road widening projects typically include placing fill immediately adjacent to the existing roadway to match the existing grade, paving, and preparing side slopes. Installation of guardrails, medians, and other safety components are typically included in new alignment/roadway and road widening projects. Bank stabilization on newly formed side slopes are also components of these projects.

Several additional activities and components are common to new alignment/roadway and road widening projects such as staging area establishment, culvert extension and installation (described later), and drainage system installation and enhancements. Blasting may also be required for these projects. Projects designed to increase mobility often occur in urban areas. In these cases, very little undeveloped or undisturbed property is affected and most of the impacts would occur in the existing rights of way. New highway interchange construction could occur in areas that are highly developed or within areas that are becoming increasingly developed, but do not typically occur in rural areas.

Some new road construction is designed to improve the safety of the highway system. These projects include installation of sidewalks, slope flattening (which often require culvert extensions), and alignment modifications. Slope flattening and clear zone maintenance reduces hazards for automobiles that inadvertently leave the roadway. The clear zone is the total roadside border area that is available for safe, unobstructed use by errant vehicles. Slope flattening typically involves the placement and removal of fill material on existing cutslopes. Slopes are flattened to make them more traversable and improve site distance. Slope and ditch repair involves re-grading ditches and slopes to the current safety standards and design slopes. It may also include filling in or repairing sides of the ditches where necessary. Alignment modifications may include adding auxiliary lanes (e.g., truck climbing and acceleration lanes), channelization (new turn lanes), on- and off-ramp extensions, or realigning an intersection to improve the sight distance. If a new lane is added, an alignment modification of the adjacent road may be necessary to maintain continuity of the roadway.

Alignment modifications may also straighten curves or approaches to bridges. Alignment modifications could range in length from a few hundred ft. to a couple thousand ft. for curve realignments, or up to a few miles for realigning a major section of roadway. Truck lanes, turn lanes, and acceleration lanes typically average between 10 and 12 ft. wide. Sidewalk widths vary from 5 to 10 ft. wide, depending on jurisdiction and intended use. Road realignments and widenings often range between 0.25 and 5.0 miles in length. New interchanges and interchange improvements are also common safety projects.

Project-specific PDCs for new alignments/roadway and road widening (roadway construction):

P1.1 New alignments/roadways and road widening projects will occur, provided earthen fill or other project components will not be placed below the OHWM or MHWL of a waterbody where sturgeon or sea turtles occur (e.g., no in-water components).

P1.2 Projects will not impede or restrict normal flows in/out of areas where sturgeon or sea turtles occur.

P1.3 Projects will not occur if they contribute sediments, toxicants, or pollutants into receiving waters where sturgeon or sea turtles occur; projects will not occur if they lead to reduction in natural sediments/sediment patterns in areas where sturgeon occur.

P1.4 Projects will use stormwater collection and treatment systems that discharge stormwater that meets or exceeds State Water Quality Standards into waters where sturgeon or sea turtles occur.

Critical Habitat-specific PDCs:

P1.5 New alignments/roadways and road widening projects will not occur in Atlantic Sturgeon critical habitat, where the PBFs are present, if any permanent earthen fill is necessary.

Project Type #2 - New Bridge, Bridge Replacement, and Bridge Widening; New Piers and Replacement/Relocated Piers

While roadway bridges are the most common type of bridge in a transportation project, pedestrian bridges, bicycle (multi-use) bridges, and fishing piers are also common. Bridges typically span from one upland location to another, whereas fishing piers extend from the shore into the water. A variety of other over-water structures exist, such as floating docks or floating breakwaters, but the FHWA/state DOT projects in NC, SC or GA rarely include these other structures.

Both bridges and piers have substructures and superstructures. The main substructure components are abutments, piers (interior bents), end-bents, footings, and piles/columns. The substructure supports the superstructure, which consists of the horizontal components spanning the obstacle or feature the bridge crosses and includes primary and secondary load-carrying members and connections. The main superstructure components are girders (beams), the bridge deck, rails (e.g., guardrails), drainage features, sidewalks, and lighting. For this evaluation, bridges and piers are discussed together with an understanding that materials and techniques will differ depending on the structure.

New bridge, bridge replacement, and bridge widening activities are typically undertaken to replace functionally obsolete and/or structurally deficient bridges or expand, restore, or improve safety and functionality of existing bridges. New bridge projects include constructing bridges in new locations, where there is no existing infrastructure. Bridge replacement projects construct new bridges parallel to, or on the same alignment as, an existing bridge; no structural components from the existing bridge are used in the new bridge. Bridge replacement projects may utilize approach fills from old/existing bridges. Bridge widening projects expand the roadway width and typically consist of adding girders, interior bents and expanding the bridge deck, consistent with the components of the existing structure. For bridge replacement projects the existing bridge typically is removed following completion of the new bridge. Bridge widening projects typically add girders (beams), add interior bents, and expand the bridge deck.

Bridge construction may be a component of a larger roadway construction project or a stand-alone project. There are multiple types of bridges including but not limited to concrete slab, concrete arch, concrete box girder, concrete T beam, steel beam, pre-tensioned concrete beam, post-tensioned concrete beam, steel truss, and timber trestle. Bridges can span wetlands, streams, and other water bodies as well as roadway and other transportation infrastructure. Some bridges span the stream systems they are crossing, while others have piers in the channel. Small bridges may be precast (prefabricated) and transported to a site for installation. The number of piers in the channel varies by bridge. Most new bridges are designed to span as much of the river as possible, and to provide the least amount of constriction that is practicable on the system. Many bridge piers are now deep foundations such as driven piles or drilled shafts, eliminating shallow footings that are susceptible to scour.

Bridge replacements tend to be long-term projects requiring one or more years to complete. Installation of new bridges may require construction of a detour bridge. Occasionally, bridges use two new spans and one new span is constructed adjacent to the old bridge and acts as the detour bridge while the original is removed and replaced with the second span. Most bridge replacements use the same alignment or are constructed parallel to the old alignment. Temporary construction platforms are typically built to facilitate construction of new or replacement bridges. Generally, in-water work is timed to minimize impacts to sensitive aquatic species. Some sedimentation of the waterway may occur during pile driving and removal. Hydroacoustic impacts also occur during pile driving and removal. Bridge removal can also result in sediment and small concrete debris entering the water. Concrete debris is typically removed from the aquatic environment following demolition. These activities may also include constructing or replacing new bicycle/pedestrian/multi-use facilities.

Major bridge replacement construction activities often include:

- Clearing and grading for road widening
- Clearing and grubbing of existing streamside vegetation
- Construction of stormwater facilities
- Excavation for new bridge abutments
- Constructing temporary work platforms/cofferdams
- Construction of bridge columns/piers/abutments
- Concrete pouring
- Pile installation and removal
- Riprap placement
- Paving with asphalt or concrete
- Bridge demolition

Piles are installed using several different methods, as described above (Section 5.1.2). Cofferdams are often installed to create an isolated work area, which can be dewatered for bridge construction (Section 5.1.2).

Bridges can be removed using several methods, including: (1) dismantled over water from adjacent bridge deck or approach; (2) dismantled over the water and lowered onto a barge and barged out to a dismantling site; (3) dismantled over water and sections removed by crane; and (4) falsework (temporary structures) can be built under and around the bridge, and the bridge dismantled by sections. Bridge removal methods are selected based on a number of factors, including the structure of the bridge, the size of the bridge and river, the location within the system, the topography, and the amount of access to the bridge and the banks. Since many older bridges have bridge piers in the system, these also need to be removed. Concrete piers can be removed by demolition using a hoe ram (as long as pieces do not enter the water), or removed by a vibratory hammer; they can be cut off two ft. below the ground level, or a temporary cofferdam can be constructed and the material can be hydraulically removed. The bridge demolition method will be determined by site and project-specific conditions. Blasting is also used for bridge/pier demolition.

Bridge replacement projects often require column construction within stream channels, which typically involves the isolation of the column location through the use of a large diameter steel sleeve that is driven into the stream substrate. All work, including excavation for the footing, placement of forms, and pouring of the concrete, would then be completed within the sleeve at each column location. This technique helps minimize construction impacts by isolating the work from the stream.

Bridge replacements may require more than one construction season, due to multiple factors such as project complexity or if the in-water work may be limited to certain periods to minimize impacts to sensitive aquatic species. Often, work on the out-of-water portions or behind cofferdams will occur year-round. Bridge replacements on parallel alignment are the most common bridge project type in NC, SC, and GA because this approach maintains traffic and access to locations during construction. Bridges replaced on parallel alignment may make use of existing bridge fill and approaches. Old bridges are removed following construction of the new bridges. Bridge replacement on existing alignment is less common. In coastal areas dominated by salt marshes and tidal creeks, access to barrier islands is typically via a single bridge making replacement on existing alignment relatively difficult and costly.

Transportation agencies regularly include fishing piers to enhance the value of roadway projects. Fishing piers extend from the shoreline, terminate in the water, and are typically composed of wood planking, composite planking, or grated decking. Barges or temporary work trestles are commonly used for pier construction.

The superstructures of small fishing piers can be easily removed by hand or small machinery; removing larger piers may require excavators, jackhammers, or other specialized equipment. Pier substructures can be removed in various ways, including direct pull of piles. Chapter 3 discusses demolition of pier substructures. Demolition of pier components leading to accumulation of material in waterbodies may require dredging to remove the material.

Project-specific PDCs for new bridges and piers, replacement/relocation piers, replacement bridges, and bridge widening projects:

P2.1 New Bridges/new crossings

P2.1.1 Installation of new bridges/crossings that span (no in-water piers/piles/columns) the waterbody (e.g., river, stream, or tidal creek) will occur; new bridges/crossings with any in-water structures are not authorized; new crossings with in-water structures are not covered under this agreement.

P2.1.2 Approach/causeway fill will not be placed below the OHWM or MHWL of the waterbody or impede or restrict normal flows.

P2.1.3 Shoreline stabilization for new bridges (approaches/causeway/embankment) will adhere to Shoreline Stabilization PDCs (Project Type #5; see below).

P2.1.4 New bridges that span the water body, will not allow fishing in areas where swimming sea turtles or sturgeon are known to occur; "no fishing," "fishing prohibited," or "It is illegal to fish here" signs will be used when practicable.

P2.2 New Piers/Replacement Piers

P2.2.1 Installation of new piers in areas where swimming sea turtles or sturgeon are known to occur are not authorized.

P2.2.2 Replacement or relocated piers in areas where swimming sea turtles or sturgeon are known to occur are not authorized.

P2.2.3 New or replacement piers within 0.25miles of areas where sea turtles or sturgeon are known to occur, or where Atlantic sturgeon critical habitat is present, will adhere to the following:

P2.2.3.1 Take-off/causeway fill for piers will not be placed below the OHWM or MHWL of the waterbody or impede or restrict normal flows.

P2.2.3.2 Shoreline stabilization activities for new or replacement piers (approaches/causeway/embankment) will adhere to Shoreline Stabilization PDCs

(Project Type #5; see below).

P2.3 Bridge Replacements

P2.3.1 Bridge replacements on existing or parallel alignments are authorized, provided the original/existing structure is completely removed and the projects follow the PDCs outlined in Section 5.2 (“Noise”) below and Appendix A, and all other relevant PDCs, including P2.1.2.

P2.3.1 Bridge replacements on existing or parallel alignments that span the waterbody and remove all old/existing structures from the waterway are authorized.

P2.3.3 Replacement bridges will not allow fishing in areas where swimming sea turtles are known to occur (i.e. the salt/freshwater interface); “no fishing,” “fishing prohibited,” or “It is illegal to fish here” signs will be used.

P2.3.4 Replacement bridges will generally be the same size/shape as the original/existing bridges.

P2.3.4.1 Increases in length and height from original/existing bridges are authorized; decreases in height are not authorized.

P2.3.4.2 Increases of up to 100% of the original width is authorized. For example, if the original bridge is 28 feet wide, the replacement bridge could be up to 56 feet wide.

P2.4 Bridge Widening

P2.4.1 Bridge widening projects are authorized, provided projects follow the PDCs outlined in Section 5.2 (“Noise”) below and Appendix A, and all other relevant PDCs, including P2.1.2

P2.4.2 Widened bridges will not allow fishing in areas where swimming sea turtles or sturgeon are known to occur (i.e the salt/freshwater interface and all known sturgeon rivers and streams); “no fishing,” “fishing prohibited,” or “It is illegal to fish here” signs will be used.

P2.4.3 Widening of up to 100% of the original width of the bridge is authorized. For example, if the original bridge is 25 feet wide, the widened bridge could be up to 50 feet wide.

P2.5 Bottom substrate/habitat impacts

P2.5.1 Impacts from piles/columns/footings and other substructure components of bridges and piers in the bottom substrate/habitat will be limited to 200 ft^2 (0.004 acre) or less for *any bridge or pier project.* This is the total impact of newly installed, constructed or cast-in-place structures, not measured as the NET impact area (e.g., area of new structures minus the area of old structures that will be removed).

P2.5.2 Projects should avoid impacts to submerged aquatic vegetation (i.e., seagrasses), to the maximum extent practicable; projects will not impact more than 100 ft^2 of submerged aquatic vegetation.

Critical Habitat-specific PDCs:

P2.7 Bridge/pier replacements within the same footprint of the original/existing structure are authorized. Increases in impact area of piles/columns/footings from the originally authorized structures are not authorized.

P2.8 Bridge/pier replacement parallel to the original/existing structure is authorized, provided the original/existing structure is completely removed and the total impact area of newly installed, constructed, or cast-in-place structures is 200 ft^2 (0.004 acres) or less.

P2.9 Bridge widening is authorized, provided the total impact area of newly installed, constructed, or cast-in-place structures is 100 ft^2 (0.002 acres) or less.

P2.10 All bridge components installed, constructed, or cast-in-place in Atlantic sturgeon critical habitat, where the following features are present, are limited to substrate impacts of 100 ft^2 (0.002 acres) or less *AND* work must be completed outside of the spawning/migration season:

- Suitable hard bottom substrate (e.g., rock, cobble, gravel, limestone, boulder, etc.) in low salinity waters (i.e., 0.0-0.5 parts per thousand range [ppt]) for settlement of fertilized eggs and refuge, growth, and development of early life stages.

Project Type #3 - Bridge Repair, Maintenance, and Retrofit; Pier Repair and Maintenance

Bridge repair, maintenance, and retrofit activities are implemented to prolong the use and function of bridges, ensure motorist safety, and protect the environment. Bridge repair typically consists of removing and replacing deteriorated deck concrete or rehabilitating other existing components of the bridge, including piles and girders. Bridge repairs may also consist of seismic retrofitting, which includes such items as strengthening pilings and bents. Whether a bridge is repaired, rehabilitated, or replaced depends on the age of a bridge and damage that may occur to a bridge (e.g., from a storm event, earthquake, or vehicle or boat collision). The length of stream and/or wetland potentially affected by bridge repair and maintenance depends upon the scale of the bridge project and the required actions. Bridge replacement activities are described above.

Bridge scour repair work tends to occur during low-water times of year, and bridge painting may only occur late spring through fall when temperatures are high enough to allow the paint to dry properly. Seismic retrofit activities are not temperature and/or time sensitive and may occur anytime throughout the year, while joint replacement and bridge deck replacement are temperature dependent activities, limited to the warmer months. Bridge maintenance projects can be long-term, lasting more than one construction season.

Scour Repair Projects

Scour at bridge piers can become a major safety issue for some bridges. Repair of scoured bridge piers can include construction of temporary cofferdams around affected piers to isolate work areas; concrete or gabion repair to footing, columns or abutments; placement of riprap at scour locations; or installation of concrete armor tetrapods (four-legged, interlocking concrete structures).

Construction of temporary access fills or trestles may be required to provide a working platform for machinery. Working platforms are usually constructed of light, loose riprap matched to the material necessary for the repair. The platform material is then repositioned as the machinery backs away from the work site. Installation methods vary on a site-specific basis. In navigable waters, access from a barge may be required. Whenever possible, equipment, such as excavators, will operate from stream banks, bridges, or temporary work platforms to avoid in-channel operation. If in-water equipment operation is necessary, aquatic spider excavators are often used, especially if access to the site is difficult, as they are small, relatively light, and have rubber tires to minimize substrate disturbance. Aquatic spiders are typically used in small streams, because the size of rock they can pick up is limited. Sometimes materials can be placed directly on the streambed with little to no excavation; in other instances, excavation is necessary to key in materials. Often, stream flow and anticipated erosion will determine specific aspects of design such as anchoring.

Maintenance Projects

Bridge maintenance activities may include washing, painting, debris removal from bridge piers, guardrail repairs, lighting and signage repairs, and structural rehabilitation. Such activities generally include work such as repairing damage or deterioration in various bridge components; cleaning out drains; repairing expansion joints; cleaning and repairing structural steel; sealing concrete surfaces; concrete patching; and sanding and painting. Bridge painting involves washing the bridge with highly pressurized water, abrasive sand blasting to remove all corrosion, and then applying a minimum of a number of coats of paint. Paint must be applied when temperatures are above 40°F, and it is not raining. Steel bridges also require rivet replacement and crack stabilization. These activities are often added to a bridge painting contract. Debris removal can be accomplished in a variety of ways depending on the type and quantity of debris, and the size and configuration of the bridge. Hand removal is possible in some instances, although the use of mechanical aids, such as chainsaws, winches, and heavy equipment, are often necessary. Structural rehabilitation may include replacement or repair of degraded steel superstructure, repair to bridge approaches, or repair or replacement of bridge rail. Work is typically conducted in a stepwise fashion, moving from one section of the structure to the next, rather than on the entire structure at once.

Bridge deck repair and replacement is another activity that occurs regularly. Removal may involve traditional mechanical methods such as jackhammers, concrete saws, and cold-milling (grinding), or hydro-demolition (hydro-milling). Hydro-demolition uses a high-pressure water jet stream (up to 20,000 PSI) to remove unsound concrete. Concrete debris is contained and then removed with vacuum equipment. Deck repair can involve either partial-depth or full-depth patching. Partial-depth replacement repairs surficial damage to the travel surface by cleaning and filling voids with a suitable material (concrete, asphalt, etc.). In general, when full-depth patching occurs, a temporary form is held against the underside of the deck and material fills the void from above. Longer bridges have finger joints that must be repaired and replaced as needed.

Seismic Retrofit Projects

Many bridges are undergoing or have undergone seismic retrofits. Retrofits can involve any of the following depending on the structure: (1) removing and replacing bolts and or rivets with high-strength connections; (2) installation of concrete catcher blocks at piers (not typically pre-cast, but constructed using steel-reinforced forms filled with concrete poured on site); (3) installation of pier sleeves (collars) to the depth of the spread footing; and (4) installation of longitudinal restrainers, transverse girder restrainers, and/or transverse deck restrainers which are typically installed under the bridge as looped steel cables or bolts. No fill or pile driving is required for their installation. Longitudinal restrainers prevent abutting spans from being pulled apart during an earthquake. Transverse restrainers pin abutting spans together, preventing them from being sheared apart vertically or laterally during an earthquake.

Pile Jackets

Pile jackets are a material or sleeve applied around a pile as protection. Types of equipment involved in pile jacket construction typically include barges, cranes, pumps, boats, etc. The equipment will be trucked, self-propelled or barged to the site. Turbidity curtains, silt fences, sand bags, synthetic bales or some combination of these items are typically used as directed by the project engineer to maintain State Water Quality Standards. Pile jackets typically include cathodic protection, cathodic protection with structural protection, and structural support jackets, as described below. Since this activity is limited to a pile jacket attached to an existing pile and does not extend to the sea floor, it does not increase the size of impact for in-water work.

1. Cathodic Protection Pile Jackets - Cathodic protection is a technique used to control the corrosion of a metal surface by making it the cathode of an electrochemical cell. This pile jacket type provides galvanic cathodic protection to a pile to control corrosion but does not provide any additional structural strength to the pile. The jackets are a fiberglass form with pre- installed zinc mesh. The bottom of the pile jacket is always placed in the water, typically -6 in MLW with an anode installed below the jacket on a galvanized steel strap. The jacket contains negative and positive connection wires that are connected to the existing pile, the anode, zinc mesh and then to a terminal box. The jacket is then filled with an epoxy grout.
2. Structural Cathodic-Protection Pile Jackets - This is the same type of system as the cathodic jacket but it also provides structural strengthening. The jacket is made wider to accommodate the new reinforcing steel and is filled with concrete.
3. Structural-Only Jackets - These are purely for structural strengthening and do not provide cathodic protection. The jackets are not used in an environment where corrosion related damage can occur.

Project-specific PDCs for bridge and pier repair, maintenance, and retrofit projects:

P3.1 Scour repair projects are limited to the minimum amount necessary to achieve the project goal, which includes: (1) the area of previously authorized scour protection (e.g., original footprint of previously authorized riprap around columns/piers/piles), and (2) 0.5 acre of new riprap for scour protection (typically upstream or adjacent to columns/piers/piles). Total scour protection (new + previously authorized) will not exceed 0.5 acre.

P3.1.1 Scour holes at the base of bridge piers or abutments will be repaired by placing the minimum amount of riprap necessary to mitigate the scour.

P3.2 Scour repair projects will not use poured concrete, reinforced concrete, or concrete mattresses for scour protection outside of the originally authorized project footprint. Only riprap will be used for scour protection outside of the originally authorized project footprint.

P3.3 Maintenance projects are authorized, provided there is no introduction of debris, pollutants, toxicants, sediments, or other materials or chemicals into the waterbody. Full containment, such as diaper curtains, will be used when necessary, to avoid/eliminate any possible introductions of materials or chemicals.

P3.4 Installation of pile jackets, cathodic protection, and seismic retrofit components are authorized, provided there is no increase in impact area to the bottom (substrate) and the construction of the structure has been authorized by the U.S. Coast Guard under Section 9 of the Rivers and

Harbors Act of 1899 or other applicable laws.

P3.5 Water-dependent project activities will be timed to avoid the presence of sturgeon and sea turtles.

P3.6 Riprap will be placed in a slow, deliberate manner so as to not effect slow moving ESA-listed species. Contractors will minimize "dropping" riprap into the water from above the waterline.

P3.7 Projects will avoid impacts to submerged aquatic vegetation (i.e., seagrasses), to the maximum extent practicable; projects will not impact more than 25 ft^2 of submerged aquatic vegetation.

Critical Habitat-specific PDCs:

P3.8 Projects will not occur in Atlantic Sturgeon critical habitat, where the PBFs are present, if the project will result in substrate impacts (square feet) additional to those of the originally authorized project footprint, or in a different location than those of the originally authorized project footprint.

Project Type #4 - Culvert Installation, Replacement, Repair, Maintenance, and Cleaning

Culvert projects primarily occur in areas where sturgeon and sea turtles do not occur, such as storm drains/ditches and small streams/channels/tidal creeks. Sturgeon primarily occur in large, main-stem rivers, estuaries and primary tidal creeks, while sea turtles occur primarily in estuaries and primary tidal creeks. As it relates to road crossings and conveying water, these areas are typically crossed using bridges. However, some large, secondary tidal creeks where culverts are located may be used by juvenile sturgeon.

Culvert projects consist of replacing undersized, broken, or damaged culverts with new structures to sustain adequate flows, or placing (installing or constructing) new culverts in areas where they did not previously occur. Culvert maintenance projects include making repairs to the structural integrity of the culvert or protecting an existing culvert with bank stabilization. Cleaning involves removing sediments or debris from within or near the opening of a culvert

Culverts are drains, pipes, or other conduits that convey water through or around a structure or obstruction. For highway projects, culverts typically pass water under roads and embankments. Culverts may differ in type (shape) and include closed and open-bottom culverts. Closed culverts are mainly rectangular structures (box culverts) or circular, elliptical, or arched pipes. Commonly used open-bottom culvert shapes include arched, high and low profile arched, and rectangular (open-bottom box culverts). Culverts may be composed of plastic, corrugated metal, concrete, or reinforced concrete, and may include features, such as baffles, steps, or ledges, to aid fish passage and/or control flows. Culverts may be precast (prefabricated) or cast-in-place at the project location and may have various inlet configurations, such as sloped inlets or wing walls. Factors affecting selection of inlet configuration include performance (e.g., flow dynamics and erosion control) and aesthetics.

Culvert installation may occur independently or as part of a larger roadway projects. Proper culvert sizing is determined by consulting hydraulics manuals and fish passage guidance. Average culvert lengths range between 18 and 200 ft. Culvert installation and replacements typically require less than 3 months to complete, while repair, maintenance and cleaning projects range in time from hours to less than 3 weeks. Typical culvert replacements involve removing vegetation at the outlet and inlet area, removing existing pavement and roadbed to extract the existing culvert, placing the new culvert, backfilling and replacing the pavement, installing armoring and headwalls, re-vegetating if necessary, and if flow is present, dewatering the work area and establishing a flow bypass prior to initiating work. In-water construction typically occurs during low-flow months or during dry periods. Cofferdams are often used to facilitate culvert construction, repair, and maintenance.

Project-specific PDCs for culvert installation, replacement, repair, maintenance, and cleaning projects:

P4.1 New and replacement culverts will be sized to handle all expected/predicted flows, including low-flow conditions, normal flows, high flows, storm flows, and the full range of tidal flows.

P4.1.1 Channel width, depth, velocity, and slope that provide upstream and downstream passage of aquatic organisms will be preserved or enhanced according to current NMFS criteria or as developed in cooperation with NMFS to accommodate site-specific conditions.

P4.1.2 Culvert replacement projects that will decrease the culvert size will not be undertaken.

P4.1.3 Culverts may be replaced with small bridges.

P4.1.4 New and replacement culverts will be limited to 1000 linear feet or less of total shoreline/bank impacts (500 linear feet for each side of the bank) and total bottom/substrate impacts of 0.5 acre or less.

P4.2 Modified or disturbed portions of streams, banks, and riparian areas will be restored to natural and stable contours (elevations, profile, and gradient) following completion of work.

P4.3 All structures necessary for in-water work will be removed immediately following completion of in-water work.

P4.4 Appropriate measures will be taken to maintain normal flows during work activities. Culvert projects will be limited to blocking no more than 50% of the width of the waterbody at any given time. In tidal areas (e.g., tidal creeks), the width of the water body should be considered/measured at mean low water (MLW).

P4.5 Culvert projects will not allow heavy machinery into a channel with water. Work may take place from an upland area, work trestle, inside a dewatered cofferdam, or other area.

P4.6 For culvert installation, replacement, repair, and maintenance projects undertaken in areas where juvenile sturgeon may occur, water-dependent activities will be conducted only in-the-dry (in dewatered cofferdams).

P4.6.1 Cofferdam installation will follow all other relevant PDCs (e.g., cofferdams used for culvert projects will not obstruct or block more than 50% of the flow in a waterway).

P4.7 Scour holes at culvert inlets will be repaired by placing the minimum amount of riprap necessary to mitigate the scour and no more than 0.1 acre for a single, complete project.

P4.8 Projects should avoid impacts to submerged aquatic vegetation (i.e., seagrasses), to the maximum extent practicable; projects will not impact more than 100 ft^2 of submerged aquatic vegetation.

Critical Habitat-specific PDCs:

P4.9 Projects will not occur in Atlantic Sturgeon critical habitat where the PBFs are present.

Project Type #5 - Installation, Maintenance, and Removal of Shoreline Stabilization

Shoreline stabilization involves the direct protection of embankments at bridges, culverts, and roadway sections from erosive forces of flowing water. A variety of structures or materials can be built or placed parallel to shore on an existing, restored, or modified shoreline. Revetments, bulkheads, seawalls, and gabions protect the area immediately behind them, but afford no protection to adjacent areas or areas in front. These structures stabilize shorelines by enclosing and protecting areas, preventing the shoreline from functioning normally.

Rock riprap is the most common shoreline stabilization material used in transportation projects. Rock riprap is used as a general term to describe a variety of stone, rubble, concrete or other rock armoring used for shoreline protection and stabilization. Riprap is typically defined within the construction specifications of a project. Installing rock riprap consists of placing rock, typically in the form of hard quarry stone or fieldstone, on a shaped and graded slope. A transitional layer of gravel, small stone, or fabric can be placed between the underlying soil and the riprap to prevent material migration. Riprap is typically placed from the toe of the fill to the top of the fill. Various other structures, such as metal sheet piling, can be installed in conjunction with riprap for shoreline stabilization projects. Riprap is used in a variety of scenarios due to its versatility and cost. Riprap placement varies and may extend to the top of the bank or extend up the mean annual peak flow line, but can be placed up to one foot above the 100-year flood level. Woody and herbaceous plantings are used above this level. Riprap is not suitable for banks with grades steeper than 2:1. Bank grading may be required prior to stabilizing the bank. If necessary, a rock or earthen berm may be constructed to catch rocks dumped (end-dumped) from trucks before they enter the stream.

Stone revetments are filter-type structures that reduce wave energy while preventing migration of the soil beneath. Stone revetments are constructed by placing progressively larger stones atop a graded shoreline covered in geotextile fabric. Stone revetments typically include a layer of armoring (typically large stone riprap) that reduces the energy of waves and flowing water. Beneath the armoring are various sizes of smaller stones, fine gravel, and other materials that are placed on geotextile fabric (filter cloth). The geotextile fabric is placed on backfill, which is typically graded to a 2:1 slope. Other structures, such as toe protection and a splash apron may also be installed with stone revetments. Stone revetments are typically used when groundwater influx is part of the erosional process (e.g., ground water penetrates from the underlying soil while incoming waves strike the shoreline).

Retaining walls, bulkheads, and seawalls are all vertical wall structures that separate the natural shoreline from the water. These vertical walls are typically constructed of vinyl, metal sheet pile, or prefabricated concrete slabs, but timber may also be used. These structures are typically installed from land or from a shallow-draft barge with land-based equipment by trenching, grading, or shaping the shoreline and installing vertical pieces. Vertical wall structures may be supported by piles installed by vibratory or impact hammer and/or deadmen anchors that hook underground behind the wall stabilizing them to the uplands. Footers can also be used, which are typically short/low level walls placed directly in front of a vertical wall to protect the bottom from erosion and scouring. Riprap footers are also used and are typically placed by trenching the location (i.e., dredging), placing filter fabric, and then placing riprap on top of the fabric.

Gabions are enclosures or cages filled with material. These cages can be various shapes (e.g. cylindrical or rectangular) and sizes, can be filled with a variety of materials, and can be used in a number of scenarios. For shoreline stabilization in transportation projects, gabions are typically rectangular structures made of wire mesh or galvanized steel chain link fabric filled with rock riprap. Gabions are modular, so they can be moved and placed easily, and typically contain rock riprap, which can be an advantage to loose riprap that may become dislodged and removed by hydrodynamic forces.

Shore-connected structures are those structures used for shoreline stabilization, erosion control, and sediment accretion that are connected to the shore and extend out into the water. Groins are the most common shore-connected structure used for shoreline stabilization. Groins are typically made of large rock riprap (armor stone) and are built perpendicular to the shore, extending from the backshore out into the water. Although groins are typically straight perpendicular structures, groins can be hooked or curved or have a shore-parallel T-head at their seaward end. Groins are regularly used to disrupt the natural processes and currents along shorelines, including the longshore drift system on beaches of barrier islands. The purpose of a groin is to block the downstream flow (in rivers or streams) or longshore current so that sediment accumulates on the updrift/upstream side of the groin, accreting sediment and widening the shoreline. However, this further depletes the sediment supply to the shoreline on the downdrift/downstream side, which may lead to severe erosion. A common solution to this problem is to build a series of groins, often extending the entire length of a shoreline (USACE 1992).

Living shoreline is a broad term that encompasses a range of shoreline stabilization techniques along estuarine coasts, bays, sheltered coastlines, and tributaries. A living shoreline has a footprint that is made up mostly of native material, often incorporating vegetation or other living, natural elements. Many living shoreline projects combine “soft” elements with some type of harder shoreline structure, such as oyster reefs or rock sills, for added stability. Living shoreline projects typically use natural (e.g. oyster shell) and nature-based (e.g. rocks where they do not naturally occur) materials for added stability rather than metal, concrete or synthetic materials. Living shorelines maintain continuity of the natural land-water interface and reduce erosion while providing habitat value and enhancing coastal resilience.

Installation methods vary on a site-specific basis. In navigable waters, access from shore or a nearby structure is common; however, barges may be utilized. Whenever possible, equipment, such as excavators, will operate from banks, bridges, or temporary work platforms to avoid in-channel operation. Sometimes, materials can be placed directly on the streambed with little to no excavation; in other instances, excavation is necessary to key in materials. Often stream flow and anticipated erosion will determine specific aspects of design such as anchoring. Anchoring may be required for structures that include large woody debris. Several techniques exist including wood or steel piling, earth anchors, or rock overburden.

Project-specific PDCs for installation, maintenance, and removal of shoreline stabilization:

P5.1 Installation of new shoreline stabilization:

P5.1.1 Will not exceed 500 feet in length (for any type: e.g., seawalls, riprap, revetments).

Seawalls/Bulkheads/Retaining Walls

P5.1.2 Will not extend any further waterward than 12 inches as measured from the mean high water line (MHWL).

Riprap/Revetments

P5.1.3 Will not extend more than 2.5 feet waterward of the MHWL (including the toe).

P5.1.4 Shoreline stabilization materials will be free of debris and are limited to sand cement, concrete, and quarry stone. Slope paving, poured concrete, or reinforced concrete is not authorized.

Living Shorelines

P5.1.5 Living shoreline projects will adhere to NOAA guidance and criteria provided in *Guidance for Considering the Use of Living Shorelines, 2015.* Artificial reef projects are not authorized.

P5.1.6 Living shorelines are limited to 500 linear feet in length, no more than 30 feet waterward of the high tide line/ordinary high water mark or 5 feet waterward of the existing wetlands (whichever distance is greater), or result in no more than 0.5 acre area between the natural shoreline and outermost structure (breakwater).

P5.1.7 All shore-parallel wave attenuation structures will include a minimum 5 ft opening/gap between structures at least every 100 feet and may be staggered or overlapped or left open so long as the five-foot separation between sections is maintained.

P5.1.8 Discharge of earthen fill material, other than material associated with vegetative planting is not authorized.

P5.1.6 Living shoreline projects will be developed in cooperation with NMFS to accommodate site-specific conditions.

P5.2 Maintenance/replacement of existing shoreline stabilization:

P5.2.1. Is only allowed in the previously authorized (permitted) footprint of the original/existing shoreline stabilization (i.e., no waterward extension or lateral expansion beyond the previous footprint).

P5.3 Removal of any length of shoreline stabilization (e.g., seawall, riprap) is allowed, provided the shoreline is stabilized.

P5.4 Shoreline stabilization construction/activities are not authorized at the mouths/inlets of rivers/estuaries where sturgeon are known to migrate to/from spawning grounds.

P5.5 Placement of backfill is authorized if it is necessary for stabilization/leveling.

P5.6 Shoreline stabilization structures other than vertical walls shall be no steeper than a 2H:1V slope.

P5.7 Construction and/or repairs to groins, jetties, breakwaters that are perpendicular to shore, and beach nourishment/renourishment are not authorized.

P5.8 Projects should avoid impacts to submerged aquatic vegetation (i.e., seagrasses), to the maximum extent practicable; projects will not impact more than 100 ft^2 of submerged aquatic vegetation.

Critical-Habitat specific PDCs:

P5.9 Shoreline stabilization repair/replacement within the same footprint of the original/existing shoreline stabilization (i.e., no waterward extension or lateral expansion beyond the previous footprint) are authorized.

P5.10 Installation of new shoreline stabilization is limited to 500 linear feet and may not extend waterward more than 12-inches (for seawalls/bulkheads/retaining walls) or 24-inches (for riprap/revetments).

P5.11 Installation of new shoreline stabilization is not authorized in Atlantic Sturgeon critical habitat, where the following PBF is present:

- Suitable hard bottom substrate (e.g., rock, cobble, gravel, limestone, boulder, etc.) in low salinity waters (i.e., 0.0-0.5 parts per thousand range [ppt]) for settlement of fertilized eggs and refuge, growth, and development of early life stages.

P5.12 Living shorlines are restrited to areas that are in water depths less than/shallower than -6 feet (2 m) MHWL/OHWM.

Project Type #6 - Pavement Preservation

Pavement preservation consists of patching, repairing, and replacing roadway surfaces and pavement. These include three types of pavement: (1) asphalt, (2) chip seal, and (3) concrete. If the existing pavement is in good condition, it may be covered over with a new layer of asphalt. Repair of badly deteriorated pavement could require grinding of existing pavement or replacement of the road foundation material prior to repaving. This typically involves grinding off and replacing the existing asphalt pavement.

Most paving occurs during March through November, though can occur throughout the year depending on weather. Activities may occur seven days a week, taking place either during the daylight hours, night hours, or both, depending on traffic volumes. Project duration depends on the size of the area being paved and could take from 1 to 120 working days to complete. Pavement preservation through chip sealing (alternately termed bituminous surface treatment or BST) involves the application of hot liquid asphalt and a layer of crushed rock on an existing asphalt surface. The application of BST is a temperature- and weather-sensitive activity. These projects may include a rock crushing operation to produce the necessary aggregate.

Hotmix Asphalt (HMA) paving is also a temperature- and weather-sensitive activity. Typically, the existing pavement is ground down (cold-milling) and replaced, or simply overlaid with new asphalt. Cold milling creates dry pavement grounds that are hauled to a dumpsite, spread along the road shoulders, or recycled into new pavement. Profile grinding is another optional method of removing the pavement surface. All asphalt paving projects involve the use of an asphalt plant area where asphalt is mixed with crushed rock to produce the new HMA, as well as occasionally crushing of rock for the pavement materials.

Preservation of existing Portland Cement Concrete Pavement (PCCP) is typically accomplished by removal and replacement of the existing PCCP, the placement of additional dowel bars into the existing pavement, or grinding of the existing surface. The removal results in concrete rubble that is typically hauled to a dumpsite. This is often accompanied by profile grinding as is the placement of additional dowel bars. Profile-grinding employs a series of diamond saws cooled by water that cut away the pavement. This creates pavement slurry that requires disposal at a dumpsite. Since paving may result in a slightly higher road surface, manholes, inlets, and guardrail may need to be raised or replaced. Guardrail raising involves the removal of existing guardrail, installation of taller posts, and reinstallation or replacement (depending on condition) of the rail.

Culverts may also require extension, repair, or installation as part of pavement preservation projects. Repair or replacement of worn or damaged culverts prevents damage to the roadbed from water saturating the roadbed fill material. Culverts require maintenance when at least 25 percent of their capacity is restricted by debris, sediment, or vegetation.

Installation of roadside signs, guide posts, and raised pavement markers; guardrail improvements, fence installation and repair; and paint striping may also be included in a paving project. For most projects, installation of road signs, guideposts, and fencing involves minor amounts of excavation and vegetation removal. However, installation of very large signs, including concrete footings and steel supports, can potentially disturb substantial areas. Trenching may also be required to run utilities from existing sources to lighted signs. Paint striping may be completed with oil-based or latex-based paints, self-adhesive strips, or inset durable lane strips. Painting must be conducted in dry weather.

Project specific PDCs for pavement preservation:

P6.1 Projects are authorized, provided there is no introduction of debris, pollutants, toxicants, sediments, or other materials or chemicals into waterbodies where sea turtles and sturgeon are known to occur. Projects will be timed in a way, or containment methods will be used, to avoid/eliminate any possible introductions of materials or chemicals into receiving waters.

P6.2 Projects that increase the impact area (footprint) of the existing structure/roadway are not authorized.

4.2 Estimated Number of Activities/Projects

The estimated number of projects and activities are based on previous number of annual projects undertaken by FHWA and State DOTs in North Carolina, South Carolina, and Georgia as well as forecasts for anticipated projects in the upcoming 5 years. Additionally, FHWA and state DOTs may use this Programmatic Consultation for activities (e.g., cofferdams) provided they adhere to all relevant PDCs, but do not necessarily fall into one of the six categories of projects or are not for the purpose of one of the larger project types. Therefore, additional numbers of these types of activities were estimated and included into the numbers found in Table 4. The anticipated number of upcoming projects are found in Table 3, while the corresponding activities, many of which are needed to complete these projects, are found in Table 4. The number of projects estimated to be undertaken in Atlantic sturgeon critical habitat are found in Table 5, while the number of activities estimated to be undertaken in Atlantic sturgeon critical habitat are found in Table 6.

Table 3. Number of Projects Estimated to be Undertaken Using this Programmatic Consultation per 5-Year Period

	Category of Project	Number of Projects during the Next 5 Years	Average Number of Projects Per Year
1	New alignment/roadway; road widening	45	9
2	New/replacement bridge & pier; bridge widening	50	10
3	Bridge & pier repair, maintenance & retrofit	60	12
4	Culvert installation, replacement, repair & maintenance	50	10
5	Shoreline stabilization	105	21
6	Pavement Preservation	45	9

Table 4. Number of Activities Estimated to be Undertaken Using this Programmatic Consultation per 5-Year Period

	Category of Activity	Number of Projects during the Next 5 Years	Average Number of Projects Per Year
1	Erosion, turbidity & sediment control	355	71
2	Staging areas	355	71
3	Site preparation	310	62
4	Geotechnical drilling	60	12
5	Scientific survey devices	50	10
6	Temporary platforms, fills & cofferdams	150	30
7	Pile Installation & Removal	125	25
8	Blasting	40	8
9	Dredging	45	9
10	Equipment	355	71

Table 5. Number of Projects Estimated to be Undertaken Using this Programmatic Consultation per 5-Year Period in Atlantic Sturgeon Critical Habitat

	Category of Project	Number of Projects during the Next 5 Years	Average Number of Projects Per Year

1	New alignment/roadway	N/A	N/A
2	New/replacement bridge & pier; bridge widening	30	6
3	Bridge repair, maintenance & retrofit	45	9
4	Culvert installation, replacement, repair & maintenance	N/A	N/A
5	Shoreline stabilization	75	15
6	Pavement Preservation	N/A	N/A

Table 6. Number of Activities Estimated to be Undertaken Using this Programmatic Consultation per 5-Year Period in Atlantic Sturgeon Critical Habitat

	Category of Activity	Number of Projects during the Next 5 Years	Average Number of Projects Per Year
1	Erosion, turbidity & sediment control	150	30
2	Staging areas	N/A	N/A
3	Site preparation	150	30
4	Geotechnical drilling	15	3
5	Scientific survey devices	20	4
6	Temporary platforms, fills & cofferdams	125	25
7	Pile Installation & Removal	75	15
8	Blasting	20	4
9	Dredging	25	5
10	Equipment	N/A	N/A

4.3 Assumptions

Because this is a programmatic consultation, the exact location, number of activities, and effects of each individual activity is unknown. Therefore, we must look at the likely outcome of each activity individually and in aggregate. Below is a list of assumptions made and the rationale for each assumption. The effects analysis for this Programmatic Informal Consultation is based on these assumptions. The programmatic review discussed in Section 4.5, allows for regular reviews between NMFS and FHWA to determine if the assumptions and effects of the actions are commensurate with those that were anticipated in this document. This review process includes determining if changes are occurring in the number of projects predicted to be authorized for activities and projects analyzed under this Evaluation. At the time of review, consultation would be re-initiated if the effects that occurred in a given timeframe did not match those defined in this document.

1. Because the exact location of each project and activity is unknown, we must look at the most likely conditions to be encountered, the worst-case scenario for each species, and identify whether PDCs can prevent the effect from occurring or ensure the effect is discountable or insignificant. For example, when considering effects to Atlantic sturgeon from an average cofferdam installation, we consider a typical site with conditions commonly found in Atlantic sturgeon habitat. These projects are often found in rivers. We also consider the worst-case scenario of in-water construction in which the project could possibly harm or impede movement of this species, or could interfere with reproduction. To reduce this risk, the PDCs preclude projects that impede or restrict movement of species.

   Some of the areas where these species are found are not included within our action area. For instance, when sturgeon move into the rivers (such as the Savannah River), they are likely beginning migrations for spawning purposes. In order to protect sturgeon migrating in and out of spawning rivers, projects near the mouths of spawning rivers are not included in this consultation. Similarly, effects to hatchling sea turtles are not considered under this consultation because they are not within the action area.

2. We assume that individual projects are not likely to occur simultaneously in the same project specific action area. For instance, we assume that only 1 seawall will be installed at a time within a given area (e.g., tidal creek). We also consider the effects in aggregate if more than 1 activity were to occur during a project simultaneously within an area. Since each of these projects is likely to be completed quickly (a couple of days to a couple of months depending on the type of activity), it is unlikely that multiple identical activities will occur simultaneously. For the effects analysis, we assume a worst-case scenario of up to 2 activities occurring in the same area simultaneously.

   Because we do not know the level of development that will occur within a given region or the distance between projects analyzed under this Consultation, we assume that projects are not likely to occur simultaneously in a small area. For instance, we assume that only 1 bridge will be replaced at a time within a given area (e.g., river). We also consider the aggregate effects if more than 1 project were to occur simultaneously within a region. Since each of these projects are large and require significant effort, it is unlikely that multiple projects will occur simultaneously. For the effects analysis, we assume a worst-case scenario of up to 2 projects (e.g., bridge replacement projects) occurring in the same area simultaneously.

3. Because this is a new Programmatic Consultation, FHWA provided an estimate of the number and size of activities (as well as thresholds contained within PDCs) that they believe will be authorized using this Document as the Section 7 consultation. The number of activities and projects anticipated to be authorized was estimated over a 5-year period in Tables 3 and 4. Table 7 (below) provides additional assumptions used to estimate the area of impact that may occur in the bottom/substrate. Most of the assumptions are based on the size of impact. We based our analysis on the data provided and thresholds (PDCs), and believe that these are reasonable assumptions to facilitate an accurate estimated for the loss of habitat and critical habitat.

Table 7. Assumptions That Were Used to Calculate Potential Loss or Temporary Loss of Habitat/Substrate

	Activity	Assumptions made to estimate the impacts
1	Erosion and turbidity	2,159 ft^2 (maximum total size x number of activities = total impacts
2	Staging areas	No impact
3	Site preparation	No impact
4	Drilling & sampling	1 ft^2 x number of activities = total impacts
5	Scientific survey devices	25 ft^2 (maximum impact) x number of activities = total impacts
6	Temporary platforms, access fills, and cofferdams	0.5 acres (maximum total size) x number of activities = total impacts
7	Pile Installation/Removal	200 ft^2 (maximum total size) x total activities = total impacts
8	Blasting	No impact
9	Dredging	1000ft^2 x number of activities = total impacts 500ft^2 x number of activities = total impacts
10	Equipment	No impact
	Project	
1	New alignments	No impact
2	Bridges & Piers	200 ft^2 (maximum total size) x number of projects = total impacts
3	Bridge/Pier repair and maintenance	0.5 acres x number of projects = total impacts
4	Culverts	500 linear feet x number of projects = total impacts 0.5 acre x number of projects = total impacts
5	Shoreline stabilization	500 linear feet (max length) x average 1.25 ft waterward x number of projects = total impacts
6	Pavement preservation	No impact

4.4 Project-Specific Review

As discussed in Section 3, FHWA will follow certain steps before moving forward on a project using this Programmatic Informal Consultation to satisfy the Section 7 consultation requirement. FHWA must conduct a project-specific review to ensure that all of the PDCs are incorporated into the action. If the PDCs are incorporated into the action, then a request for coverage under the Programmatic Informal Consultation is submitted to NMFS as described below:

Submission to NMFS: FHWA or the appropriate state transportation agency must email the following information to NMFS at nmfsgenericemailaddress@noaa.gov

1. A completed Excel spreadsheet corresponding to the applicable activities in the format shown in Appendix B. The table in Appendix B provides the required format and column headings. Descriptions and formatting requirements for each of the columns are also located in Appendix B. This spreadsheet may be modified as necessary if modifications are approved in advance by NMFS.
2. Any other supporting documentation necessary to support the effects determination made by FHWA or its delegated authority. This should include project plans, site survey (e.g., benthic, seagrass, hard bottom), photos, environmental assessment, and any other relevant documentation.

