UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Southeast Regional Office
263 13th Avenue South
St. Petersburg, Florida 33701-5505
https://www.fisheries.noaa.gov/region/southeast

06/03/2021

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SERO-2020-02530
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Division Administrator, Georgia Division
Federal Highway Administration
U.S. Department of Transportation
61 Forsyth Street SW, Suite 17T100
Atlanta, Georgia 30303

Ref.: GDOT PI No. 0013741, Georgia Department of Transportation, Houlihan Bridge Replacement, Port Wentworth, Chatham County, Georgia

Dear Sir or Madam:

The enclosed Biological Opinion ("Opinion") responds to your request for consultation with us, the National Marine Fisheries Service (NMFS), pursuant to Section 7 of the Endangered Species Act (ESA) for the following action.

Permit Number(s)	**Applicant(s)**	**SER Number**	**Project Type(s)**
GDOT PI No. 0013741	Georgia Department of Transportation	SERO-2020-02530	Bridge Replacement

The Opinion considers the effects of a proposed bridge replacement by the Georgia Department of Transportation (GDOT) on the following listed species and designated critical habitat: Atlantic sturgeon (South Atlantic [SA] Distinct Population Segment [DPS]), shortnose sturgeon, and Atlantic sturgeon (SA DPS) critical habitat (South Atlantic Unit 3). NMFS concludes that the proposed action is likely to adversely affect Atlantic sturgeon (SA DPS) and shortnose sturgeon, but will not jeopardize the continued existence of Atlantic sturgeon (SA DPS) or shortnose sturgeon. NMFS concludes that the proposed action may affect, but is not likely to adversely affect, Atlantic sturgeon critical habitat, South Atlantic Unit 3.

This consultation is being conducted with the Georgia Department of Transportation as the non-federal representative designated by the Federal Highway Administration, Georgia Division.

NMFS is providing an Incidental Take Statement (ITS) with the Opinion. The ITS describes reasonable and prudent measures (RPMs) NMFS considers necessary or appropriate to minimize the impact of incidental take associated with this action. The ITS also specifies nondiscretionary terms and conditions, including monitoring and reporting requirements with which (the) Federal Highway Administration (FHWA) and GDOT must comply to carry out the RPMs.

The project has been assigned the tracking number SERO-2020-02530 in our NMFS Environmental Consultation Organizer (ECO). Please refer to the ECO number in all future inquiries regarding this consultation. Please direct questions regarding this Opinion to Daniel Owen, Consultation Biologist, by phone at (727) 209-5961, or by email at Daniel.Owen@noaa.gov.

Sincerely,

STRELCHECK.ANDREW.JAMES.1365863152
Digitally signed by STRELCHECK.ANDREW.JAMES.1365863152
Date: 2021.06.03 15:59:29 -04'00'

Andy Strelcheck
Acting Regional Administrator

Enclosures: Biological Opinion
File: 1514-22.L.3

Endangered Species Act - Section 7 Consultation
Biological Opinion

Action Agency:	Federal Highway Administration
Applicant:	Georgia Department of Transportation Permit Number 0013741
Activity:	Houlihan Bridge Replacement, Port Wentworth, Chatham County, Georgia
Consulting Agency:	National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Regional Office, Protected Resources Division, St. Petersburg, Florida Tracking Number SERO-2020-02530
Approved by:	STRELCHECK.ANDREW.JAMES.1365863152 Digitally signed by STRELCHECK.ANDREW.JAMES.1365863152 Date: 2021.06.03 16:00:33 -04'00' Andy Strelcheck, Acting Regional Administrator NMFS, Southeast Regional Office St. Petersburg, Florida
Date Issued:	06/03/2021

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ACRONYMS AND ABBREVIATIONS

ADD	Augusta Diversion Dam
BMP	best management practice
CFR	Code of Federal Regulations
DB	Design-Build
DO	dissolved oxygen
DPS	Distinct Population Segment
EFH	Essential Fish Habitat
EPA	Environmental Protection Agency
ESA	Endangered Species Act
FR	Federal Register
FWC	Florida Fish and Wildlife Conservation Commission
FHWA	Federal Highway Administration
FWRI	Fish and Wildlife Research Institute
GADNR	Georgia Department of Natural Resources
GDOT	Georgia Department of Transportation
IPCC	Intergovernmental Panel on Climate Change
ITS	Incidental Take Statement
MHW	Mean High Water
MLW	Mean Low Water
MSA	Magnuson-Stevens Fishery Conservation and Management Act
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
PSC	pre-stressed concrete
OHWM	ordinary high water mark
Opinion	Biological Opinion
PBF	Physical and Biological Feature
PRD	Protected Resources Division
PSC	pre-stressed concrete
ROW	right-of-way
RPM	Reasonable and Prudent Measures
SA	South Atlantic
SCDNR	South Carolina Department of Natural Resources
SHEP	Savannah Harbor Expansion Project
SNWR	Savannah National Wildlife Refuge
SR	State Route
TL	total length
U.S.	United States
USACE	United States Army Corps of Engineers
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey

WCS	Wildlife Conservation Section
YOY	young-of-year

UNITS OF MEASUREMENT

ac	acre(s)
°C	degrees Celsius
CPUE	catch per unit effort
cm	centimeter(s)
°F	degrees Fahrenheit
ft	foot/feet
ft^2	square foot/feet
in	inch(es)
km	kilometer(s)
lin ft	linear foot/feet
m	meter(s)
mi	mile(s)
mi^2	square mile(s)
ms	millisecond
RKM	river kilometer

INTRODUCTION

Section 7(a)(2) of the Endangered Species Act (ESA) of 1973, as amended (16 U.S.C. § 1531 et seq.), requires that each federal agency ensure that any action authorized, funded, or carried out by such agency is not likely to jeopardize the continued existence of any endangered or threatened species or result in the destruction or adverse modification of critical habitat of such species. Section 7(a)(2) requires federal agencies to consult with the appropriate Secretary in carrying out these responsibilities. The National Oceanic and Atmospheric Administration (NOAA) National Marine Fisheries Service (NMFS) and the United States Fish and Wildlife Service share responsibilities for administering the ESA.

Consultation is required when a federal action agency determines that a proposed action "may affect" listed species or designated critical habitat. Informal consultation is concluded after NMFS determines that the action is not likely to adversely affect listed species or critical habitat. Formal consultation is concluded after NMFS issues a Biological Opinion (Opinion) that identifies whether a proposed action is likely to jeopardize the continued existence of a listed species, or destroy or adversely modify critical habitat, in which case reasonable and prudent alternatives to the action as proposed must be identified to avoid these outcomes. The Opinion states the amount or extent of incidental take of the listed species that may occur, develops measures (i.e., reasonable and prudent measures) to reduce the effect of take, and recommends conservation measures to further the recovery of the species.

This document represents NMFS's Opinion based on our review of impacts associated with the proposed action to issue a permit within Chatham County, Georgia. This Opinion analyzes the project's effects on threatened and endangered species and designated critical habitat, in accordance with Section 7 of the ESA. We based our Opinion on project information provided by Federal Highway Administration (FHWA), and other sources of information including the published literature cited herein.

1 CONSULTATION HISTORY

We initially received an informal consultation request (SERO-2019-03490) from FHWA, the lead federal agency that is partially funding the proposed Georgia Department of Transportation (GDOT) project for the replacement of an existing bridge, known as the Houlihan Bridge, which crosses the Savannah River, on November 12, 2019. The consultation was withdrawn May 15, 2020, because the applicant determined blasting within the Savannah River was required for demolition purposes. Planning for the project proceeded starting on May 15, 2020, and NMFS provided technical assistance (INQ-2020-00097). We received an updated letter requesting formal consultation on August 24, 2020. We requested additional information on December 14, 2020 and February 19, 2021. We received a final response on March 1, 2021, and initiated consultation that day.

2 DESCRIPTION OF THE PROPOSED ACTION AND ACTION AREA

2.1 Proposed Action

Georgia Department of Transportation (GDOT) (the applicant) proposes to replace the existing State Route (SR) 25 Bridge (Structure ID: 051-0054-0) over the Savannah River in Port Wentworth, Chatham County, Georgia (Figure 1). The proposed project would replace the existing 33.6-foot (ft) wide by 1,465-ft long bridge with a new 43.25-ft wide by 2,681-ft long bridge with two, 12-ft wide travel lanes and 8-ft wide shoulders. The alignment would be offset 50 ft north of and parallel to the existing alignment. The proposed bridge would be a fixed span that would provide the required 100 ft horizontal and 55 ft vertical clearance (from Mean Low Water [MLW]) to meet navigational needs. The proposed bridge is lengthened relative to the existing bridge in order to reduce impacts to rights-of-way (ROW) and consequently environmentally sensitive areas, including Savannah National Wildlife Refuge (SNWR) property. Traffic will be maintained on the existing bridge during the majority of construction. However, road closures of short duration (30 days or less) requiring an off-site detour may be required to complete tie-in work. The proposed ROW would vary between 114-ft and 231-ft wide to the west of the Savannah River. To the east of the Savannah River, no additional ROW would be required and the proposed ROW width would remain approximately 200-ft wide. The applicant anticipates easement acquisition on both the north and south side of the existing ROW. A temporary work platform/trestle north of the proposed bridge will be utilized during construction and a temporary work platform/trestle to the south of the existing bridge will be utilized for demolition. The total project length is approximately 0.79 miles (mi) (4,196 ft) and the total disturbed acreage is 7.26 acres (ac). The boat ramp located south of the existing bridge will be utilized to allow access for construction equipment.

New Bridge Construction
The proposed bridge will be a fixed span bridge 50.1 ft above Mean High Water (MHW) and 58.2 ft above MLW. The proposed bridge will include 28 bents, including twelve two-column bents that consist of poured concrete footings supported by 12, 30-in^2 pre-stressed concrete (PSC) piles at each bent. A total of seven of the two-column bents will be installed within the Savannah River. The remaining 21 bents are within or partially within emergent tidal wetlands. The applicant anticipates cofferdams will be required for construction. As a component of the

proposed bridge construction, a fender system would be constructed on the edges of the navigational channel in the Savannah River to protect the bridge structure from boats utilizing the navigational channel. The applicant anticipates that the fender system would be constructed by driving either timber or composite piles into the riverbed and then bundling them together. Longitudinal panels would then be bolted to the piles to serve as bumpers in the event that a boat strays towards the bridge bents. The proposed fender system will extend from the river bed to above the water surface.

The applicant anticipates that a combination of temporary work trestles, located north of the proposed alignment, including spurs for bent construction, and a barge will be utilized for construction of the replacement bridge over Savannah River. Temporary work trestles and spurs would likely be utilized in the shallower water on the edges due to the tidal fluctuation of the river and the need to prevent any barge groundings. It is likely that a barge would be utilized for the areas of deeper water within the Savannah River. The work trestles will extend from both banks but would not extend across the entire river in order for the navigation channel to remain open. The applicant anticipates that the temporary work trestles would likely consist of 20-foot spans supported on driven metal shell piles. It is estimated that the temporary work trestles may require up to 258 driven metal shell piles within the Savannah River. It is estimated that each metal shell pile would be installed/removed utilizing a vibratory hammer and would take up to 1 hour for installation and 1 hour for removal for a total of 516 hours. The temporary work trestles would be removed once construction of the pavement, approach slabs, guardrail and bridge have been completed. It is anticipated the temporary work trestles would be in the Savannah River for up to 24 months.

The construction of the new bridge will require seven bents to be constructed within the Savannah River. Each of the seven 20-ft by 43-ft bents will require a cofferdam with a 40-ft by 63-ft footprint totaling 2,520 ft^2 for each bent. Total impacts for the seven bents would be 17,640 ft^2 (7 bents x 2,520 ft^2 = 17,640 ft^2). The applicant anticipates that the cofferdams would be installed by driving sheet piles with a vibratory pile hammer, taking a total of approximately 140 hours to drive all sheet piles. Upon completion of the sheet pile driving, twelve 30-in wide PSC piles will be driven with an impact hammer into the riverbed to support the cast-in-place footers. Driving the PSC piles is anticipated to take an additional 48 hours per bent. Total driving time per each bent for sheet piling and PSC piles would be 188 hours for a total of 1,316 hours (12 PSC piles x 188 hours per pile = 1,316 hours) of pile driving for the seven bents within the Savannah River. Each bent would be formed and filled with concrete by a crane-mounted bucket. The applicant estimates that the total in-water area to be permanently impacted by the placement of cofferdams, PSC piles, poured concrete footers, and the driven pile bridge fender system equals 19,247 ft^2 (0.44 ac). The applicant anticipates that each bent would take a maximum of 6 weeks for installation. Overall construction of the proposed bridge would take up to 24 months. Table 1 provides a summary of the pile installation details within the Savannah River for the proposed project.

Table 1. Pile Installation Details for Piles within the Savannah River

Pile Type	Number of Piles	Installation Method	Max Piles Per Day
24-in Steel Pipe (temporary)	530	Vibratory	40

Pile Type	Number of Piles	Installation Method	Max Piles Per Day
24-in Steel Sheet (temporary)	810	Vibratory	40
30-in Concrete (permanent)	84	Impact	10
16-in Marine Composite (permanent)	100	Vibratory	40

Existing Bridge Demolition
Demolition of the existing bridge would begin once the proposed bridge has been completed and is open to traffic. The existing bridge, including piles and fenders within the river, would be removed via a combination of barges and temporary work platforms/trestles located to the south of the existing bridge. The work trestles would extend from both banks, but would not extend across the river to allow for the navigable channel to remain open. The applicant anticipates that the temporary work trestle would likely consist of 20-ft spans supported on driven metal shell piles. The applicant estimates that the temporary work trestles will require up to 272 driven metal shell piles within the Savannah River. The applicant states that each metal shell pile would be installed/removed utilizing a vibratory hammer and would take up to 1 hour for installation and 1 hour for removal, for a total of 544 hours. The work trestles for demolition of the existing bridge would remain in place up to 18 months.