NMFS may acknowledge receipt of the transportation agency's email submission through an auto-reply email. During the first year of implementation, the transportation agency will wait 15 calendar days before moving forward with the activity. The timeframe begins the calendar day following the receipt of the auto reply email. For example, if the FHWA transmits the required information on Monday and receives the auto reply email the same day the calculation of 15 calendar days starts with Tuesday as the first day.

During 15-day period, NMFS has the opportunity to spot-check projects for compliance with this Programmatic Informal Consultation. If the transportation agency receives acknowledgement of NMFS's receipt of the application package, and receives no subsequent notification within the review periods stating that the project does not comply with the Programmatic Informal Consultation, then coverage under the Programmatic Informal Consultation is extended to the action and the transportation agency may proceed on the 15th calendar day. Additionally, coverage under the Programmatic Informal Consultation can occur before the end of the 15-day period if the transportation agency receives confirmation of compliance from NMFS.

4.5 Programmatic Review

NMFS and FHWA will conduct programmatic reviews annually, or at another agreed-upon period, to evaluate (1) the effectiveness of the Programmatic Informal Consultation; (2) whether the PDCs continue to be appropriate and are being implemented effectively; and (3) whether the project-specific consultation procedures are being complied with and are effective. The purpose of this evaluation is to assess the effectiveness of the consultation and verify conclusions regarding the potential effects to ESA-listed species and critical habitat, review data on the aggregate effects of the combined projects from the previous year(s), and evaluate the need for changes to PDCs or procedures. If the results of the programmatic review show that the anticipated effects to listed species or critical habitat defined in this document are being exceeded, reinitiation of consultation may be required. Reviews will be conducted in the following way:

FHWA Reports: The FHWA or the state transportation agency will provide NMFS with a completed spreadsheet of all activities authorized using this Programmatic Consultation as the Section 7 consultation during each year, ending on June 30; the report is due 90 days later. Before submitting the spreadsheet to NMFS, FHWA or the state transportation agency will quality-control check the spreadsheet for accuracy (e.g., properly formatted, completely filled out, no duplicates, latitude/longitude data is accurate and entered according to the formatting requirements provided) and review the data to confirm that this Programmatic Informal Consultation is being implemented properly (activities are following the PDCs). The FHWA shall provide a short summary of their findings with their email submission of the spreadsheet to nmfsgenericemailaddress@noaa.gov.

Annually: The annual review will cover all projects that occur within a year and will occur at the end of that year. A year will end on June 30 and a new year will begin July 1. During this review, FHWA will evaluate a random sample of projects authorized using this Consultation as the Section 7 consultation analysis by selecting a subset of activities and will review them in detail. Additionally, FHWA may select projects from each of the 6 categories of projects (e.g., 3 bridge replacements, 3 shoreline stabilization) to evaluate. FHWA will document the results of the annual review in a formal letter to NMFS. NMFS will review this annual report and provide comments or set up a conference call to discuss the result. The FHWA annual report will include:

1. The annual spreadsheet of projects permitted during the previous year in the format shown in Appendix B. This spreadsheet may be modified as necessary if modifications are approved by NMFS.
2. Discussion of the results of the in-depth project reviews as discussed above.
3. Analysis and discussion regarding the number of activities and projects anticipated under each category to determine if the number of projects exceeds those provided in Tables 3 through 6, and to determine if the extent of critical habitat loss exceeds the amounts discussed in Section 6 of this document.
4. Results and summary of the pre- and post-construction compliance inspections completed during the previous year.
5. Any lessons learned or procedural changes necessary to improve the program.

Monthly/Quarterly Call: During the first year of implementation, FHWA or the state transportation agency and NMFS will conduct a monthly or quarterly call, or as needed, to discuss projects under this Programmatic Informal Consultation used as the Section 7 analysis. This call will provide the opportunity to discuss issues as they arise and answer questions about the implementation of the program as a whole. Re-initiation of the programmatic informal consultation may be required if new information reveals effects not considered in this consultation, or a new species is listed or critical habitat is designated that may be affected by the actions covered. If the FHWA or a state DOT alters an action such that it is not consistent with the programmatic informal consultation, that action would no longer be qualified to use the programmatic informal consultation and would need to seek separate section 7 consultation.

5. Effects of the Action

Potential routes of effects from all the activities proposed under this programmatic to each of the listed species (see Table 1) and critical habitat units (see Table 2 and 10) likely to occur in or near the action areas were evaluated. Tables 8 and 9 provide effects determinations from each activity category and project type for all the species and critical habitats that occur in or near the action area. In Section 6.1, we provide the rationale for our effects analysis in a step- down approach broken down by activity type. For each species and/or critical habitat that may be affected, we first determine if the activity has the potential to cause a direct physical effect resulting in injury or death of the species or adverse effects to the PBFs of critical habitat. Then we discuss if the actions (construction of the project or indirect effects resulting from the presence of the new structure) will result in behavioral effects to the species.

Specifically, we look to see if the actions will affect foraging, sheltering, reproduction, or migration of the species. We also look to see whether and how the activities would affect the PBFs of critical habitat. The effects of noise generated during construction is discussed in Section 5.2 and in Appendix A. Each activity will adhere to the PDCs provided in Section 5. Activities that are likely to adversely affect species or critical habitats are not included or covered by the Programmatic Informal Consultation.

Table 8. Summary of Determination of Effects to Species and Critical Habitat by Activity Type[5]

	Category of Activity	Sea Turtles (Green, Kemp's ridley, leatherback, loggerhead, Hawksbill	Sturgeon (shortnose & Atlantic)	Atlantic Sturgeon Critical Habitat
1	Erosion, turbidity & sediment control	NLAA	NLAA	NLAA
2	Staging areas	NLAA	NLAA	NE
3	Site preparation	NLAA	NLAA	NLAA
4	Geotechnical drilling	NLAA	NLAA	NLAA
5	Scientific survey devices	NLAA	NLAA	NLAA
6	Temporary platforms, fills & cofferdams	NLAA	NLAA	NLAA
7	Pile Installation & Removal	NLAA	NLAA	NLAA
8	Blasting	NLAA	NLAA	NLAA
9	Dredging	NLAA	NLAA	NLAA
10	Equipment	NLAA	NLAA	NE

[5] Some of the effects determinations summarized in this table cover multiple types of activities. The effects determinations summarized above are the worst-case scenario and the determinations may be different from each activity type within the category of activities.

Table 9. Summary of Determination of Effects to Species and Critical Habitat by Activity Type[6]

	Category of Project	Sea Turtles (Green, Kemp's ridley, leatherback, loggerhead, Hawksbill	Sturgeon (shortnose & Atlantic)	Atlantic Sturgeon Critical Habitat
1	New alignment/roadway	NLAA	NLAA	NE
2	New/replacement bridge; bridge widening	NLAA	NLAA	NLAA
3	Bridge repair, maintenance & retrofit	NLAA	NLAA	NLAA
4	Culvert installation, replacement, repair & maintenance	NE	NLAA	NE
5	Shoreline stabilization	NLAA	NLAA	NLAA
6	Pavement Preservation	NLAA	NLAA	NE

Table 10. The Physical and Biological Features of Atlantic Sturgeon Critical Habitat

Atlantic sturgeon	The physical and biological features essential to the conservation of Atlantic sturgeon are: (1) Suitable hard bottom substrate (e.g., rock, cobble, gravel, limestone, boulder, etc.) in low salinity waters (i.e., 0.0-0.5 parts per thousand range [ppt]) for settlement of fertilized eggs and refuge, growth, and development of early life stages. (2) Transitional salinity zones inclusive of waters with a gradual downstream gradient of 0.5-30 ppt and soft substrate (e.g., sand, mud) downstream of spawning sites for juvenile foraging and physiological development. (3) Water of appropriate depth and absent physical barriers to passage (e.g., locks, dams, reservoirs, gear, etc.) between the river mouth and spawning sites necessary to support: (i) unimpeded movement of adults to and from spawning sites; (ii) seasonal and physiologically dependent movement of juvenile Atlantic sturgeon to appropriate salinity zones within the river estuary; and (iii) staging, resting, or holding of subadults or spawning condition adults - water depths in main river channels must also be deep enough (at least 1.2 m) to ensure continuous flow in the main channel at all times when any sturgeon life stage would be in the river. (4) Water quality conditions, especially in the bottom meter of the water column, with temperature and oxygen values that support: (i) spawning; (ii) annual and inter-annual adult, subadult, larval, and juvenile survival; and (iii) larval, juvenile, and subadult growth, development, and recruitment. Appropriate temperature and oxygen values will vary interdependently, and depending on salinity in a particular habitat. For example, 6 mg/L dissolved oxygen (D.O.) for juvenile rearing habitat is considered optimal, whereas D.O. less than 5.0 mg/L for longer than 30 days is considered suboptimal when water temperature is greater than 25°C. In temperatures greater than 26°C,

[6] Some of the effects determinations summarized in this table cover multiple types of projects (e.g., scour repair, seismic retrofit). The effects determinations summarized above are the worst-case scenario and the determinations may be different from each activity type within the category of activities.

	D.O. greater than 4.3 mg/L is needed to protect survival and growth. Temperatures of 13° C to 26° C for spawning habitat are considered optimal.

5.1 Potential Effects to Species and Critical Habitat

5.1.1 Activities Common to Several Project Types

Activity #1 – Installation, Maintenance, and Removal of Temporary Erosion, Turbidity, and Sediment Control Devices

Temporary erosion, turbidity, and sediment control measures analyzed in this evaluation include common techniques and materials such as sediment control fence, filter dams, and sediment basins based on the limitations defined in the PDCs (Section 5.1). The installation of uncommon, proprietary, or unproven/untested techniques and materials has not been analyzed. FHWA/State DOTs anticipate that temporary erosion, turbidity and sediment control activities will be required for nearly every project type included in this agreement during the next 5 years using this document as the Section 7 consultation (Table 4), representing approximately 900 projects. If each activity (silt curtain) is constructed to the maximum allowed length in the PDCs (i.e., 550 lin ft) and placed at a maximum of 10 ft waterward of the MHWL/OHWM, this would result in a potential temporary loss of up to 2,159 ft^2 (550 ft long x 10 ft wide [area of a half-ellipsoid]) of habitat. The installation of 900 curtains, each temporarily impacting 2,159 ft^2, would result in a potential temporary loss of up to 1,943,100 ft^2 (44.6 acres) of habitat over the next 5 years. We believe this is an over estimate based on the assumption that each project would require a silt/turbidity curtain that is 550 ft long and will extend 10-feet waterward. Since silt/turbidity curtains are not required or effective for all projects, we will assume that approximately 35% of projects will require silt curtains, resulting in a potential temporary loss of up to 680,085 ft^2 (15.6 acres). We believe the projects may effect, but are not likely to adversely affect sea turtles and sturgeon due in part to their temporary nature and near-shore location.

We believe the projects will have no effect on hawksbill and leatherback sea turtles due to the species' very specific life history strategies, which are not supported near shorelines where activities will take place (e.g., installing sediment control fence and anchoring turbidity curtains). Leatherback sea turtles have a pelagic, deepwater life history, where they forage primarily on jellyfish. Hawksbill sea turtles typically inhabit inshore reef and hard bottom areas where they forage primarily on encrusting sponges.

We believe that installation of silt/turbidity curtains may affect, but are not likely to adversely affect Atlantic sturgeon critical habitat and that siltation control fence and other stationary methods will have no effect on Atlantic sturgeon critical habitat.

Potential routes of effects to each of the listed species and critical habitat are discussed below.

Potential routes of effect to sea turtles and sturgeon

- <u>Physical Effects:</u> We do not believe that temporary erosion, turbidity, and sediment control activities (i.e., sediment control fence, filter dams, or sediment basins, or potential upland minor shaping [trenching] the shoreline to fit sediment control fence) or the installation of turbidity curtains present a plausible route of injury from direct physical contact with mobile protected species (i.e., sea turtles and sturgeon). It is not plausible to expect that these mobile species will remain underneath materials being installed, including turbidity curtains, and suffer a contact injury. In addition, the NMFS's *Sea Turtle and Smalltooth Sawfish Construction Conditions* (PDC) require construction to stop temporarily if an ESA-listed species is sighted within 50 ft of mechanical construction equipment. Furthermore, turbidity controls will only enclose a small portion of the project sites at any time, will be removed after construction, and serve as a barrier to species presence during construction. Therefore, we believe these activities will have no direct physical effect on listed species. Operating construction machinery could also physically strike or harm sea turtles or sturgeon. The possibility of this occurring is discountable given the species' mobility and the fact that construction machinery will not be located beneath the water line. Construction machinery may reach into the water (e.g., excavator bucket) for the placement of materials/measures, but the PDCs along with the mobility of the species make the risk of direct construction impacts (i.e., sturgeon/sea turtles struck by machinery or materials) discountable.

- Foraging and Sheltering: Mobile species may be affected by their being temporarily unable to use an area for forage or refuge habitat due to potential avoidance of construction activities caused by temporary erosion, turbidity, and sediment control activities. These effects are described below based on the construction limitations defined by the PDCs:
    - Sea turtles: Sea turtles may be affected by being temporarily unable to use the site for forage habitat due to potential avoidance of construction activities and physical exclusion from areas contained by turbidity curtains. These effects will be insignificant, given each activity's small footprint. The potential loss of nearshore foraging habitat is insignificant because of the PDC requiring construction to avoid and minimize submerged aquatic vegetation potentially used for sea turtle foraging. Potential seagrass impacts would be limited to along the shoreline and will be temporary. Sea turtles can travel long distances to forage and would be unaffected by minor losses of seagrasses from temporary erosion, turbidity, and sediment control activities. The PDCs also preclude construction on beaches used by nesting sea turtles.
    - Sturgeon: The project activities will impact only a very small portion of foraging and/or sheltering habitat, and these effects will be temporary. Sturgeon will have access to alternate, similar, undisturbed habitat nearby (e.g., up and downstream of the site). These are areas where sturgeon could move to and their potential foraging and sheltering would be unaffected by project activities. Additionally, sturgeon are opportunistic feeders and forage over large areas. Therefore, we would expect them to be able to locate prey beyond the immediate area of the activities and adverse effects to foraging and shelter are extremely unlikely. Thus, the risk of effects from these activities are insignificant.
- Migration: Temporary erosion, turbidity, and sediment control activities covered are limited to small footprints that do not obstruct the movement of species in the area. Therefore, migration of these species will not be adversely affected by the installation of these materials/devices.
- Behavior: The presence of materials, machinery, and personnel during these activities may result in behavioral responses (e.g., startle, avoid, and abandon) that could affect migrating, feeding, resting, or reproducing, for example. However, because of the PDCs for the activities, generally small nature of the activities, mobility of sea turtles and sturgeon, and assumption that similar habitat will be available nearby, we believe behavioral effects will be insignificant.

- Noise: The potential noise effects from construction activities are discussed separately in Section 5.2

Potential routes of effects to Atlantic sturgeon critical habitat

FHWA anticipates that 325 temporary erosion, turbidity, and sediment control activities may be authorized in the next 5 years in Atlantic sturgeon critical habitat using this document as the Section 7 consultation (Table 6), and of those, 50 will require the use of silt curtains. The PDCs require silt curtains not exceed 550 lin ft and not be placed more than 10-ft waterward of the MHWL or OHWM. If each project is constructed to the maximum allowed length in the PDCs (i.e., 550 lin ft) and placed at a maximum of 10-ft waterward of the MHWL, this would result in a potential loss of up to 2,159 ft^2 (550 ft long x 10 ft wide [area of a half-ellipsoid]) of habitat. This is likely an over estimate based on the assumption that each project is 550 ft long and will extend 10-feet waterward of the MHWL. The installation of 50 curtains, each temporarily impacting 2,159 ft^2, would result in a total potential temporary loss of up to 107,950 ft^2 (2.48 acres) of habitat over the next 5 years. We believe these activities are not likely to adversely affect Atlantic sturgeon critical habitat.

The PBFs necessary for the conservation of Atlantic sturgeon and the reasons adverse effects are not likely are:

1. Suitable hard bottom substrate (e.g., rock, cobble, gravel, limestone, boulder, etc.) in low salinity waters (i.e., 0.0-0.5 parts per thousand range [ppt]) for settlement of fertilized eggs and refuge, growth, and development of early life stages. The PDCs preclude impacts or installation of silt/turbidity curtains in critical habitat where this PBF is present.
2. Transitional salinity zones inclusive of waters with a gradual downstream gradient of 0.5-30 ppt and soft substrate (e.g., sand, mud) downstream of spawning sites for juvenile foraging and physiological development. The installation of curtains is expected to temporarily restrict access to and cover soft substrate habitat, but not alter the physical or chemical properties of the substrate itself or the water. Furthermore, Atlantic sturgeon generally occupy deeper waters than those excepted to be impacts by silt/turbidity curtains. Therefore the impacts to transitional salinity zones inclusive of waters with a gradual downstream gradient of 0.5-30 ppt and soft substrate (e.g., sand, mud) downstream of spawning sites for juvenile foraging and physiological development from silt/turbidity curtains are expected to be insignificant.
3. Water of appropriate depth and absent physical barriers to passage (e.g., locks, dams, reservoirs, gear, etc.) between the river mouth and spawning sites necessary to support: (i) unimpeded movement of adults to and from spawning sites; (ii) seasonal and physiologically dependent movement of juvenile Atlantic sturgeon to appropriate salinity zones within the river estuary; and (iii) staging, resting, or holding of subadults or spawning condition adults - water depths in main river channels must also be deep enough (at least 1.2 m) to ensure continuous flow in the main channel at all times when any sturgeon life stage would be in the river. The PDCs preclude installing silt/turbidity curtains in a way that would impact depth or represent a physical barrier to passage.
4. Water quality conditions, especially in the bottom meter of the water column, with temperature and oxygen values that support: (i) spawning; (ii) annual and inter-annual adult,

subadult, larval, and juvenile survival; and (iii) larval, juvenile, and subadult growth, development, and recruitment. Appropriate temperature and oxygen values will vary interdependently, and depending on salinity in a particular habitat. For example, 6 mg/L dissolved oxygen (D.O.) for juvenile rearing habitat is considered optimal, whereas D.O. less than 5.0 mg/L for longer than 30 days is considered suboptimal when water temperature is greater than 25°C. In temperatures greater than 26°C, D.O. greater than 4.3 mg/L is needed to protect survival and growth. Temperatures of 13° C to 26° C for spawning habitat are considered optimal. There is no plausible route of effect for this PBF from the installation of silt/turbidity curtains.

Activity #2 - Staging Areas

Staging area establishment, maintenance, and removal measures analyzed in this evaluation include common techniques and materials such as sediment control fence and light construction activities based on the limitations defined in the PDCs (Section 5.1). The establishment of staging areas in channels, streams, creeks, rivers, or intertidal areas has not been analyzed. FHWA/State DOTs anticipates staging areas will be required for nearly every project type included in this agreement during the next 5 years using this document as the Section 7 consultation (Table 4), representing approximately 900 projects.

We believe the projects will have no effect on hawksbill and leatherback sea turtles due to the species' very specific life history strategies, which are not supported near shorelines where activities will take place (e.g., installing sediment control fence and perimeter site fencing [chain-link fence]). Leatherback sea turtles have a pelagic, deepwater life history, where they forage primarily on jellyfish. Hawksbill sea turtles typically inhabit inshore reef and hard bottom areas where they forage primarily on encrusting sponges. Potential routes of effects to each of the listed species and critical habitat are discussed below.

We believe that establishing, maintaining, and removing staging areas will have no effect on Atlantic sturgeon critical habitat.

Potential routes of effect to sea turtles and sturgeon

- Physical Effects: We do not believe that establishment, maintenance, and removal of staging areas (i.e., installing sediment control fence) present a plausible route of injury from direct physical contact with mobile protected species (i.e., sea turtles and sturgeon). Due to the PDCs that restrict staging area establishment to outside of channels and intertidal areas, it is not plausible to expect any direct physical effect on listed species.
- Foraging and Sheltering: Mobile species may be affected by their being temporarily unable to use an area for forage or refuge habitat due to potential avoidance of construction activities caused by temporary erosion, turbidity, and sediment control activities associated with staging areas. These effects are described in the category above.
- Migration: Staging areas are limited to areas outside active channels and intertidal areas. Therefore, migration of these species will not be adversely affected by the installation of these areas, or materials/devices associated with staging areas.
- Behavior: The presence of materials, machinery, and personnel during these activities may result

in behavioral responses (e.g., startle, avoid, and abandon) that could affect migrating, feeding, resting, or reproducing, for example. However, because of the PDCs for the activities, generally small nature of the activities, mobility of sea turtles and sturgeon, and assumption that similar habitat will be available nearby, we believe behavioral effects will be insignificant.

Activity #3 - Site Preparation

Site preparation activities analyzed in this evaluation include common techniques and materials such as clearing and grubbing using heavy machinery, hand clearing, and debris/obstruction removal based on the limitations defined in the PDCs (Section 5.1). The use of uncommon or proprietary techniques or methods has not been analyzed. FHWA/State DOTs anticipate that site preparation activities will be required for a majority of project types included in this agreement during the next 5 years using this document as the Section 7 consultation (Table 4), representing approximately 805 projects.

We believe the projects will have no effect on hawksbill and leatherback sea turtles due to the species' very specific life history strategies, which are not supported near shorelines where activities will take place (e.g., hand clearing or shorelines). Leatherback sea turtles have a pelagic, deepwater life history, where they forage primarily on jellyfish. Hawksbill sea turtles typically inhabit inshore reef and hard bottom areas where they forage primarily on encrusting sponges.

We believe that site preparation activities may affect, but are not likely to adversely affect Atlantic sturgeon critical habitat.

Potential routes of effects to each of the listed species and critical habitat are discussed below.

Potential routes of effect to sea turtles and sturgeon

- Physical Effects: We do not believe that site preparation activities present a plausible route of injury from direct physical contact with mobile protected species (i.e., sea turtles and sturgeon). It is not plausible to expect that these mobile species will remain underneath equipment or materials that may be near the shoreline and suffer a contact injury. In addition, the NMFS's *Sea Turtle and Smalltooth Sawfish Construction Conditions* (PDC) require construction to stop temporarily if an ESA-listed species is sighted within 50 ft of mechanical construction equipment. Furthermore, turbidity controls will likely be installed and will serve as a barrier to species presence during construction. Therefore, we believe these activities will have no direct physical effect on listed species. Operating construction machinery could also physically strike or harm sea turtles or sturgeon. The possibility of this occurring is discountable given the species' mobility and the fact that construction machinery will be limited to small machinery, may not reach more than 5-ft waterward or 5-feet below the OHWM or MHWL, and must be lowered into the water at a rate of 60 feet per minute. Construction machinery may reach into the water (e.g., mini-excavator bucket) for clearing, grubbing, or grading purposes, but the PDCs along with the mobility of the species make the risk of direct construction impacts (i.e., sturgeon/sea turtles struck by machinery or materials) discountable.

- Foraging and Sheltering: Mobile species may be affected by their being temporarily unable to use an area for forage or refuge habitat due to potential avoidance of construction activities caused by site preparation activities. These effects are described below based on the limitations defined by the PDCs:

- Sea turtles: Sea turtles may be affected by being temporarily unable to use the site for forage habitat due to potential avoidance of construction activities and physical exclusion from areas contained by turbidity measures (which are discussed above). These effects will be insignificant, given each activity's small footprint. The potential loss of nearshore foraging habitat is insignificant because of the PDC requiring all projects to avoid and minimize impacts to submerged aquatic vegetation potentially used for sea turtle foraging and PDC limiting the extent of in-water site preparation activities. Additionally, potential seagrass impacts would be limited to along the shoreline. Sea turtles can travel long distances to forage and would be unaffected by minor losses of seagrasses from site preparation activities and temporary silt curtains. The PDCs also preclude construction on beaches used by nesting sea turtles.
- Sturgeon: The project activities will impact only a very small portion of foraging and/or sheltering habitat, and these effects will be temporary. Sturgeon will have access to alternate, similar, undisturbed habitat nearby (e.g., up and downstream of the site). These are areas where sturgeon could move to and their potential foraging and sheltering would be unaffected by project activities. Additionally, sturgeon are opportunistic feeders and forage over large areas. Therefore, we would expect them to be able to locate prey beyond the immediate area of the activities and adverse effects to foraging and shelter are extremely unlikely. Thus, the risk of adverse effects from these activities are insignificant.

- Migration: Site preparation activities covered are limited to primarily on-land activities that do not obstruct the movement of species in the area. Therefore, migration of these species will not be adversely affected by these activities.
- Behavior: The presence of materials, machinery, and personnel during these activities may result in behavioral responses (e.g., startle, avoid, and abandon) that could affect migrating, feeding, resting, or reproducing, for example. However, because of the PDCs for the activities, generally land-based nature of the activities, mobility of sea turtles and sturgeon, and assumption that similar habitat will be available nearby, we believe behavioral effects will be insignificant.

Potential routes of effects to Atlantic sturgeon critical habitat

FHWA anticipates that 375 site preparation activities may be authorized in the next 5 years in Atlantic sturgeon critical habitat using this document as the Section 7 consultation (Table 6). The PDCs preclude any work that may impact the physical and biological features of Atlantic sturgeon critical habitat and require in-water activities be limited to 5-ft waterward and 5-ft below the MHWL or OHWM. Because of the PDCs and the land-based nature of activities, we believe these activities are not likely to adversely affect Atlantic sturgeon critical habitat.

The PBFs necessary for the conservation of Atlantic sturgeon and the reasons adverse effects are not likely are:

1. Suitable hard bottom substrate (e.g., rock, cobble, gravel, limestone, boulder, etc.) in low salinity waters (i.e., 0.0-0.5 parts per thousand range [ppt]) for settlement of fertilized eggs and refuge, growth, and development of early life stages. Site preparation activities may contribute small amounts of sediment into the water, temporarily elevating turbidity, but this will not alter the

physical or chemical properties of the substrate itself or the water. Therefore, the impacts to suitable hard bottom substrate from site preparation activities are expected to be insignificant.

2. Transitional salinity zones inclusive of waters with a gradual downstream gradient of 0.5-30 ppt and soft substrate (e.g., sand, mud) downstream of spawning sites for juvenile foraging and physiological development. Site preparation activities may contribute small amounts of sediment into the water, but will not alter the physical or chemical properties of the substrate itself or the water. Furthermore, Atlantic sturgeon generally occupy deeper waters than those excepted to be impacted by site preparation activities and erosion, turbidity, and sedimentation controls will be installed as soon as possible following minimal clearing. Therefore the impacts to transitional salinity zones inclusive of waters with a gradual downstream gradient of 0.5-30 ppt and soft substrate (e.g., sand, mud) downstream of spawning sites for juvenile foraging and physiological development from site preparation activities are expected to be insignificant.

3. Water of appropriate depth and absent physical barriers to passage (e.g., locks, dams, reservoirs, gear, etc.) between the river mouth and spawning sites necessary to support: (i) unimpeded movement of adults to and from spawning sites; (ii) seasonal and physiologically dependent movement of juvenile Atlantic sturgeon to appropriate salinity zones within the river estuary; and (iii) staging, resting, or holding of subadults or spawning condition adults - water depths in main river channels must also be deep enough (at least 1.2 m) to ensure continuous flow in the main channel at all times when any sturgeon life stage would be in the river. There is no plausible route of effect for this PBF from the installation of silt/turbidity curtains.

4. Water quality conditions, especially in the bottom meter of the water column, with temperature and oxygen values that support: (i) spawning; (ii) annual and inter-annual adult, subadult, larval, and juvenile survival; and (iii) larval, juvenile, and subadult growth, development, and recruitment. Appropriate temperature and oxygen values will vary interdependently, and depending on salinity in a particular habitat. For example, 6 mg/L dissolved oxygen (D.O.) for juvenile rearing habitat is considered optimal, whereas D.O. less than 5.0 mg/L for longer than 30 days is considered suboptimal when water temperature is greater than 25°C. In temperatures greater than 26°C, D.O. greater than 4.3 mg/L is needed to protect survival and growth. Temperatures of 13° C to 26° C for spawning habitat are considered optimal. Site preparation activities may contribute small amounts of sediment into the water, temporarily elevating turbidity, which can decrease dissolved oxygen. However, because of limited extent and duration of the expected turbidity, we believe these effects are insignificant.

Activity #4 - Geotechnical Drilling and Hazardous Waste Sampling

Geotechnical drilling and hazardous waste sampling activities analyzed in this evaluation include common techniques and methods based on the limitations defined in the PDCs (Section 5.1). The use of uncommon or proprietary techniques or methods has not been analyzed. FHWA/State DOTs anticipates that geotechnical drilling and hazardous waste sampling activities will be required by approximately 250 projects included in this agreement during the next 5 years using this document as the Section 7 consultation (Table 4). Bore holes are limited to 13.54-inches in diameter (144 inches^2; 1ft^2).

We believe the projects will have no effect on hawksbill and leatherback sea turtles due to the species' very specific life history strategies, which are not supported near shorelines where activities will take place (e.g., hand clearing or shorelines). Leatherback sea turtles have a pelagic, deepwater life history, where they forage primarily on jellyfish. Hawksbill sea turtles typically inhabit inshore reef and hard bottom areas where they forage primarily on encrusting sponges.

We believe that geotechnical drilling and hazardous waste sampling activities may affect, but are not likely to adversely affect Atlantic sturgeon critical habitat.

Potential routes of effects to each of the listed species and critical habitat are discussed below.

Potential routes of effect to sea turtles and sturgeon

- Physical Effects: Effects include the risk of injury from construction activities including physical effects from the placement of drilling materials or operating drilling machinery. Drilling operations involve the use of small boats, barges, and/or tracked drill rigs. We believe there will be no effect to these mobile species from drilling activities. We do not expect that these mobile species will remain underneath the drilling devices during operation and suffer a contact injury. Operating machinery for drilling and sampling could also physically strike or harm sea turtles or sturgeon. The possibility of this occurring is discountable given the species' mobility and the fact that the presence of the machinery will cause animals to move away from the site. Implementation of NMFS's *Sea Turtle and Smalltooth Sawfish Construction Conditions* (PDC) further reduces interaction risk because these conditions require construction to stop temporarily if a sea turtle or sturgeon (PDC) is sighted within 50 ft of operating machinery. Limiting construction to daylight hours will help construction workers to spot any ESA-listed species near the project areas. Therefore, we believe the risk of direct impacts to species is discountable.

- Foraging and Sheltering: Mobile species may be affected by their being temporarily unable to use an area for forage or refuge habitat due to potential avoidance of activities caused by drilling and sampling operations. These effects are described below based on the construction limitations defined by the PDCs:
    - Sea turtles: Sea turtles may be affected by being temporarily unable to use the site for forage habitat due to potential avoidance of construction activities and physical exclusion from areas contained by construction machinery. These effects will be insignificant, given each activity's small footprint. The potential loss of nearshore foraging habitat is insignificant because of the PDC requiring all projects to avoid and minimize impacts to submerged aquatic vegetation potentially used for sea turtle foraging. Sea turtles can travel long distances to forage and would be unaffected by minor losses of seagrasses from drilling and sampling activities. The PDCs also preclude construction on beaches used by nesting sea turtles.
    - Sturgeon: The project activities will impact only a very small portion of foraging and/or sheltering habitat, and these effects will be temporary. Sturgeon will have access to alternate, similar, undisturbed habitat nearby (e.g., up and downstream of the site). These are areas where sturgeon could move to and their potential foraging and sheltering would be unaffected by project activities. Additionally, sturgeon are opportunistic feeders and forage over large areas. Therefore, we would expect them to be able to locate prey beyond the immediate area of the activities and adverse effects to foraging and shelter are extremely unlikely. Thus, the risk of effects from these activities are insignificant.

- Migration: Drilling and sampling activities covered are limited to small footprints that do not obstruct the movement of species. Therefore, migration of these species will not be affected (i.e., no effect) by the installation of these materials/devices.

- Behavior: The presence of materials, machinery, and personnel during these activities may result in behavioral responses (e.g., startle, avoid, and abandon) that could affect migrating, feeding, resting, or reproducing, for example. However, because of the PDCs for the activities, generally small nature of the activities, mobility of sea turtles and sturgeon, and assumption that similar habitat will be available nearby, we believe behavioral effects will be insignificant.

- Noise: Because we do not expect that these mobile species will remain near the drilling devices during operation and noise effects from drilling activities are expected to be minimal, we believe any noise effects will be insignificant. Noise effects are also described below in Section 5.2

Potential routes of effects to Atlantic sturgeon critical habitat

FHWA anticipates that 50 drilling and sampling activities may be authorized in the next 5 years in Atlantic sturgeon critical habitat using this document as the Section 7 consultation (Table 6). The PDCs limit bore holes to 13.54-inches in diameter (144 $inches^2$; $1ft^2$) and preclude barge grounding and tracked-rigs in critical habitat areas. Total impacts during the next 5 years would equal approximately 50 ft^2 ($1ft^2$ impact per project x 50 projects). Because of the PDCs and small footprint of activities, we believe these activities are not likely to adversely affect Atlantic sturgeon critical habitat.

The PBFs necessary for the conservation of Atlantic sturgeon and the reasons adverse effects are not likely are:

1. Suitable hard bottom substrate (e.g., rock, cobble, gravel, limestone, boulder, etc.) in low salinity waters (i.e., 0.0-0.5 parts per thousand range [ppt]) for settlement of fertilized eggs and refuge, growth, and development of early life stages. The PDCs preclude drilling and sampling in this PBF of critical habitat. Therefore, there will be no effect to suitable hard bottom substrate from site drilling and sampling activities.
2. Transitional salinity zones inclusive of waters with a gradual downstream gradient of 0.5-30 ppt and soft substrate (e.g., sand, mud) downstream of spawning sites for juvenile foraging and physiological development. Drilling and sampling activities may contribute small amounts of sediment into the water, causing temporarily elevated turbidity in the immediate vicinity of the drilling, but this will not alter the physical or chemical properties of the substrate itself or the water. Therefore the impacts to transitional salinity zones inclusive of waters with a gradual downstream gradient of 0.5-30 ppt and soft substrate (e.g., sand, mud) downstream of spawning sites for juvenile foraging and physiological development from drilling and sampling activities are expected to be insignificant.
3. Water of appropriate depth and absent physical barriers to passage (e.g., locks, dams, reservoirs, gear, etc.) between the river mouth and spawning sites necessary to support: (i) unimpeded movement of adults to and from spawning sites; (ii) seasonal and physiologically dependent movement of juvenile Atlantic sturgeon to appropriate salinity zones within the river estuary; and (iii) staging, resting, or holding of subadults or spawning condition adults - water depths in main

river channels must also be deep enough (at least 1.2 m) to ensure continuous flow in the main channel at all times when any sturgeon life stage would be in the river. The PDCs preclude drilling and sampling activities from obstructing or impeding movements, therefore there is no plausible route of effect.

4. Water quality conditions, especially in the bottom meter of the water column, with temperature and oxygen values that support: (i) spawning; (ii) annual and inter-annual adult, subadult, larval, and juvenile survival; and (iii) larval, juvenile, and subadult growth, development, and recruitment. Appropriate temperature and oxygen values will vary interdependently, and depending on salinity in a particular habitat. For example, 6 mg/L dissolved oxygen (D.O.) for juvenile rearing habitat is considered optimal, whereas D.O. less than 5.0 mg/L for longer than 30 days is considered suboptimal when water temperature is greater than 25°C. In temperatures greater than 26°C, D.O. greater than 4.3 mg/L is needed to protect survival and growth. Temperatures of 13° C to 26° C for spawning habitat are considered optimal. Drilling and sampling activities have not been shown, and are not believed, to impact water temperature or dissolved oxygen values outside the immediate vicinity of the drilling apparatus. Therefore, we believe the effects are insignificant.

Activity #5 – Installation, Maintenance, and Removal of Scientific Survey Devices

Temporary scientific survey activities analyzed in this evaluation include techniques and methods based on the limitations defined in the PDCs (Section 5.1). FHWA/State DOTs anticipate that 200 temporary scientific survey activities will be authorized in the next 5 years using this document as the Section 7 consultation (Table 4). The maximum impact from scientific survey devices will be 25 ft^2. The PDCs specify that all areas must be returned to pre-construction elevations upon completion of the project, which is limited to 24 months.

We believe the projects will have no effect on hawksbill and leatherback sea turtles due to the species' very specific life history strategies, which are not supported near shorelines where activities will take place (e.g., hand clearing or shorelines). Leatherback sea turtles have a pelagic, deepwater life history, where they forage primarily on jellyfish. Hawksbill sea turtles typically inhabit inshore reef and hard bottom areas where they forage primarily on encrusting sponges.

We believe that scientific survey activities will have no effect on critical habitat based on the construction limitations defined in the PDCs.

Potential routes of effects to each of the listed species are discussed below.

Potential routes of effect to sea turtles and sturgeon

- Physical Effects: Effects include the risk of injury from construction activities including physical effects from the placement of devices and operation of equipment. Installing, maintaining, and removing scientific survey devices involve the use of small boats, barges, and/or tracked drill rigs. We believe there will be no effect to these mobile species from these activities. We do not expect that these mobile species will remain underneath the devices during placement or equipment during operation and suffer a contact injury. Operating machinery for the installation, maintenance, and removal of scientific survey devices could also physically strike or harm sea turtles or sturgeon. The possibility of this occurring is discountable given the species' mobility and the fact that the presence of the machinery will cause animals to move away from the site.

Implementation of NMFS's *Sea Turtle and Smalltooth Sawfish Construction Conditions* (PDC) further reduces interaction risk because these conditions require construction to stop temporarily if a sea turtle or sturgeon (PDC) is sighted within 50 ft of operating machinery. Limiting construction to daylight hours will help construction workers to spot any ESA-listed species near the project areas. Therefore, we believe the risk of direct impacts to species is discountable.

- Foraging and Sheltering: Mobile species may be affected by their being temporarily unable to use an area for forage or refuge habitat due to potential avoidance of activities caused by Installing, maintaining, and removing scientific survey devices. These effects are described below based on the construction limitations defined by the PDCs:
    - Sea turtles: Sea turtles may be affected by being temporarily unable to use the site for forage habitat due to potential avoidance of activities. These effects will be insignificant, given each activity's small footprint and rapid construction time. The potential loss of nearshore foraging habitat is insignificant because of the PDC limiting scientific survey device impacts to 25ft^2 total and 15ft^2 of submerged aquatic vegetation potentially used for sea turtle foraging. Sea turtles can travel long distances to forage and would be unaffected by minor losses of seagrasses from drilling and sampling activities. The PDCs also preclude construction on beaches used by nesting sea turtles.
    - Sturgeon: The project activities will impact only a very small portion of foraging and/or sheltering habitat, and these effects will be temporary. Sturgeon will have access to alternate, similar, undisturbed habitat nearby (e.g., up and downstream of the site). These are areas where sturgeon could move to and their potential foraging and sheltering would be unaffected by project activities. Additionally, sturgeon are opportunistic feeders and forage over large areas. Therefore, we would expect them to be able to locate prey beyond the immediate area of the activities and adverse effects to foraging and shelter are extremely unlikely. Thus, the risk of effects from these activities are insignificant.
- Migration: Installing, maintaining, and removing scientific survey devices are limited to small footprints that do not obstruct the movement of species. Therefore, migration of these species will not be affected (i.e., no effect) by the installation of these materials/devices.
- Behavior: The presence of materials, machinery, and personnel during these activities may result in behavioral responses (e.g., startle, avoid, and abandon) that could affect migrating, feeding, resting, or reproducing, for example. However, because of the PDCs for the activities, generally small nature of the activities, rapid construction time, mobility of sea turtles and sturgeon, and assumption that similar habitat will be available nearby, we believe behavioral effects will be insignificant.

Activity #6 - Temporary Platforms, Access Fills, and Cofferdams

FHWA anticipates 850 temporary platforms, access fill, and/or cofferdam activities will be authorized in the next 5 years using this document as the Section 7 consultation (Table 4). This activity category is limited to the placement of (1) temporary work platforms, (2) access fills, and (3) cofferdams to dewater an area for construction. All of these activities are typically associated with construction of linear transportation projects such as bridges, but cofferdams are also associated with culvert installation, maintenance, and removal. Each activity may also be used for other transportation-related work. The PDCs limit effects to seagrasses and also preclude construction activities from restricting migratory movement of species. Effects from the installation of temporary platforms, access fills, and/or cofferdams will be temporally limited to no more than 120 days (except for temporary work platforms located outside Atlantic sturgeon critical habitat – limited to no more than 24 months), and restricted to no more than 0.5 acres of total impacts for a single, complete project. Of those 0.5 acres of impacts, total cofferdam impacts for a single, complete project are limited to 4,000 ft^2 (0.09 ac). Individual cofferdams are limited to either (1) 500 ft^2 (0.011 ac) in size and a maximum of 2 cofferdams may only be in place at any given time; a maximum of 8 cofferdams may be used for a single, complete project, or (2) 1000 ft^2 (0.023 ac) in size and a maximum of 1 cofferdam (regardless of size) may be installed/in place at any given time; a maximum of 4 cofferdams (regardless of size) may be installed for a single, complete project. Temporary access fills are limited to no more than 0.5 acres total while substrate impacts from temporary platforms are limited to 500 ft^2 (0.011 acres)(outside of Atlantic sturgeon critical habitat) and 200 ft^2 (0.004 acres) or 100ft^2 (0.002 acres) (within Atlantic sturgeon critical habitat). Temporary platforms, temporary fills, and cofferdams must be removed in their entirety and the affected areas must be returned to pre- construction elevations.

We believe the projects will have no effect on hawksbill and leatherback sea turtles due to the species' very specific life history strategies, which are not supported near shorelines where activities will take place (e.g., hand clearing or shorelines). Leatherback sea turtles have a pelagic, deepwater life history, where they forage primarily on jellyfish. Hawksbill sea turtles typically inhabit inshore reef and hard bottom areas where they forage primarily on encrusting sponges.

We believe that temporary platform, access fill, and cofferdam activities may affect, but are not likely to adversely affect any of the species or critical habitat discussed below based on the construction limitations defined in the PDCs.

Potential routes of effects to each of the listed species and critical habitat are discussed below.

Potential routes of effect to sea turtles and sturgeon

- Physical Effects: Effects include the risk of injury from construction activities including physical effects from construction materials or operating construction machinery during construction activities. Installation of temporary platforms and access fills typically involves the use of barges, land-based equipment, turbidity curtains or cofferdams. These activities can extend temporary dirt roads or create islands/platforms in the water, or involve installation of piles for temporary platforms. Cofferdams are placed in the water and then dewatered so that construction can occur "in-the-dry" inside the cofferdam. Mobile species are able to avoid construction activities including cofferdam placement and placement of pilings for temporary platforms or fill for temporary roads or work islands. Implementation of NMFS's *Sea Turtle and Smalltooth Sawfish Construction Conditions* (PDC) further reduces interaction risk because these conditions require construction to stop temporarily if a sea turtle or sturgeon is sighted within 50 ft of operating machinery. Limiting construction to daylight hours will help construction workers to spot any ESA-listed species near the project areas. Therefore, the risk of injury from physical effects to sea turtles and sturgeon is considered insignificant.
- Foraging and Sheltering: Mobile species may be affected by their being temporarily unable to use an area for forage or refuge habitat due to potential avoidance of construction activities and

turbidity curtains. These affects are described below based on the construction limitations defined by the PDCs:

- o Sea turtles: Sea turtles may be affected by being temporarily unable to use the site for forage habitat due to potential avoidance of construction activities and physical exclusion from areas contained by cofferdams, fill, or turbidity curtains. These effects are expected to be insignificant, given (1) all activities are temporary, (2) areas will be returned to pre-construction conditions, (3) all activities shall avoid and minimize impacts to seagrasses potentially used for sea turtle foraging, and (4) all activities will not occur on or contiguous to sea turtle nesting beaches. Sea turtles can travel long distances to forage and would be unaffected by minor losses of seagrasses from these activities.
- o Sturgeon: As discussed, all activities will be temporary. Sturgeon are opportunistic feeders that forage over large areas and will be able to locate prey beyond the immediate area of temporary activity. As discussed in Section 6.1.1 (Dredging), sediments disturbed are likely to recolonize with benthic prey in 3-24 months (Culter and Mahadevan 1982; Saloman et al. 1982; Wilber et al. 2007). Therefore, the temporary placement of materials for access fills or cofferdams will likely only temporarily reduce foraging opportunities for sturgeon in the area. Thus, impact from these activities is expected to be insignificant.

- Migration: The PDCs preclude activities from restricting the migration of species, including at the mouths of rivers where sturgeon are known to migrate, and near sea turtle nesting beaches used by female sea turtle or hatchlings migrating on or off nesting beaches (i.e., loggerhead critical habitat's nearshore reproductive habitat). Therefore, there will be no effect on migration of these species from the construction of these structures.
- Noise: The potential noise effects from construction activities are discussed separately in Section 6.2

Potential routes of effects to Atlantic sturgeon critical habitat

FHWA anticipates that 200 temporary platforms, access fill, and/or cofferdam activities may be authorized in the next 5 years in Atlantic sturgeon critical habitat using this document as the Section 7 consultation (Table 6). The PDCs preclude the placement or construction of temporary cofferdams and access fills in areas where the PBFs are present, if the activity will adversely affect the PBFs. In the rare scenario where temporary cofferdams and access fills placed in Atlantic sturgeon critical habitat would not adversely affect the PBFs, their installation is limited to no more than 120 days and the same size thresholds listed above (0.5 acres of impacts total; total cofferdam impacts for a single, complete project are limited to 4,000 ft^2 (0.09 ac); temporary access fills are limited to no more than 0.5 acres). Temporary platforms installed in Atlantic sturgeon critical habitat are temporally limited to 120 days and 200 ft^2 (0.004 acres) or less of substrate impacts. However, if suitable hard bottom substrate is present (PBF 1, below), temporary platforms installed in Atlantic sturgeon critical habitat are temporally limited to 90 days and 100 ft^2 (0.002 acres) or less of substrate impacts and must be installed and removed outside of the migration/spawning season (platforms or cofferdams are not authorized when this PBF is present). Therefore, based on the PDCs and size thresholds in critical habitat, the FHWA estimates that the average project will result in approximately 500 ft^2 (0.01 ac) of impacts for an estimated total of 100,000 ft^2 (2.29 acres) of impacts from 200 activities (200 activities by 500 ft^2 = 100,000 ft^2). Furthermore, of these impacts, the maximum impact that is authorized to suitable hard bottom habitat (PBF 1, below) would be approximately 20,000 ft^2 (0.45 acres) from 200 activities (200 activities x 100 ft^2 = 20,000 ft^2). We believe this is an over-estimate and is extremely unlikely to occur. All of these effects will be temporary and the area will be returned to pre-construction elevations. We believe that these activities are not likely to adversely affect Atlantic sturgeon critical habitat.

The PBFs necessary for the conservation of Atlantic sturgeon are:

1. Suitable hard bottom substrate (e.g., rock, cobble, gravel, limestone, boulder, etc.) in low salinity waters (i.e., 0.0-0.5 parts per thousand range [ppt]) for settlement of fertilized eggs and refuge, growth, and development of early life stages. The activities will temporarily impact the suitable hard bottom substrate in low salinity waters. These effects will be short-term in nature and will occur outside of the times of year where sturgeon may be present to utilize this habitat for spawning. Construction PDCs also require that areas be restored to pre-construction conditions. Additionally, since these activities will likely be spread out over space and time and are each small in nature, we believe the activities will have an insignificant effect to suitable hard bottom substrate in low salinity waters in Atlantic sturgeon critical habitat.