The removal of the existing bridge is estimated to take up to 18 months. For the demolition of the existing bridge, the contractor may work from temporary work trestles, existing roadway embankments, and a barge. Demolition of the existing bridge deck would likely occur utilizing track-based hydraulic rams attached to excavators. Existing beams would be lifted using cranes from a barge or temporary work trestle. Removal of the existing bridge piles would likely include vibrating the piles out or cutting them at or below the substrate level; however, depth of removal would be coordinated with the U.S. Coast Guard.

The DB team can also use crushing, jackhammer/hoe ram, wire saw cutting, and mechanical pulling/vibrating equipment. Blasting is anticipated for removal of the existing center pivot and may be needed for the existing rest piers, in which case blasting mats would be utilized for debris containment. A 40-ft by 40-ft cofferdam/containment structure is anticipated for the removal of the existing bridge center support, if these methods are utilized.

The proposed project includes a number of construction restrictions and conservation measures for pile blasting listed here:

- The explosive weight on the blasting charges will not exceed 5 pounds per charge, and a minimum delay of 9 milliseconds (ms) between each charge’s detonation.
- Stemming materials shall be placed in blast holes prior to blasting to contain the force of the blast within the structure. Blast mats shall be placed on the tops of structures to contain “fly rock” during the blast.
- Small “scare charges” are permitted just prior to the blast to temporarily chase nearby animals away and minimize impacts to wildlife.

- The blasting would be restricted to occurring between November 16 and January 31 (the time period in which sturgeon presence in the project area is least likely).
- Protected Species Observers (PSOs) would be required prior to, during, and after blasting. Personnel will conduct a sturgeon monitoring/relocation plan in order to remove sturgeon from the blast "Danger Zone," which is defined in paragraph 7 of the Blasting Conservation Measures below.

The applicant anticipates that blasting would consist of a single blast event; however, due to the size of the center pivot structure and the possibility of blasting the adjacent rest piers, four rounds of blasting may be needed, possibly spanning two days.

Additional Overall Construction Details

Clamshell dredging will occur within the proposed cofferdams in order to remove muck from the bases. An estimated 3 ft of muck will be removed from a total surface area of 19,247 ft^2, for a total of 2,139 cubic yards (yd^3) of dredged material. All dredging spoil material will be placed in an approved upland 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.

The project is anticipated to take up to 36 months; however, this timing will not be finalized until after Request for Proposal (RFP) review for design-build. Traffic would be maintained on the existing alignment during construction, except for 30-day or less road closures that may be required to complete tie-in work, resulting in an off-site detour. Traffic would be shifted to the new bridge before demolition of the existing bridge. The applicant estimates that temporary work platform/trestles would be installed and removed within 24 months each depending on the weather and temporary work platform/trestle dimensions.

General Conservation Measures

The applicant has also agreed to the following additional general conservation measures:

1. All project personnel employed to work on this project shall be notified about the potential presence and appearance of the federally protected Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*) and shortnose sturgeon (*Acipenser brevirostrum*), and that there are civil and criminal penalties for harming, harassing, pursuing, hunting, shooting, killing, capturing, or collecting these species.
2. Trained spotters provided by the contractor shall be onsite for sightings of Atlantic sturgeon and shortnose sturgeon during in-water work. Personnel designated by the contractor shall receive training by the Georgia Department of Natural Resources (GADNR), Wildlife Conservation Section (WCS), Brunswick, Georgia. The contact person for the GADNR WCS is Clay George at (912) 264-7218.
3. The contractor shall cease all construction activities and vessel movement in open water upon the sighting of an Atlantic sturgeon or shortnose sturgeon, within 300 feet of the Project area. The Project area is defined as the area within existing and/or required right-of-way, and temporary and permanent easements for the proposed project. The contractor shall only resume construction activities once the Atlantic sturgeon or shortnose sturgeon, has not been observed within 300 ft of the Project area for at least 30 minutes.

4. All project-related vessels within the Savannah River shall operate at an "Idle Speed/No Wake" speed while in water with less than a 4-ft clearance from the river bottom to the vessel. All vessels will follow routes of deep water when entering or exiting the Project area, and while operating in the Project area, whenever possible. The vessel shall operate at "no wake/idle" speeds after a protected species has been observed in and until it has departed the Project area by at least 300 ft. Atlantic sturgeon(s) or shortnose sturgeon(s) will not be herded away or harassed into leaving any area.
5. Propellers on all boats, 21 ft in length and less, shall be equipped with propeller guard systems, approved by the Project Engineer, designed to prevent harm to Atlantic sturgeon and shortnose sturgeon.
6. Any installation of turbidity curtains, or other in-water equipment will be properly secured with materials that reduce risk of entanglement of marine species. In-water lines (ropes, chain, cable, including the lines to secure turbidity curtains) will be stiff, taut, and non-looping. Flexible lines such as ropes, that could loop around or entangle an animal, shall be enclosed in a plastic or rubber sleeve to add rigidity to prevent tangling. In all instances, no excess line will be allowed in the water.
7. 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.
8. Installation of turbidity curtains will be shore-parallel (anchored on the shore at both ends) and may not exceed 550 ft in length; curtains must be securely anchored and will not impede or obstruct movement of protected species. Turbidity curtains will not exceed more than 10-ft waterward from the shoreline. Turbidity curtains will only extend waterward into depths no greater than 3.6 ft in the main river channel, and will not impede or obstruct movement of sturgeon. Turbidity curtains should extend to 1-ft or less from the bottom (acceptable to lay on the bottom, especially at low tides).
9. In-water work shall not be allowed in the Savannah River from 90 feet west of, to 330 feet east of, the existing center pivot from January 1 to October 31 outside of dewatered cofferdams, with the exception of blasting, which has separate conservation measures, as discussed below.
10. Construction machinery will not be located in an active channel or below the ordinary high water mark (OHWM) or MHWL in Atlantic sturgeon critical habitat (Savannah River) 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/platforms and/or barges. Materials and equipment placed in the Savannah River shall be placed in a manner that does not entrap fish that may occur within the construction area or block access for them to navigate through the construction area. The navigability of the waterway for animal species movement in and out of the Project area shall remain uninterrupted and freely open at all times during construction activities.
11. Barges shall not be allowed to ground within the Savannah River.
12. Water jetting within Savannah River 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, turbidity curtains shall be used.
13. Channel obstructions, such as cofferdams, pilings, and fills, shall be limited to no more than 33% of the width of the Savannah River from tidal wetland to tidal wetland edge at

any one time. The navigability of the Savannah River will remain uninterrupted and freely open for species movement in/out of the area.

14. Extreme care shall be taken in lowering equipment or materials, including, but not limited to piles, sheet piles, casings for drilled shaft construction, spuds, pile templates, etc., below the water surface (Savannah River) and into the riverbed, taking precaution not to harm Atlantic sturgeons or shortnose sturgeons that may have entered the construction area undetected. The maximum speed at which these items can be lowered shall be 60 ft per minute. No equipment or construction materials of any type shall be allowed to fall or be placed in the river unless within a containment structure such as a cofferdam or caisson.
15. The project shall not result in noise in excess of the established thresholds for physical injury or behavioral modification (single strike and cumulative exposure) for the sturgeon. The DB Team will ensure all pile installation/removal activities using relevant best management practices (BMPs) and other methods to avoid and minimize hydroacoustic impacts. Impact driven piles will require bubble curtains or other approved BMPs to reduce noise during construction.
16. 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.
17. Temporary sheet pile cofferdams will be installed and removed by vibratory hammers only. Sheet piling and piles that cannot be effectively removed in this manner shall be cut off below the ground line. Holes left from the removal of temporary piles and sheet piles shall be allowed to fill with natural river sediments.
18. One of the following methods will be used to give any Atlantic sturgeon or shortnose sturgeon the opportunity to leave an area prior to full-force pile driving or hammering (including jack hammering) on each pile. These procedures will be used for a minimum of 15 minutes prior to full-force pile driving or hammering: A) “Ramp up” method (i.e., pile driving or hammering starts at a very low force and gradually builds up to full force), B) “Soft start” method (i.e., noise from hammers (including jack hammering) is initiated for 15 seconds, followed by a 1-minute waiting period – this sequence is repeated multiple times), or C) “Dry firing” method (i.e., operating the pile hammer by dropping the hammer with no compression).
19. Any break in pile driving hammer usage for greater than one hour will require an additional use of ramp up, dry-firing, or soft start measures described above for at least 10 minutes before proceeding with full-force pile driving.
20. The DB Team will employ the use of bubble curtains around any piles or steel casing for drilled shafts installed utilizing impacts hammers.
21. In the event any incident occurs that causes harm to the Atlantic sturgeon or shortnose sturgeon, the Contractor shall report the incident immediately to the Project Engineer who in turn will notify the State Environmental Administrator, GDOT, Office of Environmental Services at (404) 631-1101 or (404) 631-1100. All activity, with the exception of erosion and sedimentation control and traffic control, shall cease pending consultation by the Department with the Lead Federal Agency and the USFWS. GDOT will contact NMFS Protected Resources Division (PRD) at (727) 824-5312 or at takereport.nmfsser@noass.gov.

22. In the event of possible harm to the Atlantic sturgeon or shortnose sturgeon, all activity shall cease pending consultation by the Department with the NMFS. The Contractor shall document the incident with photographs and report the findings immediately to the Engineer who in turn will notify the National Oceanic and Atmospheric Administration (NOAA) at 844-788-7491 or nmfs.ser.sturgeonnetwork@noaa.gov for the Atlantic sturgeon or shortnose sturgeon. The record of the fish shall be submitted by the Contractor to the Project Engineer and the State Environmental Administrator, GDOT OES via the Ecology submittals inbox (ecology_submittals@dot.gat.gov) with the P.I. No. in the subject line of the email.
23. The Contractor shall keep a log detailing any incidents that cause harm or injury to the Atlantic sturgeon or shortnose sturgeon during the project until construction has been completed and time charges have stopped. Following project completion, the log and a report summarizing any incidents that caused harm or injury to these species shall be submitted to the Project Engineer and the State Environmental Administrator, Georgia Department of Transportation, GDOT OES via the Ecology submittals inbox (ecology_submittals@dot.gat.gov) with the PI No. 0013741 in the subject line of the email.

Blasting Conservation Measures

Blasting plan conservation measures were developed and agreed upon with the NMFS Atlantic sturgeon coordinator (INQ-2020-00097). The applicant has also agreed to the following conservation measures for a blasting event occurring in the Action Area, which are defined below:

1. GDOT must ensure that blasting is conducted when sturgeon occur in relatively low density, water temperatures are below 15° Celsius (C), and dissolved oxygen is 4.5 milligrams per liter (mg/L) or greater. These conditions are most commonly met in the Savannah River from late November through January. Blasting shall not be allowed from February 1 to November 15 to minimize the likelihood of injury to Atlantic sturgeon and shortnose sturgeon. Blasting is allowed from November 16 through January 31, provided the protective measures for blasting are established and implemented by the contractor, water temperatures are below 15° C, and dissolved oxygen is 4.5 mg/L or greater. Water temperature and dissolved oxygen information can be obtained from the nearest functional United States Geological Survey (USGS) gauging station reporting dissolved oxygen and water temperature. One currently exists on the SR 25 Bridge over the Savannah River (USGS Gage 02198920). There are several other gauging stations within close proximity to the project on the Savannah, Middle, or Back River. The closest functional station will be utilized to provide the necessary data if the USGS Gage 02198920 is inoperable when needed.
2. Dates for blasting must be scheduled, to the extent practicable, when a daylight tide is low to allow relocation trawling and/or gillnetting to occur, while still ensuring adequate time for captured animals to be handled appropriately before blasting commences. Blasting should then occur midway through a rising (or falling) tide.
3. A wildlife watch and relocation plan will be implemented that includes pre-blast, during blast, and post-blast monitoring of the Danger Zone, which is defined in paragraph 7 below, for Atlantic sturgeon and shortnose sturgeon using protocols developed in coordination with NMFS (INQ-2020-00097) before, during, and after the blasting.

a. GDOT must ensure that relocation trawling and/or gillnetting is conducted by an entity with proper experience and state permits (i.e., Section 10 permit).
b. Trawls may be towed at an average speed up to 3.0 knots for up to 15 minutes; however, when anticipating larger catches, towing time should be minimized to limit overdue stress on catches. If a trawl (or other gear) becomes snagged on bottom substrate or debris, it must be untangled immediately to reduce stress on captured animals. Sweeps of blast area and trawling activities should be completed 15 minutes prior to commencement of blasting.
c. Any gillnetting must only be done when water temperatures are below 15° C, and dissolved oxygen concentrations are 4.5 mg/L or greater. Soak times may not exceed 3 hours. Nets must be constantly tended. If, at any time, during a set the gear becomes snagged on substrate or debris, care must be given to loosen the tension on the net before attempting to free it.
d. All captured sturgeon, regardless of gear type, must be transferred to the nearest holding station (with sufficient capacity to safely hold sturgeon) as quickly as possible, no later than 20 minutes following the end of a trawl.
e. GDOT and/or its hired relocation/monitoring expert, must ensure an adequate number of holding stations are onsite. Holding stations may be located on land (if easily accessible by boat) or other vessels, so long as they meet the proper holding requirements.
f. Holding stations should have appropriate recirculation/oxygenation pumps to ensure conditions are suitable for maintaining the catch for an appropriate duration to allow blasting activities to occur prior to release back into Savannah River.
g. GDOT must ensure that the following precautions are taken during relocation trawling and/or gillnetting, transfer to/between holding stations, and while remaining in the holding stations:
    i. On-board holding tanks will be of sufficient capacity to safely hold captured sturgeon.
    ii. On-board holding tanks must be in good maintenance, have aerated live-wells that allow for total replacement of water volume every 15 minutes, contain backup oxygenation, and air stones via compressed oxygen for smaller on-board holding tanks when working with a larger number of fish.
    iii. The maximum amount of time a fish should be held after removal from capture gear is approximately two hours, unless more time is needed to recover from the effects of an anesthetic or because prolonged holding would benefit a sturgeon.
    iv. Due to space limitations, the largest sturgeon should be processed first instead of subjected to confined holding conditions.
    v. Animals should be handled rapidly, but with care and kept in water to the maximum extent possible during holding and handling. During handling procedures, the animal must be kept wet at all times using water from which it was removed (e.g. river water).
h. GDOT must ensure that once blasting is complete, animals must be returned to the water as quickly as possible. Smaller individuals may be returned by hand.