2. Transitional salinity zones inclusive of waters with a gradual downstream gradient of 0.5-30 ppt and soft substrate (e.g., sand, mud) downstream of spawning sites for juvenile foraging and physiological development. The activities will temporarily impact this PBF, but the effects will be short-term in nature and will not impede sturgeon movement. Construction PDCs also require that areas be restored to pre-construction conditions. We believe the activities will not alter the physical or chemical properties of the substrate itself or the water. The activities may temporarily impact the food abundance and sediment quality to support prey (i.e., epibenthic crustaceans and infaunal polychaetes within the cofferdam footprint). These effects are primarily short-term in nature, consisting of a temporary loss of benthic invertebrate populations. Observed rates of benthic community recovery after dredging (for comparison), range from 3-24 months (Culter and Mahadevan 1982; Saloman et al. 1982; Wilber et al. 2007). The relatively species-poor benthic assemblages associated with low-salinity estuarine sediments can recover in periods of time ranging from a few months to approximately 1 year, while the more diverse communities of high salinity estuarine sediments may require a year or longer. Additionally, since these activities will likely be spread out over space and time and are each small in nature, we believe the activities will have an insignificant effect to transitional salinity zones inclusive of waters with a gradual downstream gradient of 0.5-30 ppt and soft substrate (e.g., sand, mud) downstream of spawning sites for juvenile foraging and physiological development.

3. Water of appropriate depth and absent physical barriers to passage (e.g., locks, dams, reservoirs, gear, etc.) between the river mouth and spawning sites necessary to support: (i) unimpeded movement of adults to and from spawning sites; (ii) seasonal and physiologically dependent movement of juvenile Atlantic sturgeon to appropriate salinity zones within the river estuary; and (iii) staging, resting, or holding of subadults or spawning condition adults - water depths in main river channels must also be deep enough (at least 1.2 m) to ensure continuous flow in the main channel at all times when any sturgeon life stage would be in the river. The PDCs preclude activities that impede sturgeon movement, therefore, there is no plausible route of effect.

4. Water quality conditions, especially in the bottom meter of the water column, with temperature and oxygen values that support: (i) spawning; (ii) annual and inter-annual adult, subadult, larval, and juvenile survival; and (iii) larval, juvenile, and subadult growth, development, and recruitment. Appropriate temperature and oxygen values will vary interdependently, and depending on salinity in a particular habitat. For example, 6 mg/L dissolved oxygen (D.O.) for juvenile rearing habitat is considered optimal, whereas D.O. less than 5.0 mg/L for longer than 30 days is considered suboptimal when water temperature is greater than 25°C. In temperatures greater than 26°C, D.O. greater than 4.3 mg/L is needed to protect survival and growth. Temperatures of 13° C to 26° C for spawning habitat are considered optimal. There is no plausible route of effect to for this PBF.

Activity #7 - Pile Installation and Removal

The installation and removal of piles and footings analyzed in this Opinion is based on the construction limitations defined in the PDCs in Section 5.1. It does not allow the installation of piles for fishing piers in areas where swimming sea turtles occur. FHWA anticipates that in the next 5 years, approximately 500 pile installation and removal activities will be authorized using this Document as the Section 7 consultation (Table 4). We believe that the construction, maintenance, and removal of pile- supported structures may indirectly affect sea turtles from an increase in vessel traffic.

We believe the projects will have no effect on hawksbill and leatherback sea turtles due to the species' very specific life history strategies, which are not supported at these project sites. Leatherback sea turtles have a pelagic, deepwater life history, where they forage primarily on jellyfish. Hawksbill sea turtles typically inhabit inshore reef and hard bottom areas where they forage primarily on encrusting sponges.

Potential routes of effects to each of the listed species and critical habitat is discussed below.

Potential routes of effect to sea turtles and sturgeon

- Physical Effects: Effects include the risk of injury from construction activities including physical effects from construction materials (including turbidity curtains) or operating machinery during construction activities. Installation (construction) and removal of piles and footings typically involves the use of boats and/or barges, but may also be conducted from the uplands. Piles are installed using an impact hammer, vibratory hammer, or by jetting. In areas with hard substrate, piles may be installed by first making a hole using an auger or a punch that is repeatedly dropped from a barge. We do not believe that pile driving presents a plausible route of injury effects from direct physical contact with mobile protected species. It is not plausible to expect that these mobile species will remain underneath a pile, regardless of the installation method, or turbidity curtains being installed and suffer an injury. In addition, the NMFS's *Sea Turtle and Smalltooth Sawfish Construction Conditions* (PDC) further reduces interaction risk because these conditions require construction to stop temporarily if an ESA-listed species is sighted within 50 ft of operating machinery. Limiting construction to daylight hours increases the likelihood that construction workers would spot any ESA-listed species near the project areas. Additionally, turbidity controls will serve as a barrier to species present during construction and will be removed promptly upon project completion. Furthermore, PDCs also require that all equipment and materials be lowered into the water at a rate of 60 feet per minute and one of three methods are used to give any animals the opportunity to leave an area prior to full-force pile driving. Therefore, we believe that there will be no physical effects to sea turtles and sturgeon from the installation or removal of piles.

- Foraging and Sheltering: Mobile species may be affected by their being temporarily unable to use an area for forage or refuge habitat due to potential avoidance of construction activities caused by pile placement or removal, or the installation of silt curtains. Additionally, mobile species may be affected by their being permanently unable to use an area for forage or refuge habitat due to the conversion of bottom and water column habitat to piles, columns or footings. These effects will be insignificant due to the small size of each pile placed (less than 24-inches in diameter, each; less than 200 ft^2 (0.004 acres) of total impacts) and the limited time it will take to complete each action. Additionally, a turbidity barrier will temporarily exclude mobile species from the construction site. Silt curtains will be removed promptly upon project completion, making the habitat available to species after construction is complete. These effects are described below based on the construction limitations defined by the PDCs:
    - Sea turtles: The PDCs state that the projects must avoid and minimize impacts to sea grasses that may be used for foraging by sea turtles. Additionally, to avoid impacts to seagrasses, PDCs require that elevated structures (e.g., pile supported structures) maximize light transmission. This would allow seagrasses to persist in an area, though likely at reduced densities. Potential seagrass impacts would be limited to those in the footprint of piles and below the elevated structure. Sea turtles can travel long distances to forage and would be unaffected by minor losses of seagrasses from these activities. Sea turtles will be able to forage and shelter in surrounding areas while work is underway, and can return to foraging in the project area when work is complete. Therefore, effects to foraging will be insignificant.
    - Sturgeon: Sturgeon are opportunistic feeders and forage over large areas. We would expect them to be able to locate prey beyond the immediate area of pile installation and removal, and return when construction is complete. Therefore, adverse effects to foraging and shelter are extremely unlikely. Thus, the risk of effects from these activities are insignificant.
- Migration: The installation and removal of piles and footings will not impact the migration of mobile protected species. Additionally, the PDCs preclude pile/column/footing installation at the mouths/inlets of rivers/estuaries where sturgeon are known to migrate to/from spawning grounds and prohibit the placement of piles/columns/footings that impede the navigability of the waterway for vessel traffic and/or species movement in the area. Adverse effects to migration associated with these activities are extremely unlikely to occur, therefore, potential risk of affecting migration from these activities is discountable.
- Behavior: The presence of materials, machinery, and personnel during these activities may result in behavioral responses (e.g., startle, avoid, and abandon) that could affect migrating, feeding, resting, or reproducing, for example. However, because of the PDCs for the activities, generally small nature of the activities, mobility of sea turtles and sturgeon, and assumption that similar habitat will be available nearby, we believe behavioral effects will be insignificant.

- Noise: The potential noise effects from construction activities are discussed separately in Section 5.2
- Vessel Strikes: Sea turtles are susceptible to vessels strikes. An increase in vessel traffic for construction purposes and following construction could result from the installation of piles and pile-support structures. This is discussed separately in Section 6.3 and again in Section 7.

Potential routes of effects to Atlantic sturgeon critical habitat

FHWA anticipates that 150 pile and footing installation and removal activities may be authorized in the next 5 years in Atlantic sturgeon critical habitat using this document as the Section 7 consultation (Table 6). The PDCs limit impacts to 200 ft^2 (0.004 acres) or less, or 100 ft^2 (0.002 acres) or less where suitable hard bottom habitat is present (PBF 1, below) for pile and footing installation/construction. Therefore, based on the PDCs and size thresholds in critical habitat, the FHWA estimates that the maximum project will result in 200 ft^2 (0.004 ac) of impacts for an estimated total of 30,000 ft^2 (0.69 acres) of impacts from 150 activities (150 activities by 200 ft^2 = 30,000 ft^2). Furthermore, of these impacts, the maximum impact that is authorized to suitable hard bottom habitat (PBF 1, below) would be approximately 15,000 ft^2 (0.34 acres) from 150 activities (150 activities x 100 ft^2 = 15,000 ft^2). We believe this is an over-estimate and is extremely unlikely to occur. We understand that piles may be square or round, and footers are square, and that the area of impact from a round pile would be less than that of a square pile; however, because the thresholds are set as a total limit, the shape of the pile or footer is inconsequential.

Of the PBFs, we believe that following may be affected.

The PBFs necessary for the conservation of Atlantic sturgeon are:

1. Suitable hard bottom substrate (e.g., rock, cobble, gravel, limestone, boulder, etc.) in low salinity waters (i.e., 0.0-0.5 parts per thousand range [ppt]) for settlement of fertilized eggs and refuge, growth, and development of early life stages. Effects to substrate will be insignificant due to the small size of the impacts from pile and footing installation and because suitable spawning sites will be available nearby. We also believe the activities will not alter the physical or chemical properties of the water. Furthermore, since these activities will likely be spread out over space and time, we believe these effects are insignificant.
2. Transitional salinity zones inclusive of waters with a gradual downstream gradient of 0.5-30 ppt and soft substrate (e.g., sand, mud) downstream of spawning sites for juvenile foraging and physiological development. Effects to substrate will be insignificant due to the small size of the impacts from pile and footing installation and because prey will only be displaced from the small footprint of the pile or footing to areas immediately adjacent to the pile or footing. We also believe the activities will not alter the physical or chemical properties of the substrate itself or the water. Furthermore, since these activities will likely be spread out over space and time, we believe these effects are insignificant.
3. Water of appropriate depth and absent physical barriers to passage (e.g., locks, dams, reservoirs, gear, etc.) between the river mouth and spawning sites necessary to support: (i) unimpeded movement of adults to and from spawning sites; (ii) seasonal and physiologically dependent movement of juvenile Atlantic sturgeon to appropriate salinity zones within the river estuary; and (iii) staging, resting, or holding of subadults or spawning condition adults - water depths in main

river channels must also be deep enough (at least 1.2 m) to ensure continuous flow in the main channel at all times when any sturgeon life stage would be in the river. The PDCs preclude activities that impede sturgeon movement, therefore, there is no plausible route of effect.

4. Water quality conditions, especially in the bottom meter of the water column, with temperature and oxygen values that support: (i) spawning; (ii) annual and inter-annual adult, subadult, larval, and juvenile survival; and (iii) larval, juvenile, and subadult growth, development, and recruitment. Appropriate temperature and oxygen values will vary interdependently, and depending on salinity in a particular habitat. For example, 6 mg/L dissolved oxygen (D.O.) for juvenile rearing habitat is considered optimal, whereas D.O. less than 5.0 mg/L for longer than 30 days is considered suboptimal when water temperature is greater than 25°C. In temperatures greater than 26°C, D.O. greater than 4.3 mg/L is needed to protect survival and growth. Temperatures of 13° C to 26° C for spawning habitat are considered optimal. There is no plausible route of effect for this PBF.

Activity #8 - Blasting

FHWA anticipates 75 blasting activities will be authorized in the next 5 years using this document as the Section 7 consultation (Table 4). The PDCs preclude any blasting when listed species may be present, in the mouths of rivers where sturgeon are known to migrate/spawn, and in freshwater rivers when sturgeon are migrating/spawning.

We believe the projects will have no effect on hawksbill and leatherback sea turtles due to the species' very specific life history strategies, which are not supported near shorelines where activities will take place. Leatherback sea turtles have a pelagic, deepwater life history, where they forage primarily on jellyfish. Hawksbill sea turtles typically inhabit inshore reef and hard bottom areas where they forage primarily on encrusting sponges.

We believe that blasting may affect sea turtles (Greens, loggerheads, and Kemp's ridleys), sturgeon and Atlantic sturgeon critical habitat.

Potential routes of effects to each of the listed species and critical habitat are discussed below.

Potential routes of effect to sea turtles and sturgeon

- Physical Effects: Due to the implementation of the PDC (buffer zones and precluding blasting while ESA listed species are present) we believe the effects to sea turtles and sturgeon will be insignificant.
- Foraging and Sheltering: Mobile species may be affected by their being temporarily unable to use an area for forage or refuge habitat due to potential avoidance of activities related to blasting operations. These effects will be small and temporary in nature and sturgeon and sea turtles will be able to access these areas immediately following blasting activities.

Potential routes of effects to Atlantic sturgeon critical habitat

FHWA anticipates that 30 blasting activities that may be authorized in the next 5 years in Atlantic sturgeon critical habitat using this document as the Section 7 consultation (Table 6). The PDCs preclude blasting in areas where suitable hard bottom substrate is present (PBF 1, below). However, blasting is authorized in areas where other PBFs are present, provided sturgeon are not present during blasting operations.

Of the PBFs, we believe the following may be affected.

The PBFs necessary for the conservation of Atlantic sturgeon are:

1. Suitable hard bottom substrate (e.g., rock, cobble, gravel, limestone, boulder, etc.) in low salinity waters (i.e., 0.0-0.5 parts per thousand range [ppt]) for settlement of fertilized eggs and refuge, growth, and development of early life stages. The PDCs preclude blasting if this PBF is present, therefore, there is no plausible route of effect.

2. Transitional salinity zones inclusive of waters with a gradual downstream gradient of 0.5-30 ppt and soft substrate (e.g., sand, mud) downstream of spawning sites for juvenile foraging and physiological development. Effects to substrate will be insignificant due to the small size of the impacts from blasting operations and because prey will only be displaced from small area near the blasting. We also believe the activities will not alter the physical or chemical properties of the substrate itself or the water. Furthermore, since these activities will likely be spread out over space and time, we believe these effects are insignificant.

3. Water of appropriate depth and absent physical barriers to passage (e.g., locks, dams, reservoirs, gear, etc.) between the river mouth and spawning sites necessary to support: (i) unimpeded movement of adults to and from spawning sites; (ii) seasonal and physiologically dependent movement of juvenile Atlantic sturgeon to appropriate salinity zones within the river estuary; and (iii) staging, resting, or holding of subadults or spawning condition adults - water depths in main river channels must also be deep enough (at least 1.2 m) to ensure continuous flow in the main channel at all times when any sturgeon life stage would be in the river. The PDCs preclude activities that impede sturgeon movement, therefore, there is no plausible route of effect.

4. Water quality conditions, especially in the bottom meter of the water column, with temperature and oxygen values that support: (i) spawning; (ii) annual and inter-annual adult, subadult, larval, and juvenile survival; and (iii) larval, juvenile, and subadult growth, development, and recruitment. Appropriate temperature and oxygen values will vary interdependently, and depending on salinity in a particular habitat. For example, 6 mg/L dissolved oxygen (D.O.) for juvenile rearing habitat is considered optimal, whereas D.O. less than 5.0 mg/L for longer than 30 days is considered suboptimal when water temperature is greater than 25°C. In temperatures greater than 26°C, D.O. greater than 4.3 mg/L is needed to protect survival and growth. Temperatures of 13° C to 26° C for spawning habitat are considered optimal. Blasting operations are rapid, beginning and ending in a matter of seconds, therefore, there is no plausible route of effect to for this PBF.

Activity #9 - Dredging

FHWA anticipates that 100 dredging activities will be authorized in the next 5 years using this document as the Section 7 consultation (Table 4). Minor dredging for (1) work site access; (2) placement of erosion and scour control-measures or shoreline stabilization (usually required to embed geotextile fabric or riprap in order to avoid reducing the navigable depth of channels or waterways, or so the toe of the slope can be stabilized to allow smooth transition of the work to the natural surrounding elevation); (3) creation of "pilot holes" for pilings; and (4) to remove pilings/footers is allowed, with size thresholds (PDCs) limited to -5.0 ft MLW and limited in size to 1000 ft^2 (0.02

acre). Total impact area for these activities over the 5-year period of the consultation could reach 100,000 ft^2 (2.29 acre), as a maximum. Dredging can by complete from the shore or from a barge-mounted dredge using a dragline dredging, backhoe, trackhoe, clamshell, or other commonly used excavation equipment. The PDCs preclude the use of hopper dredges, or dredging at the mouths/inlets of rivers where sturgeon migrate/spawn. PDCs also require that effects to seagrasses must be avoided or minimize to the extent possible, and not exceed 100ft^2. Disposal of material is allowed in upland disposal sites, USACE-permitted beneficial use sites, or EPA-designated ocean dredged material disposal sites. Beneficial use and ocean disposal sites must have undergone Section 7 consultation to determine the potential effects of disposal on ESA-listed species and critical habitat. The PDCs preclude beach renourishment. Considering the limitations and requirements of the PDCs, we believe that dredging analyzed under this document will not result in adverse effects to any of the species or critical habitat below.

Potential routes of effect to sea turtles and sturgeon

- Physical Effects: We believe the risk of injury to sea turtles and sturgeon from the proposed activity is discountable due to the species' ability to move away and expected avoidance behavior. The proposed activity allows the use of non-hopper dredging equipment. NMFS has previously determined in dredging Biological Opinions that, while oceangoing hopper-type dredges may lethally entrain protected species including sea turtles and sturgeon, non-hopper type dredging methods (e.g., mechanical such as clamshell, and bucket dredging; hydraulic [suction] cutterhead, and pipeline) are slower and extremely unlikely to overtake or adversely affect them. Dredging analyzed under this document is limited to minor dredging projects. Hence, these areas will be dredged using smaller equipment (i.e., cutterhead dredges likely 18-in diameter or less), which is less likely to overtake mobile species. The PDCs require implementation of NMFS's *Sea Turtle and Smalltooth Sawfish Construction Conditions* that will further reduce the risk by requiring all construction workers to watch for sawfish and stop all work if a sturgeon or sea turtle is seen within 50 ft of operations, all of which makes adverse effects extremely unlikely to occur.

  Despite rare reports of cold-stunned turtles (i.e., lethargic, dying, or previously dead) being taken by cutterhead dredges, in Laguna Madre, Texas (NMFS SWPBO 2015: Robert Hauch, Galveston USACE, pers. comm. to Eric Hawk, NMFS PRD, March 6, 2012), we have no new information that would change the basis of our conclusion that the risk of these effects is discountable. Due to these species' mobility, it is extremely unlikely that these species' would be struck by the transit and anchoring of equipment and barges at the project site; therefore, the increased risk is discountable .

- Foraging and Sheltering: Mobile species may be affected by their being temporarily unable to use an area for forage or refuge habitat due to potential avoidance of maintenance dredging activities. The PDCs also restrict activities that may adversely affect foraging and refuge habitat to mobile species in the following ways:
  - Sea Turtles: As stated above, the PDCs require avoidance and minimization of impacts to non-ESA-listed seagrasses potentially used for sea turtle foraging, and preclude construction on beaches used by nesting sea turtles. Sea turtles are unlikely to use man-made canals, channels, berths, marinas or intake/outfall structures for sheltering habitat.

Therefore, dredging will have insignificant effects to foraging for sea turtles. Minor dredging is allowed in other areas, but these areas are also unlikely to be used as foraging and sheltering habitat for sea turtles. Hence, minor dredging will have insignificant effects to foraging for sea turtles.

  - Sturgeon: The PDCs allow dredging within areas utilized by sturgeon, including critical habitat. However, the PDCs preclude dredging in mouths/inlets of rivers, when sturgeon are likely to be migrating for spawning purposes and in freshwater rivers when sturgeon may be present for spawning purposes. Sturgeon are opportunistic feeders that forage over large areas and will be able to locate prey beyond the minor dredging footprint and maintenance of existing channels. Therefore, minor dredging will have insignificant effects to foraging and sheltering for sturgeon.

- Migration: Dredging could impede movement of species depending on the size of the dredging footprint and the location of turbidity curtains; however, we believe these effects are extremely unlikely to occur. The PDCs state that activities cannot impede movement of species. The PDCs also preclude dredging in mouths/inlets of rivers, when sturgeon are likely to be migrating for spawning purposes and in freshwater rivers when sturgeon may be present for spawning purposes, as well as near sea turtle nesting beaches (i.e., loggerhead critical habitat's nearshore reproductive habitat) so as not to impede migration of sea turtles to or from these areas. Therefore, the risk of affecting migration is considered discountable.

Potential routes of effects to Atlantic sturgeon critical habitat

FHWA anticipates that 25 dredging activities that may be authorized in the next 5 years in Atlantic sturgeon critical habitat using this document as the Section 7 consultation (Table 6). The PDCs preclude dredging in areas where suitable hard bottom substrate is present (PBF 1 & 3, below). However, dredging is authorized in areas where other PBFs are present. Dredging in these areas is limited to -5.0 ft MLW and limited in size to 500 ft² (0.01 acre). Total impact area for these activities over the 5 year period of the consultation could reach 12,500 ft² (0.29 acre), as a maximum.

Of the PBFs, we believe that following may be affected.

The PBFs necessary for the conservation of Atlantic sturgeon are:

1. Suitable hard bottom substrate (e.g., rock, cobble, gravel, limestone, boulder, etc.) in low salinity waters (i.e., 0.0-0.5 parts per thousand range [ppt]) for settlement of fertilized eggs and refuge, growth, and development of early life stages. The PDCs preclude dredging if this PBF is present, therefore, there is no plausible route of effect.

2. Transitional salinity zones inclusive of waters with a gradual downstream gradient of 0.5-30 ppt and soft substrate (e.g., sand, mud) downstream of spawning sites for juvenile foraging and physiological development. Effects to food abundance are expected to be insignificant. Dredged material removal will temporarily affect the food abundance (i.e., benthic invertebrates within the dredging footprint). These effects are primarily short-term in nature, consisting of a temporary loss of benthic invertebrate populations in the dredged areas. Observed rates of benthic community recovery after dredging, range from 3- 24 months (Culter and Mahadevan 1982; Saloman et al. 1982; Wilber et al. 2007). The relatively species-poor benthic assemblages associated with low salinity estuarine sediments can recover in periods of time ranging from a few

months to approximately 1 year, while the more diverse communities of high salinity estuarine sediments may require a year or longer. We also believe the activities will not alter the physical or chemical properties of the substrate itself or the water. Furthermore, since these activities will likely be spread out over space and time, we believe these effects are insignificant.

3. Water of appropriate depth and absent physical barriers to passage (e.g., locks, dams, reservoirs, gear, etc.) between the river mouth and spawning sites necessary to support: (i) unimpeded movement of adults to and from spawning sites; (ii) seasonal and physiologically dependent movement of juvenile Atlantic sturgeon to appropriate salinity zones within the river estuary; and (iii) staging, resting, or holding of subadults or spawning condition adults - water depths in main river channels must also be deep enough (at least 1.2 m) to ensure continuous flow in the main channel at all times when any sturgeon life stage would be in the river. The PDCs preclude dredging if this PBF is present, therefore, there is no plausible route of effect.

4. Water quality conditions, especially in the bottom meter of the water column, with temperature and oxygen values that support: (i) spawning; (ii) annual and inter-annual adult, subadult, larval, and juvenile survival; and (iii) larval, juvenile, and subadult growth, development, and recruitment. Appropriate temperature and oxygen values will vary interdependently, and depending on salinity in a particular habitat. For example, 6 mg/L dissolved oxygen (D.O.) for juvenile rearing habitat is considered optimal, whereas D.O. less than 5.0 mg/L for longer than 30 days is considered suboptimal when water temperature is greater than 25°C. In temperatures greater than 26°C, D.O. greater than 4.3 mg/L is needed to protect survival and growth. Temperatures of 13° C to 26° C for spawning habitat are considered optimal. Dredging activities may contribute small amounts of sediment into the water, temporarily elevating turbidity, which can decrease dissolved oxygen. However, because of limited extent and duration of the expected turbidity, we believe these effects are insignificant.

Activity #10 - Equipment

General equipment associated with roadway construction will be required for every project undertaken or authorized by FHWA (Table 4). Considering the limitations and requirements of the PDCs, we believe that equipment analyzed under this document will not result in adverse effects to any of the species. We believe there will be no effect to Atlantic sturgeon critical habitat.

Potential routes of effect to sea turtles and sturgeon

- Physical Effects: Effects include the risk of injury from construction equipment or operation of that equipment during construction activities. We do not believe that the use of equipment presents a plausible route of injury effects from direct physical contact with mobile protected species. It is not plausible to expect that these mobile species will remain underneath equipment and suffer an injury. In addition, the NMFS's *Sea Turtle and Smalltooth Sawfish Construction Conditions* (PDC) further reduces interaction risk because these conditions require construction to stop temporarily if an ESA-listed species is sighted within 50 ft of operating machinery. Limiting construction to daylight hours increases the likelihood that construction workers would spot any ESA-listed species near the project areas. Additionally, all equipment will be removed promptly upon project completion. Furthermore, PDCs require that all equipment and materials be lowered into the water at a rate of 60 feet per minute to give any animals the opportunity to leave an area.

Therefore, we believe that there will be no physical effects to sea turtles and sturgeon from equipment.

- Foraging and Sheltering: Sturgeon and sea turtles may be affected by their being temporarily unable to use an area for forage or refuge habitat due to potential avoidance of construction equipment. These effects will be insignificant due to the small size of area where equipment will be located and the limited time it will take to complete each action. All equipment will be removed promptly upon project completion, making the habitat available to species after construction is complete. These effects are described below based on the construction limitations defined by the PDCs:
    - Sea turtles: Sea turtles can travel long distances to forage and would be unaffected by minor, temporary losses of access to seagrasses. Sea turtles will be able to forage and shelter in surrounding areas while work is underway, and can return to foraging in the project area when work is complete. Therefore, effects to foraging will be insignificant.
    - Sturgeon: Sturgeon are opportunistic feeders and forage over large areas. We would expect them to be able to locate prey beyond the immediate area of a project. Therefore, adverse effects to foraging and shelter are extremely unlikely. Thus, the risk of effects from these activities are insignificant.
- Migration: Equipment will not impede or obstruct the migration of these species.
- Behavior: The presence of materials, machinery, and equipment, and personnel to operate equipment during these activities may result in behavioral responses (e.g., startle, avoid, and abandon) that could affect migrating, feeding, resting, or reproducing, for example. However, because of the PDCs for the activities, generally small nature of the activities, mobility of sea turtles and sturgeon, and assumption that similar habitat will be available nearby, we believe behavioral effects will be insignificant.

5.1.2 Specific Transportation Project Types

Project Type #1 - New Alignments/Roadways and Road Widening (Roadway Construction)

The FHWA anticipates there will be 135 new alignment/roadway and road widening projects in the next 5 years using this document as the Section 7 consultation (Table 3). The PDCs preclude impacts to Atlantic sturgeon critical habitat or any aquatic areas where sea turtles and sturgeon may occur. We believe the projects will have no effect on hawksbill and leatherback sea turtles due to the species' very specific life history strategies, which are not supported near shorelines where activities will take place (e.g., installing sediment control fence and perimeter site fencing [chain-link fence]). Leatherback sea turtles have a pelagic, deepwater life history, where they forage primarily on jellyfish. Hawksbill sea turtles typically inhabit inshore reef and hard bottom areas where they forage primarily on encrusting sponges. Potential routes of effects to each of the listed species are discussed below. The presence of machinery, personnel, and construction noise may affect sea turtles and sturgeon.

Potential routes of effect to sea turtles and sturgeon

- Behavior: The presence of materials, machinery, and personnel during these activities may result in behavioral responses (e.g., startle, avoid, and abandon) that could affect migrating, feeding, resting, or reproducing, for example. However, because of the PDCs for the activities, generally small nature of the activities, mobility of sea turtles and sturgeon, and assumption that similar habitat will be available nearby, we believe behavioral effects will be insignificant.

Project Type #2 - New Bridge, Bridge Replacement, and Bridge Widening; New and Replacement Piers

The FHWA anticipates that 150 new bridge, bridge replacement, bridge widening, new pier, and pier replacement projects may be authorized in the next 5 years using this document as the Section 7 consultation (Table 3). The projects analyzed in this section are based on the construction limitations defined in the PDCs in Section 5.1. The PDCs do not allow the installation, replacement or relocation of fishing piers in areas where swimming sea turtles occur. Effects from pile, column, and footing installation and removal related to these projects has been analyzed in Section 6.1.1 and 6.2.

We believe the projects will have no effect on hawksbill and leatherback sea turtles due to the species' very specific life history strategies, which are not supported near shorelines where activities will take place (e.g., installing sediment control fence and anchoring turbidity curtains). Leatherback sea turtles have a pelagic, deepwater life history, where they forage primarily on jellyfish. Hawksbill sea turtles typically inhabit inshore reef and hard bottom areas where they forage primarily on encrusting sponges.

Potential routes of effects to each of the listed species and critical habitat are discussed below.

Potential routes of effect to sea turtles and sturgeon

- Physical Effects: We do not believe that these projects (or their components or equipment) present a plausible route of injury from direct physical contact with mobile protected species (i.e., sea turtles and sturgeon). It is not plausible to expect that these mobile species will remain underneath materials being installed, including turbidity curtains, and suffer a contact injury. In addition, the NMFS's *Sea Turtle and Smalltooth Sawfish Construction Conditions* (PDC) require construction to stop temporarily if an ESA-listed species is sighted within 50 ft of mechanical construction equipment. Furthermore, turbidity controls will be used for many of these projects and serve as a barrier to species presence during construction. Therefore, we believe these activities will have no direct physical effect on listed species. Operating construction machinery could also physically strike or harm sea turtles or sturgeon. The possibility of this occurring is discountable given the species' mobility and the fact that construction machinery will not be located beneath the water line. Construction machinery may reach into the water (e.g., excavator bucket) for the placement of materials/measures, but the PDCs along with the mobility of the species make the risk of direct construction impacts (i.e., sturgeon/sea turtles struck by machinery or materials) discountable.

- Foraging and Sheltering: Mobile species may be affected by their being temporarily unable to use an area for forage or refuge habitat due to potential avoidance of construction activities caused by these projects. Additionally, mobile species may be affected by their being permanently unable to use an area for forage or refuge habitat due to the conversion of bottom and water column habitat to piles, columns or footings. These effects will be insignificant due to the small size of substructures for each project (less than 200 ft^2 (0.004 acres) of total impacts) and the limited time it will take to complete each action. Additionally, a turbidity barrier will temporarily exclude mobile species from the construction site. Silt curtains will be removed promptly upon project completion, making the habitat available to species after construction is complete. These effects are described below based on the construction limitations defined by the PDCs:

- Sea turtles: The PDCs state that the projects must avoid and minimize impacts to sea grasses that may be used for foraging by sea turtles. Additionally, to avoid impacts to seagrasses, PDCs require that elevated structures (e.g., pile supported structures) maximize light transmission. This would allow seagrasses to persist in an area, though likely at reduced densities. Potential seagrass impacts would be limited to those in the footprint of piles and below the elevated structure. Sea turtles can travel long distances to forage and would be unaffected by minor losses of seagrasses from these activities. Sea turtles will be able to forage and shelter in surrounding areas while work is underway, and can return to foraging in the project area when work is complete. Therefore, effects to foraging will be insignificant.
- Sturgeon: Sturgeon are opportunistic feeders and forage over large areas. We would expect them to be able to locate prey beyond the immediate area of the projects and return when construction is complete. Therefore, adverse effects to foraging and shelter are extremely unlikely. Thus, the risk of effects from these activities are insignificant.

- Migration: The installation, removal and widening of bridges and piers will not impact the migration of mobile protected species. Additionally, the PDCs preclude pile/column/footing installation at the mouths/inlets of rivers/estuaries where sturgeon are known to migrate to/from spawning grounds and prohibit the placement of piles/columns/footings that impede the navigability of the waterway for vessel traffic and/or species movement in the area. Adverse effects to migration associated with these activities are extremely unlikely to occur, therefore, potential risk of affecting migration from these activities is discountable.
- Behavior: The presence of materials, machinery, and personnel during these activities may result in behavioral responses (e.g., startle, avoid, and abandon) that could affect migrating, feeding, resting, or reproducing, for example. However, because of the PDCs for the activities, generally small nature of the activities, mobility of sea turtles and sturgeon, and assumption that similar habitat will be available nearby, we believe behavioral effects will be insignificant.
- Noise: The potential noise effects from construction activities are discussed separately in Section 5.2
- Vessel Strikes: Sea turtles are susceptible to vessels strikes. An increase in vessel traffic for construction purposes and following construction could result from the installation of piles and pile-support structures. This is discussed separately in Section 6.3 and again in Section 7.

Potential routes of effects to Atlantic sturgeon critical habitat

FHWA anticipates that 100 new bridge, bridge replacement, bridge widening, new pier, and pier replacement projects may be authorized in the next 5 years in Atlantic sturgeon critical habitat using this document as the Section 7 consultation (Table 5). The PDCs limit impacts to 200 ft^2 (0.004 acres) or less, or 100 ft^2 (0.002 acres) or less where suitable hard bottom habitat is present (PBF 1, below). Therefore, based on the PDCs and size thresholds in critical habitat, the FHWA estimates that the maximum project will result in 200 ft^2 (0.004 ac) of impacts for an estimated total of 20,000 ft^2

(0.46 acres) of impacts from 100 activities (100 activities by 200 ft^2 = 20,000 ft^2). Furthermore, of these impacts, the maximum impact that is authorized to suitable hard bottom habitat (PBF 1, below) would be approximately 10,000 ft^2 (0.23 acres) from 100 activities (100 activities x 100 ft^2 = 10,000 ft^2). We believe this is an over-estimate and is extremely unlikely to occur, because we don't believe that each project will take place where PBF 1 is present.

Of the PBFs, we believe that following may be affected.

The PBFs necessary for the conservation of Atlantic sturgeon are:

1. Suitable hard bottom substrate (e.g., rock, cobble, gravel, limestone, boulder, etc.) in low salinity waters (i.e., 0.0-0.5 parts per thousand range [ppt]) for settlement of fertilized eggs and refuge, growth, and development of early life stages. Effects to substrate will be insignificant due to the small size of the impacts from pile and footing installation and because suitable spawning sites will be available nearby. We also believe the activities will not alter the physical or chemical properties of the water. Furthermore, since these activities will likely be spread out over space and time, we believe these effects are insignificant.
2. Transitional salinity zones inclusive of waters with a gradual downstream gradient of 0.5-30 ppt and soft substrate (e.g., sand, mud) downstream of spawning sites for juvenile foraging and physiological development. Effects to substrate will be insignificant due to the small size of the impacts from pile and footing installation and because prey will only be displaced from the small footprint of the pile or footing to areas immediately adjacent to the pile or footing. We also believe the activities will not alter the physical or chemical properties of the substrate itself or the water. Furthermore, since these activities will likely be spread out over space and time, we believe these effects are insignificant.
3. Water of appropriate depth and absent physical barriers to passage (e.g., locks, dams, reservoirs, gear, etc.) between the river mouth and spawning sites necessary to support: (i) unimpeded movement of adults to and from spawning sites; (ii) seasonal and physiologically dependent movement of juvenile Atlantic sturgeon to appropriate salinity zones within the river estuary; and (iii) staging, resting, or holding of subadults or spawning condition adults - water depths in main river channels must also be deep enough (at least 1.2 m) to ensure continuous flow in the main channel at all times when any sturgeon life stage would be in the river. The PDCs preclude activities that impede sturgeon movement, therefore, there is no plausible route of effect.
4. Water quality conditions, especially in the bottom meter of the water column, with temperature and oxygen values that support: (i) spawning; (ii) annual and inter-annual adult, subadult, larval, and juvenile survival; and (iii) larval, juvenile, and subadult growth, development, and recruitment. Appropriate temperature and oxygen values will vary interdependently, and depending on salinity in a particular habitat. For example, 6 mg/L dissolved oxygen (D.O.) for juvenile rearing habitat is considered optimal, whereas D.O. less than 5.0 mg/L for longer than 30 days is considered suboptimal when water temperature is greater than 25°C. In temperatures greater than 26°C, D.O. greater than 4.3 mg/L is needed to protect survival and growth. Temperatures of 13° C to 26° C for spawning habitat are considered optimal. There is no plausible route of effect to for this PBF.

Project Type #3 - Bridge Repair, Maintenance, and Retrofit

The FHWA anticipates that 150 bridge repair, maintenance, and retrofit projects may be authorized in the next 5 years using this document as the Section 7 consultation (Table 3). The projects analyzed in this section are based on the construction limitations defined in the PDCs in Section 5.1. It does not allow the installation, replacement or relocation of new bridges. Effects from temporary erosion and turbidity control methods and devices related to these projects has been analyzed in Section 6.1.1.

We believe the projects will have no effect on hawksbill and leatherback sea turtles due to the species' very specific life history strategies, which are not supported near shorelines where activities will take place (e.g., installing sediment control fence and anchoring turbidity curtains). Leatherback sea turtles have a pelagic, deepwater life history, where they forage primarily on jellyfish. Hawksbill sea turtles typically inhabit inshore reef and hard bottom areas where they forage primarily on encrusting sponges.

Potential routes of effects to each of the listed species and critical habitat are discussed below.

Potential routes of effect to sea turtles and sturgeon

- Physical Effects: We do not believe that bridge repair, maintenance, and retrofit projects present a plausible route of injury from direct physical contact with mobile protected species (i.e., sea turtles and sturgeon). It is not plausible to expect that these mobile species will remain underneath materials being installed and suffer a contact injury. In addition, the NMFS's *Sea Turtle and Smalltooth Sawfish Construction Conditions* (PDC) require construction to stop temporarily if an ESA- listed species is sighted within 50 ft of mechanical construction equipment. Furthermore, turbidity controls will only enclose a small portion of the project sites at any time (analyzed under Activity #1), will be removed after construction, and serve as a barrier to species presence during construction. Additionally, PDCs requiring equipment to be lowered into the water at a rate of 60 feet per minute will allow mobile species to leave the area. Therefore, we believe that bridge repair, maintenance, and retrofit projects will have no direct physical effect on listed species.
- Foraging and Sheltering: Mobile species may be affected by their being temporarily unable to use an area for forage or refuge habitat due to potential avoidance of construction activities or the installation of silt curtains. Additionally, mobile species may be affected by their being unable to effectively use an area for forage or refuge habitat due to the conversion of bottom habitat to rip rap. These effects will be insignificant due to the small size of each project and the limited time it will take to complete each action. Additionally, turbidity barrier will temporarily exclude mobile species from the construction site. Silt curtains will be removed promptly upon project completion, making the habitat available to species after construction is complete. These effects are described below based on the construction limitations defined by the PDCs:
    - Sea turtles: Sea turtles may be affected by being temporarily unable to use the site for forage habitat due to potential avoidance of construction activities and physical exclusion from areas contained by turbidity curtains. Additionally, potential foraging habitat may be permanently covered or removed by riprap. These effects will be insignificant, given each activity's small footprint and short construction time. The potential loss of foraging habitat is insignificant because of the PDC requiring construction to avoid and minimize submerged aquatic vegetation potentially used for sea turtle foraging. Potential seagrass impacts would be limited to 25 ft^2 in area. Sea turtles can travel long distances to forage

and would be unaffected by minor losses of seagrasses from shoreline stabilization projects. The PDCs also preclude construction on beaches used by nesting sea turtles.

- Sturgeon: Sturgeon are opportunistic feeders and forage over large areas. The project activities will impact only a very small portion of foraging and/or sheltering habitat. Sturgeon will have access to alternate, similar, undisturbed habitat nearby (e.g., up and downstream of the site). These are areas where sturgeon could move to and their potential foraging and sheltering would be unaffected by project activities. Therefore, we would expect them to be able to locate prey beyond the immediate area of the activities and adverse effects to foraging and shelter are extremely unlikely. Thus, the risk of effects from these activities are discountable.

- Migration: Bridge repair, maintenance, and retrofit projects covered by this evaluation will not obstruct the movement of species in the area. Additionally, the PDCs preclude construction when sturgeon are migrating into and out of the river for spawning and on or contiguous to ocean beaches used by female sea turtle or hatchlings migrating on or off nesting beaches. Therefore, migration of these species will not be affected (i.e., no effect) by the construction of these structures.
- Behavior: The presence of materials, machinery, and personnel during these activities may result in behavioral responses (e.g., startle, avoid, and abandon) that could affect migrating, feeding, resting, or reproducing, for example. However, because of the PDCs for the activities, generally small nature of the activities, mobility of sea turtles and sturgeon, and assumption that similar habitat will be available nearby, we believe behavioral effects will be insignificant.
- Noise: The potential noise effects from construction activities are discussed separately in Section 5.2

Potential routes of effects to Atlantic sturgeon critical habitat

FHWA anticipates that 100 bridge repair, maintenance, and retrofit projects may be authorized in the next 5 years in Atlantic sturgeon critical habitat using this document as the Section 7 consultation (Table 5). The PDCs require in-water impacts (e.g., rip rap for scour protection) are limited to 0.5 acre. If each project is constructed to the maximum allowed area in the PDCs (i.e., 1.5 acre) this could result in a potential loss of up to 50 acres (100 projects x 0.5 acre = 50 acres of habitat). This is likely a drastic over-estimate since most bridge repair, maintenance, and retrofit projects will not be scour projects, and impact areas are typically smaller (e.g., 0.2-0.3 acre). We believe these activities are not likely to adversely affect Atlantic sturgeon critical habitat.

The PBFs necessary for the conservation of Atlantic sturgeon are:

1. Suitable hard bottom substrate (e.g., rock, cobble, gravel, limestone, boulder, etc.) in low salinity waters (i.e., 0.0-0.5 parts per thousand range [ppt]) for settlement of fertilized eggs and refuge, growth, and development of early life stages. The PDCs preclude impacts in critical habitat where this PBF is present.
2. Transitional salinity zones inclusive of waters with a gradual downstream gradient of 0.5-30 ppt and soft substrate (e.g., sand, mud) downstream of spawning sites for juvenile foraging and physiological development. The placement of materials is expected to cover the

sediments in the footprint of the activity, but not alter the physical or chemical properties of the substrate itself or the water. Furthermore, effects to foraging (e.g., prey) will be insignificant due to the small size of the impacts and because prey will only be displaced from the small footprint to areas immediately adjacent to the riprap placement; some prey may utilize riprap. Therefore, the impacts to transitional salinity zones inclusive of waters with a gradual downstream gradient of 0.5-30 ppt and soft substrate (e.g., sand, mud) downstream of spawning sites for juvenile foraging and physiological development from shoreline stabilization are expected to be insignificant.

3. Water of appropriate depth and absent physical barriers to passage (e.g., locks, dams, reservoirs, gear, etc.) between the river mouth and spawning sites necessary to support: (i) unimpeded movement of adults to and from spawning sites; (ii) seasonal and physiologically dependent movement of juvenile Atlantic sturgeon to appropriate salinity zones within the river estuary; and (iii) staging, resting, or holding of subadults or spawning condition adults - water depths in main river channels must also be deep enough (at least 1.2 m) to ensure continuous flow in the main channel at all times when any sturgeon life stage would be in the river. The PDCs preclude undertaking projects in a way that would represent a physical barrier to passage. Additionally, PDCs prohibit changing water depths/bottom elevations and limit riprap placement to 2 feet above the existing/original bottom elevation.
4. Water quality conditions, especially in the bottom meter of the water column, with temperature and oxygen values that support: (i) spawning; (ii) annual and inter-annual adult, subadult, larval, and juvenile survival; and (iii) larval, juvenile, and subadult growth, development, and recruitment. Appropriate temperature and oxygen values will vary interdependently, and depending on salinity in a particular habitat. For example, 6 mg/L dissolved oxygen (D.O.) for juvenile rearing habitat is considered optimal, whereas D.O. less than 5.0 mg/L for longer than 30 days is considered suboptimal when water temperature is greater than 25°C. In temperatures greater than 26°C, D.O. greater than 4.3 mg/L is needed to protect survival and growth. Temperatures of 13° C to 26° C for spawning habitat are considered optimal. Water quality may be temporarily impacted by the placement of materials (e.g., riprap), however this impact will be insignificant as turbidity curtains will be used to contain disturbed sediments and elevated turbidity will be very brief in duration.

Project Type #4 - Culvert Installation, Replacement, Repair, and Maintenance

The FHWA anticipates that 125 culvert projects may be authorized in the next 5 years using this document as the Section 7 consultation (Table 3). The projects analyzed in this section are based on the construction limitations defined in the PDCs in Section 5.1. It does not allow culvert projects in Atlantic sturgeon critical habitat or on large, main-stem rivers. This analysis focuses on culverts in large, secondary tidal creeks or streams where juvenile sturgeon may occur. Effects from temporary erosion and turbidity controls, cofferdams, and other methods and devices related to culvert projects has been analyzed in Section 6.1.1.

We believe the projects will have no effect on sea turtles due to the species' specific life history strategies, which are not supported in areas where culverts will be installed, replaced, or repaired.

Potential routes of effects to sturgeon are discussed below.

Potential routes of effect to sturgeon

- Physical Effects: Effects include the risk of injury from construction activities including physical effects from construction materials (including turbidity curtains) or operating machinery during construction activities. Installation (construction) and removal of culverts typically involves the use of cofferdams, boats and/or barges, but may also be conducted from the uplands. We do not believe that culvert projects represent a plausible route of injury effects from direct physical contact with mobile protected species. It is not plausible to expect that these mobile species will remain underneath a culvert, regardless of the installation method, or turbidity curtains being installed and suffer an injury. In addition, the NMFS's *Sea Turtle and Smalltooth Sawfish Construction Conditions* (PDC) further reduces interaction risk because these conditions require construction to stop temporarily if an ESA-listed species is sighted within 50 ft of operating machinery. Limiting construction to daylight hours increases the likelihood that construction workers would spot any ESA-listed species near the project areas. Additionally, turbidity controls and cofferdams will serve as a barrier to species present during construction and will be removed promptly upon project completion. Furthermore, PDCs also require that all equipment and materials be lowered into the water at a rate of 60 feet per minute. Therefore, we believe that there will be no physical effects to sturgeon from culvert projects.

- Foraging and Sheltering: Mobile species may be affected by their being temporarily unable to use an area for forage or refuge habitat due to potential avoidance of construction activities caused by culvert maintenance, placement or removal, or the installation of silt curtains or cofferdams. Additionally, mobile species may be affected by their being permanently unable to use an area for forage or refuge habitat due to the conversion of bottom and water column habitat to concrete/culvert. These effects will be insignificant due to the small size of each project (less than 0.5 acre of total bottom impacts; 500 linear feet of shoreline impacts) and the limited time it will take to complete each action. Additionally, turbidity barriers and cofferdams will temporarily exclude mobile species from the construction site. Silt curtains and cofferdams will be removed promptly upon project completion, making the habitat available to species after construction is complete. Since sturgeon are opportunistic feeders and forage over large areas. We would expect them to be able to locate prey beyond the immediate area of pile installation and removal, and return when construction is complete. Therefore, adverse effects to foraging and shelter are extremely unlikely. Thus, the risk of effects from these activities are insignificant.

- Migration: The maintenance, installation and removal of culverts may temporarily impact the movement of sturgeon from one area to another during high (storm) flows. However, this will be short-term and temporary in nature. Additionally, PDCs prevent any impact to the migration of mobile protected species. Additionally, the PDCs preclude culvert projects of any type at mouths/inlets of rivers/estuaries where sturgeon are known to migrate for spawning purposes. Adverse effects to migration associated with these activities are extremely unlikely to occur, therefore, potential risk of affecting migration from these activities is discountable.

- Behavior: The presence of materials, machinery, and personnel during these activities may result in behavioral responses (e.g., startle, avoid, and abandon) that could affect migrating, feeding, resting, or reproducing, for example. However, because of the PDCs for the activities, generally small nature of the activities, mobility of sturgeon, and assumption that similar habitat will be available nearby, we believe behavioral effects will be insignificant.

- Noise: The potential noise effects from construction activities are discussed separately in Section 5.2

Project Type #5 - Installation, Maintenance, and Removal of Shoreline Stabilization

Shoreline stabilization activities analyzed in this evaluation include seawalls and riprap based on the construction limitations defined in the PDCs (Section 5.1). This does not analyze the installation of jetties and groins or beach renourishment material. The installation of living shorelines, instead of seawalls or riprap, is analyzed separately following the analysis of more traditional forms of shoreline stabilization. FHWA anticipates that 250 shoreline stabilization activities will be undertaken in the next 5 years using this Programmatic Consultation as the Section 7 consultation (Table 3). We believe the projects will have no effect on hawksbill and leatherback sea turtles due to the species' very specific life history strategies, which are not supported at shoreline stabilization project sites. Leatherback sea turtles have a pelagic, deepwater life history, where they forage primarily on jellyfish. Hawksbill sea turtles typically inhabit inshore reef and hard bottom areas where they forage primarily on encrusting sponges. We believe that shoreline stabilization activities may affect sea turtles, sturgeon, and Atlantic sturgeon critical habitat. Potential routes of effects to each of the listed species and critical habitat are discussed below.

Potential routes of effect to sea turtles and sturgeon

- Physical Effects: We do not believe that shoreline stabilization activities (i.e., seawalls, riprap, pile and/or sheet pile used for seawall installation, or potential upland minor dredging/shaping [trenching] the shoreline to fit the seawall) present a plausible route of injury from direct physical contact with mobile protected species (i.e., sea turtles and sturgeon). It is not plausible to expect that these mobile species will remain underneath materials being installed and suffer a contact injury. In addition, the NMFS's *Sea Turtle and Smalltooth Sawfish Construction Conditions* (PDC) require construction to stop temporarily if an ESA- listed species is sighted within 50 ft of mechanical construction equipment. Furthermore, turbidity controls will only enclose a small portion of the project sites at any time (analyzed under Activity #1), will be removed after construction, and serve as a barrier to species presence during construction. Therefore, we believe that the installation of shoreline stabilization materials will have no direct physical effect on listed species.

- Foraging and Sheltering: Mobile species may be affected by their being temporarily unable to use an area for forage or refuge habitat due to potential avoidance of construction activities caused by shoreline stabilization projects. These effects are described below based on the construction limitations defined by the PDCs:
    - Sea turtles: Sea turtles may be affected by being temporarily unable to use the site for forage habitat due to potential avoidance of construction activities and physical exclusion from areas contained by turbidity curtains. Additionally, potential foraging habitat may be permanently covered or removed by seawalls or riprap. These effects will be insignificant, given each activity's small footprint and short construction time. The potential loss of nearshore foraging habitat is insignificant because of the PDC requiring construction to avoid and minimize submerged aquatic vegetation potentially used for sea turtle foraging.

Potential seagrass impacts would be limited to along the shoreline for shoreline stabilization projects and are limited to 100 ft^2 in area. Sea turtles can travel long distances to forage and would be unaffected by minor losses of seagrasses from shoreline stabilization projects. The PDCs also preclude construction on beaches used by nesting sea turtles.

- Sturgeon: Sturgeon are opportunistic feeders and forage over large areas. The project activities will impact only a very small portion of foraging and/or sheltering habitat. Sturgeon will have access to alternate, similar, undisturbed habitat nearby (e.g., up and downstream of the site). These are areas where sturgeon could move to and their potential foraging and sheltering would be unaffected by project activities. Additionally, sturgeon typically forage in waters between 2-4 meters in depth. Therefore, we would expect them to be able to locate prey beyond the immediate area of the activities and adverse effects to foraging and shelter are extremely unlikely. Thus, the risk of effects from these activities are discountable.

- Migration: Shoreline stabilization activities covered by this evaluation are limited to along the shoreline and do not obstruct the movement of species in the area. Additionally, the PDCs preclude construction when sturgeon are migrating into and out of the river for spawning and on or contiguous to ocean beaches used by female sea turtle or hatchlings migrating on or off nesting beaches. Therefore, migration of these species will not be affected (i.e., no effect) by the construction of these structures.
- Behavior: The presence of materials, machinery, and personnel during these activities may result in behavioral responses (e.g., startle, avoid, and abandon) that could affect migrating, feeding, resting, or reproducing, for example. However, because of the PDCs for the activities, generally small nature of the activities, mobility of sea turtles and sturgeon, and assumption that similar habitat will be available nearby, we believe behavioral effects will be insignificant.
- Noise: The potential noise effects from construction activities are discussed separately in Section 5.2

Potential routes of effects to Atlantic sturgeon critical habitat

FHWA anticipates that 150 shoreline stabilization projects may be authorized in the next 5 years in Atlantic sturgeon critical habitat using this document as the Section 7 consultation (Table 5). The PDCs require that shoreline stabilization projects not exceed 500 linear ft and not be placed more than 12-inches (for seawalls/bulkheads/retaining walls) or 24-inches (for riprap/revetments) waterward of the MHWL or OHWM. If each project is constructed to the maximum allowed length in the PDCs (i.e., 500 lin ft) and placed at an average maximum of 1.5-ft waterward of the MHWL (maximum distance for seawalls is 12-inches and riprap is 24-inches) this could result in a potential loss of up to 750 ft^2 (0.01 acre) for each project and a total loss of 112,500 ft^2 (2.58 acres)(150 shoreline stabilization projects x 500 linear feet x 1.5 feet wide = 112,500 ft^2 of habitat). This is likely an over estimate since most shoreline stabilization projects are typically smaller (e.g., 100-200 linear feet). We believe these activities are not likely to adversely affect Atlantic sturgeon critical habitat.

The PBFs necessary for the conservation of Atlantic sturgeon are:

5. Suitable hard bottom substrate (e.g., rock, cobble, gravel, limestone, boulder, etc.) in low salinity waters (i.e., 0.0-0.5 parts per thousand range [ppt]) for settlement of fertilized eggs and refuge, growth, and development of early life stages. The PDCs preclude impacts or installation of shoreline stabilization in critical habitat where this PBF is present.
6. Transitional salinity zones inclusive of waters with a gradual downstream gradient of 0.5-30 ppt and soft substrate (e.g., sand, mud) downstream of spawning sites for juvenile foraging and physiological development. The placement of materials along the shoreline is expected to cover the sediments in the footprint of the activity, but not alter the physical or chemical properties of the substrate itself or the water. Additionally, Atlantic sturgeon generally occupy deeper waters than those excepted to be impacts by shoreline stabilization, so any soft substrate that would be covered by shoreline stabilization projects is likely in shallower water than is typically used by Atlantic sturgeon. Furthermore, effects to foraging (e.g., prey) will be insignificant due to the small size of the impacts and because prey will only be displaced from the small footprint to areas immediately adjacent to the shoreline stabilization. Therefore the impacts to transitional salinity zones inclusive of waters with a gradual downstream gradient of 0.5-30 ppt and soft substrate (e.g., sand, mud) downstream of spawning sites for juvenile foraging and physiological development from shoreline stabilization are expected to be insignificant.
7. Water of appropriate depth and absent physical barriers to passage (e.g., locks, dams, reservoirs, gear, etc.) between the river mouth and spawning sites necessary to support: (i) unimpeded movement of adults to and from spawning sites; (ii) seasonal and physiologically dependent movement of juvenile Atlantic sturgeon to appropriate salinity zones within the river estuary; and (iii) staging, resting, or holding of subadults or spawning condition adults - water depths in main river channels must also be deep enough (at least 1.2 m) to ensure continuous flow in the main channel at all times when any sturgeon life stage would be in the river. The PDCs preclude installing shoreline stabilization in a way that would represent a physical barrier to passage.
8. Water quality conditions, especially in the bottom meter of the water column, with temperature and oxygen values that support: (i) spawning; (ii) annual and inter-annual adult, subadult, larval, and juvenile survival; and (iii) larval, juvenile, and subadult growth, development, and recruitment. Appropriate temperature and oxygen values will vary interdependently, and depending on salinity in a particular habitat. For example, 6 mg/L dissolved oxygen (D.O.) for juvenile rearing habitat is considered optimal, whereas D.O. less than 5.0 mg/L for longer than 30 days is considered suboptimal when water temperature is greater than 25°C. In temperatures greater than 26°C, D.O. greater than 4.3 mg/L is needed to protect survival and growth. Temperatures of 13° C to 26° C for spawning habitat are considered optimal. Water quality may be temporarily impacted by the placement of materials (e.g., riprap, piles and sheet piles), however this impact will be insignificant as turbidity curtains will be used to contain disturbed sediments, elevated turbidity will be very brief in duration, and Atlantic sturgeon will typically be located in deeper water.

Potential routes of effect to sea turtles and sturgeon from living shorelines

FHWA anticipates that approximately 50 living shoreline projects may be authorized in the next 5 years using this document as the Section 7 consultation. Considering the PDCs that limit construction, we believe living shorelines will have insignificant or discountable effects on sturgeon and sea turtles.

Physical Effects:

- Effects include the risk of injury from the installation of living shoreline and nearshore oyster reefs including physical effects from the placement of construction materials and turbidity curtains. We do not see a plausible route of effect from placement of these nearshore, shallow-water materials, which are often placed by hand or using small mechanical equipment. Mobile species would be able to avoid these activities. Placement would occur in shallow waters where species present could be easily detected and avoided. Therefore, we believe that there will be no physical effects to sea turtles or sturgeon from living shoreline and oyster reef projects.

- Breakwater material is typically barged to the site and lowered with a crane or dumped overboard at the desired location. Mobile species are able to avoid interaction with this type of equipment and placement. Therefore, physical impacts are extremely unlikely to occur, the risk of injury from breakwater material placement with machinery is considered discountable.

Foraging and Sheltering:

- Sea turtles: The PDCs minimize effects to existing seagrasses that may be used by sea turtles for foraging and sheltering. Therefore, we do not expect placement of these materials to affect sea turtles. Ultimately, the restoration of seagrass beds and installation of artificial reefs may have a beneficial effect to sea turtles by increasing foraging areas.

- Sturgeon: The presence of living shorelines, seagrass restoration, and oyster reefs will have an insignificant effect to sturgeon foraging or sheltering because the PDCs require they be placed in waters shallower than 6 ft (2 m) MHWL in locations are shallower than waters typically accessed by sturgeon for foraging and sheltering. Living shorelines, seagrass restoration, and oyster reefs are limited to waters less than 6 ft (2 m) deep. Sturgeon are suction feeders, and due to their feeding morphology, they are usually found at deeper depths (2-4 m), where the lower wave energy near the substrate (relative to the shallower swash zone) interferes less with feeding. The use of a living shorelines and nearshore oyster reefs may provide an indirect benefit to sturgeon by enhancing the diversity of prey available to them. This may happen by the creation of a patchwork oyster reefs that, over time, provide more dissimilar and structurally complex habitat for prey species (Boudreaux et al. 2006). As these prey species (e.g., macrofaunal species such as amphipods, polychaetes, gastropods, and bivalves) increase in abundance in the shallow nearshore project area, there will be a spill-over effect to neighboring areas that are deeper than 6 ft, where increased prey abundance will benefit foraging sturgeon in the long-term. The use of oyster reefs as breakwaters while mitigating against coastal erosion also encourages nektonic production that could lead to greater prey availability in the immediate surroundings for sturgeon (Seitz et al. 2006).

Migration: The presence of reef material can impede movement of species in the area. The PDCs require that oyster reefs and living shorelines provide a break in the structures to allow for movement of species between the structures and to provide ready access to shorelines. Artificial reefs in deeper water are not authorized. Additionally, the PDCs preclude construction activities in areas where Atlantic sturgeon are migrating into and out of the river for spawning; and near sea turtle nesting beaches used by female sea turtle or hatchlings migrating on or off nesting beaches (i.e., loggerhead critical habitat's nearshore reproductive habitat). Seagrass restoration results in an increase in natural seagrasses in shallow, water that would have no effect on migration of any species. Therefore, we believe there will be no effect on migration of these species from these aquatic enhancement activities.

Noise: The potential noise effects from construction activities are discussed separately in Section 5.2.

Potential routes of effect to Atlantic sturgeon critical habitat from living shorelines

FHWA anticipates that approximately 12 living shoreline projects may be authorized in the next 5 years in Atlantic sturgeon critical habitat using this document as the Section 7 consultation. Discussion of effects are below.

1. Suitable hard bottom substrate (e.g., rock, cobble, gravel, limestone, boulder, etc.) in low salinity waters (i.e., 0.0-0.5 parts per thousand range [ppt]) for settlement of fertilized eggs and refuge, growth, and development of early life stages. The PDCs preclude impacts or installation of living shorelines in critical habitat where this PBF is present.
2. Transitional salinity zones inclusive of waters with a gradual downstream gradient of 0.5-30 ppt and soft substrate (e.g., sand, mud) downstream of spawning sites for juvenile foraging and physiological development. According to the PDCs, the living shoreline activities are limited to water depths less than 6 ft (2 m) MHWL/OHWM. We believe these activities that occur in nearshore waters are not likely to significantly affect food abundance. The effects associated with living shorelines on prey abundance would be limited to redistribution of prey in the immediate areas covered by materials placed in the sediment. Such redistribution is not expected to have an adverse affect on overall prey abundance, and overall abundance may actually increase as a result of the living shoreline activities. Additionally, sediment quality may be affected by the conversion of the substrate to living shorelines, but any such affect are expected to be minor in scope, and therefore insignificant. The effects to sediment will be limited to the immediate footprint where materials are placed, leaving all surrounding sediments unaffected. Further, sturgeon generally forage in waters deeper than 2 m and the placement of these structures in waters less than 2 m are not expected to affect sturgeon use of this shallow area.
3. Water of appropriate depth and absent physical barriers to passage (e.g., locks, dams, reservoirs, gear, etc.) between the river mouth and spawning sites necessary to support: (i) unimpeded movement of adults to and from spawning sites; (ii) seasonal and physiologically dependent movement of juvenile Atlantic sturgeon to appropriate salinity zones within the river estuary; and (iii) staging, resting, or holding of subadults or spawning condition adults - water depths in main river channels must also be deep enough (at least 1.2 m) to ensure continuous flow in the main channel at all times when any sturgeon life stage would be in the river. The PDCs preclude installing shoreline stabilization in a way that would represent a

physical barrier to passage.

4. Water quality conditions, especially in the bottom meter of the water column, with temperature and oxygen values that support: (i) spawning; (ii) annual and inter-annual adult, subadult, larval, and juvenile survival; and (iii) larval, juvenile, and subadult growth, development, and recruitment. Appropriate temperature and oxygen values will vary interdependently, and depending on salinity in a particular habitat. For example, 6 mg/L dissolved oxygen (D.O.) for juvenile rearing habitat is considered optimal, whereas D.O. less than 5.0 mg/L for longer than 30 days is considered suboptimal when water temperature is greater than 25°C. In temperatures greater than 26°C, D.O. greater than 4.3 mg/L is needed to protect survival and growth. Temperatures of 13° C to 26° C for spawning habitat are considered optimal. Water quality may be temporarily impacted by the placement of materials, however this impact will be insignificant as elevated turbidity will be very brief in duration, and Atlantic sturgeon will typically be located in deeper water.

Project Type #6 - Pavement Preservation

There are estimated to be 400 patching, repairing, and replacing roadway surface and pavement projects in the next 5 years using this document as the Section 7 consultation. The PDCs preclude impacts to Atlantic sturgeon critical habitat or any aquatic areas where sea turtles and sturgeon may occur. However, the presence of machinery, personnel, and construction noise may affect sea turtles and sturgeon.

Potential routes of effect to sea turtles and sturgeon

- Behavior: The presence of materials, machinery, and personnel during these activities may result in behavioral responses (e.g., startle, avoid, and abandon) that could affect migrating, feeding, resting, or reproducing, for example. However, because of the PDCs for these activities, generally small nature of the activities, mobility of sea turtles and sturgeon, and assumption that similar habitat will be available nearby, we believe behavioral effects will be insignificant.

5.2 Noise

We believe that the noise generated by projects and activities analyzed in this consultation, including the noise generated by the installation of piles and sheet piles, may affect, but is not likely to adversely affect ESA-listed sea turtles and sturgeon. Effects determinations related to in-water construction noise is based on the analysis in NMFS's Programmatic Biological Opinion on SAJ-82 for Monroe County, Florida (NMFS 2014) and U.S. Army Corps of Engineers Jacksonville District's Programmatic Biological Opinion (JAXBO). This consultation considers the effect of noise on all species under NMFS's jurisdiction that are found within the action area of this programmatic consultation, including sturgeon and sea turtles, along with an explanation of the calculations and thresholds used to make these effects determinations (Appendix A).

The FHWA/State DOTs may choose to use different pile types and sizes, but must ensure all pile installation activities not exceed the established thresholds for physical and behavioral impacts, to be included in this consultation. The FHWA/State DOTs may accomplish this using relevant best management practices and other methods to avoid and minimize hydroacoustic impacts. A series of pile types, sizes, and hammer types have been analyzed below and in Appendix A, for use as reference/models. Projects that adhere to these previously analyzed scenarios will not need further review to be included in this consultation. However, projects that do not conform to these previously analyzed scenarios must conduct project-specific hydroacoustic analyses and submit these analyses to NMFS for review. These analyses should clearly identify the numbers/variables used, the area of influence (ensonified zone), and other relevant information. This hydroacoustic information should be clearly marked in a separate section of submittal materials for ease of review. If NMFS does not respond within 30 days, FHWA/State DOTs may proceed with their project.

Installing piles and sheet piles generates sound waves that can result in physical injuries to sea turtles and sturgeon or change their behavior, as explained in more detail below. In order to determine the hydroacoustic effects on the species from the installation of piles and sheet piles (generally referred to as noise effects), we need to calculate the area in which the noise levels will be elevated (also known as the ensonified zone) as well as the portion of the ensonified zone in which the species may experience potentially adverse behavioral effects (the behavioral zone) and potentially adverse physical injuries (physical injury zone). These calculations require knowing the material that the pile or sheet piles are made of (e.g., wood, concrete, metal), the size of the pile or sheet pile (i.e., diameter, width, length), the equipment that will be used to install it (e.g., sledge hammer, vibratory hammer, impact hammer), and the number of strikes or vibratory time required to install the pile or sheet pile. The PDCs in this section limit the types and sizes of materials that can be used and the allowable installation methods.

Another consideration in evaluating the effects noise may have on species is whether the pile driving, and thus the noise generated, will occur in open water or in confined spaces. This differentiation is important. If a project occurs in a confined space, the animal may not be able to avoid the physical injury and/or behavioral zone or may become trapped in an area due to those zones blocking the only escape route. For our noise analysis, we define a *confined space* as any area that has a solid object (e.g., shorelines or seawalls) that creates a constricted passage area such that species attempting to move through the area would be forced to pass through the cumulative injurious zone, which is the zone in which species could be exposed to physically injurious noise levels if they remained in the area over a period of time. To allow species to move through the project areas without being exposed to noise at levels that could be injurious over time, the PDCs limit certain pile types and installation methods in these confined spaces to ensure that the cumulative injurious zone is limited to a maximum of half the width of the confined area.

Here, we adopt NMFS' definition for a confined space in Florida: we consider the confined space to be any area that has a solid object (e.g., shorelines or seawalls) within 150 ft of the pile or sheet pile installation site. These confined space distances were calculated by doubling the cumulative injurious zone for large fish found in Florida (calculations provided in Tables 11 and 12). Again, this ensures that a fish or sea turtle would have at least half the width of the escape route free from cumulative injurious noise so that they could move through the area as needed without being exposed to potentially injurious noise levels over time. Docks or other pile-supported structures do not stop or reflect noise and do not create a confined space. Conversely, in an open-water environment, the animal would be able to move freely away from the noise without being forced to stay in areas where the noise levels over time could cause injury.

Noise - Project Design Criteria (PDCs)

Since the effects of in-water noise from pile and sheet pile installation are dependent on the type and size of material installed and the manner and location in which it is installed, the PDCs for pile and sheet pile installation are based on those factors, and are broken into different categories identified as A-E below. The tables below identify the PDC category for the type of activity, depending on whether it occurs in an open water environment or in a confined space.

PDCs for In-Water Noise from Pile and Sheet Pile Installation

Open Water

The letters A-E in the tables below specify the PDC category. Activities labeled A-D must follow the corresponding PDCs for labeled Category A-D below. Activities labeled E are excluded from this consultation, as stated in Category E below.

	Pilot hole (auger or drop punch)	**Jetting**	**Vibratory**	**Impact hammer**
Wood piles 14-inch (in) diameter or less	A	A	A	B
Concrete pile 24-in diameter/width or less	A	A	A	B
Metal pipe pile 24-in diameter or less	A	A	A	E
Vinyl sheet pile- any size	A	A	A	B
Metal sheet pile- any size	A	A	A	E

Confined Space

We consider the confined space to be any area that has a solid object (e.g., shorelines or seawalls) within 150 ft of the pile installation site.

	Pilot hole (auger or drop punch)	**Jetting**	**Vibratory**	**Impact hammer**
Wood pile 14-in diameter or less	A	A	A	B
Concrete pile 24-in diameter/width or less (5 piles or less installed/day)	A	A	A	C
Concrete pile 24-in	A	A	A	D

diameter/width or less (6-10 piles installed/day)				
Metal pipe pile 24-in diameter or less	A	A	A	E
Vinyl sheet pile	A	A	A	B
Metal sheet pile- any size	A	A	A	E

A. The Projects identified as A above must comply with PDCs identified for all projects in this consultation. Specific PDCs related to noise include:

1. All work must occur during daylight hours only (PDC AP11).

2. All construction personnel are responsible for observing water-related activities to detect the presence of these species and avoid them (PDC AP2 & AP 15).

B. The projects identified as B above must follow all of the conditions under A, above, AND also must limit the maximum number of piles installed per day to no more than 10 piles per day.

C. **The projects identified as C above must follow all of the conditions under A, above, AND also must limit the maximum number of piles installed per day to no more than 5 piles per day.**

D. **The projects identified as D above must follow all of the conditions under A and B, above, AND also must abide by one of the noise abatement measures below, as chosen by the applicant**:

1. Bubble curtain: The bubble curtain design must adhere to the guidelines for unconfined and confined bubble curtains described in Appendix A.

2. Temporary noise attenuation pile (TNAP) also known as a pile isolation casing: The TNAP design must be constructed of a double-walled tubular casing (a casing within a larger casing), with at least a 5-in-wide area between the casings that is dewatered to create a hollow space or 5-in wide area between the casings completely filled with closed-cell foam or other noise dampening material between the walls. The TNAP must be long enough to be seated firmly on the sea bottom, fit over the pile being driven, and extend at least 3 ft above the surface of the water.

3. The use of any other alternative noise control method must receive prior approval by NMFS.

E. **The projects identified as E are not covered under this consultation.**

Noise created by construction activities can physically injure or change animal behavior in the affected areas. Thus, we will evaluate 2 general categories of effects to listed species as a result of noise:

physically injurious effects and behavioral effects. We discuss behavioral responses to noise first below because certain behavioral responses (i.e., avoidance) could affect whether the animal experiences physical injury because of noise.

Behavioral responses from in-water noise associated with pile installation

Animals may have varied behavioral responses to noise, depending on the level of noise, season, location, habitat, and life stage exposed to the noise. Different species also have different life histories and sound-detection capabilities that could influence their response, in addition to a different set of potential behavioral responses that may be triggered by a given stimulus (e.g., some may try to hide in the area while others may swim away). Although the behavioral response of noise avoidance is advantageous at preventing potential injury from the exposure to noise, avoidance behavior may disrupt or interfere with feeding, mating, migration, sheltering, or may increase the risk to individuals (e.g., via predation). Not all individuals are likely to have an avoidance response. Despite exposure to noise that may cause others to move away and abandon the area altogether, some individuals may be biologically motivated to remain in a habitat for feeding, sheltering, mating, or other biologically important reasons or because they are using the area as an established pathway between habitats.

To determine the potential effects from exposure to noise, it is important to understand the ways in which ESA-listed species in the action area may respond to the noise. Responses to pile or sheet pile driving from specific species in the action area are not well documented. However, we expect that species will avoid areas with construction activities that include the combination of the physical movement and presence of construction equipment, presence of turbidity curtains, general construction related noise and specifically louder noises generated from in-water pile and sheet pile installation. Specifically,

- Sea turtles: Studies have reported sea turtles responding to air gun noise and another loud impulsive noise source in the ocean by demonstrating alarm or avoidance behaviors (DeRuiter and Doukara 2010; McCauley et al. 2000a; McCauley et al. 2000b). Therefore, we would expect sea turtles would avoid in-water construction noise.
- Sturgeon: Krebs et al. (2012) reported that most tagged Atlantic sturgeon are likely to avoid areas during periods of high construction noise. As such, we would expect shortnose and Gulf sturgeon would also avoid in-water construction noise.

Potential effects from in-water noise associated with pile and sheet pile installation

As stated earlier, noise generated during the installation of pile and sheet piles can cause physical injury or result in behavioral effects. Physical injurious effects from noise can occur in 2 ways. First, effects can result if a single noise event occurs that exceeds the peak pressure threshold for direct physical injury to an animal. This would result in an immediate adverse effect on the animal. Second, effects can result from prolonged exposure to noise levels that exceed the daily cumulative sound exposure level (cSEL) threshold for the animal, which results in a physical injury to the animals if exposed to the noise levels for sufficient periods.

Physical Injury

Physical injury can range from minor physiological effects to physiological effects that could potentially result in mortality. Potential physiological effects to both fish and turtles are highly diverse, and range from very small ruptures of capillaries such as in fish fins (which are relatively minor physical responses) to severe hemorrhaging of major organ systems such as the liver, kidney, or brain (Hastings and Popper 2005) which may ultimately result in mortality. Other potential effects include rupture of the swim bladder, which is the air-filled organ in the abdominal cavity of most bony fish species that is involved in maintenance of buoyancy. Sturgeon have swim bladders that are susceptible to rupture from noise.

ESA-listed species within the physical injury zone can suffer physical injury as described above and can also suffer from a reduction in their ability to hear (another form of physical injury), which can decrease their ability to detect and avoid predators, decrease their ability for passive listening to detect prey species, interfere with the detection of conspecifics (in vocal species), and inhibit their overall ability to detect cues in the acoustic soundscape. Permanent hearing loss or permanent threshold shift is the irreversible loss of hearing abilities. Both permanent threshold shift or loss and other physical injuries could have negative consequences for an animal. Temporary hearing loss, or temporary threshold shift, is a temporary hearing impairment from exposure to loud noises that is recoverable with time (hours to days). Temporary hearing loss is not considered a permanent physical injury, but could have some temporary effects to the auditory sense of an animal.

As explained above and in Appendix A, physical injurious noise can occur from exposure to the noise generated during a single-strike (peak pressure) or the exposure to noise generated over the course of a day (as measured by cSEL).

- Physical injury (single-strike): For the types of pile and sheet pile installation analyzed in this here, we would only expect a peak pressure injury from impact driving of metal piles or metal sheet piles; therefore, these are the only pile installation activities that are excluded, as described in the PDCs for *In-water Noise from Pile and Sheet Pile Installation* (provided above and listed as not covered, Category E) (see Appendix A for the calculations supporting this conclusion). None of the activities covered under this programmatic informal consultation (as restricted by the PDCs) will result in single-strike injury to any of the species in the action area.

- Physical injury (cumulative exposure): To determine if ESA-listed sea turtles or fish in the action area would be affected by noise exposure over the course of a full day of construction (cSEL), we rely on the information provided above regarding how the species in our action area respond to noise. As discusses above, we believe that all of these species will avoid the cumulative exposure area by moving out of the way of the noise. Because we expect mobile species to move away from the sound exposure (as discussed in detail below), we believe it is extremely unlikely that the species would be exposed to the noise for the amount of time required to cause injury and that the effect from noise would be discountable.

We do not expect ESA-listed sea turtles and fish to suffer physical injury from the noise generated during pile and sheet pile installation covered under this programmatic consultation. We also do not believe that it will cause temporary or permanent hearing threshold shifts to these species that would cause physiological or behavioral changes in important life functions such as foraging.

Consideration of the potential for physically injurious or behavioral noise effects based on project location

For areas within the action area that we consider to be biologically significant (e.g., known areas used for reproduction or migration for sturgeon), an additional PDC (AP9.2) is provided to ensure that noise from in-water construction does not interfere with important biological functions and will have no effect on their ability to use these biologically significant. Therefore, we believe the noise generated during pile and sheet pile installation will have no effect on mobile species in biologically significant areas and that the PDCs above will protect these species during biologically important activities such as migrating and spawning.

Species movement and migration is another factor when considering the behavioral effects of noise exposure in a specific project location. Certain project construction locations could impede the species' ability to move away from or around the sound source, and that is why we also consider if the project would occur in an open-water or confined location. In a confined location (described above), the species could be trapped and exposed to the noise throughout the course of the day's construction (construction is limited to daylight hours), resulting in potential physically injurious cumulative sound exposure effects or could interfere with foraging or other biologically important activities. By limiting the work in these confined areas and limiting work to only daytime hours, species will be able to maneuver around the cumulative sound exposure zone during construction and be able to avoid any behavioral effects from the exposure to the noise by moving through or away from the area during quiet periods at night. Thus, such effects would be extremely unlikely to occur and discountable. In addition, since they will be able to leave or maneuver around ensonified areas, they will be able to safely move to nearby similar habitat for foraging and refuge or move onto important biologically significant areas. Therefore, we believe the noise generated during pile and sheet pile installation will have an insignificant effect on mobile species by not limiting their movement or migration.

Summary of physically injurious and behavioral effects

We believe that there will be no direct physical effects from exposure to peak pressure noise from pile or sheet pile driving allowed since the consultation does not apply to activities that could result in peak pressure injury. Additionally, we believe the cumulative injury zones are limited in size and location to allow ESA-listed fish and sea turtles to move around or avoid the zones, thus limiting the species exposure. As described above, these species are not expected to stay within the cumulative noise zones during construction and therefore we believe it is extremely unlikely that they will suffer injury, and the potential effect is discountable (Table 13).

We also believe that noise from pile driving allowed under this consultation is not likely to adversely affect ESA-listed fish and sea turtles from exposure to behavioral noise zones (Table 13). The species are highly mobile and can avoid these zones, making it extremely unlikely that they will experience behavioral impacts, and thus the potential effect is discountable. The noise may change the animal's behavior—causing it to move to avoid physical injury or behavioral responses from noise exposure. Triggering an avoidance behavior is an effect on the species, but we believe this effect is insignificant as well. Pile driving cannot occur in areas identified as biologically important to these species thus, we do not expect exposure to noise to cause the animals to alter any important life functions, and we believe these highly mobile species will be able to relocate to areas of similar habitat outside of the construction zones.

Not Likely to Adversely Affect

Pile installation by jetting, using an auger or drop punch to create a pilot hole, or installing I-beam boatlifts using a vibratory hammer will not result in physical injury (injury from exposure to peak pressure or cumulative sound exposure) or behavioral noise effects, because it will not create noise levels in excess of the respective thresholds for physical injury to, or behavioral responses in, sea turtles and ESA-listed fishes (Table 19). The methods used to determine the sound expected from these installation methods, and the final calculations, are provided in Appendix A.

Calculations for physically injurious and behavioral effects from pile and sheet pile installation

Tables 11-12 below provide a summary of the radii at which ESA-listed sea turtles and fish (Atlantic and shortnose sturgeon) will experience physical peak pressure injury, physical injury from cumulative exposure to noise, or behavioral injury at given noise thresholds from the pile and sheet pile installation analyzed under this consultation. These calculations are explained in more detail in Appendix A. As noted at the outset, of the types of pile and sheet pile installation analyzed, we would only expect single strike (peak pressure) injury from impact driving of metal piles or metal sheet piles; therefore, these activities are excluded from this consultation as described in the PDCs for *In-water Noise from Pile and Sheet Pile Installation* (provided above and listed as not covered, category E).

Table 1. Impact Hammer Sound Source Levels and Impact Radius Distances

	Source Level (dB re 1 µPa[7])	**Radius for Fish less than 2 grams**	**Radius for Fish over 2 grams**	**Radius for Sea Turtles**
14-in wood pile and vinyl sheet Calculated 10 piles installed per day with 45 strikes per pile = 450 strikes per day				
Physical Injury (peak pressure)	195 dB Peak	0 m (1 ft)	0 m (1 ft)	0 m (1 ft)
Physical Injury (Cumulative exposure)	cumulative	1 pile = 4 m (12 ft) 5 piles = 11 m (36 ft) 10 piles = 17 m (56 ft)	1 pile = 2 m (7 ft) 5 piles = 6 m (19 ft) 10 piles = 9 m (30 ft)	1 pile = 2 m (7 ft) 5 piles = 6 m (19 ft) 10 piles = 9 m (30 ft)
Behavior (Root Mean Square [RMS])	185 dB RMS	215 m (705 ft)	215 m (705 ft)	46 m (150 ft)
24-in concrete pile Calculated 10 piles installed per day with 160 strikes per pile = 1,600 strikes per day				
Physical Injury (peak pressure)	200 dB Peak	0 m (1 ft)	0 m (1 ft)	0 m (1 ft)
Physical Injury	cumulative	1 pile = 9 m (28	1 pile = 5 m (15	1 pile = 5 m (15

[7] dB re 1 µPa is a unit of measurement of sound in decibels relative to 1 micro-Pascal-squared second

(Cumulative exposure)		ft) 5 piles = 25 m (83 ft) 10 piles = 40 m (131 ft)	ft) 5 piles = 14 m (50 ft) 10 piles = 22 m (71 ft)	ft) 5 piles = 14 m (50 ft) 10 piles = 22 m (71 ft)
Behavior (RMS)	185 dB	215 m (705 ft)	215 m (705 ft)	46 m (150 ft)
24-in metal sheet pile **Calculated 10 sheet piles installed per day with 660 strikes per pile = 6,600 strikes per day**				
Physical Injury (peak pressure)	220 dB Peak	9 m (30 ft)	9 m (30 ft)	9 m (30 ft)
Physical Injury (Cumulative exposure)	cumulative	1 pile = 410 m (1,345 ft) 10 piles = 858 m (2,815 ft)	1 pile = 223 m (731 ft) 10 piles = 858 m (2,815 ft)	1 pile = 223 m (731 ft) 10 piles = 858 m (2,815 ft)
Behavior (RMS)	204 dB RMS	858 m (2,8215 ft)	858 m (2,8215 ft)	185 m (607 ft)

Table 2. Vibratory Hammer Sound Source Levels and Impact Radius Distances

	Source Level (dB re 1 µPa)	Radius for Fish over 2 grams	Radius for Sea Turtles
13-in wood, concrete, vinyl, or metal piles Calculated 10 piles installed per day for 30 minutes (1,800 seconds) per pile = 18,000 seconds per day			
Physical Injury (peak pressure)	186 dB Peak	0 m (0 ft)	0 m (0 ft)
Physical Injury (Cumulative exposure)	cumulative	0 m (0 ft)	0 m (0 ft)
Behavior (RMS)	170 dB RMS	22 m (72 ft)	5 m (16 ft)
24-in metal sheet pile Calculated 10 sheet piles installed per day for 30 minutes (1,800 seconds) per pile = 3,600 seconds per day			
Physical Injury (peak pressure)	192 dB Peak	0 m (0 ft)	0 m (0 ft)
Physical Injury (Cumulative exposure)	cumulative	0 m (0 ft)	0 m (0 ft)
Behavior (RMS)	178 dB RMS	74 m (243 ft)	16 m (52 ft)
We do not consider the noise effects of small fish for vibratory hammer, because the noise calculations are based on fish less than 0.6 grams and none of the ESA-listed fish in our action area are that small.			

Table 3. Effects Determinations for In-water Construction Noise Analyzed under this Consultation to Sea Turtles and Sturgeon

		Pilot hole (auger or drop punch)	Jetting	Vibratory	Impact hammer
Wood pile 14-in diameter or less		NE	NE	NLAA	NLAA
Concrete pile 24-in diameter/width or less (5 piles or less installed/day)		NE	NE	NLAA	NLAA
Concrete pile 24-in diameter/width or less (6-10 piles installed/day)		NE	NE	NLAA	NLAA
Metal pipe pile 24-in diameter or less		NE	NE	NLAA	NC
Vinyl sheet pile		NE	NE	NLAA	NLAA
Metal sheet pile- any size		NE	NE	NLAA	NC

NE = no effect; NLAA = may affect, not likely to adversely affect

NC = not covered under this Opinion due to the potential effects to listed species

5.3 Increased Vessel Traffic

We anticipate an increase in construction vessels during the implementation of each of these activities. Because sturgeon and sea turtles are mobile and likely to avoid these vessels we believe adverse effects are extremely unlikely, and the risk of a vessel strike from these slow moving barges or other construction equipment will be discountable. Additionally, General and Equipment PDCs require the use of propeller guards and idle/no-wake speed during operation.

Vessel traffic, both recreational and commercial, has been documented in stranding reports to adversely affect protected species such as marine mammals and sea turtles. However, little information exists on interactions with sturgeon (shortnose and Atlantic). This is likely due to the fact that these species are all primarily demersal and rarely would be at risk from moving vessels. There are limited stranding records of sturgeon struck by vessels in the northeast resulting from interactions of large shipping vessels in narrow channels that eliminate the ability of the sturgeon to avoid the vessel due to the deep drafts of the shipping vessels. Because vessels need sufficient water to navigate without striking the bottom, shallow areas are marked with navigational markers for recreational boaters to avoid these areas. Therefore, impacts with demersal species are extremely unlike to occur and effects to sturgeon are discountable. Because this consultation does not analyze the impacts of vessel access facilities, such as docks, boat ramps, or boat lifts, we believe any increase in recreational or commercial vessel traffic from the proposed action would be insignificant, and therefore, would have no detectable impact on sturgeon or sea turtles.

5.4 Summary and Aggregate Effects of Proposed Action to Listed Species and Critical Habitat

Section 5 addressed the individual and aggregate effect of each of the types of projects/activities that can be authorized using this Consultation as the Section 7 consultation and the likelihood of the project to adversely affect listed species or critical habitat. Our effects determinations for species and critical habitat are summarized in Tables 8 and 9.

After analyzing the individual and aggregate effects of all activities considered under this Consultation, and the likelihood that activities will not occur simultaneously in the same area, we have determined that the activities covered will either have no effect or may affect, but are not likely to adversely affect sea turtles, shortnose sturgeon, Atlantic sturgeon, and Atlantic sturgeon critical habitat.

None of the types of projects or activities analyzed are likely to change the nearshore or estuarine waters where sea turtles and sturgeon occur, or the large, main-stem rivers where sturgeon occur in NC, SC, and GA. However, these activities will allow for the continued development of NC, SC, and GA, all while protecting species and critical habitat because project effects are minimized by the PDCs such that any potential adverse effects are discountable or insignificant. This will be confirmed through the project-level and programmatic review process defined in this Consultation.

6. Status of Listed Species and Critical Habitat Likely to be Affected by the Proposed Action

6.1 Sea Turtles

There are five species of sea turtles (green, hawksbill, Kemp's ridley, leatherback, and loggerhead) that travel widely throughout the South Atlantic, Gulf of Mexico, and the Caribbean. These species are highly migratory and therefore could occur within the action areas of transportation projects in NC, SC, and GA. Section 1.1.1 will address the general threats that confront all sea turtle species. The remainder of Section 1.1.2 through Section 1.1.6 will address information on the distribution, life history, population structure, abundance, population trends, and unique threats to each species of sea turtle.

6.1.1 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, those 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 and USFWS 1991; NMFS and USFWS 1992; NMFS and USFWS 1993; NMFS and USFWS 2008; NMFS et al. 2011). 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 federally 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 et al. 1994; Bolten et al. 1994; Crouse 1999). 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 1997b). 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 piles, beach armoring and renourishment, and sand extraction (Bouchard et al.1998; Lutcavage et al. 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; Witherington et al. 2003; Witherington et al. 2007). In addition, coastal development is usually accompanied by artificial lighting which can alter the behavior of nesting adults (Witherington 1992) and is often fatal to emerging hatchlings that are drawn away from the water (Witherington and Bjorndal 1991). In-water erosion control structures such as breakwaters, groins, and jetties can impact nesting females and hatchling 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., DDT, polychlorinated biphenyls [PCBs], and perfluorinated chemicals), and others that may cause adverse health effects to sea turtles (Garrett 2004; Grant and Ross 2002; Hartwell 2004; Iwata et al. 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 and Saulitis 1997). Hydrocarbons also have the potential to impact prey populations, and therefore may affect listed species indirectly by reducing food availability in the action area.

The April 20, 2010, explosion of the Deepwater Horizon oil rig affected sea turtles in the Gulf of Mexico. There is an on-going assessment of the long-term effects of the spill on Gulf of Mexico marine life, including sea turtle populations. 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. Approximately 536 live adult and juvenile sea turtles were recovered from the Gulf and brought into rehabilitation centers; of these, 456 were visibly oiled (these and the following numbers were obtained from http://www.nmfs.noaa.gov/pr/health/oilspill/). To date, 469 of the live recovered sea turtles have been successfully returned to the wild, 25 died during rehabilitation, and 42 are still in care and may be returned to the wild eventually.

During the clean-up period, 613 dead sea turtles were recovered in coastal waters or on beaches in Mississippi, Alabama, Louisiana, and the Florida Panhandle. As of February 2011, 478 of these dead turtles had been examined. Many of the examined sea turtles showed indications that they had died as a result of interactions with trawl gear, most likely used in the shrimp fishery, and not as a result of exposure to or the ingestion of oil.

During the spring and summer of 2010, nearly 300 sea turtle nests were relocated from the northern Gulf to the east coast of Florida with the goal of preventing hatchlings from entering the oiled waters of the northern Gulf. From these relocated nests, 14,676 sea turtles were ultimately released from Florida beaches and included 14,235 loggerheads, 125 Kemp's ridleys, and 316 greens.

A thorough assessment of the long-term effects of the spill on sea turtles has not yet been completed. Nevertheless, 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. The population level effects of the spill and associated response activity are likely to remain unknown for some period into the future.

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 and USFWS 2007a). 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 and USFWS 2007a).

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 and USFWS 2007a). 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 et al. 2006; Daniels et al. 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 et al. 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) could influence the distribution and abundance of lower trophic levels (e.g., phytoplankton, zooplankton, submerged aquatic vegetation, crustaceans, mollusks, forage fish) 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 and 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.

6.1.2 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 and 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 and 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 1998).

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 and 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[8]), (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 and 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 and 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 and 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 and 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 (Carr 1986; Conant et al. 2009; Witherington 2002). Oceanic juveniles grow at rates of 1-2 inches (2.9-5.4 cm) per year (Bjorndal et al. 2003; Snover 2002) over a period as long as 7-12 years (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 (Bolten and 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,

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

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 the 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, 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 et al. 2007)Georgia Department of Natural Resources, unpublished data; South Carolina Department of Natural Resources, 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 et al. 2008; Girard et al. 2009; Hart et al. 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 et al. 2003; NMFS-SEFSC 2009; NMFS 2001; NMFS and USFWS 2008; TEWG 1998; TEWG 2000; TEWG 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 and 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.

<u>Peninsular Florida Recovery Unit</u>

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 and USFWS 2008). The statewide estimated total for 2015 was 89,295 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 1). FWRI performed a detailed analysis of the long-term loggerhead index nesting data (1989-2016; 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 represents 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 (http://myfwc.com/research/wildlife/sea-turtles/nesting/loggerhead-trend/).

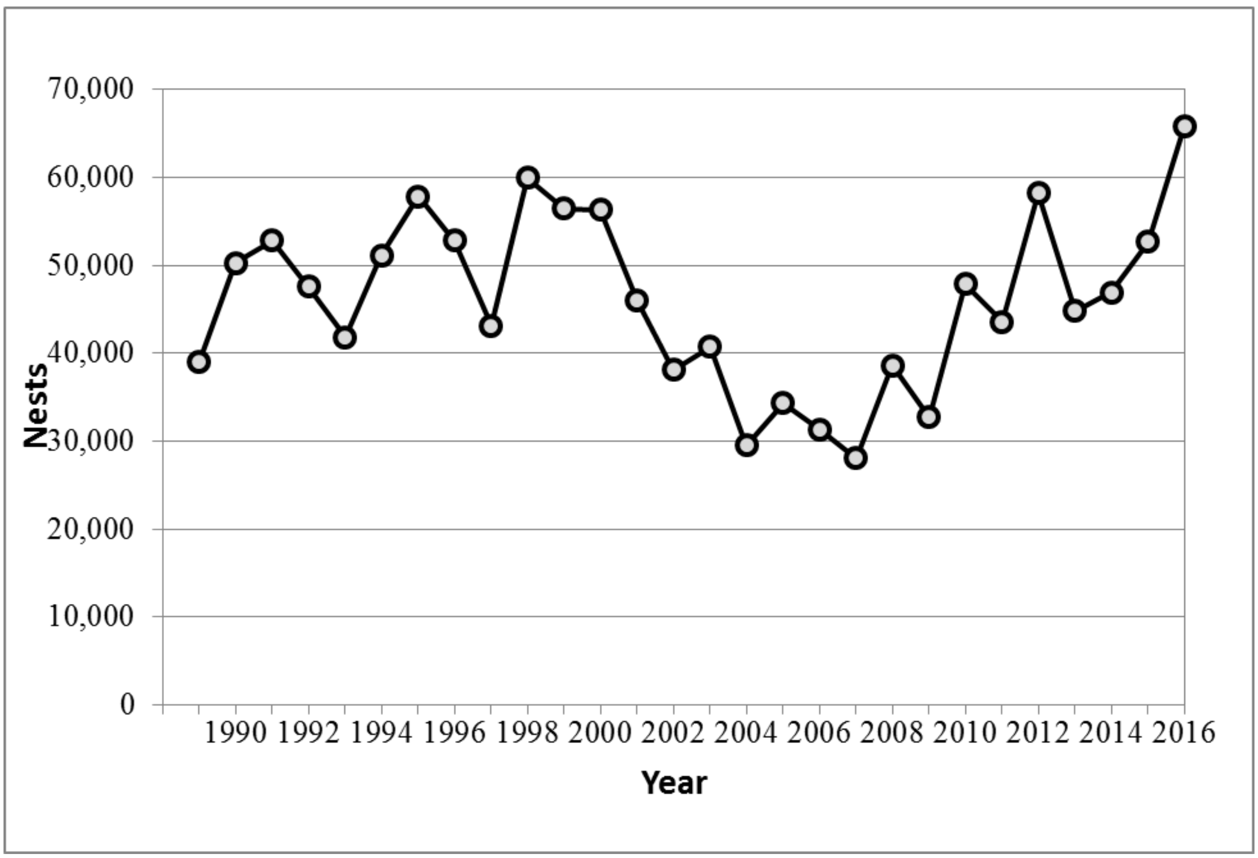

Figure 1. Loggerhead sea turtle nesting at Florida index beaches since 1989

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 (Georgia Department of Natural Resources [GADNR] unpublished data, North Carolina Wildlife Resources Commission [NCWRC] unpublished data, South Carolina Department of Natural Resources [SCDNR] unpublished data), and represent approximately 1,272 nesting females per year, assuming 4.1 nests per female (Murphy and 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 14) 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.

Table 14. Total Number of NRU Loggerhead Nests (GADNR, SCDNR, and NCWRC nesting datasets compiled at Seaturtle.org)

Nests Recorded	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
Georgia	1,649	998	1,760	1,992	2,241	2,289	1,196	2,319	3,265
South Carolina	4,500	2,182	3,141	4,015	4,615	5,193	2,083	5,104	6,443
North Carolina	841	302	856	950	1,074	1,260	542	1,254	1,612
Total	**6,990**	**3,472**	**5,757**	**6,957**	**7,930**	**8,742**	**3,821**	**8,677**	**11,320**

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 2009-2012, and 2012 shows the highest index nesting total since the start of the program (Figure 2).