Larger individuals should be returned using a sling to minimize stress to the animal. Monitors must remain on-site for one hour to ensure that all sturgeon returned to the river have acclimated properly and are no in distress.

i. Post-blast monitoring of the Danger Zone shall include net sampling to document any animal, including sturgeon, injured or killed by the blast. If any sturgeon are killed or injured by blasting, the contractor shall report the findings immediately to the Project Engineer, who in turn will notify the State Environmental Administrator, GDOT, Office of Environmental Services at (404) 631-1101.
j. Pre- and post-blast visual observations from the surface (from boats) should be conducted to detect Atlantic sturgeon and shortnose sturgeon.
k. Following project completion, a report summarizing the monitoring/relocation results shall be submitted to the Project Engineer and the State Environmental Administrator, GDOT OES via the Ecology submittals inbox (ecology_submittals@dot.gat.gov) with PI No. 0013741 in the subject line of the email. GDOT will in turn, provide a copy of the final monitoring/relocation report to NMFS.

4. A pre-blast meeting shall be held to discuss all requirements and safety procedures. Participants of the pre-blast meeting shall include the DB Team, and the blasting DB Team, Department personnel, and applicable state and federal agencies at their discretion including NMFS, USFWS, Federal Highway Administration (FHWA), the GADNR, and the USACE.
5. Confined blast with stemmed charges must be contained (i.e., with blasting mats, within a debris containment box, or within cofferdams).
6. The explosive weight on the blasting charges may not exceed 5 pounds (lbs) per charge, and a minimum delay of 9 ms between each charge's detonation is required. Stemming material shall be placed in blast holes prior to blasting to contain the force of the blast within the structure. Blast mats shall be placed on top of the structures to contain "fly rock" during the blast. Small "scare charges" are required just prior to the blast to temporarily chase nearby animals away and minimize impacts to wildlife. Demolished material shall be removed from the river with an excavator or clamshell bucket.
7. A Danger Zone around the blast area (also referred to as the Exclusion Zone) will be established based on the maximum weight of explosives detonated (in lbs) per delay.
   a. The size of the Danger Zone will be calculated using the following equation:
      $R=520(3\sqrt{W})$
      Where:
      R = radius of the danger zone
      W = maximum weight of explosives in pounds per delay (i.e., 5 lbs)
   b. Therefore, at the maximum explosive weight of 5 lbs per charge, the radius of the Danger Zone will be 3,488 ft (i.e., the entire width of the river for 3,488 ft north and south, of the blast site).
8. The DB team shall be required to perform pre- and post-construction side scan sonar surveys. The preconstruction side scan sonar survey shall occur prior to issuance of Notice to Proceed. The post-construction side scan sonar survey shall occur within 60 days following the completion of all in-water work. The Design Build team shall be responsible for submitting this information and coordinating the results with the GDOT, USACE, USFWS, and NMFS.

Figure 1. Image showing the project location on the Savannah River located in Port Wentworth, Chatham County, Georgia (©2019 Google).

2.2 Action Area

The project site is located within the designated critical habitat for the South Atlantic Distinct Population Segment (DPS) of Atlantic Sturgeon (South Atlantic Unit 3) at latitude 32.165370°, longitude -81.155330° (North American Datum 1983, center point of the existing bridge structure). The action area is defined by regulation as "all areas to be affected directly or indirectly by the federal action and not merely the immediate area involved in the action" (50 Code of Federal Regulations [CFR] 402.02). As such, the action area includes both the proposed project's footprint, as well as the immediately surrounding areas that may be affected by effects of the proposed action. As a result, the action area includes not only the project area as discussed above, but also areas up and downstream that could be affected by interdependent and interrelated actions, including vessel transit areas, such as Houlihan Landing or other area boat ramp or docking facilities. The predominant controlling factor on establishment of the action area for evaluation on marine species is noise, which would affect the species mobility within the river. Noise from proposed project activities would extend the area of consideration for potential direct and indirect impacts. In order to effectively consider all construction activities effects on Atlantic sturgeon, shortnose sturgeon, and designated Atlantic sturgeon critical habitat, the action area for the proposed project extends 3,500 ft upstream and downstream of the proposed Project area within the Savannah River. This is the maximum range of effects based on the activities most likely to cause harm to the species (i.e., noise, blasting, vessel transit, turbidity effects) (Figure 3).

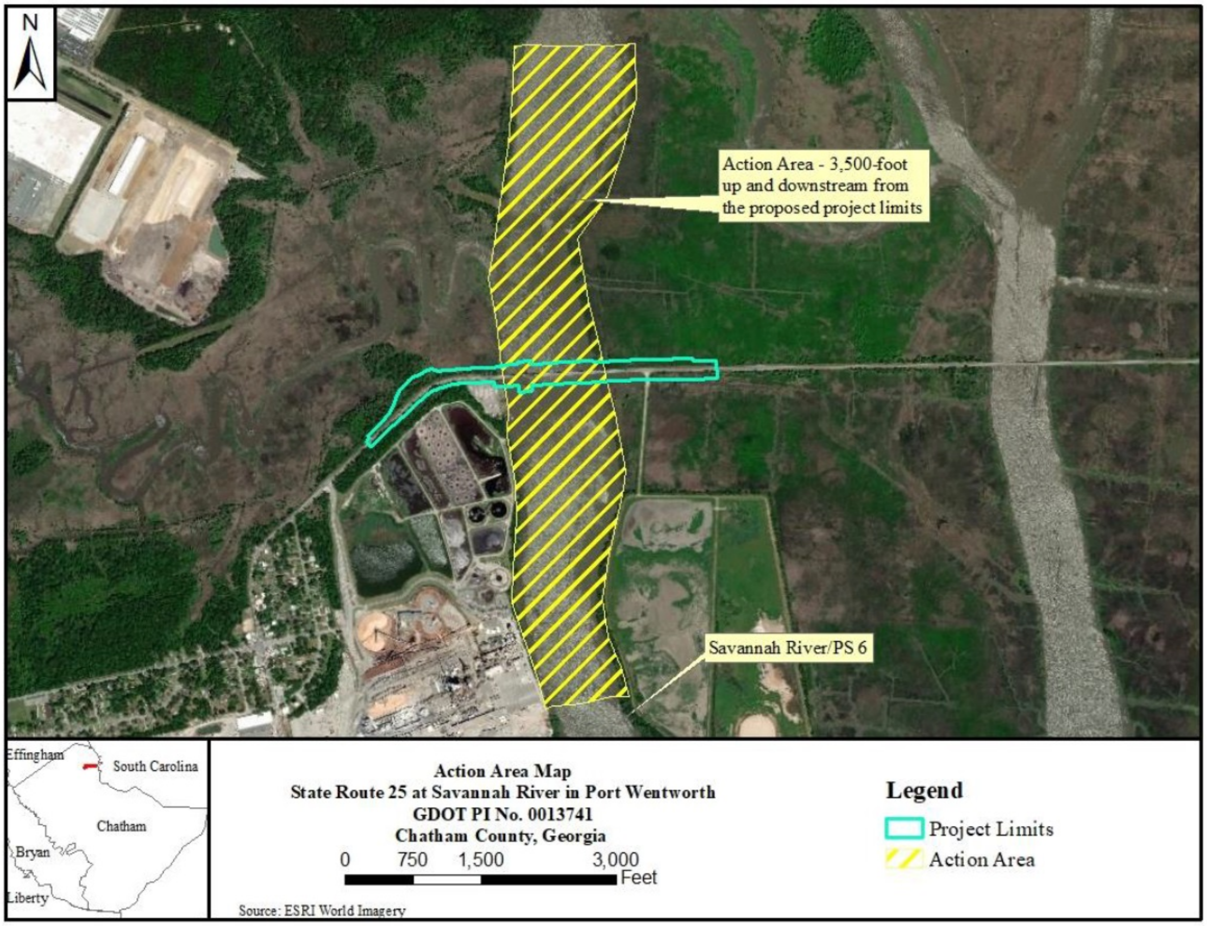

Figure 2. Image showing the action area from "Ecology Resource Survey and Assessment of Effects Report: State Route (SR) 25 at Savannah River in Port Wentworth, Chatham County, Georgia", pg. 126 of 362.

For the purposes of this Federal action, the action area includes a combination of the existing roadbed, freshwater forested wetlands, tidal forested wetlands, tidal emergent wetlands, and the Savannah River. The project area is located approximately 21 miles upstream of the Atlantic Ocean at Tybee Island. The substrate composition for the majority of the project area is muck and silt. The project area does not contain any submerged aquatic vegetation or other sensitive habitats, and the site does not contain suitable spawning grounds for listed sturgeon species. Water quality within the Savannah River and surrounding wetlands is good. The Savannah River is a tidally influenced river system with a mean high water (MHW) elevation of 9.62 ft and a mean low water (MLW) elevation of 1.48 ft NAVD88 at the project site, and it flows from north to south on outgoing tides. The deepest point of the river at the project site is approximately 45.09 ft deep at MHW, and the bankfull width of the river channel is approximately 1,060 ft. The site includes the existing bridge over the Savannah River (Structure ID 052-0054-0). The existing bridge is 1,465 ft long and 36.5 ft wide, and traverses the Savannah River in an east-west orientation. The bridge was built in 1922 and reconstructed in 1954. The overwater area of the bridge is approximately 1.03 ac.

3 STATUS OF LISTED SPECIES AND CRITICAL HABITAT

Table 2 provides the effect determinations for species the FHWA and/or NMFS believe may be affected by the proposed action.

Table 2. Effects Determination(s) for Species the Action Agency and/or NMFS Believe May Be Affected by the Proposed Action

Species	ESA Listing Status[1]	Action Agency Effect Determination	NMFS Effect Determination
Fish			
Atlantic sturgeon (SA DPS)	E	LAA	LAA
Shortnose sturgeon	E	LAA	LAA

The project area is located within designated critical habitat for the South Atlantic DPS of Atlantic sturgeon (South Atlantic Unit 3). Table 3 describes the Physical and Biological Features (PBFs) of the Atlantic Sturgeon South Atlantic Unit 3 designated critical habitat.

[1] E = endangered; T = threatened; NLAA = may affect, not likely to adversely affect; NE = no effect

Table 3. Description of PBFs in Atlantic Sturgeon Critical Habitat, South Atlantic Unit 3

	PBF	Purpose/Function of PBF
Hard Substrate (PBF 1)	Hard bottom substrate (e.g., rock, cobble, gravel, limestone, boulder, etc.) in low salinity waters (i.e., 0.0-0.5 parts per thousand [ppt] range)	Necessary for settlement of fertilized eggs, refuge, growth, and development of early life stages
Salinity Gradient and Soft Substrate (PBF 2)	Aquatic habitat with a gradual downstream salinity gradient of 0.5 ppt up to as high as 30 ppt and soft substrate (e.g., sand, mud) between the river mouth and spawning sites	Necessary for juvenile foraging and physiological development
Unobstructed Water of Appropriate Depth (PBF 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 mouth and spawning sites	Necessary to support: • Unimpeded movement of adults to and from spawning sites • Seasonal and physiologically dependent movement of juvenile Atlantic sturgeon to appropriate salinity zones within the river estuary • 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 meters [m]) to ensure continuous flow in the main channel at all times when any sturgeon life stage would be in the river
Water Quality (PBF 4)	Water quality conditions, especially in the bottom 1 m of the water column with the appropriate combination of temperature and oxygen values	Necessary to support: • Spawning • Annual and inter-annual adult, subadult, larval, and juvenile survival • 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 milligrams per liter (mg/L) dissolved oxygen (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 support spawning habitat.

In Section 3.2, we discuss the status of Atlantic sturgeon and shortnose sturgeon species likely to be adversely affected by the project actions.

Three of the four PBFs described in Table 3 are present in the action area: salinity gradient and soft substrate (PBF 2), unobstructed water of appropriate depth (PBF 3), and water quality (PBF 4). We believe that all three PBFs present in the action area may be affected by the proposed action.

Table 4 provides the effects determinations for critical habitat occurring within the action area that the FHWA and/or NMFS believe may be affected by the proposed action.

Table 4. Effects Determination(s) for Designated Critical Habitat the Action Agency and/or NMFS Believe May Be Affected by the Proposed Action

Species	Unit	Action Agency Effect Determination	NMFS Effect Determination
Atlantic Sturgeon (SA DPS)	South Atlantic Unit 3	Not likely to adversely affect	Not likely to adversely affect

3.1 Potential Routes of Effect Not Likely to Adversely Affect Listed Species and Critical Habitat

South Atlantic DPS of Atlantic Sturgeon and Shortnose Sturgeon
We have identified potential effects of the proposed action on Atlantic sturgeon and shortnose sturgeon. We believe that these species are not likely to be adversely affected by the aspects of the proposed action described below.

During in-water construction, Atlantic and shortnose sturgeon may be physically injured if struck by construction equipment, vessels, or materials. This effect is extremely unlikely to occur due to the ability of the species to move away from the project site if disturbed. Sturgeon are mobile and are able to avoid construction noise, moving equipment, and placement or removal of materials during construction. The applicant's implementation of the conservation measures outlined above will further reduce the risk by requiring all construction workers to watch for ESA-listed species. Operation of any mechanical construction equipment will cease immediately if a sturgeon is seen within a 300-ft radius of the equipment. Activities will not resume until the protected species has departed the project area of its own volition. Additionally, the primarily demersal habits of sturgeon would rarely put sturgeon at risk from vessels at the surface.

The action area contains habitat that may be used by Atlantic and shortnose sturgeon for foraging and refuge. Sturgeon may be temporarily affected by their inability to access the action area due to their avoidance of construction activities and physical exclusion from the action area due to mechanical equipment (e.g., bridge demolition and construction equipment). However we believe this effect will be insignificant. Sturgeon could be affected by the placement of temporary in-water structures (e.g., temporary work bridge/trestles) in areas that may serve as migration, foraging, or refuge habitat. However, after the temporary structures are constructed, they will not block upstream access and will be removed after bridge construction and demolition is completed. Therefore, we believe the effect to Atlantic and shortnose sturgeon from the placement of temporary in-water structures will be insignificant. Both species of sturgeon are opportunistic feeders that forage over large areas and the area of temporary impact is relatively small compared to the surrounding area, which has suitable foraging and refuge habitat available. Furthermore, once the mechanical equipment and temporary structures are removed, sturgeon can use the area for foraging and refuge again. In addition, in-water work shall not be allowed in the Savannah River from 90 ft west of, to 330 ft east of, the existing center pivot from January 1 to October 31 outside of dewatered cofferdams, with the exception of blasting. This ensures that all in-water work (other than blasting) will occur when sturgeon are least likely to be in the project area (January-April) making it very unlikely the species will be present during construction. However, if sturgeon are present, they would only be excluded from a limited project area temporarily and permanently from 33% of river habitat (substrate).

Atlantic and shortnose sturgeon may be affected by the permanent loss of habitat due to the placement of pile-supported structures, fender system, cofferdams, poured concrete footers, and the driven pile bridge fender system. However, the effect to sturgeon from the potential loss of foraging habitat due to the placement of pile-supported structures is insignificant. Atlantic and shortnose sturgeon are opportunistic feeders that forage over large areas. The area of permanent impact is relatively small (0.44 ac) compared to the surrounding area, which has suitable foraging and refuge habitat available in the Middle River, the adjacent Little Back River, and the mainstem of the Savannah River.

Noise created by pile driving activities can physically injure animals or change animal behavior in the affected areas. Injurious effects can occur in 2 ways. First, immediate adverse effects can occur to listed species if a single noise event exceeds the threshold for direct physical injury. Second, effects can result from prolonged exposure to noise levels that exceed the daily cumulative exposure threshold for the animals, and these can constitute adverse effects if animals are exposed to the noise levels for sufficient periods. Behavioral effects can be adverse if such effects interfere with animals migrating, feeding, resting, or reproducing, for example. Our evaluation of effects to listed species as a result of noise created by construction activities is based on the analysis prepared in support of the Opinion for SAJ-82.[2] The noise analysis in this consultation evaluates effects to ESA-listed Atlantic and shortnose sturgeon identified by NMFS as potentially affected in the table above.

The 30-in PSC piles used to construct the 7 of the 12 two column bents for the project will be installed within the Savannah River with an impact hammer. The entirety of the radius for potential injury to fish through either single strike or cumulative sound effects will be contained within the cofferdams; therefore, sturgeon are not expected to experience any direct physical injury from impact pile driving of these piles. Behavioral effects to listed fish species may extend up to 825 ft from the pile being driven. Sturgeon, however, are highly mobile species and are easily able to move away from noise disturbances to avoid potential effects. In addition, because the Savannah River has two braided channels east of the project area that provide suitable habitat for utilization and migration past the project area, we believe behavioral effects will be insignificant. If an individual chooses to remain within the behavioral response zone, it could be exposed to behavioral noise impacts during pile installation. Since pile driving will only occur during daytime hours, sturgeon will be able to utilize or migrate through the project area during

[2] NMFS. Biological Opinion on Regional General Permit SAJ-82 (SAJ-2007-01590), Florida Keys, Monroe County, Florida. June 10, 2014.

the night. Additionally, the impact driving will be temporary because a maximum of 10 piles will be installed per day, for a total of 1,316 hours over the course of the project. Furthermore, any behavioral effects from the PSC pile driving will be mitigated by using the cofferdam and/or using a bubble curtain (total sound attenuation of at least 10 decibels [dB]). Therefore, we believe the behavioral noise effects associated with the installation of the 30-in PSC piles by impact hammer will be insignificant.

Sturgeon may also be affected by noise associated with the vibratory hammer installation of the 24-in sheet piles for the cofferdams, the wooden/composite fender piles, and the steel pipe piles (24-in diameter) driven into the estuary's bottom for the construction of temporary work trestles (as well as their later removal). The potential removal of the existing obsolete bridge's piles via vibratory hammer during the demolition process would have effects similar to those described herein for 24 in steel pipe piles. The maximum extent of vibratory pile driving effects is determined by the type of pile with the greatest sound impact, which in this case is the 24-in sheet piles. Based on our noise calculations, installation of 24 in metal sheet piles by vibratory hammer will not result a single noise event that exceeds the threshold for direct physical injury for sturgeon. Yet, this installation method could result in behavioral effects at radii of 329 ft (100 m) for sturgeon. As explained above, due to the mobility of sturgeon species, we expect them to move away from noise disturbances. Because there is similar habitat nearby, we believe this effect will be insignificant. If an individual chooses to remain within the behavioral response zone, it could be exposed to behavioral noise impacts during pile installation. Since installation will occur only during the day, these species will be able to resume normal activities during quiet periods between pile installations and at night. At no point will vibratory pile driving create behavioral effects extending the width of the channel at the project site, allowing for both migration through and use of habitat within the project area. Therefore, installation of metal sheet piles by vibratory hammer will not result in any injurious noise effect, and we anticipate any behavioral effects will be insignificant. The applicant's compliance with the conservation measures listed above will provide an additional measure of protection by causing the installation activities to stop if sturgeon are spotted within 300 ft of operations. Thus, the risk of injury to sturgeon from the vibratory installation or removal of 24-in-diameter pipe piles or vibratory removal of the existing bridge's piles is extremely unlikely.

Atlantic sturgeon Critical Habitat – Unit 3

We have identified potential effects of the proposed action on Atlantic sturgeon critical habitat (South Atlantic Unit 3). Of the 4 PBFs identified for Atlantic sturgeon critical habitat (Table 3), the "hard substrate" PBF 1 is not present in the action area and is not discussed further in this Opinion. Below is our determination as to why the proposed action is not likely to adversely affect the "salinity gradient and soft substrate" (PBF 2), the "unobstructed water of appropriate depth" (PBF 3), and the "water quality" (PBF 4).

The bridge replacement may impact Atlantic sturgeon critical habitat South Atlantic Unit 3 PBF 2, salinity gradient and soft substrate, due to the permanent loss of soft substrate (e.g., sand, mud) from the placement of pile-supported structures, cofferdams, poured concrete footers, and the driven pile bridge fender system. However, the impacts to the soft substrate portion of PBF 2 due to the placement of pile-supported structures is insignificant. Atlantic and shortnose sturgeon juveniles are opportunistic feeders that forage and develop over large areas. The area of permanent impact to soft substrate is relatively small (0.44 ac) compared to the surrounding area, which has suitable soft substrate habitat available in the Middle River, the adjacent Little Back River, and the mainstem of the Savannah River. The construction activities are not expected to alter salinities within the action area, and will not affect the salinity gradient portion of PBF 2.

Additionally, the proposed action may impact PBF 3, unobstructed water of appropriate depth, through the construction of cofferdams, bents, and temporary work trestles. These potential effects will be insignificant because at all times the availability of unobstructed waters of appropriate depth will far exceed any restricted access to this PBF from bridge construction and will not result in any limitation in functionality for this PBF. The applicant proposes to install 17,640 ft^2 of temporary cofferdams (each bent is 40 ft x 63 ft; there are 7 bents total, 7 x 40 ft x 63 ft = 17640 ft^2 total) and 572 temporary 24-in steel pipe piles; this will be the greatest extent of potential impacts to PBF 3. The maximum channel width that will be blocked by cofferdams and temporary pilings is 380 ft from a bank. The full width of the channel is approximately 1,060 ft. The remaining 680 ft of available channel provides ample space for listed species to transit the site. After the removal of the cofferdams and temporary work trestles, the permanent structures will obstruct less than 150 ft of the river channel, leaving more than 900 ft of unaffected river channel available to listed fish species. Additionally, there are 2 braided channels to the east that will be unimpacted by the proposed action and available for sturgeon to move unobstructed within the watershed. The project is anticipated to have no effect on water depth.

The proposed action may also result in temporary increases in turbidity that have the potential to impact water quality (PBF 4). These potential impacts to water quality will be insignificant. The project's effects on turbidity and water quality will be contained by the project BMPs to control sediment from upland activity and by performing in-water excavation within the cofferdams, isolating disturbed sediments from the river. In addition, the conservation measures incorporated into the proposed action require all project-related vessels within the Savannah River to operate at an "Idle Speed/No Wake" speed while in water with less than a 4-ft clearance from the bottom. Total changes to turbidity in the river from project activities are not expected to exceed 25 nephelometric turbidity units at any time which is well within the tolerance of sturgeon and normal variation in turbidity within the watershed (Johnson 2018). There are no anticipated impacts to dissolved oxygen levels, temperature, or other water quality factors from the proposed action.

As a result, the proposed action is not likely to adversely affect the three PBFs of the South Atlantic Unit 3 that are present within the action area (salinity gradient and soft substrate (PBF2), unobstructed water of appropriate depth (PBF 3), and water quality (PBF 4)). The first PBF of the South Atlantic Unit 3 (hard substrate (PBF 1) is not present within the action area. Therefore, we conclude the proposed action is not likely to adversely affect Atlantic sturgeon designated critical habitat.

3.2 Status of Species Likely to be Adversely Affected

3.2.1 *South Atlantic Distinct Population Segment of 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 Description and Distribution
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, Canada, south to the St. Johns River, Florida (Murawski, Pacheco 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 lbs (Collette and Klein-MacPhee 2002, ASSRT 2007). They are distinguished by armor-like plates (called scutes) and a long protruding snout that has four barbels (slender, whisker-like feelers extending from the lower jaw used for touch and taste). Adult Atlantic sturgeon spend the majority of their lives in nearshore marine waters, returning to the rivers where they were born (natal rivers) to spawn (Wirgin, Waldman et al. 2002). Young sturgeon may spend the first few years of life in their natal river estuary before moving out to sea (Wirgin, Waldman et al. 2002). Atlantic sturgeon are omnivorous benthic (bottom) feeders and incidentally ingest mud along with their prey. Diets of adult and subadult Atlantic sturgeon include mollusks, gastropods, amphipods, annelids, decapods, isopods, and fish such as sand lance (Bigelow and Schroeder 1953, ASSRT 2007, Guilbard, Munro et al. 2007, Savoy 2007). Juvenile Atlantic sturgeon feed on aquatic insects, insect larvae, and other invertebrates (Bigelow and Schroeder 1953, ASSRT 2007, Guilbard, Munro et al. 2007).

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 Rivers' basin (ACE Basin) southward along the South Carolina, Georgia, and Florida coastal areas to the St. Johns River, Florida. The marine range of Atlantic sturgeon from the South Atlantic DPS extends from the Hamilton Inlet, Labrador, Canada, to Cape Canaveral, Florida (Figure 4).

The action area includes a lower section of the Savannah River. The location of the action means juveniles, subadult, adults could be effected by the action. While adult Atlantic sturgeon from all DPSs mix extensively in marine waters, generally adults return to their natal rivers to spawn. Genetic studies show that fewer than two adults per generation spawn in rivers other than their natal river (Wirgin, Waldman et al. 2000, King, Lubinski et al. 2001, Waldman, Grunwald et al. 2002). Young sturgeon spend the first few years of life in their natal river estuary before moving out to sea. Therefore, we expect only Atlantic sturgeon from the South Atlantic DPS to be affected by the action.