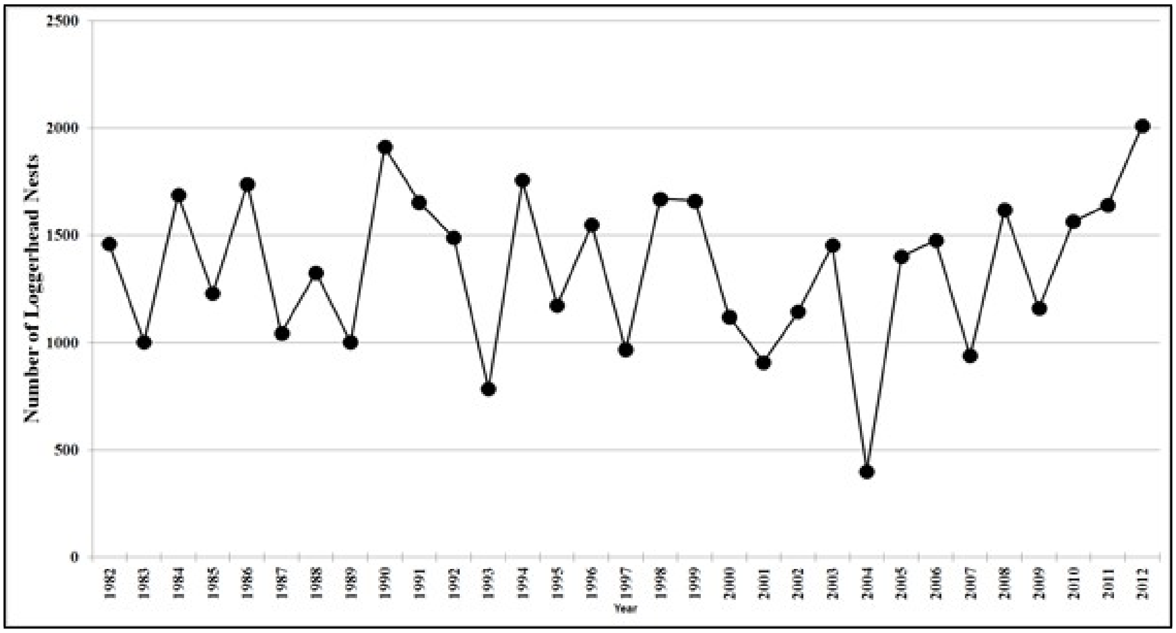

Figure 2. South Carolina index nesting beach counts for loggerhead sea turtles (from the SCDNR website: http://www.dnr.sc.gov/seaturtle/nest.htm)

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 and 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 and 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 and 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 et al. 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 et al. (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 1.1.1. 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 et al. 2008) and metal loads (D'Ilio et al. 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 1.1.1, specific impacts of the Deepwater Horizon 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 2015). 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 Northwest Atlantic Ocean loggerhead 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 loggerhead 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 Trustees 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; Weishampel et al. 2004), short inter-nesting intervals (Hays et al. 2002), and shorter nesting seasons (Pike et al. 2006).

6.1.3 Green Sea Turtle

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). 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 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.

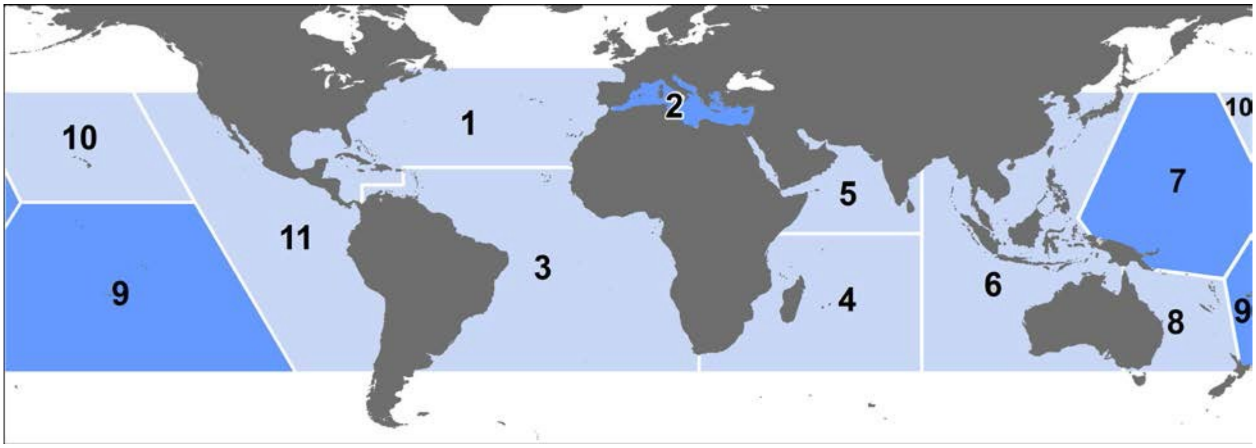

Figure 3. Threatened (light) and endangered (dark) green turtle DPSs: 1. North Atlantic, 2. Mediterranean, 3. South Atlantic, 4. Southwest Indian, 5. North Indian, 6. East Indian-West Pacific, 7. Central West Pacific, 8. Southwest Pacific, 9. Central South Pacific, 10. Central North Pacific, and 11. 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 (Bowen et al. 1992; FitzSimmons et al. 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 and 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 et al. 2007; NMFS and USFWS 1991). The vast majority of green sea turtle nesting within the southeastern United States occurs in Florida (Johnson and Ehrhart 1994; Meylan et al. 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; Hildebrand 1982; Shaver 1994), the Gulf of Mexico off Florida from Yankeetown to Tarpon Springs (Caldwell and Carr 1957), Florida Bay and the Florida Keys (Schroeder and Foley 1995), the Indian River Lagoon system in Florida (Ehrhart 1983), and the Atlantic Ocean off Florida from Brevard through Broward Counties (Guseman and Ehrhart 1992; Wershoven and 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 (Musick and 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 (Carr and 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 et al. 2010; López-Barrera et al. 2012; Marcovaldi et al. 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 et al. 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 et al. 2006; Prosdocimi et al. 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 (Balazs 1982; Frazer and Ehrhart 1985) every 2-4 years while males are known to reproduce every year (Balazs 1983). In the southeastern United States, females generally nest between June and September, and peak nesting occurs in June and July (Witherington and Ehrhart 1989b). During the nesting season, females nest at approximately 2-week intervals, laying an average of 3-4 clutches (Johnson and 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 (Witherington and 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 and Lagueux 2005; Chaloupka and Limpus 2005).

After emerging from the nest, hatchlings swim to offshore areas and go through a post-hatchling pelagic stage where they are believed to live for several years. 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 and USFWS 2007b). 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 et al. 2006; Zug and 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 et al. 2002). Green sea turtles mature slowly, requiring 20-50 years to reach sexual maturity (Chaloupka and 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 et al. 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 and USFWS 2007b).

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).

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 1970's, 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 et al. 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 and USFWS 2007b). Modeling by Chaloupka et al. (2008) using data sets of 25 years or more resulted in an estimate of the Tortuguero, Costa Rica population is 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 where an estimated 200-1,100 females nest each year (Meylan et al. 1994; Weishampel et al. 2003). Occasional nesting has also been documented along the Gulf Coast of Florida (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 (nesting databases maintained on www.seaturtle.org).

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 4). According to data collected from Florida's index nesting beach survey from 1989-2015, green sea turtle nest counts across Florida have increased approximately ten-fold from a low of 267 in the early 1990s to a high of 27,975 in 2015. 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 4). Modeling by Chaloupka et al. (2008) using data sets of 25 years or more has resulted in an estimate of the Florida nesting stock at the Archie Carr National Wildlife Refuge growing at an annual rate of 13.9%.

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 et al. 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; (Witherington et al. 2006).

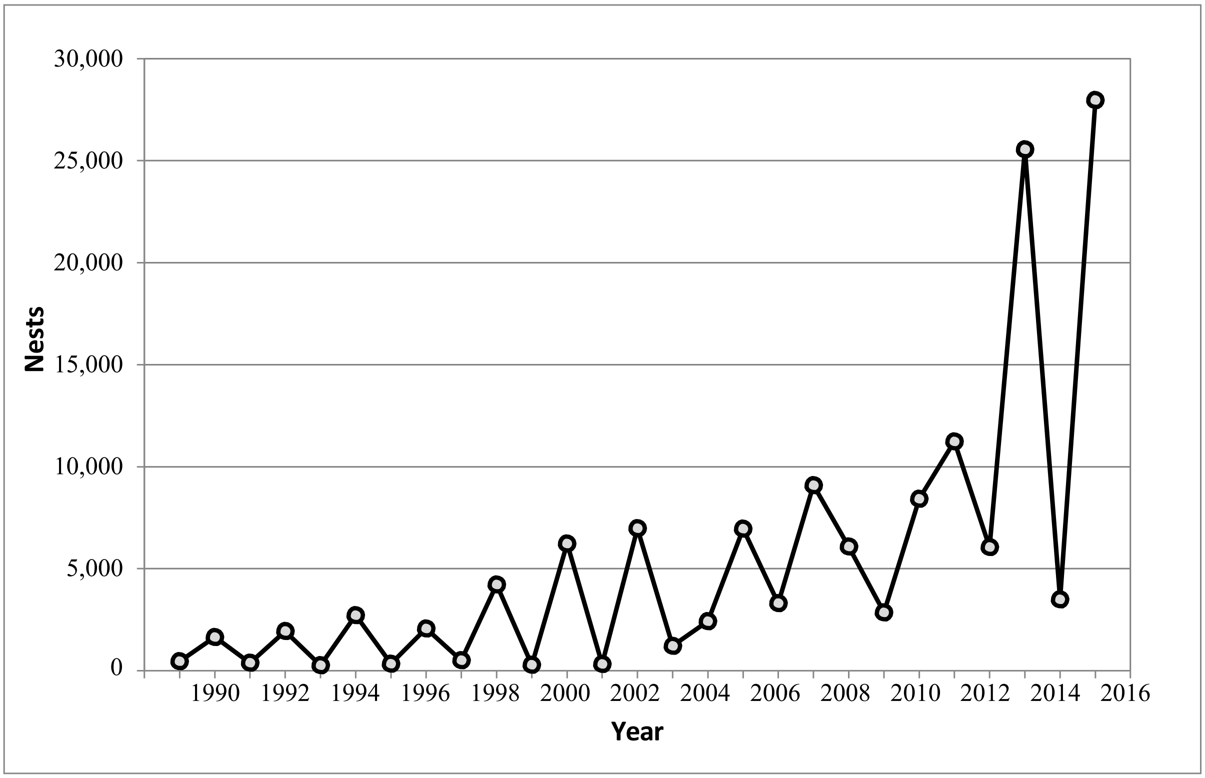

Figure 4. Green sea turtle nesting at Florida index beaches since 1989

<u>South Atlantic DPS</u>

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, Aves Island (Venezuela), and Galibi (Suriname) appear to be increasing. Others such as Trindade (Brazil), Atol das Rocas (Brazil), and Poilão 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 1.1.1.

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 et al. 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 et al. 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 et al. 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 and Lutz 2003). Sea turtles that overwinter in inshore waters are most susceptible to cold-stunning because temperature changes are most rapid in shallow water (Witherington and 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 1.1.1, 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 2015). 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 2015).

6.1.4 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 and Barichivich 2006; Schmid and Woodhead 2000). Age to sexual maturity ranges greatly from 5-16 years, though NMFS et al. (2011) 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 (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 5), 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 reached a record high of 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. In 2015, nesting in Mexico improved to 14,006 recorded nests (J. Pena, Gladys Porter Zoo, pers. comm. to M. Barnette, NMFS PRD, October 19, 2015). At this time, it is unclear if future nesting will steadily and continuously increase, similar to what occurred from 1990-2009, or if nesting will continue to exhibit sporadic declines and increases as recorded in the past 5 years.

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 209 nests in 2012 (National Park Service data, http://www.nps.gov/pais/naturescience/strp.htm, http://www.nps.gov/pais/naturescience/current-season.htm). It is worth noting that nesting in Texas has paralleled the trends observed in Mexico, with a significant decline in 2010 followed by a second decline in 2013-2014. Nesting rebounded in 2015, as 159 nests were documented along the Texas coast (D. Shaver, National Park Service, pers. comm. to M. Barnette, NMFS PRD, October 28, 2015).

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. (2011) 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 1998; TEWG 2000). While these results are encouraging, the species' limited range as well as low global abundance makes it particularly vulnerable to new sources of mortality as well as demographic and environmental 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.

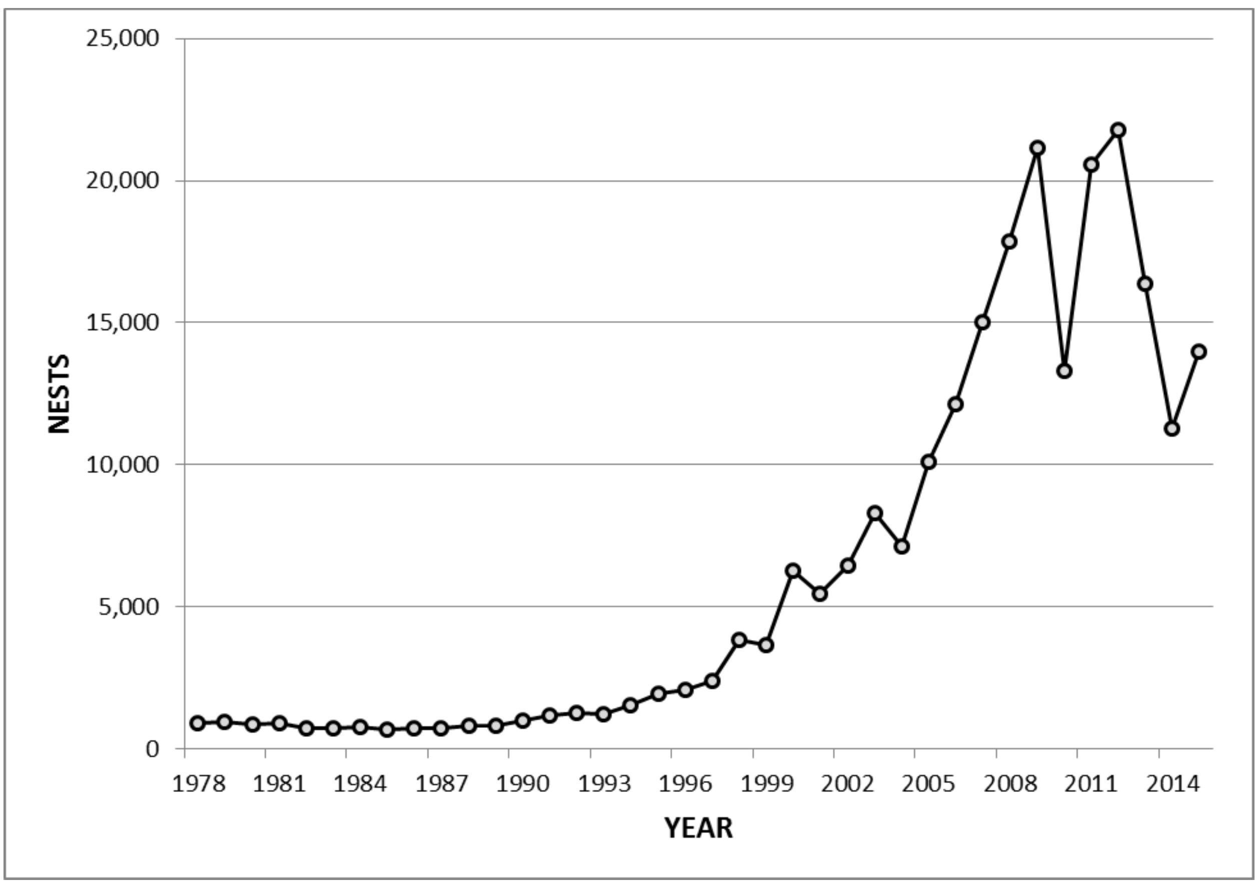

Figure 5. Kemp's ridley nest totals from Mexican beaches (Gladys Porter Zoo nesting database 2015)

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 1.1.1; 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[9] 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.

Over the past 6 years, NMFS has documented (via the Sea Turtle Stranding and Salvage Network data, http://www.sefsc.noaa.gov/species/turtles/strandings.htm) elevated sea turtle strandings in the Northern Gulf of Mexico, particularly throughout the Mississippi Sound area. 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

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

simply be a function of the 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 fishery during the summer of 2012. During May-July of that year, observers reported 24 sea turtle interactions in the skimmer trawl fishery. 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). All sea turtles were released alive. 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 fishery. Due to this issue, a proposed 2012 rule to require TEDs in the skimmer trawl fishery (77 FR 27411) was not implemented. Based on anecdotal information, these interactions were a relatively new issue for the inshore skimmer trawl fishery. 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 1.1.1, 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. 2011), 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 2015).

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 2015). 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.

6.1.5 Leatherback Sea Turtle

The leatherback 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.

Species Description and Distribution
The leatherback is the largest sea turtle in the world, with a curved carapace length (CCL) that often exceeds 5 ft (150 cm) and front flippers that can span almost 9 ft (270 cm) (NMFS and USFWS 1998a). Mature males and females can reach lengths of over 6 ft (2 m) and weigh close to 2,000 lb (900 kg). The leatherback does not have a bony shell. Instead, its shell is approximately 1.5 in (4 cm) thick and consists of a leathery, oil-saturated connective tissue overlaying loosely interlocking dermal bones. The ridged shell and large flippers help the leatherback during its long-distance trips in search of food.

Unlike other sea turtles, leatherbacks have several unique traits that enable them to live in cold water. For example, leatherbacks have a countercurrent circulatory system (Greer et al. 1973),[10] a thick layer of insulating fat (Davenport et al. 1990; Goff and Lien 1988), gigantothermy (Paladino et al. 1990),[11] and they can increase their body temperature through increased metabolic activity (Bostrom and Jones 2007; Southwood et al. 2005). These adaptations allow leatherbacks to be comfortable in a wide range of temperatures, which helps them to travel further than any other sea turtle species (NMFS and USFWS 1995). For example, a leatherback may swim more than 6,000 miles (10,000 km) in a single year (Benson et al. 2007a; Benson et al. 2011; Eckert 2006; Eckert et al. 2006). They search for food between latitudes 71°N and 47°S in all oceans, and travel extensively to and from their tropical nesting beaches. In the Atlantic Ocean, leatherbacks have been recorded as far north as Newfoundland, Canada, and Norway, and as far south as Uruguay, Argentina, and South Africa (NMFS 2001).

While leatherbacks will look for food in coastal waters, they appear to prefer the open ocean at all life stages (Heppell et al. 2003). Leatherbacks have pointed tooth-like cusps and sharp-edged jaws that are adapted for a diet of soft-bodied prey such as jellyfish and salps. A leatherback's mouth and throat also have backward-pointing spines that help retain jelly-like prey. Leatherbacks' favorite prey are jellies (e.g., medusae, siphonophores, and salps), which commonly occur in temperate and northern or sub-arctic latitudes and likely has a strong influence on leatherback distribution in these areas (Plotkin 2003). Leatherbacks are known to be deep divers, with recorded depths in excess of a half-mile (Eckert et al. 1989), but they may also come into shallow waters to locate prey items.

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[10] Countercurrent circulation is a highly efficient means of minimizing heat loss through the skin's surface because heat is recycled. For example, a countercurrent circulation system often has an artery containing warm blood from the heart surrounded by a bundle of veins containing cool blood from the body's surface. As the warm blood flows away from the heart, it passes much of its heat to the colder blood returning to the heart via the veins. This conserves heat by recirculating it back to the body's core.
[11] "Gigantothermy" refers to a condition when an animal has relatively high volume compared to its surface area, and as a result, it loses less heat.

Genetic analyses using microsatellite markers along with mitochondrial DNA and tagging data indicate there are 7 groups or breeding populations in the Atlantic Ocean: Florida, Northern Caribbean, Western Caribbean, Southern Caribbean/Guianas, West Africa, South Africa, and Brazil (TEWG 2007). General differences in migration patterns and foraging grounds may occur between the 7 nesting assemblages, although data to support this is limited in most cases.

Life History Information

The leatherback life cycle is broken into several stages: (1) egg/hatchling, (2) post-hatchling, (3) juvenile, (4) subadult, and (5) adult. Leatherbacks are a long-lived species that delay age of maturity, have low and variable survival in the egg and juvenile stages, and have relatively high and constant annual survival in the subadult and adult life stages (Chaloupka 2002; Crouse 1999; Heppell et al. 1999; Heppell et al. 2003; Spotila et al. 1996; Spotila et al. 2000). While a robust estimate of the leatherback sea turtle's life span does not exist, the current best estimate for the maximum age is 43 (Avens et al. 2009). It is still unclear when leatherbacks first become sexually mature. Using skeletochronological data, Avens et al. (2009) estimated that leatherbacks in the western North Atlantic may not reach maturity until 29 years of age, which is longer than earlier estimates of 2-3 years by Pritchard and Trebbau (1984), of 3-6 years by Rhodin (1985), of 13-14 years for females by Zug and Parham (1996), and 12-14 years for leatherbacks nesting in the U.S. Virgin Islands by Dutton et al. (2005). A more recent study that examined leatherback growth rates estimated an age at maturity of 16.1 years (Jones et al. 2011).

The average size of reproductively active females in the Atlantic is generally 5-5.5 ft (150-162 cm) CCL (Benson et al. 2007a; Hirth et al. 1993; Starbird and Suarez 1994). Still, females as small as 3.5-4 ft (105-125 cm) CCL have been observed nesting at various sites (Stewart et al. 2007).

Female leatherbacks typically nest on sandy, tropical beaches at intervals of 2-4 years (Garcia M. and Sarti 2000; McDonald and Dutton 1996; Spotila et al. 2000). Unlike other sea turtle species, female leatherbacks do not always nest at the same beach year after year; some females may even nest at different beaches during the same year (Dutton et al. 2005; Eckert 1989; Keinath and Musick 1993; Steyermark et al. 1996). Individual female leatherbacks have been observed with fertility spans as long as 25 years (Hughes 1996). Females usually lay up to 10 nests during the 3-6 month nesting season (March through July in the United States), typically 8-12 days apart, with 100 eggs or more per nest (Eckert et al. 2012; Eckert 1989; Maharaj 2004; Matos 1986; Stewart and Johnson 2006; Tucker 1988). Yet, up to approximately 30% of the eggs may be infertile (Eckert 1989; Eckert et al. 1984; Maharaj 2004; Matos 1986; Stewart and Johnson 2006; Tucker 1988). The number of leatherback hatchlings that make it out of the nest on to the beach (i.e., emergent success) is approximately 50% worldwide (Eckert et al. 2012), which is lower than the greater than 80% reported for other sea turtle species (Miller 1997). In the United States, the emergent success is higher at 54-72% (Eckert and Eckert 1990; Stewart and Johnson 2006; Tucker 1988). Thus the number of hatchlings in a given year may be less than the total number of eggs produced in a season. Eggs hatch after 60-65 days, and the hatchlings have white striping along the ridges of their backs and on the edges of the flippers. Leatherback hatchlings weigh approximately 1.5-2 oz (40-50 g), and have lengths of approximately 2-3 in (51-76 mm), with fore flippers as long as their bodies. Hatchlings grow rapidly, with reported growth rates for leatherbacks from 2.5-27.6 in (6-70 cm) in length, estimated at 12.6 in (32 cm) per year (Jones et al. 2011).

In the Atlantic, the sex ratio appears to be skewed toward females. The Turtle Expert Working Group (TEWG) reports that nearshore and onshore strandings data from the U.S. Atlantic and Gulf of Mexico coasts indicate that 60% of strandings were females (TEWG 2007). Those data also show that the proportion of females among adults (57%) and juveniles (61%) was also skewed toward females in these areas (TEWG 2007). James et al. (2007) collected size and sex data from large subadult and adult leatherbacks off Nova Scotia and also concluded a bias toward females at a rate of 1.86:1.

The survival and mortality rates for leatherbacks are difficult to estimate and vary by location. For example, the annual mortality rate for leatherbacks that nested at Playa Grande, Costa Rica, was estimated to be 34.6% in 1993-1994, and 34.0% in 1994-1995 (Spotila et al. 2000). In contrast, leatherbacks nesting in French Guiana and St. Croix had estimated annual survival rates of 91% (Rivalan et al. 2005) and 89% (Dutton et al. 2005), respectively. For the St. Croix population, the average annual juvenile survival rate was estimated to be approximately 63% and the total survival rate from hatchling to first year of reproduction for a female was estimated to be between 0.4% and 2%, assuming age at first reproduction is between 9-13 years (Eguchi et al. 2006). Spotila et al. (1996) estimated first-year survival rates for leatherbacks at 6.25%.

Migratory routes of leatherbacks are not entirely known; however, recent information from satellite tags have documented long travels between nesting beaches and foraging areas in the Atlantic and Pacific Ocean basins (Benson et al. 2007a; Benson et al. 2011; Eckert 2006; Eckert et al. 2006; Ferraroli et al. 2004; Hays et al. 2004; James et al. 2005). Leatherbacks nesting in Central America and Mexico travel thousands of miles through tropical and temperate waters of the South Pacific (Eckert and Sarti 1997; Shillinger et al. 2008). Data from satellite tagged leatherbacks suggest that they may be traveling in search of seasonal aggregations of jellyfish (Benson et al. 2007b; Bowlby et al. 1994; Graham 2009; Shenker 1984; Starbird et al. 1993; Suchman and Brodeur 2005).

Status and Population Dynamics

The status of the Atlantic leatherback population has been less clear than the Pacific population, which has shown dramatic declines at many nesting sites (Santidrián Tomillo et al. 2007; Sarti Martínez et al. 2007; Spotila et al. 2000). This uncertainty has been a result of inconsistent beach and aerial surveys, cycles of erosion, and reformation of nesting beaches in the Guianas (representing the largest nesting area). Leatherbacks also show a lesser degree of nest-site fidelity than occurs with the hardshell sea turtle species. Coordinated efforts of data collection and analyses by the leatherback Turtle Expert Working Group have helped to clarify the understanding of the Atlantic population status (TEWG 2007).

The Southern Caribbean/Guianas stock is the largest known Atlantic leatherback nesting aggregation (TEWG 2007). This area includes the Guianas (Guyana, Suriname, and French Guiana), Trinidad, Dominica, and Venezuela, with most of the nesting occurring in the Guianas and Trinidad. The Southern Caribbean/Guianas stock of leatherbacks was designated after genetics studies indicated that animals from the Guianas (and possibly Trinidad) should be viewed as a single population. Using nesting females as a proxy for population, the TEWG (2007) determined that the Southern Caribbean/Guianas stock had demonstrated a long-term, positive population growth rate. TEWG observed positive growth within major nesting areas for the stock, including Trinidad, Guyana, and the combined beaches of Suriname and French Guiana (TEWG 2007). More specifically, Tiwari et al. (2013) report an estimated three-generation abundance change of +3%, +20,800%, +1,778%, and +6% in Trinidad, Guyana, Suriname, and French Guiana, respectively.

Researchers believe the cyclical pattern of beach erosion and then reformation has affected leatherback nesting patterns in the Guianas. For example, between 1979 and 1986, the number of leatherback nests in French Guiana had increased by about 15% annually (NMFS 2001). This increase was then followed by a nesting decline of about 15% annually. This decline corresponded with the erosion of beaches in French Guiana and increased nesting in Suriname. This pattern suggests that the declines observed since 1987 might actually be a part of a nesting cycle that coincides with cyclic beach erosion in Guiana (Schulz 1975). Researchers think that the cycle of erosion and reformation of beaches may have changed where leatherbacks nest throughout this region. The idea of shifting nesting beach locations was supported by increased nesting in Suriname,[12] while the number of nests was declining at beaches in Guiana (Hilterman et al. 2003). Though this information suggested the long-term trend for the overall Suriname and French Guiana population was increasing.

The Western Caribbean stock includes nesting beaches from Honduras to Colombia. Across the Western Caribbean, nesting is most prevalent in Costa Rica, Panama, and the Gulf of Uraba in Colombia (Duque et al. 2000). The Caribbean coastline of Costa Rica and extending through Chiriquí Beach, Panama, represents the fourth largest known leatherback rookery in the world (Troëng et al. 2004). Examination of data from index nesting beaches in Tortuguero, Gandoca, and Pacuaré in Costa Rica indicate that the nesting population likely was not growing over the 1995-2005 time series (TEWG 2007). Other modeling of the nesting data for Tortuguero indicates a possible 67.8% decline between 1995 and 2006 (Troëng et al. 2007). Tiwari et al. (2013) report an estimated three-generation abundance change of -72%, -24%, and +6% for Tortuguero, Gandoca, and Pacuare, respectively.

Nesting data for the Northern Caribbean stock is available from Puerto Rico, St. Croix (U.S. Virgin Islands), and the British Virgin Islands (Tortola). In Puerto Rico, the primary nesting beaches are at Fajardo and on the island of Culebra. Nesting between 1978 and 2005 has ranged between 469-882 nests, and the population has been growing since 1978, with an overall annual growth rate of 1.1% (TEWG 2007). Tiwari et al. (2013) report an estimated three-generation abundance change of -4% and +5,583% at Culebra and Fajardo, respectively. At the primary nesting beach on St. Croix, the Sandy Point National Wildlife Refuge, nesting has varied from a few hundred nests to a high of 1,008 in 2001, and the average annual growth rate has been approximately 1.1% from 1986-2004 (TEWG 2007). From 2006-2010, Tiwari et al. (2013) report an annual growth rate of +7.5% in St. Croix and a three-generation abundance change of +1,058%. Nesting in Tortola is limited, but has been increasing from 0-6 nests per year in the late 1980s to 35-65 per year in the 2000s, with an annual growth rate of approximately 1.2% between 1994 and 2004 (TEWG 2007).

The Florida nesting stock nests primarily along the east coast of Florida. This stock is of growing importance, with total nests between 800-900 per year in the 2000s following nesting totals fewer than 100 nests per year in the 1980s (Florida Fish and Wildlife Conservation Commission, unpublished data). Using data from the index nesting beach surveys, the TEWG (2007) estimated a significant annual nesting growth rate of 1.17% between 1989 and 2005. FWC Index Nesting Beach Survey Data generally indicates biennial peaks in nesting abundance beginning in 2007 (Figure 6 and Table 4). A similar pattern was also observed statewide (Table 15). This up-and-down pattern is thought to be a result of the cyclical nature of leatherback nesting, similar to the biennial cycle of green turtle nesting. Overall, the trend shows growth on Florida's east coast beaches. Tiwari et al. (2013) report an annual growth rate of 9.7% and a three-generation abundance change of +1,863%.

Table 15. Number of Leatherback Sea Turtle Nests in Florida

[12] Leatherback nesting in Suriname increased by more than 10,000 nests per year since 1999 with a peak of 30,000 nests in 2001.

Nests Recorded	2011	2012	2013	2014	2015
Index Nesting Beaches	625	515	322	641	489
Statewide	1,653	1,712	896	1,604	NA

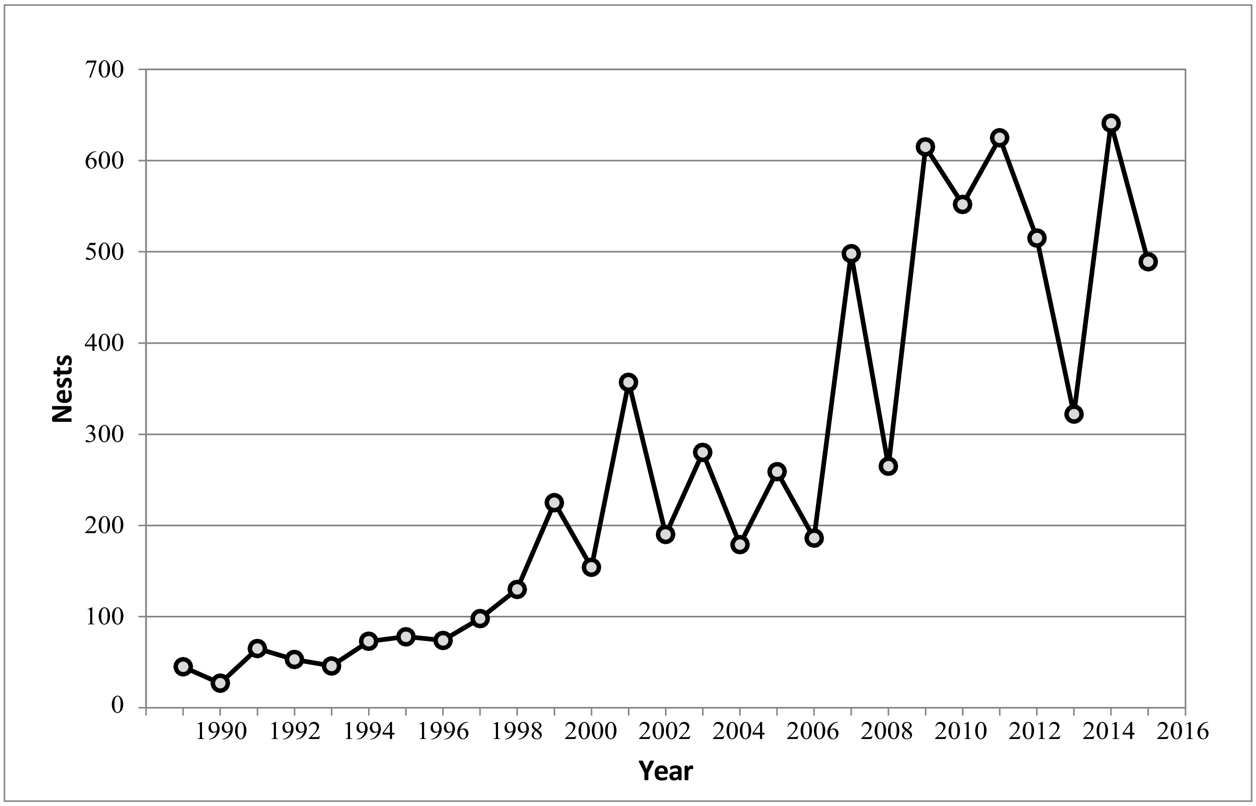

Figure 6. Leatherback sea turtle nesting at Florida index beaches since 1989

The West African nesting stock of leatherbacks is large and important, but it is a mostly unstudied aggregation. Nesting occurs in various countries along Africa's Atlantic coast, but much of the nesting is undocumented and the data are inconsistent. Gabon has a very large amount of leatherback nesting, with at least 30,000 nests laid along its coast in a single season (Fretey et al. 2007). Fretey et al. (2007) provide detailed information about other known nesting beaches and survey efforts along the Atlantic African coast. Because of the lack of consistent effort and minimal available data, trend analyses were not possible for this stock (TEWG 2007).

Two other small but growing stocks nest on the beaches of Brazil and South Africa. Based on the data available, TEWG (2007) determined that between 1988 and 2003, there was a positive annual average growth rate between 1.07% and 1.08% for the Brazilian stock. TEWG (2007) estimated an annual average growth rate between 1.04% and 1.06% for the South African stock.

Because the available nesting information is inconsistent, it is difficult to estimate the total population size for Atlantic leatherbacks. Spotila et al. (1996) characterized the entire Western Atlantic population as stable at best and estimated a population of 18,800 nesting females. Spotila et al. (1996) further estimated that the adult female leatherback population for the entire Atlantic basin, including all nesting beaches in the Americas, the Caribbean, and West Africa, was about 27,600 (considering both nesting and interesting females), with an estimated range of 20,082-35,133. This is consistent with the estimate of 34,000-95,000 total adults (20,000-56,000 adult females; 10,000-21,000 nesting females) determined by the TEWG (2007). The TEWG (2007) also determined that at of the time of their publication, leatherback sea turtle populations in the Atlantic were all stable or increasing with the exception of the Western Caribbean and West Africa populations. The latest review by NMFS USFWS (2013) suggests the leatherback nesting population is stable in most nesting regions of the Atlantic Ocean.

Threats

Leatherbacks 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 1.1.1; the remainder of this section will expand on a few of the aforementioned threats and how they may specifically impact leatherback sea turtles.

Of all sea turtle species, leatherbacks seem to be the most vulnerable to entanglement in fishing gear, especially gillnet and pot/trap lines. This vulnerability may be because of their body type (large size, long pectoral flippers, and lack of a hard shell), their attraction to gelatinous organisms and algae that collect on buoys and buoy lines at or near the surface, their method of locomotion, and/or their attraction to the lightsticks used to attract target species in longline fisheries. From 1990-2000, 92 entangled leatherbacks were reported from New York through Maine and many other stranded individuals exhibited evidence of prior entanglement (Dwyer et al. 2003). Zug and Parham (1996) point out that a combination of the loss of long-lived adults in fishery-related mortalities and a lack of recruitment from intense egg harvesting in some areas has caused a sharp decline in leatherback sea turtle populations. This represents a significant threat to survival and recovery of the species worldwide.

Leatherback sea turtles may also be more susceptible to marine debris ingestion than other sea turtle species due to their predominantly pelagic existence and the tendency of floating debris to concentrate in convergence zones that adults and juveniles use for feeding and migratory purposes (Lutcavage et al. 1997; Shoop and Kenney 1992). The stomach contents of leatherback sea turtles revealed that a substantial percentage (33.8% or 138 of 408 cases examined) contained some form of plastic debris (Mrosovsky et al. 2009). Blocking of the gut by plastic to an extent that could have caused death was evident in 8.7% of all leatherbacks that ingested plastic (Mrosovsky et al. 2009). Mrosovsky et al. (2009) also note that in a number of cases, the ingestion of plastic may not cause death outright, but could cause the animal to absorb fewer nutrients from food, eat less in general, etc.– factors which could cause other adverse effects. The presence of plastic in the digestive tract suggests that leatherbacks might not be able to distinguish between prey items and forms of debris such a plastic bags (Mrosovsky et al. 2009). Balazs (1985) speculated that the plastic object might resemble a food item by its shape, color, size, or even movement as it drifts about, and therefore induce a feeding response in leatherbacks.

As discussed in Section 1.1.1, global climate change can be expected to have various impacts on all sea turtles, including leatherbacks. Global climate change is likely to also influence the distribution and abundance of jellyfish, the primary prey item of leatherbacks (NMFS and USFWS 2007a). Several studies have shown leatherback distribution is influenced by jellyfish abundance ((Houghton et al. 2006;

Witt et al. 2007; Witt et al. 2006); however, more studies need to be done to monitor how changes to prey items affect distribution and foraging success of leatherbacks so population-level effects can be determined.

While oil spill impacts are discussed generally for all species in Section 1.1.1, specific impacts of the DWH oil spill on leatherback sea turtles are considered here. Available information indicates leatherback sea turtles (along with hawksbill turtles) were likely directly affected by the oil spill. Leatherbacks were documented in the spill area, but the number of affected leatherbacks was not estimated due to a lack of information compared to other species. But given that the northern Gulf of Mexico is important habitat for leatherback migration and foraging (TEWG 2007), and documentation of leatherbacks in the DWH oil spill zone during the spill period, it was concluded that leatherbacks were exposed to DWH oil, and some portion of those exposed leatherbacks likely died. Potential DWH-related impacts to leatherback sea turtles include direct oiling or contact with dispersants from surface and subsurface oil and dispersants, 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 likely occurred to leatherbacks, the relative proportion of the population that is expected to have been exposed to and directly impacted by the DWH event may be relatively low. Thus, a population-level impact may not have occurred due to the widespread distribution and nesting location outside of the Gulf of Mexico for this species.

6.1.6 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 (Eckert 1995; Hillis and Mackay 1989; van Dam and 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 and Luxmoore 1989; Lund 1985; Meylan and Donnelly 1999; NMFS and USFWS 1998b; Plotkin and Amos 1990; Plotkin and Amos 1988). They are highly migratory and use a wide range of habitats during their lifetimes (Musick and Limpus 1997; 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 2007c). 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 et al. 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 and USFWS 2007c).

Mitochondrial DNA studies show that reproductive populations are effectively isolated over ecological time scales (Bass et al. 1996). Substantial efforts have been made to determine the nesting population origins of hawksbill sea turtles assembled in foraging grounds, and genetic research has shown that hawksbills of multiple nesting origins commonly mix in foraging areas (Bowen and 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 (Chaloupka and Limpus 1997; Mortimer et al. 2003; Mortimer et al. 2002; Whiting 2000), to a high of 2 in (5 cm) or more per year, measured at some sites in the Caribbean (Diez and Van Dam 2002; León and 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 and Bolten 2002; Chaloupka et al. 2004). Consistent with slow growth, age to maturity for the species is also long, taking between 20 and 40 years, depending on the region (Chaloupka and Musick 1997; Limpus and Miller 2000). Hawksbills in the western Atlantic are known to mature faster (i.e., 20 or more years) than sea turtles found in the Indo-Pacific (i.e., 30-40 years) (Boulan 1983; Boulon Jr. 1994; Diez and Van Dam 2002; Limpus and Miller 2000). Males are typically mature when their length reaches 27 in (69 cm), while females are typically mature at 30 in (75 cm) (Eckert et al. 1992; Limpus 1992).

Female hawksbills return to the beaches where they were born (natal beaches) every 2-3 years to nest (Van Dam et al. 1991; Witzell 1983) and generally lay 3-5 nests per season (Richardson et al. 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 and 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 (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 (Musick and Limpus 1997) before returning to more coastal foraging grounds. In the Caribbean, hawksbills are known to almost exclusively feed on sponges (Meylan 1988; Van Dam and Diez 1997), although at times they have been seen foraging on other food items, notably corallimorphs and zooanthids (León and Diez 2000; Mayor et al. 1998; Van Dam and 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 (Van Dam and Diez 1998). Foraging sites are typically areas associated with coral reefs, although hawksbills are also found around rocky outcrops and high energy shoals which are optimum sites for sponge growth. They can also inhabit seagrass pastures in mangrove-fringed bays and estuaries, particularly along the eastern shore of continents where coral reefs are absent (Bjorndal 1997; Van Dam and Diez 1998).

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 and USFWS 2007c). 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 (Diez and 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 (Meylan 1999b; Mortimer and 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 and 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 (Mortimer and 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 and USFWS 2007c).

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 1.1.1. 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 1.1.1, 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 2015). 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 and 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 and 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 et al. 1999; Mortimer and 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 et al. 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.

6.2 Sturgeon

There are 2 species of sturgeon (Atlantic and shortnose) that travel widely through the South Atlantic. These species are highly mobile and therefore could occur within the action areas of transportation projects in NC, SC, and GA. Section 1.2.1 and 1.2.2 will address information on the distribution, life history, population structure, abundance, population trends, and threats to each species of sturgeon.

6.2.1 Atlantic Sturgeon

Five separate DPSs of Atlantic sturgeon were listed under the ESA by NMFS effective April 6, 2012 (77 FR 5880 and 5914, February 6, 2012). The New York Bight, Chesapeake Bay, Carolina, and South Atlantic DPSs were listed as endangered. The Gulf of Maine DPS was listed as threatened.

Species Descriptions and Distributions

Atlantic sturgeon are long-lived, late-maturing, estuarine-dependent, anadromous fish distributed along the eastern coast of North America (Waldman and Wirgin 1998). Historically, sightings have been reported from Hamilton Inlet, Labrador, south to the St. Johns River, Florida (Murawski et al. 1977; Smith and Clugston 1997). Atlantic sturgeon may live up to 60 years, reach lengths up to 14 ft, and weigh over 800 lb (ASSRT 2007; Collette and Klein-MacPhee 2002). They are distinguished by armor-like plates (called scutes) and a long protruding snout that has 4 barbels (slender, whisker-like feelers extending from the head used for touch and taste). Atlantic sturgeon spend the majority of their lives in nearshore marine waters, returning to their natal rivers to spawn (Wirgin et al. 2002). Young sturgeon may spend the first few years of life in their natal river estuary before moving out to sea (Wirgin et al. 2002). Sturgeon are omnivorous benthic (bottom) feeders and filter quantities of mud along with their food. Adult sturgeon diets include mollusks, gastropods, amphipods, isopods, and small fishes, especially sand lances (*Ammodytes* sp.) (Scott and Crossman 1973). Juvenile sturgeon feed on aquatic insects and other invertebrates (Smith 1985).

Historically, Atlantic sturgeon were present in approximately 38 rivers in the United States from the St. Croix River, Maine to the St. Johns River, Florida, of which 35 rivers have been confirmed to have had a historical spawning population. Atlantic sturgeon are currently present in approximately 32 of these rivers, and spawning occurs in at least 20 of them. The marine range of Atlantic sturgeon extends from the Hamilton Inlet, Labrador, Canada, to Cape Canaveral, Florida. Because adult Atlantic sturgeon from all DPSs mix extensively in marine waters, we expect fish from all DPSs to be found in the action areas of transportation projects in NC, SC, and GA.

Life History Information

Atlantic sturgeon populations show clinal variation, with a general trend of faster growth and earlier age at maturity in more southern systems. Atlantic sturgeon mature between the ages of 5-19 years in South Carolina (Smith et al. 1982), between 11-21 years in the Hudson River (Young et al. 1988), and between 22-34 years in the St. Lawrence River (Scott and Crossman 1973). Most Atlantic sturgeon adults likely do not spawn every year. Multiple studies have shown that spawning intervals range from 1-5 years for males (Caron et al. 2002; Collins et al. 2000c; Smith 1985) and 2-5 years for females (Stevenson and Secor 1999; Van Eenennaam et al. 1996; Vladykov and Greely 1963). Fecundity of Atlantic sturgeon has been correlated with age and body size, with egg production ranging from 400,000 to 8,000,000 eggs per year (Dadswell 2006; Smith et al. 1982; Van Eenennaam and Doroshov 1998). The average age at which 50% of maximum lifetime egg production is achieved is estimated to be 29 years, approximately 3-10 times longer than for other bony fish species examined (Boreman 1997).

Spawning adult Atlantic sturgeon generally migrate upriver in spring/early summer, which occurs in February-March in southern systems, April-May in mid-Atlantic systems, and May-July in Canadian systems (Bain 1997; Caron et al. 2002; Murawski et al. 1977; Smith 1985; Smith and Clugston 1997). In some southern rivers, a fall spawning migration may also occur (Moser et al. 1998; Rogers and Weber 1995; Weber and Jennings 1996). In the fall, Hager et al. (2014) captured an Atlantic sturgeon identified as a spawned-out female due to her size and concave stomach and also noted capture of other fish showing signs of wear suggesting males had been engaging in spawning behavior. In Virginia's James River, Balazik et al. (2012) captured 1 fish identified as a female in the fall during the 3-year study with a concave condition of the abdomen consistent with female sturgeon that have spawned recently. In addition, postovulated eggs recovered from the urogenital opening were in an early degradation stage, suggesting the fish had spawned within days (Balazik et al. 2012). Further physiological support for fall spawning is provided by the 9 spermiating males captured along with the female and a grand total of 106 different spermiating males captured during August–October (Balazik et al. 2012). Randall and Sulak (2012) reported similar evidence for fall spawning of the closely related Gulf sturgeon, which included multiple captures of sturgeon in September–November that were ripe or exhibited just-spawned characteristics.

Atlantic sturgeon spawning occurs in fast-flowing water between the salt front and fall line of large rivers (Bain et al. 2000; Borodin 1925; Crance 1987; Leland 1968; Scott and Crossman 1973) over hard substrate, such as cobble, gravel, or boulders, to which the highly adhesive sturgeon eggs adhere (Gilbert 1989; Smith and Clugston 1997). Hatching occurs approximately 94-140 hours after egg deposition and larvae assume a demersal existence (Smith et al. 1980). The yolk sac larval stage is completed in about 8-12 days, during which time the larvae move downstream to rearing grounds (Kynard and Horgan 2002). During the first half of their migration downstream, movement is limited to night. During the day, larvae use benthic structure (e.g., gravel matrix) as refugia (Kynard and Horgan 2002). During the latter half of migration, when larvae are more fully developed, movement to rearing grounds occurs both day and night. Juvenile sturgeon continue to move further downstream into brackish waters, and eventually become residents in estuarine waters for months or years.