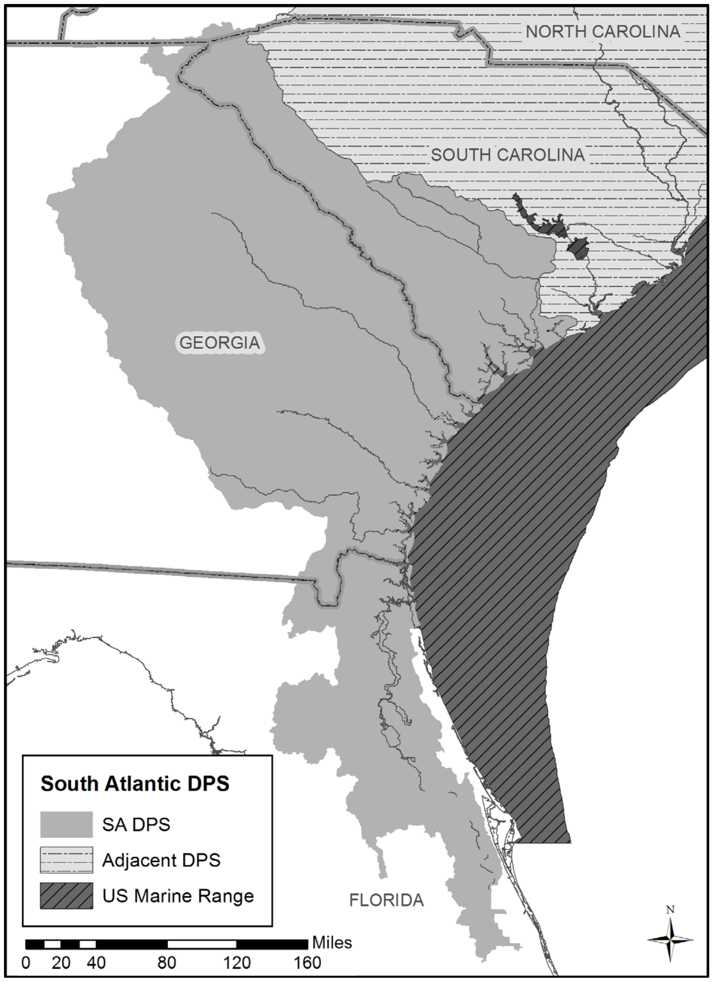

Figure 3. The South Atlantic DPS, including the adjacent portion of the marine range.

Life History Information

Atlantic sturgeon are generally referred to as having four size/developmental categories: eggs/larvae; young-of-year (YOY); juveniles and subadults; and adults. Hatching occurs approximately 94-140 hours after egg deposition. Immediately after hatching larvae enter the yolk sac larval stage and assume a demersal existence (Smith, Dingley et al. 1980). The yolk sac provides nutrients to the animals until it is completely absorbed 8-12 days after hatching (Kynard and Horgan 2002). Animals in this stage are fewer than 4 weeks old, with total lengths (TL) less than 30 millimeters (mm) (Van Eenennaam, Doroshov et al. 1996). Animals in this phase are in freshwater and are located far upstream very near the spawning beds. As the larvae develop they commence downstream migration towards the estuaries. During the first half of their downstream migration, movement is limited to night. During the day, larvae use gravel, rocks, sticks, and other three-dimensional structure as refugia (Kynard and Horgan 2002). During the latter half of migration when larvae are more fully developed, movement occurs both day and night. Salinities of 5-10 ppt are known to cause mortality at this young stage (Bain 1997, Kynard and Horgan 2002, Cech and Doroshov 2005).

As larvae grow and absorb the yolk sac, they enter the YOY phase. YOY are greater than 4 weeks old but less than 1 year, and generally occur in the natal river. These animals are generally located in freshwater downstream of the spawning beds, though they can be found in the estuaries.

Following the YOY life phase, sturgeon develop into juveniles and subadults. There is little morphometric difference, aside from overall size, between juveniles and subadults; they are primarily distinguished by their occurrence within estuarine or marine waters. Juveniles are generally only found in estuarine habitats, while subadults may be found in estuarine and marine waters. As a group, juveniles and subadults range in size from approximately 300-1500 mm TL. The term "juveniles" refers to animals 1 year of age or older that reside in the natal estuary. 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. During their first 2 years, juvenile Atlantic sturgeon remain in the estuaries of their natal rivers, which may include both fresh and brackish channel habitats below the head of tide (Hatin, Munro et al. 2007). Upon reaching age 2, juveniles become increasingly salt tolerant and some individuals will begin their outmigration to nearshore marine waters (Dovel and Berggren 1983, Bain 1997, Hatin, Munro et al. 2007). Some juveniles will take up residency in non-natal rivers that lack active spawning sites (Bain 1997). By age 5, most juveniles have completed their transition to saltwater becoming "subadults," "late-stage juveniles," or "marine migratory juveniles"; however, these animals are frequently encountered in estuaries of non-natal rivers (Bahr and Peterson 2016).

Out migration of larger juveniles may be influenced by the density of younger, less-developed juveniles. Because early juveniles are intolerant of salinity, they are likely unable to use foraging habitats in coastal waters if riverine food resources become limited. However, older, more-developed juveniles are able to use these coastal habitat, though they may prefer the relatively predator-free environments of brackish water estuaries as long as food resources are not limited (Schueller and Peterson 2010).

Adults are sexually mature individuals of 1500+ mm TL and 5 years of age or older. They may be found in freshwater riverine habitats on the spawning grounds or making migrations to and from the spawning grounds. They also use estuarine waters seasonally, principally in the spring through fall and will range widely in marine waters during the winter. After emigration from the natal estuary, subadults and adults travel within the marine environment, typically in waters shallower than 50 m in depth, using coastal bays, sounds, and ocean waters often occurring over sand and gravel substrate (Vladykov and Greely 1963, Murawski, Pacheco et al. 1977, Dovel and Berggren 1983, Smith 1985, Collins and Smith 1997, Welsh, Eyler et al. 2002, Savoy and Pacileo 2003, Stein, Friedland et al. 2004, Laney, Hightower et al. 2007, Greene, Zimmerman et al. 2009, Dunton, Jordaan et al. 2010, Erickson, Kahnle et al. 2011, Wirgin and King 2011).

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 and 19 years in South Carolina (Smith, Marchette et al. 1982), between 11 and 21 years in the Hudson River (Young, Hoff et al. 1988), and between 22 and 34 years in the St. Lawrence River (Scott and Crossman 1973). Female Atlantic sturgeon likely do not spawn every year. Multiple studies have shown that spawning intervals range from 1 to 5 years for males (Smith 1985, Collins, Smith et al. 2000, Caron, Hatin et al. 2002) and 2 to 5 years for females (Vladykov and

Greely 1963, Van Eenennaam, Doroshov et al. 1996, Stevenson and Secor 1999). Fecundity (number of eggs) of Atlantic sturgeon has been correlated with age and body size, with egg production ranging from 400,000 to 8,000,000 eggs per female per year (Smith, Marchette et al. 1982, Van Eenennaam and Doroshov 1998, Dadswell 2006). The average age at which 50 percent of maximum lifetime egg production is achieved is estimated to be 29 years, approximately 3 to 10 times longer than for other bony fish species examined (Boreman 1997).

Spawning adult Atlantic sturgeon generally migrate upriver in spring to early summer, which occurs in February-March in southern systems, April-May in Mid-Atlantic systems, and May-July in Canadian systems (Murawski, Pacheco et al. 1977, Smith 1985, Bain 1997, Smith and Clugston 1997, Caron, Hatin et al. 2002). Likely fall spawning runs have been identified in the Edisto River, South Carolina (Farrae, Post et al. 2017) and the Altamaha River, Georgia (Ingram and Peterson 2016). Telemetry data collected in 2013 and 2015 also show acoustically tagged fish making spawning runs in late summer (August – September) in the Savannah River (SCDNR, Unpublished data). A fall spawning run has also been confirmed in the Roanoke River, North Carolina (Smith, Flowers et al. 2015), in the Carolina DPS; however, they report a spring spawning run is also likely occurring. This suggests that a fall spawn is occurring in a number of southern rivers (Rogers and Weber 1995, Weber and Jennings 1996, Moser, Bichy et al. 1998, Collins, Smith et al. 2000, McCord, Collins et al. 2007). Spawning is believed to occur in flowing water between the salt front of estuaries and the fall line of large rivers, when and where optimal flows are 46-76 centimeters (cm) per second and depths are 3-27 meters (m) (Borodin 1925, Leland 1968, Scott and Crossman 1973, Crance 1987, Bain, Haley et al. 2000). Males commence upstream migration to the spawning sites when waters reach around 6°C (Smith, Marchette et al. 1982, Dovel and Berggren 1983, Smith 1985) with females following a few weeks later when water temperatures are closer to 12° or 13°C (Dovel and Berggren 1983, Smith 1985, Collins, Rogers et al. 2000). Atlantic sturgeon have highly adhesive eggs that must be laid on hard bottom in order to stick. Thus, spawning occurs over hard substrate, such as cobble, gravel, or boulders (Gilbert 1989, Smith and Clugston 1997).

Status and Population Dynamics

Secor (2002) estimates that 8,000 adult females were present in South Carolina prior to 1890. 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 prior to 1890.

The South Atlantic DPS historically supported 8 spawning subpopulations. At the time of listing only 6 spawning subpopulations were believed to have existed: the Combahee River, Edisto River, Savannah River, Ogeechee River, Altamaha River (including the Oconee and Ocmulgee tributaries), and Satilla River. We determined those rivers/river systems supported spawning if YOY were observed or mature adults were present in freshwater portions of a system. Three of the spawning subpopulations in the South Atlantic DPS are relatively robust and are considered the second (Altamaha River) and third (Combahee/Edisto River) largest spawning subpopulations across all 5 DPSs. Peterson, Schueller et al. (2008) estimated the number of spawning adults in the Altamaha River was 324 (95% CI: 143-667) in 2004 and 386 (95% CI: 216-787) in 2005. The Altamaha and Combahee/Edisto River spawning subpopulations are likely less than 6% of their historical abundance. For the remaining spawning rivers, fewer than

300 adults are estimated to be spawning annually (total of both sexes) (75 FR 61904; October 6, 2010). Bahr and Peterson (2016) estimated the age-1 juvenile abundance in the Savannah River from 2013-2015 at 528 in 2013, 589 in 2014, and 597 in 2015. The abundance of the remaining 3 spawning subpopulations in the South Atlantic DPS is likely less than 1% of their historical abundance (ASSRT 2007).

The two remaining historical spawning subpopulations in the Broad-Coosawatchie River and St. Marys River were believed to be extinct. However, new information provided from the capture of juvenile Atlantic sturgeon suggests the spawning subpopulation in the St. Marys River is not extinct and continues to exist, albeit at very low levels. Regardless of river, 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.

In 2017, the Atlantic States Marine Fisheries Commission (ASMFC) completed an Atlantic Sturgeon Benchmark Stock Assessment (ASMFC 2017). The purpose of the assessment was to evaluate the status of Atlantic sturgeon along the U.S. Atlantic coast (ASMFC 2017). The assessment considered the status of each DPS individually, as well as all 5 DPSs collectively as a single unit. The assessment determined the South Atlantic DPS abundance is "depleted" relative to historical levels. The assessment concluded there was not enough information available to assess the abundance of the DPS since the implementation of the 1998 fishing moratorium. However, it did conclude there was 40% probability the South Atlantic DPS is still subjected to mortality levels higher than determined acceptable in the 2017 assessment.

The assessment also estimated effective population sizes (N_e) when possible. Effective population size is generally considered to be the number of individuals that contribute offspring to the next generation. More specifically, based on genetic differences between animals in a given year, or over a given period of time, researchers can estimate the number of adults needed to produce that level of genetic diversity. For the South Atlantic DPS, the assessment reported N_e for the Edisto, Savannah, Ogeechee, and Altamaha rivers (Table 5). Additional estimates of N_e have been conducted since the completion of the assessment, including for additional river systems; Table 5 reports those estimates.

Table 5. Estimates of Effective Population Size by Rivers

River	Effective Population Size (N_e) (95% CI)	Sample Size	Collection Years	Reference
Edisto	55.4 (36.8-90.6)	109	1996-2005	ASMFC (2017)
	Fall Run – 48.0 (44.7-51.5)	1,154	1996-2004	Farrae, Post et al. (2017)
	Spring Run – 13.3 (12.1-14.6)	198	1998, 2003	Farrae, Post et al. (2017)
	60.0 (51.9-69.0)	145	1996, 1998, 2005	Waldman, Alter et al. (2018)
Savannah	126.5 (88.1-205)	98	2000-2013	ASMFC (2017)
	123 (103.1-149.4)	161	2013, 2014, 2017	Waldman, Alter et al. (2018)
Ogeechee	32.2 (26.9-38.8)	115	2003-2015	ASMFC (2017)
	26 23.9–28.2	200	2007-2009, 2014-2017	Waldman, Alter et al. (2018)
	23.9 (22.2-25.7)	197	2007-2009, 2014-2017	Fox, Peterson et al. (2019)
Altamaha	111.9 (67.5-216.3)	186	2005-2015	ASMFC (2017)
	149 (128.7–174.3)	245	2005, 2011, 2014, 2016-2017	Waldman, Alter et al. (2018)
	142.1 (124.2-164.0)	268	2005, 2011, 2014-2017	Fox, Peterson et al. (2019)
Satilla	21 (18.7–23.2)	68	2015-2016	Waldman, Alter et al. (2018)
St. Marys	1 (1.3–2.0)	14	2014-2015	Waldman, Alter et al. (2018)

Generally, a minimum N_e of 100 individuals is considered the threshold required to limit the loss in total fitness from in-breeding depression to <10%; while an N_e greater than 1,000 is the recommended minimum to maintain evolutionary potential (Frankham, Bradshaw et al. 2014, ASMFC 2017). N_e is useful for defining abundance levels where populations are at risk of loss of genetic fitness (ASMFC 2017). While not inclusive of all the spawning rivers in the South Atlantic DPS, the estimates reported in Table 5 suggest there is a risk for inbreeding depression ($N_e < 100$) in 4 of those rivers (Edisto, Ogeechee, Satilla, and St. Marys rivers) and loss of evolutionary potential ($N_e < 1000$) in all six. This information suggests there at least some inbreeding depression within the DPS and loss of evolutionary potential throughout all of it.