Juvenile and adult Atlantic sturgeon occupy upper estuarine habitat where they frequently congregate around the saltwater/freshwater interface. Estuarine habitats are important for juveniles, serving as nursery areas by providing abundant foraging opportunities, as well as thermal and salinity refuges, for facilitating rapid growth. Some juveniles will take up residency in non-natal rivers that lack active spawning sites (Bain 1997). Residency time of young Atlantic sturgeon in estuarine areas varies between 1-6 years (Schueller and Peterson 2010; Smith 1985), after which Atlantic sturgeon start out-migration to the marine environment. Out-migration of adults from the estuaries to the sea is cued by water temperature and velocity. Adult Atlantic sturgeon will reside in the marine habitat during the non-spawning season and forage extensively. Coastal migrations by adult Atlantic sturgeon are extensive and are known to occur over sand and gravel substrate (Greene et al. 2009). Atlantic sturgeon remain in the marine habitat until the waters begin to warm, at which time ripening adults migrate back to their natal rivers to spawn.

Upstream migration to the spawning grounds is cued primarily by water temperature and velocity. Therefore, fish in the southern portion of the range migrate earlier than those to the north do (Kieffer and Kynard 1993; Smith 1985). In Georgia and South Carolina, migration begins in February or March (Collins et al. 2000a). Males commence upstream migration to the spawning sites when waters reach around 6°C (Dovel and Berggren 1983; Smith 1985; Smith et al. 1982), with females following a few weeks later when water temperatures are closer to 12° or 13°C (Collins et al. 2000a; Dovel and Berggren 1983; Smith 1985). In some rivers, predominantly in the south, a fall spawning migration may also occur (Moser et al. 1998; Rogers and Weber 1995), with running ripe males found August through October and post-spawning females captured in late September and October (Collins et al. 2000c).

Status and Population Dynamics

At the time Atlantic sturgeon were listed, the best available abundance information for each of the 5 DPSs was the estimated number of adult Atlantic sturgeon spawning in each of the rivers on an annual basis. The estimated number of annually spawning adults in each of the river populations is insufficient to quantify the total population numbers for each DPS of Atlantic sturgeon due to the lack of other necessary accompanying life history data. A recently Atlantic sturgeon population estimate was derived from the Northeast Area Monitoring and Assessment Program (NEAMAP). NEAMAP trawl surveys were conducted from Cape Cod, Massachusetts, to Cape Hatteras, North Carolina, in nearshore waters to depths of 60 ft from fall 2007 through spring 2012. The results of these surveys, assuming 50% gear efficiency (i.e., assumption that the gear will capture some, but not all, of the sturgeon in the water colum n along the tow path, and the survey area is only a portion of Atlantic sturgeon habitat), are presented in Table 16. It is important to note that the NEAMAP surveys were conducted primarily in the Northeast and may underestimate the actual population abundances of the Carolina and South Atlantic

DPSs, which are likely more concentrated in the Southeast since they originated from and spawn there. However, the total ocean population abundance estimates listed in Table 16 currently represent the best available population abundance estimates for the 5 U.S. Atlantic sturgeon DPSs.

Table 16. Summary of Calculated Population Estimates based upon the NEAMAP Survey Swept Area, Assuming 50% Efficiency (NMFS 2013)

DPS	Estimated Ocean Population Abundance	Estimated Ocean Population of Adults	Estimated Ocean Population of Subadults (of size vulnerable to capture in fisheries)
South Atlantic	14,911	3,728	11,183
Carolina	1,356	339	1,017
Chesapeake Bay	8,811	2,203	6,608
New York Bight	34,566	8,642	25,925
Gulf of Maine	7,455	1,864	5,591

South Atlantic DPS

The South Atlantic DPS includes all Atlantic sturgeon that spawn or are spawned in the watersheds (including all rivers and tributaries) of the Ashepoo, Combahee, and Edisto River (ACE) Basins southward along the South Carolina, Georgia, and Florida coastal areas to the St. Johns River, Florida. Rivers known to have current spawning populations within the range of the South Atlantic DPS include the Combahee, Edisto, Savannah, Ogeechee, Altamaha, and Satilla Rivers. We determined spawning was occurring if young-of-the-year (YOY) were observed, or mature adults were present, in freshwater portions of a system. However, in some rivers, spawning by Atlantic sturgeon may not be contributing to population growth because of lack of suitable habitat and the presence of other stressors on juvenile survival and development.

Historically, both the Broad-Coosawatchie and St. Marys Rivers were documented to have spawning populations; there is also evidence that spawning may have occurred in the St. Johns River or one of its tributaries. The spawning population in the St. Marys River, as well as any historical spawning population in the St. Johns, are believed to be extirpated, and the status of the spawning population in the Broad-Coosawatchie is unknown. Both the St. Marys and St. Johns rivers are used as nursery habitat by young Atlantic sturgeon originating from other spawning populations. The use of the Broad-Coosawatchie by sturgeon from other spawning populations is unknown at this time. The presence of historical and current spawning populations in the Ashepoo River has not been documented; however, this river may currently be used for nursery habitat by young Atlantic sturgeon originating from other spawning populations. This represents our current knowledge of the river systems utilized by the South Atlantic DPS for specific life functions, such as spawning, nursery habitat, and foraging. Still, fish from the South Atlantic DPS likely use other river systems than those listed here for their specific life functions.

Prior to the collapse of the fishery in the late 1800s, the sturgeon fishery was the third largest fishery in Georgia. Secor (2002) estimated from U.S. Fish Commission landing reports that approximately 11,000 spawning females were likely present in Georgia and 8,000 adult females were present in South Carolina prior to 1890. The Altamaha River population of the South Atlantic DPS, with an estimated 343 adults spawning annually, is believed to be the largest remaining population in the Southeast, yet is estimated to be only 6% of its historical population size. The abundances of the remaining river populations within the South Atlantic DPS, each estimated to have fewer than 300 annually spawning adults, are estimated to be less than 1% of what they were historically (ASSRT 2007). The NEAMAP model estimates a minimum ocean population of 14,911 South Atlantic DPS Atlantic sturgeon, of which 3,728 are adults.

Carolina DPS

The Carolina DPS includes all Atlantic sturgeon that are spawned in the watersheds (including all rivers and tributaries) from the Albemarle Sound southward along the southern Virginia, North Carolina, and South Carolina coastal areas to Charleston Harbor. Rivers known to have current spawning populations within the range of the Carolina DPS include the Roanoke, Tar-Pamlico, Cape Fear, Waccamaw, and Yadkin-Pee Dee Rivers. We determined spawning was occurring if YOY were observed, or mature adults were present, in freshwater portions of a system. In some rivers, though, spawning by Atlantic sturgeon may not be contributing to population growth because of lack of suitable habitat and the presence of other stressors on juvenile survival and development. There may also be spawning populations in the Neuse, Santee, and Cooper Rivers, though it is uncertain.

Historically, both the Sampit and Ashley Rivers in South Carolina were documented to have spawning populations at one time, although the spawning population in the Sampit River is believed to be extirpated and the current status of the spawning population in the Ashley River is unknown. Both rivers may be used as nursery habitat by young Atlantic sturgeon originating from other spawning populations. This represents our current knowledge of the river systems utilized by the Carolina DPS for specific life functions, such as spawning, nursery habitat, and foraging. Still, fish from the Carolina DPS likely use other river systems than those listed here for their specific life functions.

Historical landings data indicate that between 7,000 and 10,500 adult female Atlantic sturgeon were present in North Carolina prior to 1890 (Armstrong and Hightower 2002; Secor 2002). Secor (2002) estimates that 8,000 adult females were present in South Carolina during that same time frame. The Atlantic sturgeon spawning population in at least 1 river system (the Sampit River) within the Carolina DPS has been extirpated, and the statuses of 4 additional spawning populations are uncertain. There are believed to be only 5 of 7-10 historical spawning populations remaining in the Carolina DPS. In some rivers, spawning by Atlantic sturgeon may not be contributing to population growth because of lack of suitable habitat and the presence of other stressors on juvenile survival and development. The abundances of the remaining river populations within the DPS, each estimated to have fewer than 300 spawning adults, are estimated to be less than 3% of what they were historically (ASSRT 2007). The NEAMAP model estimates a minimum ocean population of 1,356 Carolina DPS Atlantic sturgeon, of which 339 are adults.

Chesapeake Bay DPS

The Chesapeake Bay DPS includes all anadromous Atlantic sturgeons that are spawned in the watersheds that drain into the Chesapeake Bay and into coastal waters from the Delaware-Maryland border on Fenwick Island to Cape Henry, Virginia. Within this range, Atlantic sturgeon historically spawned in the Susquehanna, Potomac, James, York, Rappahannock, and Nottoway Rivers (ASSRT 2007). Spawning still occurs in the James River, and the presence of juvenile and adult sturgeon in the York River suggests that spawning may occur there as well (ASSRT 2007; Greene et al. 2009; Musick et al. 1994). However, conclusive evidence of current spawning is available for the James River, only. Atlantic sturgeon that are spawned elsewhere are known to use waters of the Chesapeake Bay for other life functions, such as foraging and as juvenile nursery habitat, before entering the marine system as subadults (ASSRT 2007; Grunwald et al. 2008; Vladykov and Greely 1963; Wirgin et al. 2007).

Historically, the Chesapeake Bay DPS likely supported more than 10,000 spawning adults (ASSRT 2007; KRRMP 1993; Secor 2002). Current estimates of the Chesapeake Bay DPS from the NEAMAP model (Table 6) indicate the current number of spawning adults is likely an order of magnitude lower than historical levels (ASSRT 2007; Kahnle et al. 2007). The NEAMAP model estimates a minimum ocean population of 8,811 Chesapeake Bay DPS Atlantic sturgeon, of which 2,319 are adults.

New York Bight DPS

The New York Bight DPS includes all anadromous Atlantic sturgeon that spawn in the watersheds that drain into coastal waters from Chatham, Massachusetts, to the Delaware-Maryland border on Fenwick Island. Within this range, Atlantic sturgeon historically spawned in the Connecticut, Delaware, Hudson, and Taunton Rivers (ASSRT 2007; Murawski et al. 1977; Secor 2002). Spawning still occurs in the Delaware and Hudson Rivers, but there is no recent evidence (within the last 15 years) of spawning in the Connecticut and Taunton Rivers (ASSRT 2007). Atlantic sturgeon that are spawned elsewhere continue to use habitats within the Connecticut and Taunton Rivers for other life functions (ASSRT 2007; Savoy 2007; Wirgin and King 2011).

Prior to the onset of expanded fisheries exploitation of sturgeon in the 1800s, a conservative historical estimate for the Hudson River Atlantic sturgeon population was 10,000 adult females (Secor 2002). Current population abundance is likely at least one order of magnitude smaller than historical levels (ASSRT 2007; Kahnle et al. 2007; Secor 2002). Based on data collected from 1985-1995, there are 870 spawning adults per year in the Hudson River (Kahnle et al. 2007). Kahnle (2007; 1998) also showed that the level of fishing mortality from the Hudson River Atlantic sturgeon fishery during the period of 1985-1995 exceeded the estimated sustainable level of fishing mortality for the riverine population, and may have led to reduced recruitment. All available data on abundance of juvenile Atlantic sturgeon in the Hudson River Estuary indicate a substantial drop in production of young since the mid-1970s (Kahnle et al. 1998). A decline appeared to occur in the mid- to late 1970s followed by a secondary drop in the late 1980s (ASMFC 2010; Kahnle et al. 1998; Sweka et al. 2007). Catch-per-unit-effort (CPUE) data suggest that recruitment has remained depressed relative to catches of juvenile Atlantic sturgeon in the estuary during the mid- to late 1980s (ASMFC 2010; Sweka et al. 2007). From 1985-2007, there were significant fluctuations in CPUE. The number of juveniles appears to have declined between the late 1980s and early 1990s. While the CPUE is generally higher in the 2000s as compared to the 1990s, significant annual fluctuations make it difficult to discern any trend. The CPUEs from 2000-2007 are generally higher than those from 1990-1999; however, they remain lower than the CPUEs observed in the late 1980s. There is currently not enough information regarding any life stage to establish a trend for the Hudson River population (ASMFC 2010; Sweka et al. 2007).

There is no abundance estimate for the Delaware River population of Atlantic sturgeon. Harvest records from the 1800s indicate that this was historically a large population, with an estimated 180,000 adult females prior to 1890 (Secor 2002; Secor and Waldman 1999). Fisher (2009) sampled the Delaware River in 2009 to target YOY Atlantic sturgeon. The effort captured 34 YOY. Brundage and O'Herron

(2003) also collected 32 YOY Atlantic sturgeon from the Delaware River in a separate study. Fisher (2011) reports that genetics information collected from 33 of the 2009 year class YOY indicates that at least 3 females successfully contributed to the 2009 year class. The capture of YOY in 2009 shows that successful spawning is still occurring in the Delaware River, but the relatively low numbers suggest the existing riverine population is limited in size. Similar to the Hudson River, there is currently not enough information to determine a trend for the Delaware River population. The ASSRT (2007) suggested that there may be less than 300 spawning adults per year for the Delaware River portion of the New York Bight DPS. The NEAMAP model estimates a minimum ocean population of 34,566 Atlantic sturgeon, of which 8,642 are adults.

Gulf of Maine DPS

The Gulf of Maine DPS includes all anadromous Atlantic sturgeons that are spawned in the watersheds from the Maine/Canadian border and, extending southward, all watersheds draining into the Gulf of Maine as far south as Chatham, Massachusetts. Within this range, Atlantic sturgeon historically spawned in the Androscoggin, Kennebec, Merrimack, Penobscot, and Sheepscot Rivers (ASSRT 2007). Spawning still occurs in the Kennebec and Androscoggin Rivers, and may still occur in the Penobscot River. Atlantic sturgeon continue to be present in the Kennebec River; in addition, they are captured in directed research projects in the Penobscot River. They are also observed in the Saco, Presumpscot, and Charles rivers where they were unknown to occur before or had not been observed to occur for many years. These observations suggest that the abundance of the Gulf of Maine DPS of Atlantic sturgeon is large enough that recolonization to rivers historically suitable for spawning may be occurring.

Historically, the Gulf of Maine DPS likely supported more than 10,000 spawning adults (ASSRT 2007; KRRMP 1993; Secor 2002), suggesting the recent estimate of spawning adults within the DPS is 1-2 orders of magnitude smaller than historical levels (i.e., hundreds to low thousands) (ASSRT 2007; Kahnle et al. 2007). The CPUE of subadult Atlantic sturgeon in a multifilament gillnet survey conducted on the Kennebec River was considerably greater for the period of 1998-2000 (CPUE = 7.43) compared to the CPUE for the period 1977-1981 (CPUE = 0.30). The CPUE of adult Atlantic sturgeon showed a slight increase over the same time period (1977-1981 CPUE = 0.12 versus 1998-2000 CPUE = 0.21) (Squiers 2004). There is also new evidence of Atlantic sturgeon presence in rivers (e.g., the Saco River) where they have not been observed for many years. Still, there is not enough information to establish a trend for this DPS. The NEAMAP model estimates a minimum ocean population of 7,455 Atlantic sturgeon, of which 1,864 are adults.

Viability of Atlantic Sturgeon DPSs

The concept of a viable population able to adapt to changing environmental conditions is critical to Atlantic sturgeon, and the low population numbers of every river population in the 5 DPSs on the East Coast put them in danger of extinction throughout their range. None of the riverine spawning populations are large or stable enough to provide with any level of certainty for continued existence of any of the DPSs. Although the largest impact that caused the precipitous decline of the species has been prohibited (directed fishing), the Atlantic sturgeon population sizes within each DPS have remained relatively constant at greatly reduced levels for 100 years. The largest Atlantic sturgeon population in the United States, the Hudson River population within the New York Bight DPS, is estimated to have only 870 spawning adults each year. The Altamaha River population within the South Atlantic DPS is the largest Atlantic sturgeon population in the Southeast and only has an estimated 343 adults spawning annually.

All other Atlantic sturgeon river populations in the U.S. are estimated to have less than 300 spawning adults annually.

Small numbers of individuals resulting from drastic reductions in populations, such as occurred with Atlantic sturgeon due to the commercial fishery, can remove the buffer against natural demographic and environmental variability provided by large populations (Berry 1971; Shaffer 1981; Soulé 1980). Recovery of depleted populations is an inherently slow process for a late-maturing species such as Atlantic sturgeon, and they continue to face a variety of other threats that contribute to their risk of extinction. Their late age at maturity provides more opportunities for individual Atlantic sturgeon to be removed from the population before reproducing. While a long life span allows multiple opportunities to contribute to future generations, it also increases the time frame over which exposure to the multitude of threats facing Atlantic sturgeon can occur.

The viability of the Atlantic sturgeon DPSs depends on having multiple self-sustaining riverine spawning populations and maintaining suitable habitat to support the various life functions (spawning, feeding, growth) of Atlantic sturgeon populations. Because a DPS is a group of populations, the stability, viability, and persistence of individual populations affects the persistence and viability of the larger DPS. The loss of any population within a DPS will result in: (1) a long-term gap in the range of the DPS that is unlikely to be recolonized; (2) loss of reproducing individuals; (3) loss of genetic biodiversity; (4) potential loss of unique haplotypes; (5) potential loss of adaptive traits; (6) reduction in total number; and (7) potential for loss of population source of recruits. The loss of a population will negatively impact the persistence and viability of the DPS as a whole, as fewer than 2 individuals per generation spawn outside their natal rivers (King et al. 2001; Waldman et al. 2002; Wirgin et al. 2000). The persistence of individual populations, and in turn the DPS, depends on successful spawning and rearing within the freshwater habitat, the immigration into marine habitats to grow, and then the return of adults to natal rivers to spawn.

Threats

Atlantic sturgeon were once numerous along the East Coast until fisheries for their meat and caviar reduced the populations by over 90% in the late 1800s. Fishing for Atlantic sturgeon became illegal in state waters in 1998 and in remaining U.S. waters in 1999. Dams, dredging, poor water quality, and accidental catch (bycatch) by fishers continue to threaten Atlantic sturgeon. Though Atlantic sturgeon populations appear to be increasing in some rivers, other river populations along the East Coast continue to struggle and some have been eliminated entirely. The 5 DPSs of Atlantic sturgeon were listed as threatened or endangered under the ESA primarily as a result of a combination of habitat restriction and modification, overutilization (i.e., being taken as bycatch) in commercial fisheries, and the inadequacy of regulatory mechanisms in ameliorating these impacts and threats.

<u>Dams</u>

Dams for hydropower generation, flood control, and navigation adversely affect Atlantic sturgeon by impeding access to spawning, developmental, and foraging habitat, modifying free-flowing rivers to reservoirs, physically damaging fish on upstream and downstream migrations, and altering water quality in the remaining downstream portions of spawning and nursery habitat (ASSRT 2007). Attempts to minimize the impacts of dams using measures such as fish passage have not proven beneficial to Atlantic sturgeon, as they do not regularly use existing fish passage devices, which are generally designed to pass pelagic fish (i.e., those living in the water column) rather than bottom-dwelling species, like sturgeon. Within the range occupied by the Carolina DPS, dams have restricted Atlantic sturgeon spawning and juvenile developmental habitat by blocking over 60% of the historical sturgeon habitat upstream of the dams in the Cape Fear and Santee-Cooper River systems. Water quality (velocity, temperature, and DO downstream of these dams, as well as on the Roanoke River, has been reduced, which modifies and restricts the extent of spawning and nursery habitat for the Carolina DPS.

Within the range of the New York Bight DPS, the Holyoke Dam on the Connecticut River blocks further upstream passage; however, the extent that Atlantic sturgeon historically would have used habitat upstream of Holyoke is unknown. Connectivity may be disrupted by the presence of dams on several smaller rivers in the New York Bight region. Connectivity is disrupted by the presence of dams on several rivers in the range of the Gulf of Maine DPS. Within the Gulf of Maine DPS, access to historical spawning habitat is most severely impacted in the Merrimack River (ASSRT 2007). Construction of the Essex Dam blocked the migration of Atlantic sturgeon to 58% of its historically available habitat (ASSRT 2007). The extent that Atlantic sturgeon are affected by operations of dams in the Gulf of Maine region is currently unknown, although Atlantic sturgeon larvae have been found downstream of the Brunswick Dam in the Androscoggin River. This suggests that Atlantic sturgeon spawning may be occurring in the vicinity of at least 1 hydroelectric project and may be affected by its operations.

Dredging

Riverine, nearshore, and offshore areas are often dredged to support commercial shipping and recreational boating, construction of infrastructure, and marine mining. Environmental impacts of dredging include the direct removal/burial of prey species; turbidity/siltation effects; contaminant resuspension; noise/disturbance; alterations to hydrodynamic regime and physical habitat; and actual loss of riparian habitat (Chytalo 1996; Winger et al. 2000). According to Smith and Clugston (1997), dredging and filling impact important habitat features of Atlantic sturgeon as they disturb benthic fauna, eliminate deep holes, and alter rock substrates.

In the South Atlantic DPS, maintenance dredging is currently modifying Atlantic sturgeon nursery habitat in the Savannah River. Modeling indicates that the proposed deepening of the navigation channel will result in reduced DO and upriver movement of the salt wedge, restricting spawning habitat. Dredging is also modifying nursery and foraging habitat in the St. Johns River. For the Carolina DPS, dredging in spawning and nursery grounds modifies the quality of the habitat and is further restricting the extent of available habitat in the Cape Fear and Cooper Rivers, where Atlantic sturgeon habitat has already been modified and restricted by the presence of dams. Dredging for navigational purposes is suspected of having reduced available spawning habitat for the Chesapeake Bay DPS in the James River (ASSRT 2007; Bushnoe et al. 2005; Holton and Walsh 1995). Both the Hudson and Delaware rivers have navigation channels that are maintained by dredging. Dredging is also used to maintain channels in the nearshore marine environment. Many rivers in the range of the Gulf of Maine DPS also have navigation channels that are maintained by dredging. Dredging outside of federal channels and in-water construction occurs throughout the range of the New York Bight and Gulf of Maine DPSs.

Water Quality

Atlantic sturgeon rely on a variety of water quality parameters to successfully carry out their life functions. Low DO and the presence of contaminants modify the quality of Atlantic sturgeon habitat and in some cases, restrict the extent of suitable habitat for life functions. Secor (1995) noted a correlation between low abundances of sturgeon during this century and decreasing water quality caused by increased nutrient loading and increased spatial and temporal frequency of hypoxic (low oxygen) conditions. Of particular concern is the high occurrence of low DO coupled with high temperatures in the river systems throughout the range of the Carolina and South Atlantic DPSs in the Southeast. Sturgeon are more highly sensitive to low DO than other fish species (Niklitschek and Secor 2009a; Niklitschek and Secor 2009c) and low DO in combination with high temperature is particularly problematic for Atlantic sturgeon. Studies have shown that juvenile Atlantic sturgeon experience lethal and sublethal (metabolic, growth, feeding) effects as DO drops and temperatures rise (Niklitschek and Secor 2005; Niklitschek and Secor 2009a; Niklitschek and Secor 2009c; Secor and Gunderson 1998).

Reductions in water quality from terrestrial activities have modified habitat utilized by the South Atlantic DPS. Low DO is modifying sturgeon habitat in the Savannah due to dredging, and non-point source inputs are causing low DO in the Ogeechee River and in the St. Marys River, which completely eliminates juvenile nursery habitat in summer. Low DO has also been observed in the St. Johns River in the summer. In the Pamlico and Neuse systems occupied by the Carolina DPS, nutrient-loading and seasonal anoxia are occurring, associated in part with concentrated animal feeding operations (CAFOs). Heavy industrial development and CAFOs have degraded water quality in the Cape Fear River. Water quality in the Waccamaw and Yadkin-Pee Dee Rivers has been affected by industrialization and riverine sediment samples contain high levels of various toxins, including dioxins. Decreased water quality also threatens Atlantic sturgeon of the Chesapeake Bay DPS, especially since the Chesapeake Bay system is vulnerable to the effects of nutrient enrichment due to a relatively low tidal exchange and flushing rate, large surface-to-volume ratio, and strong stratification during the spring and summer months (ASMFC 1998; ASSRT 2007; Pyzik et al. 2004). These conditions contribute to reductions in DO levels throughout the bay. The availability of nursery habitat, in particular, may be limited given the recurrent hypoxia (low DO) conditions within the Bay (Niklitschek and Secor 2005; Niklitschek and Secor 2010). Both the Hudson and Delaware Rivers, as well as other rivers in the New York Bight region, were heavily polluted in the past from industrial and sewer discharges. In the past, many rivers in Maine, including the Androscoggin River, were heavily polluted from industrial discharges from pulp and paper mills. While water quality has improved and most discharges are limited through regulations, many pollutants persist in the benthic environment of the New York Bight and Gulf of Maine DPSs. It is particularly problematic if pollutants are present on spawning and nursery grounds, as developing eggs and larvae are particularly susceptible to exposure to contaminants.

<u>Water Quantity</u>

Water allocation issues are a growing threat in the Southeast and exacerbate existing water quality problems. Taking water from one basin and transferring it to another fundamentally and irreversibly alters natural water flows in both the originating and receiving basins, which can affect DO levels, temperature, and the ability of the basin of origin to assimilate pollutants

(GWC 2006). Water quality within the river systems in the range of the South Atlantic and Carolina DPSs is negatively affected by large water withdrawals. Known water withdrawals of over 240 million gallons per day are permitted from the Savannah River for power generation and municipal uses. However, permits for users withdrawing less than 100,000 gallons per day are not required, so actual water withdrawals from the Savannah and other rivers within the range of the South Atlantic DPS are likely much higher. In the range of the Carolina DPS, 20 interbasin water transfers in existence prior to 1993, averaging 66.5 million gallons per day (mgd), were authorized at their maximum levels without being subjected to an evaluation for certification by the North Carolina Department of Environment and Natural Resources or other resource agencies. Since the 1993 legislation requiring certificates for transfers, almost 170 mgd of interbasin water withdrawals have been authorized, with an additional 60 mgd, pending certification. The removal of large amounts of water from these systems will alter flows, temperature, and DO. Water shortages and "water wars" are already occurring in the rivers occupied by the South Atlantic and Carolina DPSs and will likely be compounded in the future by population growth and potentially by climate change.

Climate Change

The Intergovernmental Panel on Climate Change (IPCC) projects with high confidence that higher water temperatures and changes in extremes, including floods and droughts, will affect water quality and exacerbate many forms of water pollution—from sediments, nutrients, dissolved organic carbon, pathogens, pesticides, and salt, as well as thermal pollution—with possible negative impacts on ecosystems (IPCC 2008). In addition, sea level rise is projected to extend areas of salinization of groundwater and estuaries, resulting in a decrease of freshwater availability for humans and ecosystems in coastal areas. Some of the most heavily populated areas are low-lying, and the threat of salt water entering into its aquifers with projected sea level rise is a concern (USGRG 2004). Existing water allocation issues would be exacerbated, leading to an increase in reliance on interbasin water transfers to meet municipal water needs, further stressing water quality.

Dams, dredging, and poor water quality have already modified and restricted the extent of suitable habitat for Atlantic sturgeon spawning and nursery habitat. Changes in water availability (depth and velocities) and water quality (temperature, salinity, DO, contaminants, etc.) in rivers and coastal waters inhabited by Atlantic sturgeon resulting from climate change will further modify and restrict the extent of suitable habitat for Atlantic sturgeon. Effects could be especially harmful since these populations have already been reduced to low numbers, potentially limiting their capacity for adaptation to changing environmental conditions (Belovsky 1987; Salwasser et al. 1984; Soulé 1987; Thomas 1990).

The effects of changes in water quality (temperature, salinity, DO, contaminants, etc.) in rivers and coastal waters inhabited by Atlantic sturgeon are expected to be more severe for those populations that occur at the southern extreme of the Atlantic sturgeon's range, and in areas that are already subject to poor water quality as a result of eutrophication. The South Atlantic and Carolina DPSs are within a region the IPCC predicts will experience overall climatic drying (IPCC 2008). Atlantic sturgeon from these DPSs are already susceptible to reduced water quality resulting from various factors: inputs of nutrients; contaminants from industrial activities and non-point sources; and interbasin transfers of water. In a simulation of the effects of water temperature on available Atlantic sturgeon habitat in Chesapeake Bay, Niklitschek and Secor (2005) found that a 1°C increase of water temperature in the bay would reduce available sturgeon habitat by 65%.

Vessel Strikes

Vessel strikes are a threat to the Chesapeake Bay and New York Bight DPSs. Eleven Atlantic sturgeon were reported to have been struck by vessels on the James River from 2005 through 2007. Several of these were mature individuals. From 2004-2008, 29 mortalities believed to be the result of vessel strikes were documented in the Delaware River; at least 13 of these fish were large adults. The time of year when these events occurred (predominantly May through July, with 2 in August), indicate the animals were likely adults migrating through the river to the spawning grounds. Because we do not know the percent of total vessel strikes that these observed mortalities represent, we are not able to quantify the number of individuals likely killed as a result of vessel strikes in the Chesapeake and New York Bight DPSs.

Bycatch Mortality

Overutilization of Atlantic sturgeon from directed fishing caused initial severe declines in Atlantic sturgeon populations, from which they have never rebounded. Further, continued overutilization of Atlantic sturgeon as bycatch in commercial fisheries is an ongoing impact to Atlantic sturgeon in all 5 DPSs. Atlantic sturgeon are more sensitive to bycatch mortality because they are a long-lived species, have an older age at maturity, have lower maximum reproductive rates, and a large percentage of egg production occurs later in life. Based on these life history traits, Boreman (1997) calculated that Atlantic sturgeon can only withstand the annual loss of up to 5% of their population to bycatch mortality without suffering population declines. Mortality rates of Atlantic sturgeon taken as bycatch in various types of fishing gear range between 0% and 51%, with the greatest mortality occurring in sturgeon caught by sink gillnets. Currently, there are estimates of the number of Atlantic sturgeon captured and killed in sink gillnet and otter trawl fisheries authorized by Fishery Management Plans (FMPs) in the Northeast Region (Miller and Shepherd 2011). Those estimates indicate from 2006-2010, on average there were 1,548 and 1,569 encounters per year in observed gillnet and trawl fisheries, respectively, with an average of 3,118 encounters combined annually. Mortality rates in gillnet gear were approximately 20%, while mortality rates in otter trawl gear are generally lower, at approximately 5%. Atlantic sturgeon are particularly vulnerable to being caught in sink gillnets; therefore, fisheries using this type of gear account for a high percentage of Atlantic sturgeon bycatch. Atlantic sturgeon are incidentally captured in state and federal fisheries, reducing survivorship of subadult and adult Atlantic sturgeon (ASMFC 2007; Stein et al. 2004). Little data exists on bycatch in the Southeast and high levels of bycatch underreporting are suspected. However, fisheries known to incidentally catch Atlantic sturgeon occur throughout the marine range of the species and in some riverine waters as well. Because Atlantic sturgeon mix extensively in marine waters and may access multiple river systems, they are subject to being caught in multiple fisheries throughout their range. In addition, stress or injury to Atlantic sturgeon taken as bycatch but released alive may result in increased susceptibility to other threats, such as poor water quality (e.g., exposure to toxins and low DO). This may result in reduced ability to perform major life functions, such as foraging and spawning, or even post-capture mortality.

6.2.2 Shortnose sturgeon

Shortnose sturgeon were initially listed as an endangered species by USFWS on March 11, 1967, under the Endangered Species Preservation Act (32 FR 4001). Shortnose sturgeon continued to meet the listing criteria as "endangered" under subsequent definitions specified in the 1969 Endangered Species Conservation Act and remained on the list with the inauguration of the ESA in 1973. NMFS assumed jurisdiction for shortnose sturgeon from USFWS in 1974 (39 FR 41370). The shortnose sturgeon currently remains listed as an endangered species throughout all of its range along the east coast of the United States and Canada. A recovery plan for shortnose sturgeon was published by NMFS in 1998 (NMFS 1998).

Species Description and Distribution

The shortnose sturgeon (*Acipenser brevirostrum)* is the smallest of the 3 sturgeon species that occur in eastern North America. They attain a maximum length of about 6 feet, and a weight of about 55 lbs. Shortnose sturgeon inhabit large coastal rivers of eastern North America. Although considered an anadromous species,[13] shortnose sturgeon are more properly characterized as "freshwater amphidromous," meaning that they move between fresh and salt water during some part of their life cycle, but not necessarily for spawning. Shortnose sturgeon rarely leave the rivers where they were born ("natal rivers"). Shortnose sturgeon feed opportunistically on benthic insects, crustaceans, mollusks, and polychaetes (Dadswell et al. 1984).

Historically, shortnose sturgeon were found in the coastal rivers along the east coast of North America from the Saint John River, New Brunswick, Canada, to the St. Johns River, Florida, and perhaps as far south as the Indian River in Florida (Evermann and Bean 1898; Gilbert 1989). Currently, the distribution of shortnose sturgeon across their range is disconnected, with northern populations separated from southern populations by a distance of about 250 miles (400 km) near their geographic center in Virginia (see Figure 7). In the southern portion of the range, they are currently found in the Edisto, Cooper, Altamaha, Ogeechee, and Savannah Rivers in Georgia. Sampling has also found shortnose in the Roanoke River, Albemarle Sound, and Cape Fear Rivers, while fishers have reported the species in Neuse River and Pamlico Sound (SSSRT 2010). Females bearing eggs have been collected in the Cape Fear River (Moser and Ross 1995). Spawning is known to be occurring in the Cooper River, the Congaree River, and the Yadkin-Pee Dee River (IUCN Species Assessment, in press). While it had been concluded that shortnose sturgeon are extinct from the Satilla River in Georgia, the St. Marys River along the Florida and Georgia border, and the St. Johns River in Florida (Rogers and Weber; 1995, Kahnle et al.; 1998, and Collins et al. 2000), recent targeted surveys in both the Satilla and St. Mary's have captured shortnose sturgeon. A single specimen was found in the St. Johns River by the Florida Fish and Wildlife Conservation Commission during extensive sampling of the river in 2002 and 2003.

Life History Information

Shortnose sturgeon populations show clinal variation, [14] with a general trend of faster growth and earlier age at maturity in more southern systems. Fish in the southern portion of the range grow the fastest, but growth appears to plateau over time. Conversely, fish in the northern part of the range tend to grow more slowly, but reach a larger size because they continue to grow throughout their lives. Male shortnose sturgeon mature at 2-3 years of age in Georgia, 3-5 years of age in South Carolina, and 10-11 years of age in the Saint John River, Canada. Females mature at 4-5 years of age in Georgia, 7-10 years of age in the Hudson River, New York, and 12-18 years of age in the Saint John River, Canada. Males begin to spawn 1-2 years after reaching sexual maturity and spawn every 1-2 years (Dadswell 1979; Kieffer and Kynard 1996; NMFS 1998). Age at first spawning for females is about 5 years post-maturation with spawning occurring every 3-5 years (Dadswell 1979). Fecundity of shortnose sturgeon ranges between approximately 30,000-200,000 eggs per female (Gilbert 1989).

Adult shortnose sturgeon spawn in the rivers where they were born. Initiation of the upstream movement of shortnose sturgeon to spawn is likely triggered partially by water temperatures. Shortnose sturgeon captured in 5 coastal river systems of South Carolina all spawned during temperatures ranges from 5–18°C (Post et al. 2014), which is similar to what has been documented throughout the range (Duncan et al. 2004; Hall et al. 1991; Kieffer and Kynard 1996; NMFS 1998; Taubert 1980). In the Altamaha River, Georgia, adults began their upstream migrations during likely spawning runs during the late-winter

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[13] One that lives primarily in marine waters and breeds in freshwater

[14] A gradual change in a character or feature across the distributional range of a species or population, usually correlated with an environmental or geographic transition

months when water temperatures declined to 11.6–16.9 °C (Post et al. 2014). Water depth and flow are also important at spawning sites (Kieffer and Kynard 1996). Spawning sites are characterized by moderate river flows with average bottom velocities between 1-2.5 ft (0.4-0.8 m) per second (Hall et al. 1991; Kieffer and Kynard 1996; NMFS 1998). Shortnose sturgeon tend to spawn on rubble, cobble, or large rocks (Buckley and Kynard 1985; Dadswell 1979; Kynard 1997; Taubert 1980), timber, scoured clay, or gravel (Hall et al. 1991). Southern populations of shortnose sturgeon usually spawn at least 125 miles (200 km) upriver (Kynard 1997) or throughout the fall line[15] zone if they are able to reach it. Adults typically spawn in the late winter to early spring (December-March) in southern rivers (i.e., North Carolina and south) and the mid to late spring in northern rivers. They spend the rest of the year in the vicinity of the saltwater/freshwater interface (Collins and Smith 1993).

Little is known about YOY behavior and movements in the wild, but shortnose sturgeon at this age are believed to remain in channel areas within freshwater habitats upstream of the saltwater/freshwater interface for about 1 year, potentially due to their low tolerance for salinity (Dadswell et al. 1984; Kynard 1997). Residence of YOY in freshwater is supported by several studies on cultured shortnose sturgeon (Jarvis et al. 2001; Jenkins et al. 1993; Ziegeweid et al. 2008). In most rivers, juveniles aged 1 and older join adults and show similar patterns of habitat use (Kynard 1997). In the Southeast, juveniles aged 1 year and older make seasonal migrations like adults, moving upriver during warmer months where they shelter in deep holes, before returning to the fresh/saltwater interface when temperatures cool (Collins et al. 2002; Flournoy et al. 1992). Due to their low tolerance for high temperatures, warm summer temperatures (above 82°F) may severely limit available juvenile rearing habitat in some rivers in the southeastern United States. Juveniles in the Saint John, Hudson, and Savannah Rivers use deep channels over sand and mud substrate for foraging and resting (Dovel et al. 1992; Hall et al. 1991; Pottle and Dadswell 1979).

Status and Population Dynamics

The 1998 shortnose sturgeon recovery plan identified 19 distinct shortnose sturgeon populations based on natal rivers. Since 1998, significantly more tagging/tracking data on straying rates to adjacent rivers has been collected, and several genetic studies have determined where coastal migrations and effective movement (i.e., movement with spawning) are occurring. Genetic analyses aided in identifying population structure across the range of shortnose sturgeon. Several studies indicate that most, if not all, shortnose sturgeon riverine populations are statistically different ($p < 0.05$) (King et al. 2001; Waldman et al. 2002; Wirgin et al. 2005; Wirgin et al. 2010; Wirgin et al. 2000). Gene flow is low between riverine populations indicating that while shortnose sturgeon tagged in one river may later be recaptured in another, it is unlikely the individuals are spawning in those non-natal rivers. This is consistent with our knowledge that adult shortnose sturgeon are known to return to their natal rivers to spawn. However, Fritts et al. (2016) provide evidence that greater mixing of riverine populations occurs in areas where the distance between adjacent river mouths is relatively close, such as in the Southeast.

A side from genetic differences associated with shortnose sturgeon only spawning in their natal rivers, researchers have also identified levels of genetic differentiation that indicate high degrees of reproductive isolation in at least 3 groupings (i.e., metapopulations) (Figure 7). Shortnose sturgeon in the Southeast comprise a single metapopulation, the "Carolinian Province" (Figure 7) Wirgin et al. (2010) note that

[15] The fall line is the boundary between an upland region of continental bedrock and an alluvial coastal plain, sometimes characterized by waterfalls or rapids.

genetic differentiation among populations within the Carolinian Province was considerably less pronounced than among those in the other 2 metapopulations (i.e., Virginian Province and Acadian Province) and contemporary genetic data suggest that reproductive isolation among these populations is less than elsewhere. In other words, the shortnose sturgeon populations within the Carolinian Province are more closely related to each other, than the populations that make up either the Virginian or Acadian Provinces.

The 3 shortnose sturgeon metapopulations should not be considered collectively but as individual units of management because each is reproductively isolated from the other and constitutes an evolutionarily (and likely an adaptively) significant lineage. The loss of any metapopulation would result in the loss of evolutionarily significant biodiversity and would result in a significant gap(s) in the species' range. Loss of the southern shortnose sturgeon metapopulation would result in the loss of the southern half of the species' range (i.e., there is no known reproduction south of the Delaware River). Loss of the mid-Atlantic metapopulation (Virginian Province) would create a conspicuous discontinuity in the range of the species from the Hudson River to the northern extent of the Southern metapopulation. The northern metapopulation constitutes the northernmost portion of the U.S. range. Loss of this metapopulation would result in a significant gap in the range that would serve to isolate the shortnose sturgeon that reside in Canada from the remainder of the species' range in the United States. The loss of any metapopulation would result in a decrease in spatial range, biodiversity, unique haplotypes, adaptations to climate change, and gene plasticity. Loss of unique haplotypes that may carry geographic specific adaptations would lead to a loss of genetic plasticity and, in turn, decrease adaptability. The loss of any metapopulation would increase species' vulnerability to random events.

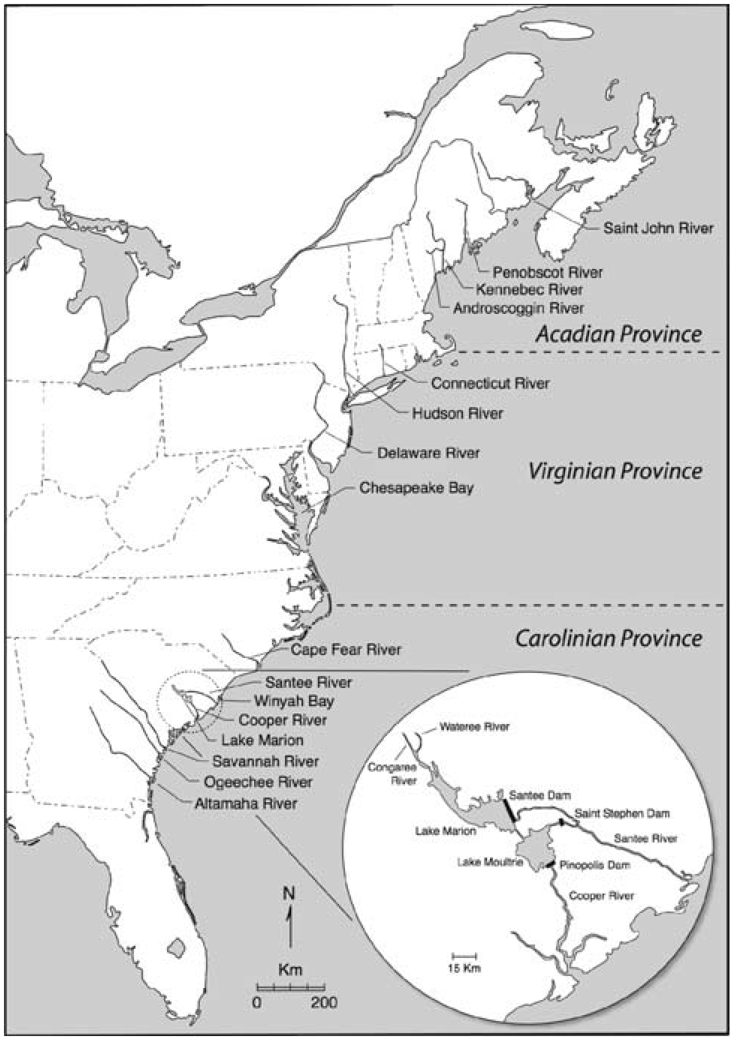

Figure 7. The North American Atlantic coast depicting 3 shortnose sturgeon metapopulations based on mitochondrial DNA control region sequence analysis (Wirgin et al. 2010).

The current status of the shortnose sturgeon in the Southeast is variable. Populations within the southern metapopulation are relatively small compared to their northern counterparts. Table 17 shows available abundance estimates for rivers in the Southeast. The Altamaha River supports the largest known shortnose sturgeon population in the Southeast with successful self-sustaining recruitment. Total population estimates in the Altamaha show large interannual variation is occurring; estimates have ranged from as low as 468 fish in 1993 to over 5,550 fish in 2006 (NMFS 1998; Peterson and Bednarski 2013). Abundance estimates for the Ogeechee River indicate the shortnose sturgeon population in this river is considerably smaller than in the Altamaha River. The highest point estimate since 1993 occurred in 2007 and resulted in a total Ogeechee River population estimate of 404 shortnose sturgeon (95% confidence interval [CI]: 175-633) (Peterson and Farrae 2011). However, subsequent sampling in 2008 and 2009 resulted in point estimates of 264 (95% CI: 126-402) and 203 (95% CI: 32-446), respectively (Peterson and Farrae 2011), suggesting the population may be declining. Spawning is also occurring in the Savannah, Cooper, Congaree, and Yadkin-Pee Dee Rivers. The Savannah River shortnose sturgeon population is possibly the second largest in the Southeast with an estimated 1,000-3,000 adults, but faces many environmental stressors and spawning is likely occurring in only a very small area. While active spawning is occurring in South Carolina's Winyah Bay complex (Black, Sampit, Yadkin-Pee Dee, and Waccamaw Rivers) the population status there is unknown. The most recent estimate for the Cooper Rivers suggests a population of approximately 220 spawning adults (Cooke et al. 2004). Status of the other riverine populations supporting the southern metapopulation is unknown due to limited survey effort, with capture in some rivers limited to less than 5 specimens.

Table 17. Shortnose Sturgeon Populations and Their Estimated Abundances

Population (Location)	Data Series	Abundance Estimate (CI)[a]	Population Segment	Reference
Cape Fear River (NC)		>50	Total	
Winyah Bay (NC, SC)		unknown		
Santee River (SC)		unknown		
Cooper River (SC)	1996-1998	220 (87-301)	Adults	(Cooke et al. 2004)
ACE Basin (Ashepoo, Combahee, and Edisto Rivers) (SC)		unknown		
Savannah River (SC, GA)		1,000 - 3,000	Adults	B. Post, SCDNR 2003; NMFS unpublished
Ogeechee River (GA)	1993	361 (326-400)	Total	Rogers and Weber 1994; NMFS 1998b
	1999-2000	147 (104-249)	Total	(Fleming et al. 2003)
	2007	404 (175-633)	Total	(Peterson and Farrae 2011)
	2008	264 (126-402)	Total	
	2009	203 (32-446)	Total	
Altamaha River (GA)	1988	2,862 (1,069-4,226)	Total	NMFS 1998a
	1990	798 (645-1,045)	Total	NMFS 1998a
	1993	468 (316-903)	Total	NMFS 1998a
	2006	5,551 (2,804–11,304)	Total	(Peterson and Bednarski 2013)
	2009	1,206 (566–2,759)	Total	
Satilla River (GA)		N/A		
Saint Marys River (FL)		N/A		
St. Johns River (FL)		unknown		FFWCC 2007c

[a] Population estimates (with confidence intervals [CIs]) are established using different techniques and should be viewed with caution. In some cases, sampling biases may have violated the assumptions of the procedures used or resulted in inadequate representation of a population segment. Some estimates (e.g., those without CIs or those that are depicted by ranges only) are the "best professional judgment" of researchers based on their sampling effort and success.

Annual variation in population estimates in many basins is due to changes in yearly capture rates that are strongly correlated with weather conditions (e.g., river flow, water temperatures). In "dry years," fish move into deep holes upriver of the saltwater/freshwater interface, which can make them more susceptible to gillnet sampling. Consequently, rivers with limited data sets among years and limited sampling periods within a year may not offer a realistic representation of the size or trend of the shortnose sturgeon population in the basin. As a whole, the data on shortnose sturgeon populations is rather limited and some of the differences observed between years may be an artifact of the models and assumptions used by the various studies.

Threats

The shortnose sturgeon was listed as endangered under the ESA as a result of a combination of habitat degradation or loss (resulting from dams, bridge construction, channel dredging, and pollutant discharges), mortality (from impingement on cooling water intake screens, turbines, climate change, dredging, and incidental capture in other fisheries), and the inadequacy of regulatory mechanisms in ameliorating these impacts and threats. The primary threats to the species today are described below.

Dams

Dams for hydropower generation, flood control, and navigation adversely affect shortnose sturgeon habitat by impeding access to spawning, developmental, and foraging habitat, modifying free-flowing rivers to reservoirs, physically damaging fish on upstream and downstream migrations, and altering water quality in the remaining downstream portions of spawning and nursery habitat. Fish passage has not proven very successful in minimizing the impacts of dams on shortnose sturgeon, as they do not regularly use existing fish passage devices, which are generally designed to pass pelagic fish (i.e., those living in the water column) rather than bottom-dwelling species like sturgeon. Dams have separated the shortnose sturgeon population in the Cooper River, trapping some above the structure while blocking access upstream to sturgeon below the dam. Telemetry studies indicate that some shortnose sturgeon do pass upriver through the vessel lock in the Pinopolis Dam on the Cooper River in the Santee Cooper Lakes (Post et al. 2014). In 2011, 2 tagged shortnose sturgeon used the vessel lock in the Pinopolis Dam to pass upstream of the dam. One of the sturgeon was still inhabiting the lakes as of 2013, while the other sturgeon entered Lake Moultrie in March and returned to the Cooper River in April, either through the Pinopolis Lock or through the turbines at Jefferies Power Station (Post et al. 2014). Shortnose sturgeon inhabit only Lake Marion, the upper of the 2 reservoirs. There is currently no estimate for the portion of the population that inhabits the reservoirs and rivers above the dam.

Additional impacts from dams include the Kirkpatrick Dam (aka Rodman Dam) located about ~12.9 km upstream from the St. Johns River, Florida on the Ocklawaha River (the largest tributary) as part of the Cross Florida Barge Canal. The Ocklawaha River has been speculated as the spawning area for shortnose sturgeon (SSSRT 2010). The New Savannah Bluff Lock and Dam located on the Savannah River on the South Carolina and Georgia border also impedes shortnose sturgeon from accessing upstream shoal areas (IUCN Species Assessment, in press).

Dredging

Riverine, nearshore, and offshore areas are often dredged to support commercial shipping and recreational boating, construction of infrastructure, and marine mining. Environmental impacts of dredging include the direct removal/burial of prey species; turbidity/siltation effects; contaminant resuspension; noise/disturbance; alterations to hydrodynamic regime and physical habitat; and actual loss of riparian habitat (Chytalo 1996; Winger et al. 2000). Dredging in spawning and nursery grounds modifies the quality of the habitat and further restricts the extent of available habitat in the Cooper and Savannah Rivers, where shortnose sturgeon habitat has already been modified and restricted by the presence of dams.

Water Quality

Shortnose sturgeon rely on a variety of water quality parameters to successfully carry out their life functions. Low dissolved oxygen (DO) and the presence of contaminants modify the quality of sturgeon habitat and, in some cases, restrict the extent of suitable habitat for life functions. Secor (1995) noted a correlation between low abundances of sturgeon during this century and decreasing water quality caused by increased nutrient loading and increased spatial and temporal frequency of hypoxic (low oxygen) conditions. Of particular concern is the high occurrence of low DO coupled with high temperatures in the river systems throughout the range of the shortnose sturgeon in the Southeast. For example, shallow water in many of the estuaries and rivers in North Carolina and South Carolina will reach temperatures nearing 30ºC in the summer months. Both low flow and high water temperatures can cause DO levels to drop to less than 3.0 mg/L (IUCN Species Assessment, in press). Sturgeon are more sensitive to low DO than other fish species (Niklitschek and Secor 2009b; Niklitschek and Secor 2009a), and low DO in combination with high temperature is particularly problematic.

Water Quantity

Water allocation issues are a growing threat in the Southeast and exacerbate existing water quality problems. Taking water from one basin and transferring it to another fundamentally and irreversibly alters natural water flows in both the originating and receiving basins. This transfer can affect DO levels, temperature, and the ability of the basin of origin to assimilate pollutants (GWC 2006). Water quality within the river systems in the range of the shortnose sturgeon is negatively affected by large water withdrawals. Known water withdrawals of over 240 million gallons per day are permitted from the Savannah River for power generation and municipal uses. However, permits for users withdrawing less than 100,000 gallons per day are not required, so actual water withdrawals from the Savannah River and other rivers within the range of the shortnose sturgeon are likely much higher. The removal of large amounts of water from the system alters flows, temperature, and DO. Water shortages and "water wars" are already occurring in the rivers occupied by the shortnose sturgeon and will likely be compounded in the future by human population growth and potentially by climate change.

Climate Change

Shortnose sturgeon in the Southeast are within a region the Intergovernmental Panel on Climate Change (IPCC) predicts will experience overall climatic drying (IPCC 2007). The Southeast has experienced an ongoing period of drought since 2007. During this time, South Carolina experienced drought conditions that ranged from moderate to extreme (SCSCO 2008). From 2006 until mid-2009, Georgia experienced the worst drought in its history. In September 2007, many of Georgia's rivers and streams were at their lowest levels ever recorded for the month, and new record low daily stream flows were recorded at 15 rivers with 20 or more years of data in Georgia (USGS 2007). The drought worsened in September 2008. All streams in Georgia except those originating in the extreme southern counties were extremely low. While Georgia has periodically undergone periods of drought—there have been 6 periods of drought lasting from 2-7 years since 1903 (USGS 2000)—drought frequency appears to be increasing (Ruhl 2003). Abnormally low stream flows can restrict access by sturgeon to habitat areas and exacerbate water quality issues such as water temperature, reduced DO, nutrient levels, and contaminants.

Shortnose sturgeon are already susceptible to reduced water quality resulting from dams, inputs of nutrients, contaminants from industrial activities and nonpoint sources, and interbasin transfers of water. The IPCC report projects with high confidence that higher water temperatures and changes in extremes in this region, including floods and droughts, will affect water quality and exacerbate many forms of water pollution from sediments, nutrients, dissolved organic carbon, pathogens, pesticides, and salt, as well as thermal pollution, with possible negative impacts on ecosystems (IPCC 2007). In addition, sea level rise is projected to extend areas of salinization of groundwater and estuaries, resulting in a decrease of freshwater availability for humans and ecosystems in coastal areas. Some of the most populated areas of this region are low-lying; the threat of saltwater entering into this region's aquifers with projected sea level rise is a concern (USGRG 2004). Existing water allocation issues would be exacerbated, leading to an increase in reliance on interbasin water transfers to meet municipal water needs, further stressing water quality. Dams, dredging, and poor water quality have already modified and restricted the extent of suitable habitat for shortnose sturgeon spawning and nursery habitat. Changes in water availability (depth and velocities) and water quality (temperature, salinity, DO, contaminants, etc.) in rivers and coastal waters inhabited by shortnose sturgeon resulting from climate change will further modify and restrict the extent of suitable habitat for shortnose sturgeon. Effects could be especially harmful since these populations have already been reduced to low numbers, potentially limiting their capacity for adaptation to changing environmental conditions (Belovsky 1987; Salwasser et al. 1984; Soulé 1987; Thomas 1990).

Bycatch

Overutilization of shortnose sturgeon from directed fishing caused initial severe declines in shortnose sturgeon populations in the Southeast, from which they have never rebounded. Further, continued collection of shortnose sturgeon as bycatch in commercial fisheries is an ongoing impact. Shortnose sturgeon are incidentally caught in state shad gillnet fisheries is occurring in the Ogeechee and Altamaha rivers (IUCN Species Assessment, in press). Shortnose sturgeon are sensitive to bycatch mortality because they are a long-lived species, have an older age at maturity, have lower maximum reproductive rates, and a large percentage of egg production occurs later in life. In addition, stress or injury to shortnose sturgeon taken as bycatch but released alive may result in increased susceptibility to other threats, such as poor water quality (e.g., exposure to toxins and low DO). This may result in reduced ability to perform major life functions, such as foraging and spawning, or even post-capture mortality.

As a wide-ranging anadromous species, shortnose sturgeon are subject to numerous federal (United States and Canadian), state, provincial, and interjurisdictional laws, regulations, and agencies' activities. While these mechanisms have addressed impacts to shortnose sturgeon through directed fisheries, there are currently no mechanisms in place to address the significant risk posed to shortnose sturgeon from commercial bycatch. Though statutory and regulatory mechanisms exist that authorize reducing the impact of dams on riverine and anadromous species, such as shortnose sturgeon, and their habitat, these mechanisms have proven inadequate for preventing dams from blocking access to habitat upstream and degrading habitat downstream. Further, water quality continues to be a problem in the historical spawning rivers along the Atlantic coast, even with existing controls on some pollution sources. Current regulatory authorities are not necessarily effective in controlling water allocation issues (e.g., no restriction s on interbasin water transfers in South Carolina, the lack of ability to regulate non-point source pollution).

6.3 Atlantic Sturgeon Critical Habitat

In August 2017, the NMFS issued the final rule to designate critical habitat for the threatened Gulf of Maine distinct population segment (DPS) of Atlantic sturgeon, the endangered New York Bight DPS of Atlantic sturgeon, the endangered Chesapeake Bay DPS of Atlantic sturgeon, the endangered Carolina DPS of Atlantic sturgeon and the endangered South Atlantic DPS of Atlantic sturgeon pursuant to the Endangered Species Act (ESA). Specific occupied areas designated as critical habitat for the Carolina DPS of Atlantic sturgeon contain approximately 1,939 km (1,205 miles) of aquatic habitat in the following rivers of North Carolina and South Carolina: Roanoke, Tar-Pamlico, Neuse, Cape Fear, Northeast Cape Fear, Waccamaw, Pee Dee, Black, Santee, North Santee, South Santee, and Cooper, and the following other water body: Bull Creek. Specific occupied areas designated as critical habitat for the South Atlantic DPS of Atlantic sturgeon contain approximately 2,883 km (1,791 miles) of aquatic habitat in the following rivers of South Carolina, Georgia, and Florida: Edisto, Combahee-Salkehatchie, Savannah, Ogeechee, Altamaha, Ocmulgee, Oconee, Satilla, and St. Marys Rivers.

Essential Features of Critical Habitat

The NMFS determined that the key conservation objectives for the Carolina and South Atlantic DPSs of Atlantic sturgeon are to increase the abundance of each DPS by facilitating increased survival of all life stages and facilitating adult reproduction and juvenile and subadult recruitment into the adult population. We determined the physical features essential to the conservation of the species and that may require special management considerations or protection, which support the identified conservation objectives, are:

(1) Hard bottom substrate (*e.g.,* rock, cobble, gravel, limestone, boulder, etc.) in low salinity waters (*i.e.,* 0.0-0.5 ppt range) for settlement of fertilized eggs and refuge, growth, and development of early life stages;

(2) Transitional salinity zones inclusive of waters with a gradual downstream gradient of 0.5- up to 30 ppt and soft substrate (*e.g.,* sand, mud) between the river mouths and spawning sites for juvenile foraging and physiological development;

(3) Water of appropriate depth and absent physical barriers to passage (*e.g.,*locks, dams, thermal plumes, turbidity, sound, reservoirs, gear, etc.) between the river mouths and spawning sites necessary to support:

(i) Unimpeded movement of adults to and from spawning sites;

(ii) Seasonal and physiologically-dependent movement of juvenile Atlantic sturgeon to appropriate salinity zones within the river estuary; and

(iii) Staging, resting, or holding of subadults or spawning condition adults.

Water depths in main river channels must also be deep enough (at least 1.2 m) to ensure continuous flow in the main channel at all times when any sturgeon life stage would be in the river.

(4) Water quality conditions, especially in the bottom meter of the water column, between the river mouths and spawning sites with temperature and oxygen values that support:

(i) Spawning;

(ii) Annual and inter-annual adult, subadult, larval, and juvenile survival; and

(iii) Larval, juvenile, and subadult growth, development, and recruitment. Appropriate temperature and oxygen values will vary interdependently, and depending on salinity in a particular habitat. For example, 6.0 mg/L DO or greater likely supports juvenile rearing habitat, whereas DO less than 5.0 mg/L for longer than 30 days is less likely to support rearing when water temperature is greater than 25 °C. In temperatures greater than 26 °C, DO greater than 4.3 mg/L is needed to protect survival and growth. Temperatures of 13 to 26 °C likely to support spawning habitat.

Further Information

Further information on designated critical habitat for the endangered Carolina distinct population segment of the Atlantic sturgeon (Carolina DPS of Atlantic sturgeon) and the endangered South Atlantic distinct population segment of the Atlantic sturgeon (South Atlantic DPS of Atlantic sturgeon) can be found at: 82 FR 39160.

7. Conclusion and Effects Determinations

Using the best available data, we analyzed the effects of the proposed actions in the context of the status of the species and aggregate effects, and determined that the proposed actions, that may be authorized using the Programmatic Informal Consultation as the Section 7 consultation analysis, are not likely to adversely affect listed species of sea turtles or shortnose or Atlantic sturgeon. Additionally, Atlantic sturgeon critical habitat will not be affected in a way that will impede the critical habitat's ability to support Atlantic sturgeon conservation, despite small, permanent effects. Therefore, the proposed actions are not likely to adversely affect Atlantic sturgeon critical habitat.

It is important to note that the conclusions drawn are based on a series of assumptions (see Section 4.3). Because a programmatic consultation by nature covers future actions that have not been specifically identified, the analysis is based on the actions that occurred during the last 5 years and future projections to estimate the number of actions that may be authorized in the future using this as the Section 7 consultation analysis requirement. Our analysis was based on a 5-year period to account for annual variability; however, projects/activities will continue to be reviewed on an annual basis and every 5 years so long as the programmatic consultation continues to be accurate. A series of assumptions are made based on the best available data, PDCs are in place to define the limits of the proposed actions (see Section 4.1), and project-level review and programmatic review reporting is required to evaluate that the activities authorized meet the assumptions made and that the effects are consistent with the analysis.

If the assumptions are inaccurate or the effects are outside of the scope of this programmatic consultation, then consultation must be reinitiated. This determination will be made at the programmatic review between FHWA and NMFS or at any time information becomes known showing activities covered by the programmatic are having effects not covered herein.

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Appendix A: In-water Construction Noise

Appendix, with minor edits for clarity, adopted from the U.S. Army Corps of Engineers Jacksonville District's Programmatic Biological Opinion (JAXBO). All citations can be found in the original document.

1. Glossary of Terms

Abandonment – In reference to species' use of an area, the long-term discontinued resting, feeding, mating, or nursing areas, or other areas that are important to the species.

Avoidance – In reference to species' reaction to noise, individuals may avoid an area for the duration a noise is present.

Behavioral Zone – The distance from pile driving within which species might experience potentially adverse behavioral reactions.

Cumulative Sound Exposure Level (cSEL) – A measurement of the accumulated sound energy associated with a series of pile strikes occurring during a construction event. cSEL at a certain level can physically injure species. cSEL can be estimated from the single-strike (SEL) and the number of strikes that likely would be required to place the pile at its final depth by using the following equation:

cSEL = sSEL + 10 log(number of pile strikes) for impact pile driving

cSEL = sSEL + 10 log(time in seconds) for vibratory pile driving.

Cylindrical Spreading – Sound that spreads away from a source in the shape of a cylinder. In some environments, sound will not propagate uniformly in all directions from a source. A simple approximation for spreading loss in a medium with upper and lower boundaries, such as the ocean, can be obtained by assuming that the sound is distributed uniformly over the surface of a cylinder having a radius equal to the range r and a height H equal to the distance between the upper and lower boundary (in the example of the ocean, the depth of the ocean). Beyond some range, the sound will hit the sea surface or sea floor, or other reflective surfaces.

Dry Firing – A method of raising and dropping the pile-driving hammer with no compression of the pistons, producing a lower-intensity sound than the full power of the hammer.

Effective Quiet – The level at which a sound becomes too quiet to contribute to hearing loss from cumulative sound exposure.

Ensonified – An area where sound is present. In the Opinion, the ensonified zone refers to the area of water where the sound from the noise-generating pile driving is present.

Habituation – Becoming accustomed to noise through repeated or prolonged exposure. Habituation can occur even when negative consequences result.

Harassment Zone – The distance from a noise within which behavioral reactions or temporary threshold shift may occur.

Impact Zone – The distance from the pile encompassing the effects of interest (i.e., the physical injury zone and/or the behavior zone).

Onset of injury - The point at which a permanent threshold shift or tissue damage occurs.

Physical Injury Zone – The distance from a noise source within which physical injury is expected.

Masking – Obscuring of softer sounds of interest by louder sounds at similar frequencies. Masking of the vocalizations of conspecifics, mates, predators, and other important signals may affect marine mammals. An analogous effect in humans would be the experience of having difficulty discerning an individual person's speech at loud parties.

Mortality Zone – The distance from a noise source within which mortality may occur.

No response – Some species may exhibit no apparent response to a noise while other species exhibit strong responses. No apparent response may indicate undetectable effects (e.g., habituation, permanent threshold shift, and stress).

Peak Pressure – The loudest sound impulse at any instant in time during a strike. Peak pressure is the maximum positive pressure between zero and the greatest pressure of signals in units of dB re 1 µPa peak or 0-peak for impulsive pile-driving noise. 0-p values are not to be confused with peak-to-peak measurements (p-p). Exposure to peak pressure above a certain level can result in physical injury.

Permanent Threshold Shift – Permanent shift in the auditory threshold from exposure to loud noise over a period of time. Permanent threshold shift is considered permanent hearing loss, and such a loss may affect foraging success, mate acquisition, and other biologically important activities.

Physical Injury – Some sounds, such as pressure waves or intense noise from a source, create pressure waves or high-energy sound waves that can result in tissue damage, including swim bladder damage. When we discuss physical injury from noise, we are referring to these types of injuries (tissue damage) and permanent threshold shift.

Physiological Stress – Noise is a potential environmental stressor and physiological stress is the term for the physiological response to that stressor. For example, noise can trigger immune system responses that can affect the health of animals.

Ramp-Up – A method that involves slowly increasing the power of the hammer, and thus the noise the hammer produces, over a period of time prior to operating at full power and beginning work.

Root Mean Square (RMS) – A type of average. In the context of measuring noise in an aquatic environment, the RMS represents the total sound energy in a single strike impulse. It is a decibel measure of the square root of the mean square pressure. For impulses, the average of the squared pressures over the time that comprise that portion of the waveform containing 90% of the sound energy of the impulse. Exposure to RMS above a certain level can result in behavior effects.

Sensitization – Increased behavioral response over time as animals learn that a repeating or ongoing noise has significant consequences.

Single Strike Sound Exposure Level (sSEL) – An index of the 90% of the sound energy in a single strike. Exposure to sSEL at certain levels can result in physical injury.

Sound Exposure Level (SEL) – Sound energy associated with a pile-driving pulse (sSEL), or series of pulses (cSEL), is characterized by the SEL. SEL is calculated by summing the cumulative pressure squared over the time of the event.

Spherical Spreading – Spherical spreading describes the decrease in level when a sound wave propagates away from a source uniformly in all directions from a sound source in the shape of a sphere.

Temporary Threshold Shift – Temporary hearing loss caused by a decreased sensitivity in hearing. The analogous effect in humans is ringing in the ears and loss of hearing experienced after a loud concert. Temporary threshold shift is generally fully recoverable within hours or days and results in short-term effects.

Watch Zone – A protective buffer zone to be monitored to detect animals that are heading towards the impacted area. The watch zone radius may vary depending on the type of project and species potentially occurring in the project area.

2. How in-water Noise effects ESA-listed Species Are Evaluated

Sea turtles and sturgeon are low-frequency hearing generalists (Table 1) and are able to detect the vibrations and lower frequency sound components associated with construction noise. Our current noise analysis is grouped into 2 categories, 1 for effects to fish and the other for effects to sea turtles. Although several different types of activities produce underwater sound, the analysis shows that the loudest noises of concern that may harm listed species result from impact pile-driving activities. Many other underwater noises are produced by construction activities that increase ambient noise levels, but are generally not harmful to sea turtles and fish. Since pile-driving activities occur in shallow, nearshore waters, our analysis does not consider the effects of this action on ESA-listed whales, which we would expect to occur in deeper waters.

Table 4. Hearing ranges of listed species

Species or Group	Hearing Range	References
sea turtles	100-2,000 Hz	Ketten and Bartol (2006); Lenhardt et al. (1996); Lenhardt (1994); McCauley et al. (2000a); McCauley et al. (2000b); Moein et al. (1994); O'Hara and Wilcox (1990)
sturgeon	100-2,000 Hz	(Fay and Popper 2000; Lovell et al. 2005; Meyer et al. 2003; Meyer and Popper 2002)

During impact pile-driving, noise is produced when the energy from the hammer is transferred to the pile and released into the surrounding water and sediment. We have characterized these construction activities and associated noise levels using the best available information provided by the USACE, the Florida Marine Contractors Association, and published literature. Depending on the type and location of pile-driving activity, noise can result in a spectrum of responses in species, ranging from minor to those that can disturb or injure vulnerable animals (Figure 1).

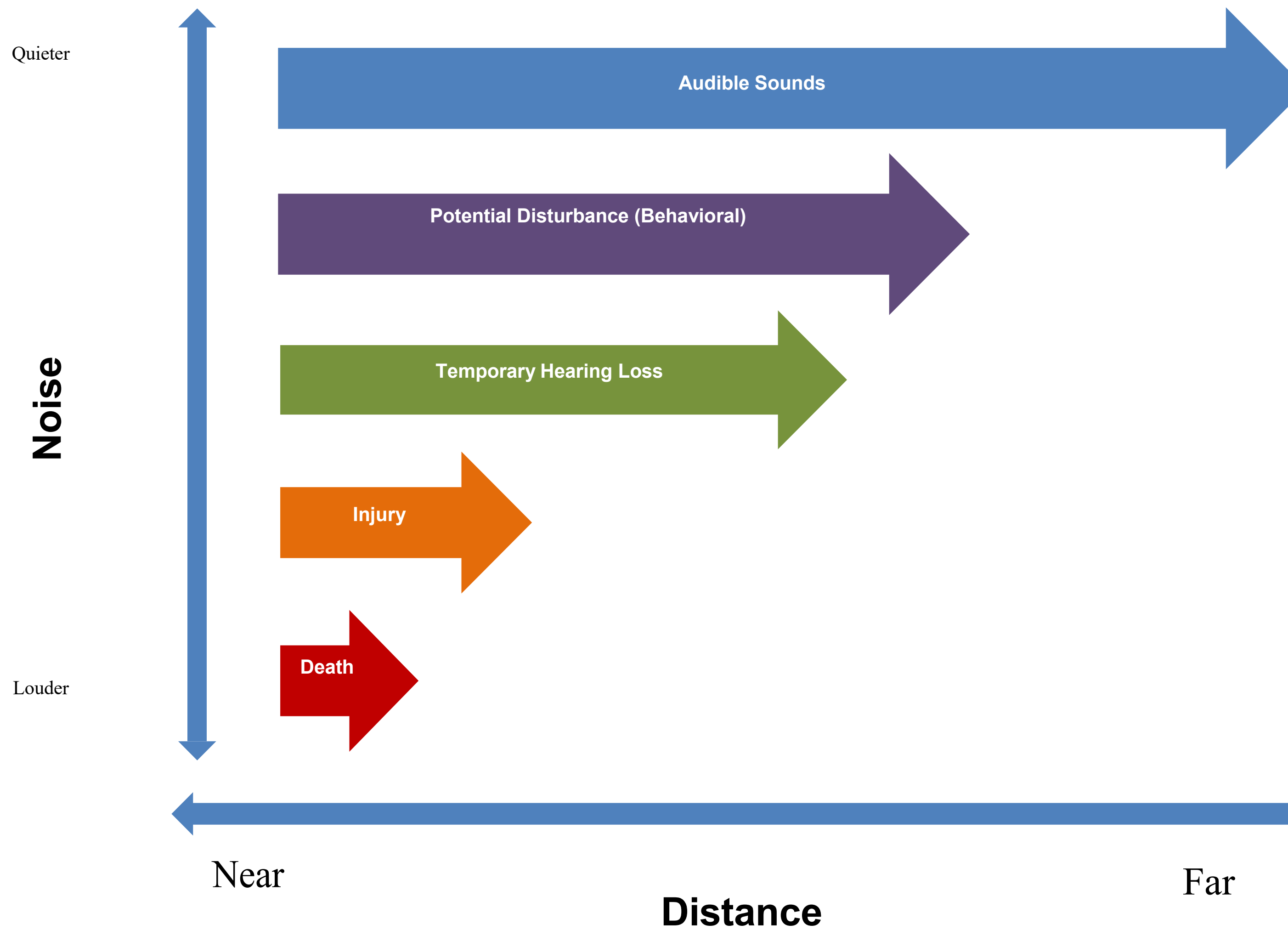


Figure 1. The relative effects to animals: distance to/from a noise source

2.1 Exposure Criteria Used to Determine Potential Effects

NMFS formed a Fisheries Hydroacoustic Working Group in 2004 to evaluate the effects of in-water noise on species under NMFS's jurisdiction. This team consists of biologists from NMFS West Coast Region, USFWS, Federal Highway Administration, and the California, Washington and Oregon Department of Transportations, supported by national experts on sound propagation activities that affect fish and wildlife species of concern. In June 2008, the agencies signed a memorandum of understanding documenting interim criteria for assessing physiological effects of pile driving on fish, until more information was available to reassess these threshold criteria. The criteria were developed for the acoustic levels at which physiological effects to fish could be expected (the onset level), referred to as interim threshold standards below. It should be noted that these onset levels for physiological effects are not the levels at which fish are necessarily mortally damaged and that some physiological effects are minor and recoverable.

These interim threshold standards are used by all of the NMFS regional offices:

- Peak pressure from a single strike: 206 decibels relative to 1 micro-Pascal (dB re 1 µPa).

- cSEL: 187 decibels relative to 1 micro-Pascal-squared second (dB re 1µPa2-s) for fishes above 2 grams (0.07 ounces).
- cSEL: 183 dB re 1µPa2-s for fishes below 2 grams (0.07 ounces).

For purposes of assessing behavioral effects of pile driving at several West Coast projects, NMFS has employed a 150 dB re 1 µPa RMS sound pressure level threshold above which it estimates fish species will experience behavioral effects at several sites including the San Francisco-Oakland Bay Bridge and the Columbia River Crossings. This behavioral threshold is also currently used by the NMFS's Greater Atlantic Regional Office and the Southeast Regional Office. NMFS's Southeast Regional Office considers the threshold for behavioral noise effects to sea turtles to be 160 dB re 1 µPa RMS sound pressure level (Skalski et al. 1992). The thresholds used by NMFS's Southeast Regional Office are summarized in Tables 72 and 73 below:

Table 5. Impact pile-driving threshold noise levels for fish and sea turtles

Effect	Animal	Threshold Level (dB re 1 µPa)[e]
Physical Injury (peak pressure)	Fish[a,b] and Sea Turtles	206 (peak pressure)
Physical Injury (Cumulative exposure)	Fish less than 2 grams	183 cSEL
Behavior	Fish[c] Sea Turtles[d]	150 (RMS) 160 (RMS)

[a] FHWA (2012). Fish are considered more sensitive to physical injury than sea turtles; therefore, fish thresholds are used for both fish and sea turtles as conservative interim criteria.

[b] (Halvorsen et al. 2012a; Halvorsen et al. 2012b)

[c] (McCauley et al. 2000b)

[d] Skalski et al. (1992)

[e] See glossary for definitions of different decibel (dB) levels.

Table 6. Continuous noise threshold levels for fish and turtles from exposure to vibratory pile-driving noise

Effect	Animal	Threshold Level (dB re 1 µPa)
Physical Injury (peak pressure)[a]	Sturgeon Sea Turtles	206 (peak pressure)
Physical Injury (Cumulative exposure)	Fish larger than 0.06 grams	234 cSEL
Behavior	Fish	150 (RMS)
	Sea Turtles	160 (RMS)

[a] Injury criteria from Hastings (2010). There are no SEL criteria for sea turtles for continuous noises.

Fish are considered more sensitive to physical injury than sea turtles; therefore, fish thresholds are used for sea turtles as conservative interim criteria

Research continues on the effects of in-water construction on fish, marine mammals, and other aquatic species. Studies by researchers indicate that the threshold of noise impacts to fish may be higher than the interim NMFS thresholds established by the Fisheries Hydroacoustic Working Group in 2008. NMFS is working to review continued research to determine if new guidance and thresholds are warranted. For instance, Halvorsen et al. (2012b)exposed 3 species of fish to pile driving noise in a laboratory setting. Following testing, fish were euthanized and examined for external and internal signs of barotrauma. Halvorsen et al. (2012b) classified the types of fish tested by differences in their anatomy that result in different physiological changes to these groups of fish from pile driving, as described below:

- Fish without swim bladders: Halvorsen et al. (2012b) tested hogchoker fish, a flat bodied fish, for this category of fish. In the southeast region, the only ESA-listed species without a swim bladder is the smalltooth sawfish.
- Physostomous (fish with open swim bladders): Halvorsen et al. (2012b) describes these fish as more evolutionarily ancestral than fish with a closed swim bladders (described below). Physostomous fish have a swim bladder that is connected to the gut via a pneaumatic duct that allows them to gulp air from the water surface and expel air quickly to adjust the volume of air within the swim bladder. They tested the lake sturgeon in their experiment for this category of fish. ESA-listed physostomous fish in the southeast region include Gulf, Atlantic, and shortnose sturgeon.
- Physoclistous (fish with closed swim bladders: Halvorsen et al. (2012b) describes these fish as recently evolved fish species. Physoclistous fish have a gas gland that provides gas exchange by diffusion between the swim bladder and blood. They tested Nile tilapia in their study for this category of fish. The only ESA-listed physostomous fish in the southeast region is the Nassau grouper.

All 3 categories of fish were exposed to a series of 5 trials beginning with a cSEL of 216 to a cSEL of 204 dB re 1uPa2-s (derived from 960 pile strikes and 186 dB re 1uPa2-s sSEL). In this and subsequent studies by Halvorsen et al. (2012a); Halvorsen et al. (2012b), injuries were categorized by a response weighted index to categorize injuries as mild, moderate, or mortal. The authors defined mild injuries response weighted index 1 as those that were non-life threatening. Based on this and similar studies, the authors made recommendations for cumulative noise exposure thresholds to be raised from the current 187 dB cSEL to 210 dB cSEL, because only mild injuries were observed up to 210 dB cSEL. Because we consider even mild injuries to be physical injury and we are concerned about the potential starting point/onset of physical injury and not the mean of when only mild injuries were observed, NMFS will continue to use the injury thresholds summarized in Tables 72 and 73 above to be conservative and protective of ESA-listed species, while acknowledging that the cumulative sound exposure threshold may be adjusted as new research becomes available.

One potentially important result of the Halvorsen et al. (2012b) study is that the hogchoker (fish without a swim bladder) did not suffer visible external or internal injuries at lower cSEL levels tested, while the swim bladder fish still suffered mild internal injuries. The fish with open swim bladders also suffered fewer internal injuries than the fish with closed swim bladders. As more research continues, this may lead to policy changes for different species of ESA-listed fish such as the smalltooth sawfish that also lacks a swim bladder. Although, another consideration for bottom-dwelling elasmobranchs such as the smalltooth sawfish is that they are often in contact with the substrate (Casper et al. 2012). The vibrations within the sediment from pile driving could also be damaging, especially when considering the body shape of sawfish. Many of the organs of these dorsoventrally flattened fishes are in close proximity to the bottom surface of the body, providing little protection from pile-driving vibrations. It is unclear if the Halvorsen et al. (2012b) study took into consideration the secondary effects of noise from vibrations within the sediment.

3. Calculations of Noise Thresholds for Pile Driving

Assumptions of the Analyses

The calculations in this document are based on a series of assumptions. These assumptions and resulting key points are provided in the list below and discussed further in this section:

- The number of piles necessary to complete construction varies by the size and intent of the project. For example, typical residential dock with an average of 15 piles requires approximately 10 hours of pile driving and can take 2 or more days to complete. Some larger residential docks can use up to 70 piles or more and noise could be produced over a period of 2 weeks or longer. Pile driving for common minor activities does not occur at night.
- Pile types considered include:
  - vinyl piles and sheet piles
  - wood piles (round timber)
  - concrete piles (in a variety of shapes including round and square)
  - metal piles used for docks and seawalls
  - metal sheet piles (steel or marine-grade aluminum).
- Noise spreads cylindrically in coastal waters and noise transmission is characterized by 15 logR spreading loss.
- Strike rates for dock construction with wood piles have been reported to occur once or twice per minute (CALTRANS 2007). The average number of strikes per pile is estimated as 45, calculated as an average of 1.5 times per minute for 30 minutes.
- Concrete pile installation is estimated to take 160 strikes per pile.
- Sheet piles and I-beams can be installed by impact hammer in no more than 12 to 15 minutes, with pile strikes about once every 1.4 seconds or 43 to 44 strikes per minute (660 strikes per pile) (CALTRANS 2007).
- Daily exposure limits are based on the installation of 10 wood or concrete piles per day.
- Vibratory pile driving may take up to 30 minutes per pile.

- Installing vinyl piles is expected to produce noise similar to that produced by the installation of wood piles. We will use the available measurements for wood piles to estimate vinyl pile noise until additional information and measures from the installation of vinyl piles is available.
- For this analysis, we considered an impact pile driver as a combustion driven device used to install piles. There are 2 main classes of impact hammers: external combustion and internal combustion. External combustion hammers use cables, steam, compressed air, or pressurized hydraulic fluid to raise the ram, which is then dropped by gravity (e.g., a drop hammer). Internal combustion hammers do not rely on gravity and force the ram into the pile (e.g., a diesel hammer). During impact pile driving, noise is produced when the energy from the hammer is transferred to the pile and released into the surrounding water and sediment as the pile makes contact with the area into which it is being driven.
- Hand installation of any type of pile was determined to not result in noise at levels that would cause physical injury from peak pressure or cumulative sound exposure or cause behavioral effects and does not require mitigation.
- The noise analysis also evaluates effects of projects occurring in both open-water and confined space settings. This differentiation is important because if a project occurs in a confined space, the animal may not be able to avoid the physical injury zone or behavioral zone or may become trapped in an area (e.g., the terminal end of a canal) due to those zones blocking the only escape route. For our noise analysis, a *confined space* is defined as any area that has a solid object (e.g., shorelines or seawalls) that creates a constricted passage area such that species attempting to move through the area would be forced to pass through the cumulative injurious zone, which is the zone in which species could be exposed to injurious noise levels if they remained in the area over a period of time. To allow species to move through the project areas without being exposed to noise at levels that could be injurious over time, the PDCs limit certain pile types and installation methods in these confined spaces to ensure that the cumulative injurious zone is limited to a maximum of half the width of the confined area.

In Florida, a confined space is considered to be any area that has a solid object (e.g., shorelines or seawalls) within 150 ft of the pile installation site. These confined space distances were calculated by doubling the cumulative injurious zone for large fish found in Florida and smaller fish found in the U.S. Caribbean an example of a confined space shown in Figure 2). Again, this ensures that a fish or sea turtle would have at least half the width of the channel free from cumulative injurious noise so that they could move through the area as needed without being exposed. Docks or other pile-supported structures do not stop or reflect noise do not create confined spaces. Conversely, in an open-water environment, the animal would be able to move away from the noise without passing through an area with injurious noise levels.

Figure 2. Example of a confined space for a noise analysis.

The left image shows a 150 ft radius in a channel resulting in the channel not being wide enough to ensure more than half the channel was free from cumulative injurious noise levels.

3.1 Pile-Driving Noise Calculations

Tables 4 and 5 below provides a summary of the noise calculation results for each of the pile types installed by each of the pile installation methods. All calculations were completed using the formulas and methods described further in this section. Pile-driving source noise data was derived from CALTRANS (2009). Source levels were back-calculated from the reported measurement distance to the pile using 15 logR cylindrical spreading loss. These calculations assume that single strike sSEL less than 150 dB does not accumulate to cause physical injury meaning the sound level has decreased sufficiently at a distance from the sound source and has reached the effective quiet (explained in more detail below).

Table 7. Impact Hammer sound source levels and impact radius distances

	Source Level (dB re 1 µPa)	**Radius for Fish less than 2 grams**	**Radius for Fish over 2 grams**	**Radius for Sea Turtles**
14-in wood pile and vinyl sheet **Calculated 10 piles installed per day with 45 strikes per pile = 450 strikes per day**				
Physical Injury (peak pressure)	195 dB Peak 175 sSEL	0 m (1 ft)	0 m (1 ft)	0 m (1 ft)
Physical Injury (Cumulative exposure)	cumulative	1 pile = 4 m (12 ft) 5 piles = 11 m (36 ft) 10 piles = 17 m (56 ft)	1 pile = 2 m (7 ft) 5 piles = 6 m (19 ft) 10 piles = 9 m (30 ft)	1 pile = 2 m (7 ft) 5 piles = 6 m (19 ft) 10 piles = 9 m (30 ft)

Behavior (RMS)	185 dB RMS	215 m (705 ft)	215 m (705 ft)	46 m (150 ft)
24-in concrete pile **Calculated 10 piles installed per day with 160 strikes per pile = 1,600 strikes per day**				
Physical Injury (peak pressure)	200 dB Peak 175 sSEL	0 m (1 ft)	0 m (1 ft)	0 m (1 ft)
Physical Injury (Cumulative exposure)	cumulative	1 pile = 9 m (28 ft) 5 piles = 25 m (83 ft) 10 piles = 40 m (131 ft)	1 pile = 5 m (15 ft) 5 piles = 14 m (50 ft) 10 piles = 22 m (71 ft)	1 pile = 5 m (15 ft) 5 piles = 14 m (50 ft) 10 piles = 22 m (71 ft)
Physical Injury (peak pressure)	185 dB	215 m (705 ft)	215 m (705 ft)	46 m (150 ft)
24-in metal sheet pile **Calculated 10 sheet piles installed per day with 660 strikes per pile = 6,600 strikes per day**				
Physical Injury (peak pressure)	220 dB Peak 194 dB sSEL	9 m (30 ft)	9 m (30 ft)	9 m (30 ft)
Physical Injury (Cumulative exposure)	cumulative	1 pile = 410 m (1,345 ft) 10 piles = 858 m (2,815 ft)	1 pile = 223 m (731 ft) 10 piles = 858 m (2,815 ft)	1 pile = 223 m (731 ft) 10 piles = 858 m (2,815 ft)
Physical Injury (peak pressure)	204 dB RMS	858 m (2,8215 ft)	858 m (2,8215 ft)	185 m (607 ft)

Table 8. Vibratory Hammer sound source levels and impact radius distances

	Source Level (dB re 1 µPa)	**Radius for Fish over 2 grams**	**Radius for Sea Turtles**
13-in wood, concrete, vinyl, or metal piles **Calculated 10 piles installed per day for 30 minutes (1,800 seconds) per pile = 18,000 seconds per day**			
Physical Injury	186 dB Peak	0 m (0 ft)	0 m (0 ft)

(peak pressure)			
Physical Injury (Cumulative exposure)	cumulative	0 m (0 ft)	0 m (0 ft)
Behavior (RMS)	170 dB RMS	22 m (72 ft)	5 m (16 ft)
24-in metal sheet pile **Calculated 10 sheet piles installed per day for 30 minutes (1,800 seconds) per pile = 3,600 seconds per day**			
Physical Injury (peak pressure)	192 dB Peak	0 m (0 ft)	0 m (0 ft)
Physical Injury (Cumulative exposure)	cumulative	0 m (0 ft)	0 m (0 ft)
Behavior (RMS)	178 dB RMS	74 m (243 ft)	16 m (52 ft)

Underwater Construction Noises below the Threshold Levels for Physical Injury or Behavioral Effects

During our calculations, we determined that auger, drop punch, jetting, installation by land-based equipment, and hand installation did not result in noise levels that would cause physical injury or behavioral effects on listed species. These activities can temporarily increase ambient noise levels in an area, but we do not expect them to result in physical injury or behavioral effects to listed species, and thus we believe they will have no effect on the species.

1. **Auger:** When installing piles into hard substrates, sometimes a pilot hole is created using an auger, or by drop punching. Noise levels from small-scale drilling operations that are representative of dock construction methods have been measured to be no more than 107 dB re 1 µPa (0-peak) at 7.5 m from the source (Willis et al. 2010). Our back-calculation resulted in an approximate source level no greater than 120 dB re 1 µPa (0-peak). Noise associated with augering is below the behavioral and injury thresholds used in this analysis, and is discountable.
2. **Drop punching** is a method that uses a 12- to 24-in-diameter steel punch dropped repeatedly from a barge-mounted crane. After the pilot hole is created, the pile is inserted then driven to resistance using an impact hammer. Noise generated during drop punching has either not been measured or is unreported in the available literature. The best available information on construction equipment striking the sea bottom comes from measurements of bucket dredge noise. The noise produced from the heavy bucket dropped onto the channel bottom was measured to be 124 dB re 1 µPa (RMS) at 150 m from the work site (Dickerson et al. 2001). Back-calculating the noise attenuation 150 m results in a potential source level of 156 dB re 1 µPa (RMS), 6 dB above the behavioral threshold for fish. However, drop punch noise falls below 150 dB re 1 µPa (RMS) within a few feet of the installation site, and is well below the potential injury thresholds used in this analysis. In addition, the PDCs in this Opinion require crews to shut down construction equipment if protected species are observed within 50 ft of the project.

3. **Jetting** uses high-pressure water sprayed beneath the pile to excavate sediment and sand layers, and is often used in conjunction with other pile-driving methods to assist penetration of the pile into the substrate. Jetting results in much lower noise levels than either impact or vibratory pile driving alone and minimizes the amount of hammering necessary. Noise measurements taken with water jetting turned on or off during pile driving resulted in no additional noise recorded above that of the pile-driving noise (CALTRANS 2007). For complete pile replacement in the existing footprint, with no new piles driven, the source levels for jetting could be up to 170.5 dB re 1 µPa (peak) (Molvaer and Gjestland 1981) or about 160 dB (RMS), which would result in small behavioral zone for smalltooth sawfish and sturgeon (about 10-15 m) and no behavioral disturbance for sea turtles. Water jetting noise has an associated behavioral zone up to 15 m for fish, but this zone is within the same distance that construction is likely occurring and is too small to have any significant effect on fish behavior or habitat and is will be insignificant.

4. **Land-based equipment** does not generate noise in the marine environment that reach levels high enough to exceed the behavioral and physical injury thresholds used in this analysis. Because the air-water interface is an almost perfect reflector of acoustic waves, the noise generated by land-based mechanical excavators, generators, or other machinery will reflect off the surface and will not be transmitted into the water at levels expected to affect the species.
5. **Hand installation** of any type of pile was determined to not result in injurious or behavioral noise impacts and does not require mitigation.

3.2 Noise Control Measures to Reduce Injury

There has been a fair amount of work performed in reducing noise from pile driving, which is summarized in Table 6. For coastal waters, 'bubble curtains' have been the primary focus of noise control efforts based on their sound attenuation capabilities (when properly designed) and cost effectiveness. Recently, confined bubble curtains and TNAPs (also referred to as pile isolation casings) have shown consistently good results as noise-reducing measures. This section evaluates the effectiveness of these noise abatement measures and others.

Table 9. Effectiveness and cost of noise control measures for pile driving

Sound Treatment	Description	Effectiveness		Cost
		Reduction	Metric	
Bubble curtain or bubble tree	Air bubbles used to block sound	5-20+ dB	RMS, Peak, SEL	$50-200
Confined bubble curtain	A fabric, solid, or tubular curtain is used to confine bubbles	9-22 dB	RMS, Peak, Particle velocity	$100-200
Pile caps	Micarta caps used between the impact piling head and the pile to reduce noise	1-8 dB	RMS, Peak, SEL	Low material cost. May increase time to install pile.

Wood pile cushions	A block of wood used between the pile head and pile to reduce noise (often used with a pile cap).	11-26 dB	RMS, Peak, SEL	Low material cost. May increase time to install pile.
Temporary Noise Attenuation Pile	A physical barrier lined with foam or other materials	8-14 dB	RMS, Peak, SEL	Unknown.
Dewatered cofferdam	Removal of water around pile	15 dB 3-35 dB	RMS, Peak	Unknown. Assumed more than bubble curtains
Vibratory hammers	Alternative to impact hammers	10-20+ dB	RMS, Peak, SEL	2-3 times cost of impact hammers
Suction piles	Replacement for existing techniques	Very large reduction	All	Potential cost savings
Press-in piles	Piles are pressed into place	Very large reduction	All	Unknown

Table modified from Pile Driving Treatments table found in Spence et al. (2007) and updated with data by Laughlin (2010).

TNAPs or pile casings consist of a steel casing lined with noise insulating foam that is placed over the pile during installment. For smaller piles associated with docks, use of polyvinyl chloride (PVC) piles may be a viable alternative to steel piles, but they have not yet been tested. A TNAP design is a hollow walled (air-filled) metal pile casing or foam-lined metal casing placed around the pile being driven. This method is best applied to vertical, non-interlocking piles. Noise levels with a TNAP can be reduced by an average of 11 dB (8 to 14 dB) (Laughlin 2010), but have been reported in previous studies to have an even greater capacity to reduce noise. In the latest report (Laughlin 2010), a double-wall TNAP was constructed using 2 concentric pipes with outside diameters of 60 in and 48 in with and a wall thickness of 1 in. The 5-in space between the inner and outer steel tubes was partially filled with a 4-in-thick, sound-absorbing material. Tests were conducted both with and without bubbles between the pile and the hollow tube via a bubble ring at the bottom of the TNAP. Bubbles resulted in a slightly greater reduction of 1-3 dB than TNAPs without bubbles. Laughlin (2010) recommended that TNAPs could be used as an alternative to the bubble curtain as an underwater noise mitigation device since the average noise reduction is about the same. New designs of TNAPs and confined bubble curtain designs are still being investigated to improve noise reduction capabilities.

Because of their shape, TNAPs cannot be used on sheet piles so a confined bubble curtain may be used to reduce noise levels. Confined bubble curtains consist of some type of aquatic barrier around a pile that is filled with bubbles. The bubbles are created by forcing compressed air through small holes drilled in PVC or steel pipe. The bubble curtain disrupts the sound waves as they passes through, thereby reducing noise levels transmitted beyond the curtain. In order to be effective, the bubble curtain must fully enclose the pile through the entire water column; the ring emitting the bubbles must be seated properly on the sea floor to avoid suspension or sinking of the PVC pipe. Reductions in peak pressure, RMS pressure, and energy are typically on the order of 5-20 dB or more (though we consider an average reduction of 11 dB for bubble curtains). Although the effectiveness of confined bubble curtains is more variable than TNAPs, the average noise reduction is about the same. Based on the best case scenario of a 20 dB reduction in noise, our estimates of the amount of noise reduction required to reduce the injury distance to less than 50 ft indicate that steel sheet piles may still have an associated injury zone even when confined bubble curtains are used. Yet, the actual noise levels will be largely dependent upon the type of sheet pile, the power of the impact hammer, the substrate hardness, and water depth.

The installation of metal sheet pile with an impact hammer requires an individual analysis for each project to determine the appropriate noise abatement needed to adequately reduce injurious and behavioral noise levels; therefore, activities involving metal sheet pile installation with an impact hammer are not covered under this Programmatic Opinion. These activities will require separate Section 7 consultation to address the increased risk of injury from noise. Projects requiring sheet piles that produce injurious noise levels will likely need to employ confined bubble curtain designs, as well as additional mitigation measures when possible, such as working at low tide, to reduce the amount of noise transmitted into the water.