The concept of a viable population able to adapt to changing environmental conditions is critical to Atlantic sturgeon. Low population numbers of every river population in the South Atlantic DPS put them in danger of extinction; none of the river populations are large or stable enough to provide with any level of certainty for continued existence of the South Atlantic DPS. Although the largest impact that caused the precipitous decline of the species has been restricted (directed fishing), the population sizes within the South Atlantic DPS have remained relatively constant at greatly reduced levels (approximately 6% of historical population sizes in the Altamaha River, and 1% of historical population sizes in the remainder of the DPS) for 100 years. 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, Soulé 1980, Shaffer 1981).

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 also allows multiple opportunities to contribute to future generations, it also increases the timeframe over which exposure to the multitude of threats facing the South Atlantic DPS can occur.

The viability of the South Atlantic DPS 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 two individuals per generation spawn outside their natal rivers (Wirgin, Waldman et al. 2000, King, Lubinski et al. 2001, Waldman, Grunwald et al. 2002). 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 fishermen continue to threaten Atlantic sturgeon. The South Atlantic DPS was listed as endangered under the ESA because 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 habitat by impeding access to spawning, developmental, and foraging habitat, modifying (diverting) 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 devices have shown limited benefit to Atlantic sturgeon as a means of minimizing impacts of dams because these devices have been historically designed for salmon and other water-column fish rather than large, bottom-dwelling species like sturgeon. However, NMFS continues to evaluate ways to effectively pass sturgeon above and below man-made barriers. For example, large nature-like fishways (e.g., rock ramps) hold promise as a mechanism for successful passage. On the Savannah River, the New Savannah Bluff Lock and Dam (NSBL&D) at the City of Augusta, denying Atlantic sturgeon access to 7% of its historically available habitat

(ASSRT 1998). However, the Augusta Shoals, the only rocky shoal habitat on the Savannah River and the former primary spawning habitat for Atlantic sturgeon in the river (Duncan, Freeman et al. 2003, USFWS 2003, Marcy, Fletcher et al. 2005, Wrona, Wear et al. 2007), is located above NSBL&D, and is currently inaccessible to Atlantic sturgeon. So, while Atlantic sturgeon have access to the majority of historical habitat in terms of unimpeded river miles, only a small amount of spawning habitat exists downstream of the NSBL&D and the vast majority of the rocky freshwater spawning habitat they need is inaccessible as a result of the NSBL&D.

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 organisms; turbidity/siltation effects; contaminant resuspension; noise/disturbance; alterations to hydrodynamic regime and physical habitat; and actual loss of riparian habitat (Chytalo 1996, Winger, Lasier 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. Dredging in nursery grounds modifies the quality of the habitat and is further curtailing the extent of available habitat in the Cape Fear, Cooper, and Savannah rivers, where sturgeon habitat has already been modified and curtailed by the presence of dams. Maintenance dredging is currently modifying Atlantic sturgeon nursery habitat in the Savannah River and modeling indicates that the deepening of the navigation channel will result in reduced dissolved oxygen (DO) and upriver movement of the salt wedge, restricting spawning habitat. Dredging is also modifying nursery and foraging habitat in the St. Johns River.

Dredging directly effects sturgeon by entraining them in dredge drag arms and impeller pumps. Mechanical dredges have also been documented to kill sturgeon. Dickerson (2013) summarized observed takes of 38 sturgeon from dredging activities conducted by USACE and observed from 1990-2013: 3 Gulf, 11 shortnose, and 23 Atlantic, and 1 unidentified due to decomposition. Of the three types of dredges included (hopper, clamshell, and pipeline) in the report, most sturgeon were captured by hopper dredge, though some takes were also noted in clamshell and pipeline dredges. Notably, reports include only those trips when an observer was on board to document capture. Additional data provided by USACE indicate another 16 Atlantic sturgeon were killed by dredging from 2016-2018. To offset the adverse effects associated with dredging, relocation trawling is sometimes used. The USACE has used this technique during dredging at Brunswick Harbor, Savannah Harbor, Kings Bay, and in the Savannah River channel. Trawling in these area captured 215 and relocated 215 Atlantic sturgeon from 2016-2018.

Seasonal restrictions on dredging operations have been imposed in some rivers for some species; from example, a March 16–May 31 prohibition to protect striped bass in the Savannah River. This spring closure likely benefits sturgeon as well. Seasonal restrictions are also placed on hopper dredging conducted offshore of Savannah Harbor in the shipping channel to protect sea turtles. To reduce the impacts of dredging on anadromous fish species, most of the Atlantic states impose work restrictions during sensitive time periods (spawning, migration, feeding) when anadromous fish are present.

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 South Atlantic DPS in the Southeast. Sturgeon are more highly sensitive to low DO than other fish species (Niklitschek and Secor 2009, Niklitschek and Secor 2009) 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 (Secor and Gunderson 1998, Niklitschek and Secor 2005, Niklitschek and Secor 2009, Niklitschek and Secor 2009). Low DO is modifying sturgeon habitat in the Savannah due to dredging, and nonpoint source inputs are causing low DO in the Ogeechee River and in the Saint Marys River, which completely eliminates juvenile nursery habitat in summer. Low DO has also been observed in the St. Johns River in the summer.

Atlantic sturgeon may be particularly susceptible to impacts from environmental contamination because they are long-lived, benthic feeders. Sturgeon feeding in estuarine habitats near urbanized areas may be exposed to numerous suites of contaminants within the substrate. Contaminants, including toxic metals, polychlorinated aromatic hydrocarbons (PAHs), organophosphate and organochlorine pesticides, polychlorinated biphenyls (PCBs), and other chlorinated hydrocarbon compounds can have substantial deleterious effects on aquatic life. These elements and compounds can cause acute lesions, growth retardation, and reproductive impairment in fishes (Cooper 1989, Sindermann 1994, ASSRT 2007).

Heavy metals and organochlorine compounds accumulate in sturgeon tissue, but their long-term effects are not known (Ruelle and Henry 1992, Ruelle and Keenlyne 1993). Elevated levels of contaminants, including chlorinated hydrocarbons, in several other fish species are associated with reproductive impairment (Cameron, Berg et al. 1992, Longwell, Chang et al. 1992, Hammerschmidt, Sandheinrich et al. 2002, Drevnick and Sandheinrich 2003), reduced egg viability (Von Westernhagen, Rosenthal et al. 1981, Giesy, Newsted et al. 1986, Mac and Edsall 1991, Matta, Cairncross et al. 1997, Billsson, Westerlund et al. 1998), reduced survival of larval fish (Berlin, Hesselberg et al. 1981, Giesy, Newsted et al. 1986), delayed maturity (Jorgensen (Jorgensen, Aas-Hansen et al. 2004) and posterior malformations (Billsson, Westerlund et al. 1998). Pesticide exposure in fish may affect antipredator and homing behavior, reproductive function, physiological development, and swimming speed and distance (Beauvais, Jones et al. 2000, Scholz, Truelove et al. 2000, Moore and Waring 2001, Waring and Moore 2004). It should be noted that the effect of multiple contaminants or mixtures of compounds at sub-lethal levels on fish has not been adequately studied. Atlantic sturgeon use marine, estuarine, and freshwater habitats and are in direct contact through water, diet, or dermal exposure with multiple contaminants throughout their range (ASSRT 2007). Trace metals, trace elements, or inorganic contaminants (mercury, cadmium, selenium, lead, etc.) are another suite of contaminants occurring in fish. Post (1987) states that toxic metals may cause death or sub-lethal effects to fish in a variety of ways and that chronic toxicity of some metals may lead to the loss of reproductive capabilities, body malformation, inability to avoid predation, and susceptibility to infectious organisms.

Waterborne contaminants may also affect the aquatic environment. Issues such as raised fecal coliform and estradiol concentrations affect all wildlife that utilize riverine habitat. The impact of many of these waterborne contaminants on sturgeon is unknown, but they are known to affect other species of fish in rivers and streams. These compounds may enter the aquatic environment via wastewater treatment plants, agricultural facilities, as well as runoff from farms (Folmar, Denslow et al. 1996, Culp, Podemski et al. 2000, Wildhaber, Allert et al. 2000, Wallin, Hattersley et al. 2002) and settle to the bottom, therefore affecting benthic foragers to a greater extent than pelagic (Geldreich and Clarke 1966). For example, estrogenic compounds are known to affect the male to female sex ratio of fish in streams and rivers via decreased gonadal development, physical feminization, and sex reversal (Folmar, Denslow et al. 1996). Although the effects of these contaminants are unknown in shortnose and Atlantic sturgeon, (Omoto, Maebayashi et al. 2002) found that varying the oral doses of estradiol-17β or 17α methyltestosterone given to captive hybrid "bester" sturgeon (*Huso huso* female × *Acipenser ruthenus* male) could induce abnormal ovarian development or a lack of masculinization. These compounds, along with high or low DO concentrations, can result in sub-lethal effects that may have negative consequences on small populations.

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, which can affect DO levels, temperature, and the ability of the basin of origin to assimilate pollutants (GWC 2006). Large water withdrawals negatively affect water quality within the river systems in the range of the South Atlantic DPS. 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 fewer 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. The removal of large amounts of water from the system will alter flows, temperature, and DO. Water shortages and "water wars" are already occurring in the rivers occupied by the South Atlantic DPS and will likely be compounded in the future by population growth and potentially by climate change.

Climate Change

Large-scale factors impacting riverine water quality and quantity that likely exacerbate habitat threats to Atlantic sturgeon of the South Atlantic DPS include drought, and intra- and inter-state water allocation. Changes in the climate are very likely be associated with more extreme precipitation and faster evaporation of water, leading to greater frequency of both very wet and very dry conditions. For example, while annual precipitation in the Southeast has increased by 0.19 inches per decade since 1950 (NCDC 2019), the southeastern United States has experienced several years of drought since 2007. During this time, Georgia and South Carolina experienced drought conditions that ranged from moderate to extreme. Between March 2007 and December 2008, 50-100% of the State of Georgia and the State of South Carolina experienced some level of drought ranging in intensity from "abnormally dry" to "exceptional," based on the drought intensity categories used by the U.S. Drought Monitor (NDMC 2018). That drought was surpassed just a few years later. Both states again experienced "abnormally dry" to "exceptional" drought conditions across 50-100% of those states again from September 2010-March 2013, experienced "abnormally dry" to "exceptional" drought conditions https://droughtmonitor.unl.edu/Data/Timeseries.aspx (NDMC 2018). While Georgia has periodically undergone periods of drought—there have been 6 periods of drought lasting from 2-7 years since 1903 (Barber and Stamey 2000)—drought frequency appears to be increasing (Ruhl 2003). Abnormally low stream flows can restrict sturgeon access to important habitats and exacerbate water quality issues such as increased water temperature, nutrient levels, and contaminants, as well reduced DO.

Long-term observations also confirm changes in temperature are occurring at a rapid rate, directly affecting PBF 4. From 1895-2018, the average annual temperature in the Southeast rose 0.1°F per decade. From 1950-2018, the increase tripled to 0.3°F per decade (NCDC 2019). Aside from observation, climate modeling also projects future increases in temperatures in the Southeast. Table 6 summarizes the increases projected for the Southeast by the mid-century (2036–2065) and late-century (2071–2100). These are projections from the Representative Concentration Pathway (RCP) model scenarios RCP8.5 and RCP4.5, used by the Intergovernmental Panel on Climate Change (IPCC), relative to average from 1976–2005 (Hayhoe, Edmonds et al. 2017).[3]

Table 6. Projected Temperature Increase in the Southeast Under Two Model Projections and Time Series (Hayhoe, Edmonds et al. 2017)

National Climate Assessment Region	RCP4.5 Mid-Century (2036–2065)	RCP8.5 Mid-Century (2036–2065)	RCP4.5 Late-Century (2071–2100)	RCP8.5 Late-Century (2071–2100)
Southeast	3.40°F (1.89°C)	4.30°F (2.39°C)	4.43°F (2.46°C)	7.72°F (4.29°C)

Atlantic 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 projects with high confidence that higher water temperatures and changes in extremes in the Southeast 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).

Sea-level rise is another consequence of climate change; it has already had significant impacts on coastal areas and these impacts are likely to increase. Since 1852, when the first topographic maps of the Southeastern United States were prepared, high tidal flood elevations have increased

[3] RCPs make predictions based on changes, if any, in future greenhouse gas emissions. Specifically, they evaluate radiative forcing, or the amount of energy stored at the Earth's surface in watts/m^2. As the amount of greenhouse gases increases in the atmosphere more energy is trapped, and the number of watts/m^2 increases. RCP2.6 and RCP8.5 represent the lowest and highest radiative scenarios, of 2.6 watts/m^2 and 8.5 watts/m^2, respectively. RCP4.5 and RCP6.0 assume intermediate levels of radiative forcing.

approximately 12 inches (30.5 cm). During the 20th century, global sea level has increased 6 to 7.8 inches (15 to 20 cm) (NAST 2000). Sea level rise is also projected to extend areas of salinization of groundwater and estuaries. 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). Saltwater intrusion will likely exacerbate existing water allocation issues, leading to an increase in reliance on interbasin water transfers to meet municipal water needs, further stressing water quality. Similarly, saltwater intrusion is likely to affect local ecosystems. Analysts attribute the forest decline in the Southeast to saltwater intrusion associated with sea level rise. Coastal forest losses will be even more severe if sea level rise accelerates as is expected as a result of global warming. Direct effects to PBF 3 are anticipated as result of these changes.