It is important to note that vibratory piling-driving methods may be a reasonable solution for reducing the peak noise levels and removing impulsive sounds in certain applications. Vibratory methods have been measured to be significantly quieter than impact pile driving methods. In many cases, the reduction in noise levels can eliminate any risk of injury and minimize the area of behavioral disturbance. The Florida Marine Contractor's Association has indicated that vibratory hammers are a viable option for the installation of I-beam used for in some boatlift designs; however, flexibility is needed for using a variety of pile driver types depending on the location and sediment layers encountered during pile driving.

3.2.1 Bubble Curtain Specifications for Pile Driving

When using an impact hammer to drive or proof concrete or metal piles, use 1 of the following sound attenuation methods:

1) If water velocity is equal to or less than 1.6 ft per second (1.1 miles per hour) for the entire installation period, surround the pile being driven by a confined or unconfined bubble curtain that will distribute small air bubbles around 100% of the pile perimeter for the full depth of the water column.
   a) General - An unconfined bubble curtain is composed of an air compressor(s), supply lines to deliver the air, distribution manifolds or headers, perforated aeration pipe, and a frame. The frame facilitates transport and placement of the system, keeps the aeration pipes stable, and provides ballast to counteract the buoyancy of the aeration pipes in operation.
   b) The aeration pipe system shall consist of multiple layers of perforated pipe rings, stacked vertically in accordance with the following:

Water Depth (m)	No. of Layers

0 to less than 5	2
5 to less than 10	4
10 to less than 15	7
15 to less than 20	10
20 to less than 25	13

c) The pipes in all layers shall be arranged in a geometric pattern which shall allow for the pile being driven to be completely enclosed by bubbles for the full depth of the water column and with a radial dimension such that the rings are no more than 0.5 m from the outside surface of the pile.

i. The lowest layer of perforated aeration pipe shall be designed to ensure contact with the substrate without burial and shall accommodate sloped conditions.

ii. Air holes shall be 1.6 millimeter (mm) (1/16-in) in diameter and shall be spaced approximately 20 mm (3/4 in) apart. Air holes with this size and spacing shall be placed in 4 adjacent rows along the pipe to provide uniform bubble flux.

iii. The system shall provide a bubble flux 3.0 m^3 per minute per linear meter of pipe in each layer (32.91 ft^3 per minute per lin ft of pipe in each layer). The total volume of air per layer is the product of the bubble flux and the circumference of the ring:

V_t= 3.0 cubic meter/minute/meter x Circumference of the aeration ring in m

or

V_t= 32.91 cubic feet/minute/feet x Circumference of the aeration ring in ft

iv. Meters shall be provided as follows:

- Pressure meters shall be installed at all inlets to aeration pipelines and at points of lowest pressure in each branch of the aeration pipeline.
- Flow meters shall be installed in the main line at each compressor and at each branch of the aeration pipelines at each inlet. In applications where the feed line from the compressor is continuous from the compressor to the aeration pipe inlet, the flow meter at the compressor can be eliminated.
- Flow meters shall be installed according to the manufactures recommendation based on either laminar flow or non-laminar flow.

2) If water velocity is greater than 1.6 ft per second (1.1 miles per hour) at any point during installation or you are constructing a seawall, surround the pile or area being driven by a confined

bubble curtain (e.g., a bubble ring surrounded by a fabric or non-metallic sleeve). The confined bubble curtain will distribute air bubbles around 100% of the pile perimeter for the full depth of the water column, according to specifications below.

a) General - A confined bubble curtain is composed of an air compressor(s), supply lines to deliver the air, distribution manifolds or headers, perforated aeration pipe(s), and a means of confining the bubbles.

b) The confinement shall extend from the substrate to a sufficient elevation above the maximum water level expected during pile installation such that when the air delivery system is adjusted properly, the bubble curtain does not act as a water pump (i.e., little or no water should be pumped out of the top of the confinement system).

c) The confinement shall contain resilient pile guides that prevent the pile and the confinement from coming into contact with each other and do not transmit vibrations to the confinement sleeve and into the water column (e.g., rubber spacers, air filled cushions).

d) In water less than 15 m deep, the system shall have a single aeration ring at the substrate level. In waters greater than 15 m deep, the system shall have at least 2 rings: 1 at the substrate level and the other at mid-depth.

e) The lowest layer of perforated aeration pipe shall be designed to ensure contact with the substrate without sinking into the substrate and shall accommodate for sloped conditions.

f) Air holes shall be 1.6 mm (1/16-in) in diameter and shall be spaced approximately 20 mm (3/4 in) apart. Air holes with this size and spacing shall be placed in 4 adjacent rows along the pipe to provide uniform bubble flux.

g) The system shall provide a bubble flux of 2.0 m^3 per minute per linear meter of pipe in each layer (21.53 ft^3 per minute per lin ft of pipe in each layer). The total volume of air per layer is the product of the bubble flux and the circumference of the ring:

   Vt = 2.0 cubic meter/minute/meter x Circumference of the aeration ring in m

   or

   Vt = 21.53 cubic feet/minute/feet x Circumference of the aeration ring in ft

(h) Flow meters shall be provided as follows:

   i. Pressure meters shall be installed at all inlets to aeration pipelines and at points of lowest pressure in each branch of the aeration pipeline.

   ii. Flow meters shall be installed in the main line at each compressor and at each branch of the aeration pipelines at each inlet. In applications where the feed line from the compressor is continuous from the compressor to the aeration pipe inlet, the flow meter at the compressor can be eliminated.

   iii. Flow meters shall be installed according to the manufacturer's recommendation based on either laminar flow or non-laminar flow.

4. How to Calculate Noise Impacts

4.1 Calculation Steps for Pile Driving

a. Review the Project for Needed Information

The basic information on the pile driving activity required to conduct an effects analysis is:

- the material composition of the piles (vinyl, wood, concrete, metal)
- the type of piles (e.g., sheet, H, tubular, square, etc.)
- the diameter of the piles
- the number of piles driven
- the number of hammer strikes per pile
- the duration to drive a single pile
- the number of piles driven per day
- the time of year of the activity
- the type of pile-driving method (e.g., hydraulic, diesel, vibratory hammer)
- other pile driving methods (e.g., drilling, jetting)
- the total duration of the project
- depth, bottom, type, and habitat characteristics
- a map of the project area

b. Choose a Spreading Loss Model

The decrease in noise level with distance from the source (also called attenuation or spreading loss) can be estimated using a spreading loss model. A general equation to be used for planning and assessment purposes to predict noise at some distance from a pile is:

TL(R) = SL – N logR*;* where

TL is the threshold level in Table 72 at a distance R from the pile in meters,

SL is the source level,

N is a coefficient for geometric spreading (e.g., spherical or cylindrical), and

R is a distance from the source.

For pile-driving projects, geometric spreading (N) can range between 10 and 20, but usually takes the form of 2 equations based on water depth.

Spherical spreading in deep water is expressed as: TL(R) = SL – 20 logR

Intermediate spreading in shallower water is expressed as: TL(R) = SL – 15 logR

A general assessment rule in determining which spreading loss model to use is to compare your impact zone distance to the water depth in the project area. Use spherical spreading (20 logR) if your impact zone is shorter than the water depth, and cylindrical (10 logR) or intermediate spreading (15 logR) if your impact zone is longer than the water depth. This is explained by the fact a sound wave will not generally travel further than the depth of the water column before being reflected. In deep water, surface reflection does not occur as quickly. Pile driving in deeper water is best modeled using spherical spreading where there are few reflections of the sound waves off hard surfaces such as the sea bottom. In shallow water, surface reflections result in non-uniform or cylindrical spreading of the sound waves (see Figure 30).

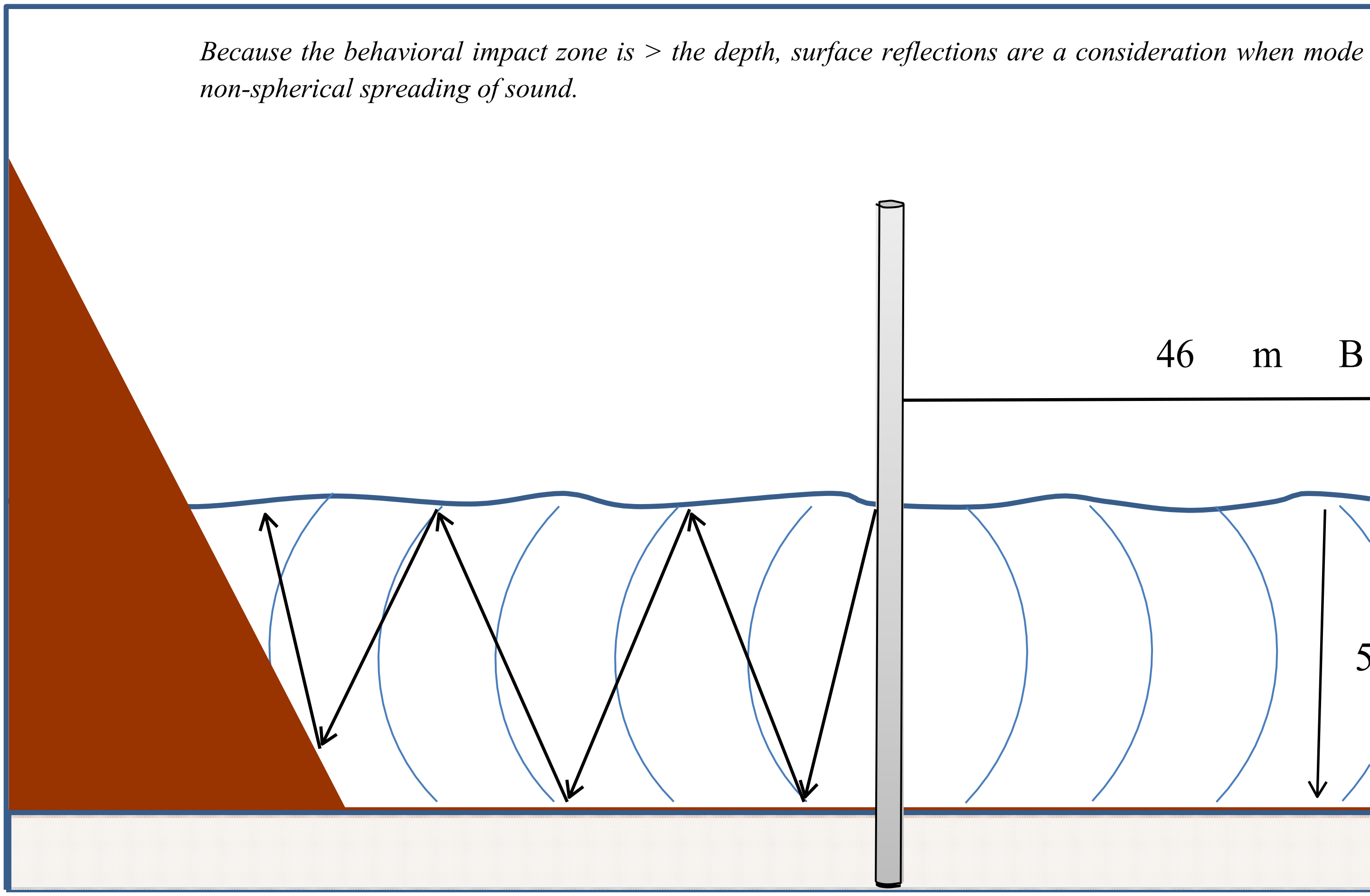


Figure 3. An example of intermediate spreading loss where surface reflections result in non-uniform spreading of sound waves

Sound propagation can range between 10 logR and 15 logR in shallow water. For planning purposes, the use of the 15 logR spreading loss model is recommended unless project-specific data is available. Aside from offshore energy projects, most pile driving occurs in shallow, coastal areas so intermediate spreading loss is the most common model used for coastal areas. To find the distance of the threshold level TL(R) to determine your impact zone use the Spreading Loss Calculator explained below in Step f.

c. Determine the Noise Reference Levels

Noise levels produced from pile-driving noise can be estimated from similar projects reported in technical papers and peer reviewed literature. Typically, the pile size, type, and pile-driving method are used to characterize noise levels. A particularly useful reference is CALTRANS (2009). The source level will need to be determined on a project-by-project basis through information provided by the applicant or through reference levels reported in the literature. Report the noise levels in the Effects Analysis. The noise levels used in the effects analysis should be tabulated for easy reference.

It is important to note the distance of the reported noise level. Many reference levels are reported at 10 m from the pile. We can back-calculate noise levels from 10 m to the pile by adding 10 dB for 10 logR cylindrical loss, 15 dB for 15 log intermediate spreading loss, and 20 dB for 20 logR spherical spreading loss. Other reference level distances can easily be back-calculated by determining the dB loss for the distance using the Spreading Loss Calculator.

d. Determine Source Level: Cumulative Sound Exposure Level

Cumulative sound exposure is based on the amount of time an animal may be exposed to noise from repeated strikes of impact hammers (or the amount of time for vibratory piling). For any given set of conditions (source level, type of transmission loss, strikes/pile) over some period of time, cumulative sound exposure (cSEL) may result in some risk of hearing loss even if the sSEL (single exposure level) is below the threshold for physical injury. This calculation is important if animals may be expected to be repeatedly exposed to noise over time (e.g., nursery or developmental areas, preferred feeding or resting areas, or semi-enclosed areas in which animals may remain).

NOTE: cSEL assumes constant exposure, and does not account for the movement of fish and sea turtles. Movements must be monitored during the activity, modeled, or considered qualitatively in the analysis.

For dock and seawall construction, which only occurs during daylight hours in residential areas, the cSEL can be calculated on a daily basis:

Daily cSEL Source Level = sSEL Source Level + 10 log(number of strikes/ pile)(number of piles/day)

As a general guideline, consider the cumulative effects of noise exposure over a 24-hr period, as long as there is sufficient "quiet" recovery time between exposures. We believe that limiting construction to only daylight hours provides sufficient quiet time for activities covered under this Opinion. The effects of repeated daily exposures over days, weeks, or months may be considered qualitatively or quantitatively if the different noise sources and exposure levels are present over time.

Another important consideration in calculating cSEL in the context of pile driving is the "effective quiet" level. For fish, the effective quiet level has been set at 150 dB (CALTRANS 2009). For sea turtles, we are applying the same level. For animals exposed to levels at or less than the effective quiet level, noise impacts will not accumulate to cause injury. Therefore, we need to calculate the distance from the source at which noise levels will attenuate below this effective quiet level. Only within this range will potentially injurious cSEL accumulate.

For example, if a pile has a 180 dB sSEL source level, the maximum cumulative sound exposure injury range is at 100 m from the pile. This is determined by finding the difference between the single-strike source level and effective quiet (180 dB – 150 dB = 30 dB). A 30 dB loss occurs at 100 m from a pile using the 15 logR spreading loss. Therefore, animals beyond 100 m would not accumulate potentially injurious cSEL and 100 m would be the limit of the physical injury zone from cumulative sound exposure.

e. Determine the Impact Zones by Calculating Threshold Distances

Using the Spreading Loss Calculator

In previous steps, you will have already calculated the source level for both a single strike and for cumulative daily strikes. In Step 4, you have chosen the spreading loss model appropriate for a project. A quick and effective method to calculate impact zone distances with the model is to first calculate the difference in dB (-dB) between the source level and threshold level, then determine what distance that dB difference occurs with the Spreading Loss Calculator.

For example, to determine the distance of the daily cumulative sound exposure level of injury, first subtract the threshold levels for each animal group in Table 2 from the cSEL source level.

<u>Calculate the Difference (-dB) Between Source Level and Injury Threshold Levels</u>

fish ≥ 2 grams and sea turtles = Source Level (cSEL) – 187 dB

fish < 2 grams = Source Level (cSEL) – 183 dB

<u>Calculate the Difference (-dB) Between Source Level and Behavioral Threshold Levels</u>

for all fish sizes = Source Level (RMS) – 150 dB

sea turtles = Source Level (RMS) – 160 dB

After determining the dB difference between source level and threshold level, use the Spreading Loss Calculator to input different ranges in the first column (Range) to find the distance that the -dB difference would occur. The calculator uses 3 spreading loss formulas to allow for quick calculations of several ranges (see Figure 4). The equations solve for any range input by the user by automatically calculating noise reduction at those distances from a pile (-dB) using 3 spreading loss equations for any range input by the user.

A graphical representation of the impact zones is provided below to help visualize the area where project impacts will occur within the species' habitat (Figure 5).

Spherical (20 logR) and Cylindrical (10 and 15 logR) Spreading Loss					
Instructions: Input range from source to obtain spherical and cylindrical spreading loss (- dB)					
Range (m)	log (R)	20 logR Spherical Spreading Loss (- dB)	10 log R Cylindrical Spreading Loss (- dB)	15 log R Cylindrical Spreading Loss (- dB)
1	0	0	0	0
2	0.301029996	6.020599913	3.010299957	4.515449935
4	0.602059991	12.04119983	6.020599913	9.03089987
8	0.903089987	18.06179974	9.03089987	13.5463498
10	1	20	10	15
25	1.397940009	27.95880017	13.97940009	20.96910013
50	1.698970004	33.97940009	16.98970004	25.48455007
100	2	40	20	30
1000	3	60	30	45
2000	3.301029996	66.02059991	33.01029996	49.51544993
10000	4	80	40	60
100000	5	100	50	75
500000	5.698970004	113.9794001	56.98970004	85.48455007
1000000	6	120	60	90

Figure 4. Screenshot of the Spreading Loss Calculator.

The dB loss over any range can be determined for 3 types spreading loss models (10 logR, 15 logR, and 20 logR). For example, at 50 m, there is a 25.5 dB reduction in noise from a pile due to intermediate transmission loss (15 logR).

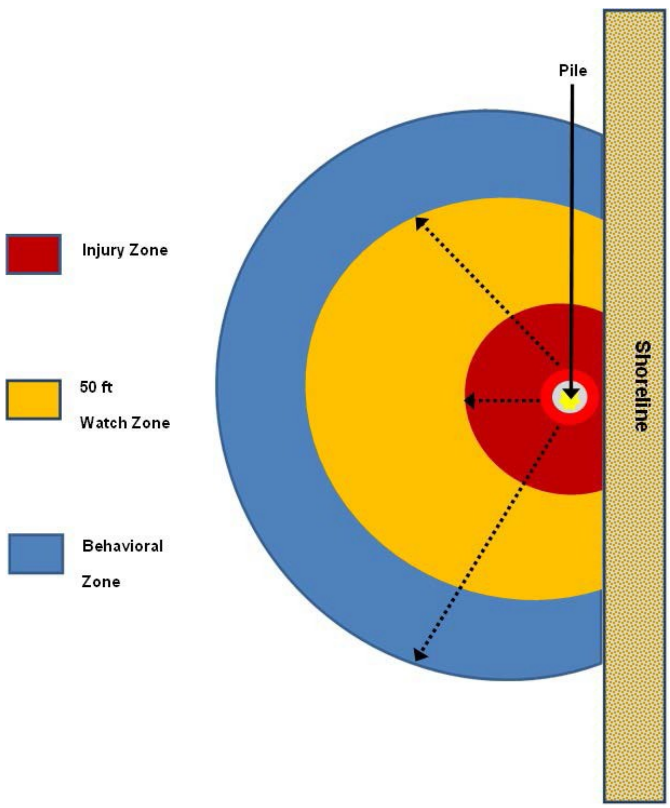


Figure 5. An example graphic visualizing impact zones for a pile-driving project.

Graphical representations of the impact zones are useful analytical tools in visualizing the area where project impacts will occur within the species' habitat.

4.2 Example Noise Calculation for a Single Family Dock

Step 1. Gather project details.

In the following example, a federal agency is proposing to issue a permit for the construction of a single family dock in Florida.

The applicant provided project details including the following:

- 16 piles will be driven by impact hammer
- all piles are 12-in-diameter wood piles
- each pile takes 30 minutes to install
- plan to install 10 piles per day
- pile installation is continuous, but only during daylight hours
- the hammer strikes at an average rate of 1.5 strikes per minute (45 strikes per pile)
- water depth ranges from 0-5 m
- sea turtles and smalltooth sawfish may be in the project area

Step 2. Determine noise reference levels and choose a spreading loss model.

Referencing the noise levels reported for a 12-in wood pile in CALTRANS (2009), the source level is estimated to be 180 dB Peak Pressure, 160 dB sSEL, and 170 dB RMS at a distance of 10 m from the pile. Because the project is in shallow water, the 15 logR intermediate spreading loss model will be used. To back-calculate the source level from the reported level measured 10 m from the pile, we added 15 dB to each of the literature values (Table 7).

Table 7. Back-Calculation of Source Levels

Type of Noise Impact	Measured Source Level (10 m from Source)	Back-Calculation to Source (15 logR)	Final Source Level
Peak Pressure	180	15	195
Single strike (sSEL)	160	15	175
RMS (behavioral)	170	15	185

Step 3. Calculate the cumulative exposure level (cSEL).

To address the sound exposure level over the course of a day, the SEL from exposure to a single pile strike (sSEL) was converted to cSEL for exposure to the total pile strikes per day. This is calculated using the following formula:

Daily cSEL Source Level = sSEL Source Level + 10 log(number of strikes/ pile)(number of piles/day)

= 175 + 10 log(45)(10)

= 175 + 26.5

= 201.5 (rounded to 202)

Step 4. Calculate the difference between project noise levels and threshold values.

To determine if noise associated with pile installation reaches a level loud enough to disturb or injure protected species, we compare project source levels to the literature threshold values (Table 8).

Table 10. Calculations of Threshold Exceedances

Effect	**Animal**	**Threshold Level (dB re 1 µPa)**	**Project Levels (dB re 1 µPa)**	**Difference in dB**
Physical Injury	All fish and turtles Fish ≥ 2 grams	206 (peak pressure) 187 (SEL)	195 (peak pressure) 175 (sSEL) 202 (cSEL)	Not exceeded Not exceeded 15
Behavior	Fish Sea turtles	150 (RMS) 160 (RMS)	185 (RMS) 185 (RMS)	35 25

Step 5. Use the Spreading Loss Calculator to determine the zone of impact in cases where source levels exceed threshold values.

Change the values in column 1 (Range) of the Spreading Loss Calculator (Figure 6) to calculate noise attenuation over specific distances. Alter the values in column 1 as necessary to find dB levels in the last column (15 logR model) that most closely match those calculated in Step 4 above (Table 8 "Difference in dB"). We demonstrate this in Figure 34 below where the arrows represent the ranges that we modified in column 1 and the resulting changes in dB loss calculated in the last column. By changing the values in column 1 (10, 46, and 215 m) we were able to match the dB of loss calculated in Table 8 above (15, 25, and 35 dB respectively). The ranges (i.e., distances) associated with the arrows correspond with the radii to which noise source levels exceed threshold levels at the project site (impact radius, Table 9).

Spherical (20 logR) and Cylindrical (10 and 15 logR) Spreading Loss				
Instructions: Input range from source to obtain spherical and cylindrical spreading loss (- dB)				
Range (m)	log (R)	20 logR Spherical Spreading Loss (- dB)	10 log R Cylindrical Spreading Loss (- dB)	15 log R Cylindrical Spreading Loss (- dB)
1	0	0	0	0
2	0.301029996	6.020599913	3.010299957	4.515449935
4	0.602059991	12.04119983	6.020599913	9.03089987
8	0.903089987	18.06179974	9.03089987	13.5463498
10	1	20	10	15
25	1.397940009	27.95880017	13.97940009	20.96910013
50	1.698970004	33.97940009	16.98970004	25.48455007
100	2	40	20	30
1000	3	60	30	45
2000	3.301029996	66.02059991	33.01029996	49.51544993
10000	4	80	40	60
100000	5	100	50	75
500000	5.698970004	113.9794001	56.98970004	85.48455007
1000000	6	120	60	90

Figure 6. Screenshot of original Spreading Loss Calculator prior to any modifications

Spherical (20 logR) and Cylindrical (10 and 15 logR) Spreading Loss				
Instructions: Input range from source to obtain spherical and cylindrical spreading loss (- dB)				
Range (m)	log (R)	20 logR Spherical Spreading Loss (- dB)	10 log R Cylindrical Spreading Loss (- dB)	15 log R Cylindrical Spreading Loss (- dB)
1	0	0	0	0
2	0.301029996	6.020599913	3.010299957	4.515449935
4	0.602059991	12.04119983	6.020599913	9.03089987
8	0.903089987	18.06179974	9.03089987	13.5463498
10	1	20	10	15
25	1.397940009	27.95880017	13.97940009	20.96910013
46	1.662757832	33.25515663	16.62757832	24.94136748
100	2	40	20	30
215	2.33243846	46.6487692	23.3243846	34.9865769
2000	3.301029996	66.02059991	33.01029996	49.51544993
10000	4	80	40	60
100000	5	100	50	75
500000	5.698970004	113.9794001	56.98970004	85.48455007
1000000	6	120	60	90

Figure 7. Screenshot of the Spreading Loss Calculator after the first column was modified

Table 11. Calculations of Impact Zones Based on Source Levels for the Project

Effect	Animal	Threshold Level (dB re 1 µPa)	Project Levels (dB re 1 µPa)	Difference in dB	Impact Zone Radius (m)
Physical Injury	All fish and turtles	206 (peak pressure)	195 (peak pressure)	Not exceeded	0
	Fish ≥ 2 grams	187 (SEL)	175 (sSEL) 202 (cSEL)	Not exceeded 15	0 10
Behavior	Fish Sea turtles	150 (RMS) 160 (RMS)	185 (RMS) 185 (RMS)	35 25	215 46

Step 6. Compare the calculated cSEL impact zone to the maximum impact zone limited by effective quiet.

Now we need to determine whether the amount of accumulated noise exposure and the corresponding cSEL impact zone would be limited by the noise reaching effective quiet.

First, calculate the difference between the source level (sSEL) and the effective quiet level (150 dB sSEL).

In this example:

175 dB sSEL (source level) – 150 dB sSEL (effective quiet level) = 25 dB

Next, consult the Spreading Loss Calculator to find the distance over which sound would attenuate by that amount.

25 dB spreading loss occurs at 46 m using 15 logR (see Figure 34)

46 m is the maximum range of the physical injury zone from cumulative sound exposure before reaching effective quiet

Last, compare the calculated cSEL impact zone radius from Step 5 (10 m) to the maximum impact zone limited by effective quiet, calculated in this step (46 m). Use the smaller of the 2 values as the cumulative sound exposure impact radius. In this case, the originally calculated 10 m is the impact zone radius for daily cumulative sound exposure.

Summary

Interpretations of the noise impact zones associated with the project shown in Table 9 are as follows:

- Potential injury for fish and sea turtles from single pile strikes (sSEL) is not measurable as the source levels do not exceed the threshold values for injury.
- Potential injury to fish from cumulative sound exposure (cSEL) each day is possible within 10 m from the pile. For the purpose of this example, fish includes sturgeon and smalltooth sawfish. Since threshold values for sea turtles are not currently known we assume the thresholds used for fish also apply to sea turtles. Therefore we assume the 10 m cumulative sound exposure injury zone also applies to sea turtles.
- Behavioral responses of sea turtles may occur up to 46 m (150 ft) from the project.
- Behavioral responses of fish may occur up to 215 m (705 ft) from the project.

Appendix B: Project-level Review Submission Format

FHWA/state DOTs will adopt a spreadsheet to track all of the required information and confirm the application of all of the PDCs (project-design criteria) for each category of activity. Below is an example spreadsheet with a list of the columns that will be included. This, or any other, spreadsheet may be modified by the FHWA, state DOTs and/or NMFS to ensure clarity of the information required and to ensure it meets the PDC requirements defined in Section 4 of this consultation.

This form is a model for all other forms that are required to be used for activities and projects authorized under this programmatic agreement, though a specific format is not required. Any forms will clearly indicate what type of activity or project is being undertaken as well as all other relevant information, including adherence to general and project-specific PDCs. FHWA and State DOTs will have discretion in developing unique forms, based on their needs. For example, FHWA may find it more efficient to indicate that all PDCs are met for a specific project or activity, rather than listing them.

Because projects (e.g., bridge replacement) typically include a number of activities (e.g., cofferdams, erosion and turbidity control), both a project form and forms for each individual activity may be completed and submitted to NMFS. Although this form indicates the possibility of deviations from the PDCs it should be noted that all deviations in most cases and unless minor will likely lead to the need for separate consultation.

All Activities/Projects		
Title	**Format**	**Description**
Date Sent to NMFS	MM/DD/YYYY	This is the date the email with the project review information was sent to NMFS
FHWA PM/POC Last Name	Text	Provide your last name only
Permit Used	Please indicate USACE permit.	The permit instrument used to authorize the activity
Any other component of project issued under different permit instrument?	[Yes or No]	Was any activity authorized under a different programmatic or separate Section 7 consultation?
Identify any other permit instrument used.	Please clarify.	If the answer to previous question was “Yes,” then describe the permit type used to authorize the other project component.
Permit Tracking Number	Enter 9 digits including the prefix and hyphens. Ex: SAC-2017-00001	This is the permit number assigned by USACE to the project.
Project Address	Street, City (nearest physical address)	Address of the project site
County	County	County the project site is located
Latitude	XX.XXXXX Ex: 31.33152	This shall be formatted in decimal degrees to 5 places.
Longitude	-XX.XXXXX Ex: -82.012340	This shall be formatted in decimal degrees to 5 places. Please provide a negative symbol before the longitude to denote the Western Hemisphere.
Waterbody	Name of waterbody	Provide easily identifiable name/names of waterbody where project will take place.
Seagrass(es) in project footprint?	[Yes or No]	Type “Yes” if seagrasses are located within the project footprint.
Impacts to seagrass(es)?	[Yes or No]	Calculate the square feet of impacts to seagrasses.

Located in Atlantic Sturgeon Critical Habitat Unit?	Please indicate the critical habitat unit or type; “N/A” may also be appropriate.	Provide the critical habitat unit that the project occurs within the boundaries of critical habitat even if it does not impact the essential features or select “N/A” if not located in geographic area of any critical habitat under NMFS PRD purview.
Atlantic Sturgeon CH Impacts to Physical and Biologcal Features.	Enter square feet of impacts. Numbers only.	Calculate the square feet of impacts to essential features. Review the document for the definition of essential features.
AP1: Relevant BMPS?	[Yes or No]	If no, explain and provide justification for not adhering.
AP2: Adhere to Sea Turtle and Sawfish Construction Conditions?	[Yes or No]	If no, explain and provide justification for not adhering.
AP3: Vessel, equipment conditions?	[Yes, No, or N/A]	If no, explain and provide justification for not adhering.
AP4: Using erosion devices/turbidity curtains?	[Yes or No]	If no, explain and provide justification for not adhering.
AP5: Petroleum products?	[Yes or No]	If no, explain and provide justification for not adhering.
AP6: Material cleaning?	[Yes or No]	If no, explain and provide justification for not adhering.
AP7: Interaction/injury reporting?	[Yes or No]	If no, explain and provide justification for not adhering.
AP8: Entanglement PDCs?	[Yes or No]	If no, explain and provide justification for not adhering.
AP9: Noise PDCs?	[Yes or No]	If no, explain and provide justification for not adhering.

AP10: SAV impacts?	[Yes or No]	If no, explain and provide justification for not adhering.
AP11: Daylight hours?	[Yes or No]	If no, explain and provide justification for not adhering.
AP12: Sea turtle nesting beaches?	[Yes or No]	If no, explain and provide justification for not adhering.
AP13: Elevated structures?	[Yes or No]	If no, explain and provide justification for not adhering.
AP14: Mouths of sturgeon rivers?	[Yes or No]	If no, explain and provide justification for not adhering.
AP15: Construction personnel?	[Yes or No]	If no, explain and provide justification for not adhering.
All PDCs met?	[Yes or No].	If no, explain and provide further justification for not adhering.
New Construction or Repair/Replacement	Please explain.	If no, explain and provide justification for not adhering.

Appendix C: Protected Resources Educational Signs

Save Sea Turtles, Sawfish, and Dolphins

While Fishing, Following These Tips:

- Report injured, entangled, hooked, or stranded dolphins and sea turtles to the 24-hour hotline:

1-877-942-5343

Download the Dolphin & Whale 911 app on your iPhone or Android for reporting marine mammals.

- Never cast towards dolphins, sea turtles, or sawfish.
- Change location or reel in your line if a dolphin, sea turtle, or sawfish shows interest in your bait or catch.
- Release catch away from dolphins when and where possible without violating any state or federal fishing regulations.
- Do not feed or attempt to feed wild dolphins or sea turtles - it's harmful and illegal.
- Do not dispose of leftover bait or cleaned fish remains in water.

- Use circle or corrodible (non-stainless steel) hooks to reduce injury.
- Use recycling bins for fishing line and do not throw trash or unwanted line in the water.
- If you hook a **SEA TURTLE**, immediately call the 24-hour hotline at 1-877-942-5343 and follow response team instructions.

If you cannot reach a response team, follow these guidelines to reduce injuries:

1) If possible, use a net or lift by the shell to bring the turtle on pier or land. Do NOT lift by hook or line.
2) Cut the line close to the hook, removing as much line as possible.
3) Release turtle.

- If you hook a **SAWFISH**:

1) Do not remove the fish from the water.
2) Cut the line close to the hook.
3) Release it as quickly as possible.
4) Report it immediately to 1-941-255-7403.

REPORT STURGEON

If you catch a sturgeon or find one dead, call the Southeast U.S. Sturgeon Hotline:

1-877-STURG 911

(1-877-788-7491)

Or email: **nmfs.ser.sturgeonnetwork@noaa.gov**

Support scientific research by reporting the following observations to the Southeast U.S. Sturgeon Hotline:

- **specific location where the fish was caught or found**
  (if alive, do not remove from the water, cut the line as close to the hook as possible, and release it. if it is dead, do not touch or move it),
- **the condition of the caught or dead fish**
  (e.g. level of decay and signs of trauma or injury),
- **presence of scientific research tags**
  (report color and writing on the tags),
- **the estimated length of the fish**
  (from nose to end of tail), and
- **if possible, a picture of the entire fish**
  (this will allow for proper species identification).

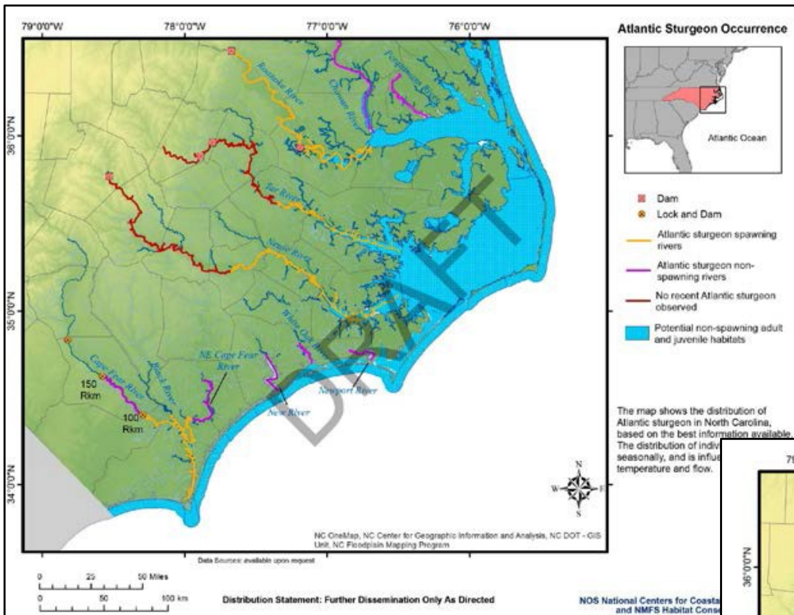
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NOAA
U.S. DEPARTMENT OF COMMERCE

http://sero.nmfs.noaa.gov

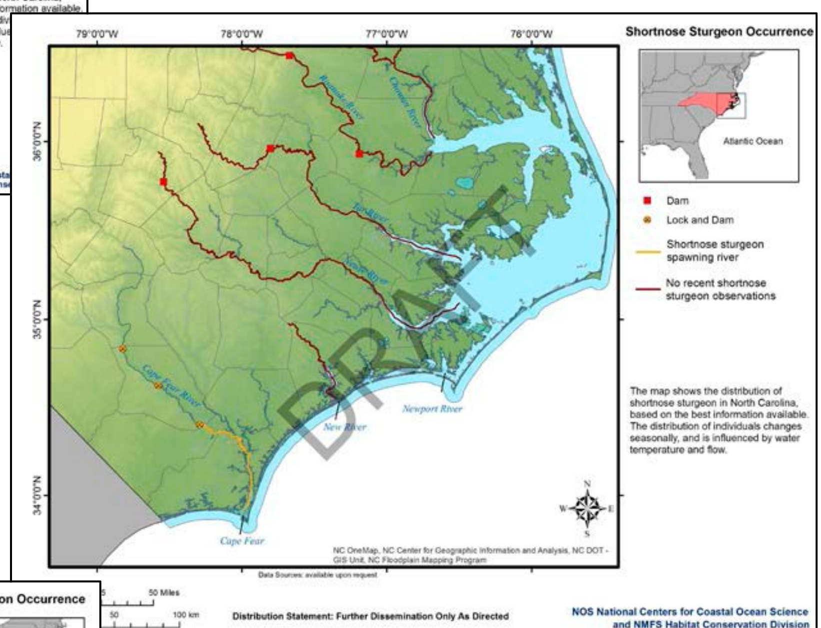
Sturgeon are federally protected in the Southeast U.S.
It's illegal to harm or keep them.

Appendix D: Sturgeon Distribution Maps and Atlantic Sturgeon Designated Critical Habitat in North Carolina, South Carolina, and Georgia

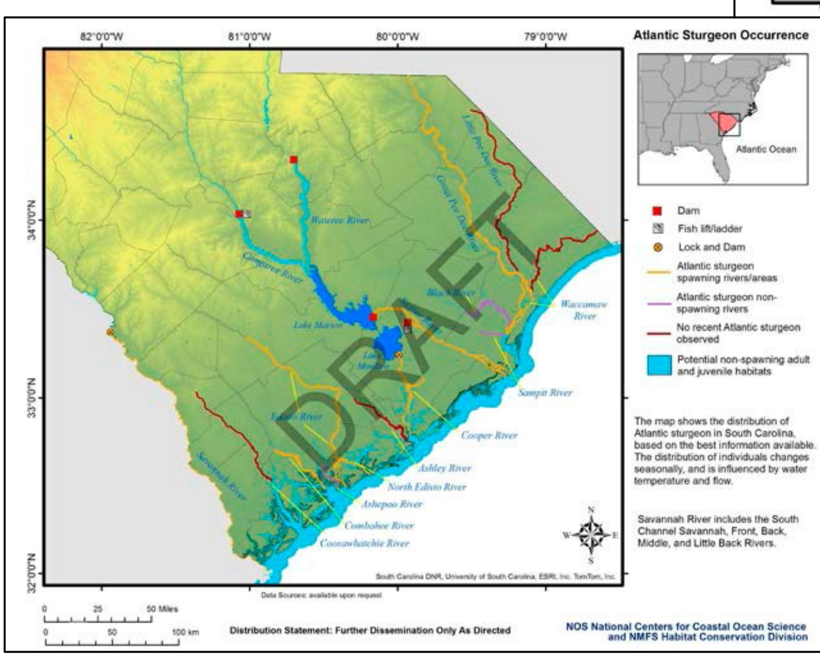
North Carolina



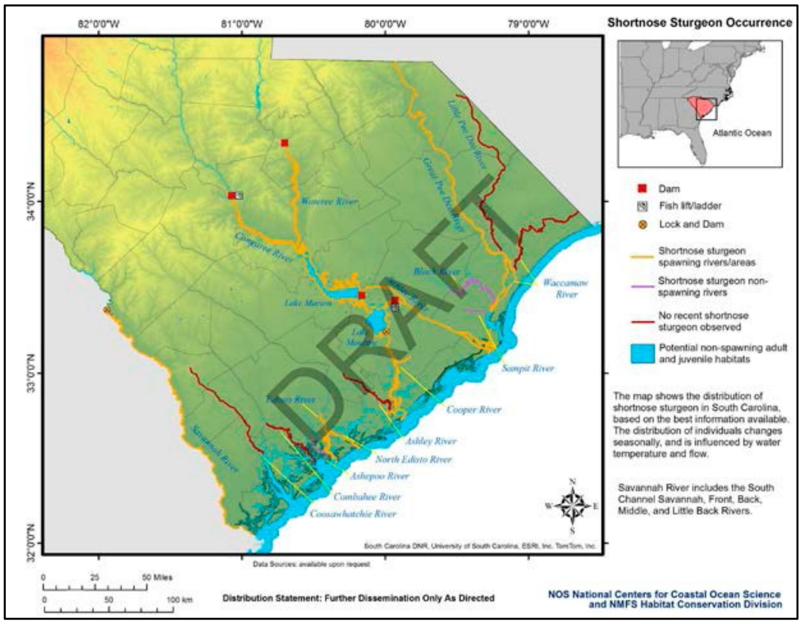
North Carolina



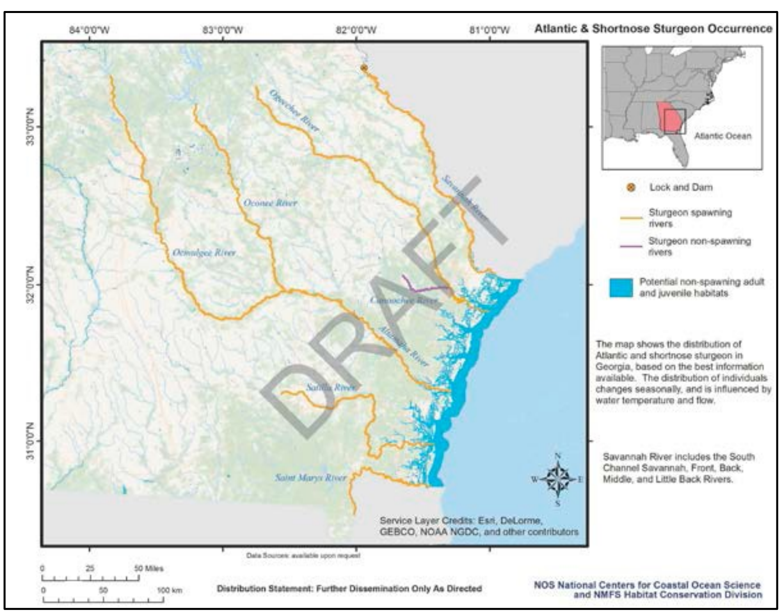
South Carolina

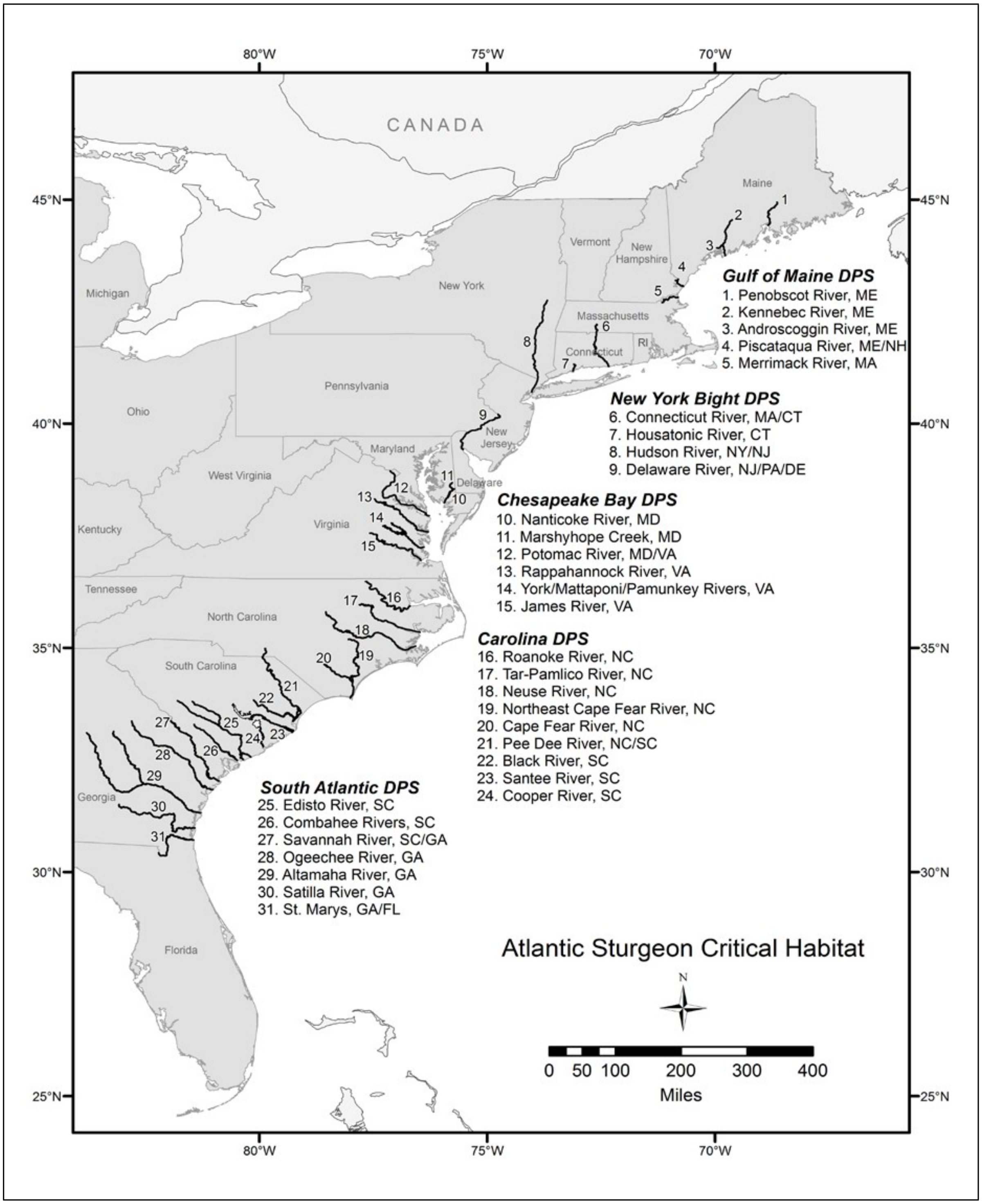


South Carolina



Georgia





80°W
75°W
70°W
45°N
40°N
35°N
30°N
25°N
CANADA
Maine
Vermont
New Hampshire
New York
Michigan
Massachusetts
Connecticut
RI
Pennsylvania
Ohio
New Jersey
Maryland
Delaware
West Virginia
Virginia
Kentucky
Tennessee
North Carolina
South Carolina
Georgia
Florida
Gulf of Maine DPS
1. Penobscot River, ME
2. Kennebec River, ME
3. Androscoggin River, ME
4. Piscataqua River, ME/NH
5. Merrimack River, MA
New York Bight DPS
6. Connecticut River, MA/CT
7. Housatonic River, CT
8. Hudson River, NY/NJ
9. Delaware River, NJ/PA/DE
Chesapeake Bay DPS
10. Nanticoke River, MD
11. Marshyhope Creek, MD
12. Potomac River, MD/VA
13. Rappahannock River, VA
14. York/Mattaponi/Pamunkey Rivers, VA
15. James River, VA
Carolina DPS
16. Roanoke River, NC
17. Tar-Pamlico River, NC
18. Neuse River, NC
19. Northeast Cape Fear River, NC
20. Cape Fear River, NC
21. Pee Dee River, NC/SC
22. Black River, SC
23. Santee River, SC
24. Cooper River, SC
South Atlantic DPS
25. Edisto River, SC
26. Combahee Rivers, SC
27. Savannah River, SC/GA
28. Ogeechee River, GA
29. Altamaha River, GA
30. Satilla River, GA
31. St. Marys, GA/FL
Atlantic Sturgeon Critical Habitat
N
0 50 100 200 300 400
Miles