The effects of future climate change will vary greatly in diverse coastal regions for the United States. Warming is very likely to continue in the United States during the next 25 to 50 years, regardless of reduction in greenhouse gases, due to emissions that have already occurred (NAST 2000). It is very likely that the magnitude and frequency of ecosystem changes will continue to increase in the next 25 to 50 years, and it is possible that they will accelerate. A warmer and drier climate would reduce stream flows and increase water temperatures. Expected consequences would be a decrease in the amount of DO in surface waters and an increase in the concentration of nutrients and toxic chemicals due to reduced flushing rate (Murdoch, Baron et al. 2000). Because many rivers are already under a great deal of stress due to excessive water withdrawal or land development, and this stress may be exacerbated by changes in climate, anticipating and planning adaptive strategies may be critical (Hulme 2005). A warmer, wetter climate could ameliorate poor water quality conditions in places where human-caused concentrations of nutrients and pollutants currently degrade water quality (Murdoch, Baron et al. 2000).

Increases in water temperature and changes in seasonal patterns of runoff will very likely disturb fish habitat and affect recreational uses of lakes, streams, and wetlands. Surface water resources in the Southeast are intensively managed with dams and channels and almost all are affected by human activities; in some systems water quality is either below recommended levels or nearly so. A global analysis of the potential effects of climate change on river basins indicates that due to changes in discharge and water stress, the area of large river basins in need of reactive or proactive management interventions in response to climate change will be much higher for basins impacted by dams than for basins with free-flowing rivers (Palmer, Reidy Liermann et al. 2008). Human-induced disturbances also influence coastal and marine systems, often reducing the ability of the systems to adapt so that systems that might ordinarily be capable of responding to variability and change are less able to do so. Because stresses on water quality are associated with many activities, the impacts of the existing stresses are likely to be exacerbated by climate change. Within 50 years, river basins that are impacted by dams or by extensive development, like the Savannah or Cooper River, will experience greater changes in discharge and water stress than unimpacted, free-flowing rivers (Palmer, Reidy Liermann et al. 2008).

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 the South Atlantic DPS. 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 (Salwasser, Mealey et al. 1984, Belovsky 1987, Soulé 1987, Thomas 1990).

Vessel Strikes

Very little is known about the effects of vessel strikes on individuals from the South Atlantic DPS. However, there is increasing evidence that vessels may pose a significant threat. NMFS does not have a dedicated sturgeon stranding program, so we rely on the public to report sightings. To promote our interest in hearing from the public, we began disseminating signs asking the public to report sightings (alive or dead) in the summer of 2018. Limited resources required us to focus our initial efforts on North Carolina; signs have been deployed in Georgia since 2020.[4] Since those signs have been deployed (summer 2018-summer 2019), we received 5 reports of dead Atlantic sturgeon in the Cape Fear River that were likely struck by ships. Prior to the deployment of these signs, there were 2 reports of potential ship strikes in the Cape Fear River from 2011 to 2014. It is unclear if this uptick represents an increasing threat from vessels or just increasing reports. It is also unclear how, or if, an apparent increase in the number of vessel-struck individuals in North Carolina relates to individuals of the South Atlantic DPS. Regardless, the lower estuaries of rivers in the South Atlantic DPS are often marsh habitats that can be very difficult for the public to access. Given the geology of these rivers and potential underreporting, it is possible, if not likely, that a significant number of sturgeon are being struck by vessels in the rivers of the South Atlantic DPS, but remain unknown to us.

The types of vessels responsible for these injury is currently unknown. However, Balazik, Reine et al. (2012) hypothesize vessel strike mortalities are likely caused by deep-draft ocean cargo ships, with drafts that coincide with the river depths most frequently used by Atlantic sturgeon. The authors reported telemetry data suggesting that while staging (holding in an area from hours to days, with minimal upstream or downstream movements), adult male Atlantic sturgeon spent most (62%) of their time within 1 m of the river bottom (Balazik, Reine et al. 2012). Under the assumption that Atlantic sturgeon do not modify their behavior as a result of vessel noise, Balazik, Reine et al. (2012) hypothesized adult male Atlantic sturgeon in the James River would rarely encounter small recreational boats or tugboats, with shallow drafts, operating in the upper portions of the water column. Thus, they conclude large cargo vessels were the most likely cause of the vessel strike injuries (Balazik, Reine et al. 2012).

Bycatch Mortality

Overutilization of Atlantic sturgeon from directed fishing caused initial severe declines in Atlantic sturgeon populations in the Southeast, from which they have never rebounded (Figure 5). Further, continued overutilization of Atlantic sturgeon as bycatch in commercial fisheries is an ongoing impact to the South Atlantic DPS. 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

[4] South Carolina has their own sturgeon encounter reporting program and share their reports with NMFS.

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. 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. Little data exists on bycatch in the Southeast and high levels of bycatch underreporting are suspected. Further, a total population abundance for the DPS is not available and it is therefore not possible to calculate the percentage of the DPS subject to bycatch mortality based on the available bycatch mortality rates for individual fisheries. 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.

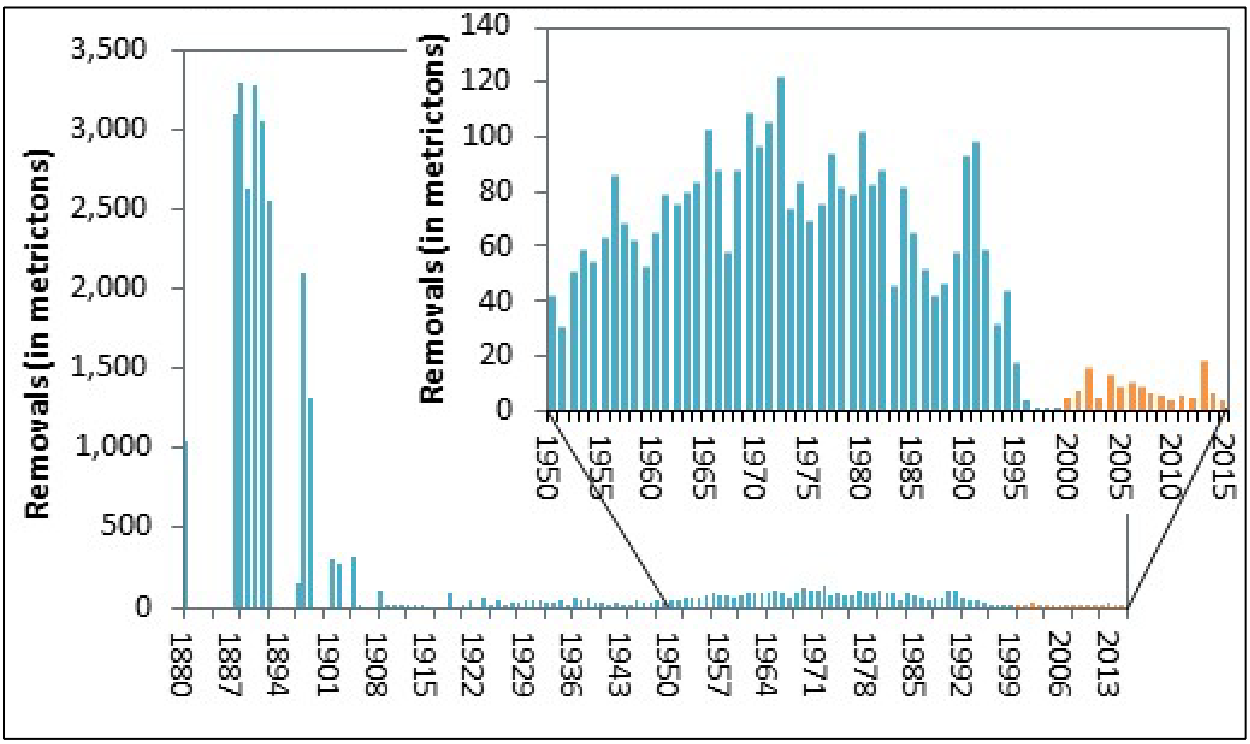

Figure 4. Atlantic Sturgeon Landings Over Time (ASMFC 2017)

Stochastic Events

Stochastic events, such as hurricanes, are common throughout the range of Atlantic sturgeon from the South Atlantic DPS. These events are unpredictable and their effect on the survival and recovery of the species in unknown; however, they have the potential to impede the survival and recovery directly if animals die as a result of them, or indirectly if habitat, is damaged as a result of these disturbances. For example, in 2018, flooding from Hurricane Florence flushed significant amounts of organic matter into rivers supporting sturgeon. The DO levels in those rivers dropped so low (i.e., 0.2 mg/L) that thousands of fish suffocated, including multiple sturgeon.

3.2.2 *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 ft, and a weight of about 55 pounds. Shortnose sturgeon inhabit large coastal rivers of eastern North America. Although considered an amphidromous species,[5] 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, Taubert 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 3.2). 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 (NMFS 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 (NMFS 2010, Ruddle 2018)), the Congaree River (Collins, Cooke et al. 2003, Post, Holbrook et al. 2017), and the Pee Dee River (NMFS 2010). While it had been concluded that shortnose sturgeon are extinct from the Satilla River in Georgia and the St. Marys River along the Florida and Georgia border, targeted surveys in both the Satilla (Fritts and Peterson 2010) and St. Marys (Fritts and Peterson 2010, Fox and Peterson 2017) 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 (NMFS 2010).

[5] Meaning they are born in freshwater, then live primarily in their natal river, making short feeding or migratory trips into salt water, and then return to freshwater.

Life History Information

Shortnose sturgeon populations show clinal variation, [6] 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. Because animals are considered mature at the onset of developing mature gonads, spawning is usually delayed relative to reaching maturity. 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, Darden et al. 2014), which is similar to what has been documented throughout the range (Taubert 1980, Hall, Smith et al. 1991, Kieffer and Kynard 1996, NMFS 1998, Duncan, Isely et al. 2004). In the Altamaha River, Georgia, adults began their upstream migrations during likely spawning runs during the late-winter months when water temperatures declined to 11.6–16.9 °C (Post, Darden 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, Smith et al. 1991, Kieffer and Kynard 1996, NMFS 1998). Shortnose sturgeon tend to spawn on rubble, cobble, or large rocks (Dadswell 1979, Taubert 1980, Buckley and Kynard 1985, Kynard 1997), timber, scoured clay, or gravel (Hall, Smith et al. 1991). Southern populations of shortnose sturgeon usually spawn at least 125 miles (200 km) upriver (Kynard 1997) or throughout the fall line[7] 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, Taubert et al. 1984, Kynard 1997). Residence of YOY in freshwater is supported by several studies on cultured shortnose sturgeon (Jenkins, Smith et al. 1993, Jarvis, Ballantyne et al. 2001, Ziegeweid, Jennings 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

[6] 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

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

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 (Flournoy, Rogers et al. 1992, Collins, Post et al. 2002). 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 (Pottle and Dadswell 1979, Hall, Smith et al. 1991, Dovel, Pekovitch et al. 1992).

Status and Population Dynamics

The 1998 shortnose sturgeon recovery plan identified 19 distinct shortnose sturgeon populations based on natal rivers (NMFS 1998). 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 ($p < 0.05$) (Wirgin, Waldman et al. 2000, King, Lubinski et al. 2001, Waldman, Grunwald et al. 2002, Wirgin, Grunwald et al. 2005, Wirgin, Grunwald et al. 2010). 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 (NMFS 1998). However, Fritts, Grunwald 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.

Aside 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 6). Shortnose sturgeon in the Southeast comprise a single metapopulation, the “Carolinian Province” (Figure 6) Wirgin, Grunwald et al. (2010) note that 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.

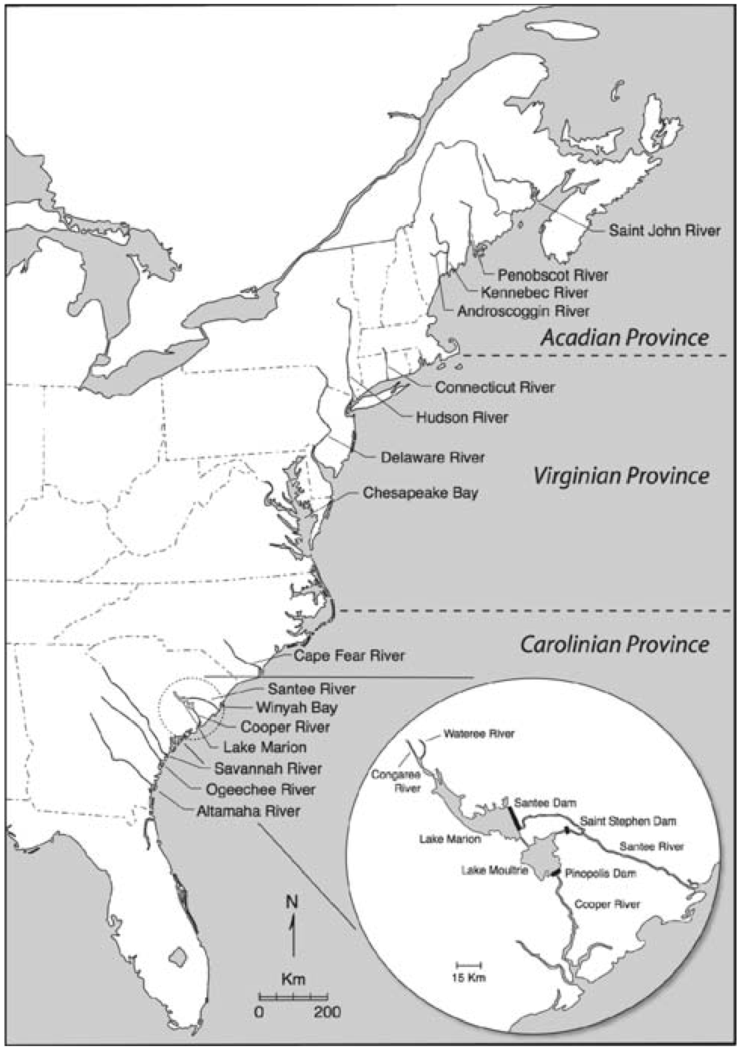

Figure 5. The North American Atlantic coast depicting 3 shortnose sturgeon metapopulations based on mitochondrial DNA control region sequence analysis (Wirgin, Grunwald et al. 2010).

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. Loss of the Carolinian Province ("southern") metapopulation of shortnose sturgeon would result in the loss of the southern half of the species' range (i.e., there is no known reproduction occurring between the Delaware River and Winyah Bay, SC). Loss of the Virginian Province ("mid-Atlantic") metapopulation would create a conspicuous discontinuity in the range of the species from the Hudson River to the northern extent of the southern metapopulation. The Acadian Province ("northern") metapopulation constitutes the northernmost portion of the U.S. range. 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.

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 7 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). 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 highest point estimate of the total population occurring in 2013 at 2,432 (95% CI: 1,025-6,102). Mean population estimates were lower in 2014 and 2015, reaching an estimated 1,390 (95% CI: 890-2,257) total individuals in 2015 (Bahr and Peterson 2017). Animals in the Savannah River face 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, Kirk 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 fewer than 5 specimens.

Table 7. 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, Kirk 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
	2013	2,432 (1,025-6,102)	Total	Bahr and Peterson (2017)
	2014	1,957 (1,261-3,133)	Total	
	2015	1,390 (890-2,257)	Total	
Ogeechee River (GA)	1993	361 (326-400)	Total	Rogers and Weber (1994);
	1999-2000	147 (104-249)	Total	Fleming, Bryce 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 (1998)
	1990	798 (645-1,045)	Total	NMFS (1998)
	1993	468 (316-903)	Total	NMFS (1998)
	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	Total	Fox, Stowe et al. (2017)

[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.

Historically, sturgeon ascended to the farthest freshwater reaches and river heads to reach natal spawning grounds (Lawson 1711, McDonald 1887, Hightower 1998). An inability to move above dams and use potentially beneficial habitats may restrict population growth (NMFS 1998). Dams blocking migration could force sturgeon to spawn at locations that were not historically used (Kynard, Kieffer et al. 1999). If sturgeon have to deposit eggs in habitat further downstream because of an upstream dam, this may make survival of their progeny less likely. Sturgeon embryos and larvae have limited salt tolerance, so their habitat must be well upstream of the salt front (Van Eenennaam, Doroshov et al. 1996). Also, if sturgeon must utilize habitat that is not suitable or less suitable than the original blocked spawning sites for successful adherence, fertilization, and development, then those eggs may not become viable progeny. This will affect the survival and recruitment of individuals of that particular year class and, over time, reduce the reproductive success and recruitment of new individuals to the population.

Fish passage devices have shown limited benefit to shortnose sturgeon as a means of minimizing impacts of dams because these devices have been historically designed for salmon and other water-column fish rather than large, bottom-dwelling species like sturgeon. However, NMFS continues to evaluate ways to effectively pass sturgeon above and below man-made barriers. For example, large nature-like fishways (e.g., rock ramps) hold promise as a mechanism for successful passage. 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, Darden 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, Darden 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 (NMFS 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 (NMFS 2010).

The presence of the dams on the Savannah River also harms sturgeon by restricting life functions other than spawning, particularly in the case of shortnose sturgeon. Sturgeon migrate to optimize feeding, avoid unfavorable conditions, and to optimize reproductive success (Northcote 1978, Tsyplakov 1978, McKeown 1984). Shortnose sturgeon are considered freshwater amphidromous species and are relatively constrained in their migratory patterns, as they typically migrate between freshwater and mesohaline river reaches but do not migrate extensively to marine habitats for feeding (Kynard 1997).

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, Lasier 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.

Dredging directly effects sturgeon by entraining them in dredge drag arms and impeller pumps. Mechanical dredges have also been documented to kill sturgeon. Dickerson (2013) summarized observed takes of 38 sturgeon from dredging activities conducted by USACE and observed from 1990-2013: 3 Gulf, 11 shortnose, and 23 Atlantic, and 1 unidentified due to decomposition. Of the three types of dredges included (hopper, clamshell, and pipeline) in the report, most sturgeon were captured by hopper dredge, though some takes were also noted in clamshell and pipeline dredges. Notably, reports include only those trips when an observer was on board to document capture. To offset the adverse effects associated dredging relocation trawling is used at times. The USACE has successfully used this technique to relocated Atlantic sturgeon, but only 2 shortnose sturgeon (1992 and 2004) have been captured in the Southeast.

Seasonal restrictions on dredging operations have been imposed in some rivers for some species; from example, a March 16–May 31 prohibition to protect striped bass in the Savannah River. This spring closure likely benefits sturgeon as well. Seasonal restrictions are also placed on hopper dredging conducted offshore of Savannah Harbor in the shipping channel to protect sea turtles. To reduce the impacts of dredging on anadromous fish species, most of the Atlantic states impose work restrictions during sensitive time periods (spawning, migration, feeding) when anadromous fish are present.

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.

Shortnose sturgeon appear to become more resilient to low levels of DO as they age. Jenkins, Smith et al. (1993) exposed 11-330 day old shortnose sturgeon to a range of DO levels at a static temperature of 22.5°C (72.5°F) for 6 hours. DO concentrations of 2.5 mg/L killed 100% of 25-day-old fish, 96% of fish 32 days old, and 86% of fish 64 days old but only 12% of the fish older than 104 days (Jenkins, Smith et al. 1993). Jenkins, Smith et al. (1993) also reported young fish died at significantly higher rates for DO concentrations of 3.0 mg/L, while this concentration did not appear to adversely affect fish >77 days old. They also concluded that regardless of age, groups exposed to 2.0 mg/L died at significantly higher rates than the control groups (Jenkins, Smith et al. 1993).

Campbell and Goodman (2004) investigated the environmental impacts of shortnose sturgeon by considering the relationship between DO, salinity, and temperature. They conducted tests with hatchery-produced fish exposed to ranges of DO, salinity, and temperature similar to what might be expected in the southeastern United States coastal river–estuary interfaces during spring and summer. For 77-day-old fish, they determined 50% mortality in 24 hours was likely when exposed to a combination of 2 ppt salinity, a temperature of 25°C (77°F), and a DO level of 2.7 mg/L. In older fish (104-days-old), a 50% mortality rate in 24 hours occurred with DO concentrations of 2.2 mg/L at 22°C (71.6°F) and salinities of 4 ppt (Campbell and Goodman 2004). However, even with relatively higher DO concentrations (3.1 mg/L), Campbell and Goodman (2004) reported a 50% mortality rate in 24 hours for 100-day-old fish when temperature increased to of 30°C (86°F), even if the salinity decreased to 2 ppt.

These studies highlight concerns regarding 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 waters 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 below 3.0 mg/L. Sturgeon are more sensitive to low DO than other fish species (Niklitschek and Secor 2009, Niklitschek and Secor 2009), and low DO in combination with high temperature is particularly problematic.

Elevated levels of environmental contaminants, including chlorinated hydrocarbons, in several fish species are associated with reproductive impairment (Cameron, Berg et al. 1992, Longwell, Chang et al. 1992), reduced egg viability (Von Westernhagen, Rosenthal et al. 1981, Hansen 1985, Mac and Edsall 1991), and reduced survival of larval fish (Berlin, Hesselberg et al. 1981, Giesy, Newsted et al. 1986). Several characteristics of shortnose sturgeon (i.e., long life span, extended residence in estuarine habitats, benthic predator) predispose the species to long-term and repeated exposure to environmental contamination and potential bioaccumulation of heavy metals and other toxicants (Dadswell 1979). Chemicals and metals such as chlordane, dichlorodiphenyldichloroethylene (*DDE*), dichlorodiphenyltrichloroethane (DDT), dieldrin, polychlorinated biphenyls (PCBs), cadmium, mercury, and selenium settle to the river bottom and are later consumed by benthic feeders such as sturgeon or macroinvertebrates, and then work their way into the food web. Some of these compounds may affect physiological processes and impede a fish's ability to withstand stress, while simultaneously increasing the stress of the surrounding environment by reducing DO, altering pH, and altering other physical properties of the waterbody. Exposure to sufficient concentrations of these chemicals can cause lethal and sub-lethal effects such as: behavioral alterations, deformities, reduced growth, reduced fecundity, and reduced egg viability (Ruelle and Keenlyne 1993, USFWS 1993).

Waterborne contaminants may also affect the aquatic environment. Issues such as raised fecal coliform and estradiol concentrations affect all wildlife that utilize riverine habitat. The impact of many of these waterborne contaminants on sturgeon is unknown, but they are known to affect other species of fish in rivers and streams. These compounds may enter the aquatic environment via wastewater treatment plants, agricultural facilities, as well as runoff from farms (Folmar, Denslow et al. 1996, Culp, Podemski et al. 2000, Wildhaber, Allert et al. 2000, Wallin, Hattersley et al. 2002) and settle to the bottom, therefore affecting benthic foragers to a greater extent than pelagic (Geldreich and Clarke 1966). For example, estrogenic compounds are known to affect the male to female sex ratio of fish in streams and rivers via decreased gonadal development, physical feminization, and sex reversal (Folmar, Denslow et al. 1996). Although the effects of these contaminants are unknown in shortnose and Atlantic sturgeon, (Omoto, Maebayashi et al. 2002) found that varying the oral doses of estradiol-17β or 17α methyltestosterone given to captive hybrid "bester" sturgeon (*Huso huso* female × *Acipenser ruthenus* male) could induce abnormal ovarian development or a lack of masculinization. These compounds, along with high or low DO concentrations, can result in sub-lethal effects that may have negative consequences on small populations.

Within the Santee River Basin, (Wilhelm and Maluk 1998) identified the following water-quality issues as high priority, regional-scale issues of concern: (1) enrichment by nitrogen and phosphorus that has caused algal populations to increase; (2) sediment erosion due to agricultural practices of the 19^{th} and 20^{th} centuries; (3) runoff from urban areas that transport trace elements and synthetic organic compounds; (4) pesticides and nutrients that can contaminate surface and ground water; and (5) mercury presence in elevated concentrations in fish that inhabit the basin. (Feaster and Conrads 2000) also identified point and non-point sources of bacterial contamination in the Santee River Basin.

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). Large water withdrawals negatively affected water quality within the river systems in the range of the shortnose sturgeon. 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 fewer 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

Large-scale factors impacting riverine water quality and quantity that likely exacerbate habitat threats to shortnose sturgeon include drought, and intra- and inter-state water allocation. Changes in the climate are very likely be associated with more extreme precipitation and faster evaporation of water, leading to greater frequency of both very wet and very dry conditions. For example, while annual precipitation in the Southeast has increased by 0.19 inches per decade since 1950 (NCDC 2019), the southeastern United States has experienced several years of drought since 2007. During this time, Georgia and South Carolina experienced drought conditions that ranged from moderate to extreme. Between March 2007 and December 2008, 50-100% of the State of Georgia and the State of South Carolina experienced some level of drought ranging in intensity from "abnormally dry" to "exceptional," based on the drought intensity categories used by the U.S. Drought Monitor (NDMC 2018). That drought was surpassed just a few years later. Both states again experienced "abnormally dry" to "exceptional" drought conditions across 50-100% of those states again from September 2010-March 2013, experienced "abnormally dry" to "exceptional" drought conditions https://droughtmonitor.unl.edu/Data/Timeseries.aspx (NDMC 2018). While Georgia has periodically undergone periods of drought—there have been 6 periods of drought lasting from 2-7 years since 1903 (Barber and Stamey 2000)—drought frequency appears to be increasing (Ruhl 2003). Abnormally low stream flows can restrict sturgeon access to important habitats and exacerbate water quality issues such as reduced DO, and increased water temperature, nutrient levels, and contaminants.

Long-term observations also confirm changes in temperature are occurring at a rapid rate. From 1895-2018, the average annual temperature in the Southeast has risen 0.1°F per decade. From 1950-2018, the increase triples to 0.3°F per decade (NCDC 2019). Aside from observation, climate modeling also projects future increases in temperatures in the Southeast. Table 8 summarizes the increases projected for the Southeast by the mid-century (2036–2065) and late-century (2071–2100). These are projections from the Representative Concentration Pathway (RCP) model scenarios RCP8.5 and RCP4.5, used by the Intergovernmental Panel on Climate Change (IPCC), relative to average from 1976–2005 (Hayhoe, Edmonds et al. 2017).[8]

Table 8. Projected Temperature Increase in the Southeast Under Two Model Projections and Time Series (Hayhoe, Edmonds et al. 2017)

National Climate Assessment Region	RCP4.5 Mid-Century (2036–2065)	RCP8.5 Mid-Century (2036–2065)	RCP4.5 Late-Century (2071–2100)	RCP8.5 Late-Century (2071–2100)
Southeast	3.40°F (1.89°C)	4.30°F (2.39°C)	4.43°F (2.46°C)	7.72°F (4.29°C)

[8] RCPs make predictions based on changes, if any, in future greenhouse gas emissions. Specifically, they evaluate radiative forcing, or the amount of energy stored at the Earth's surface in watts/m^2. As the amount of greenhouse gases increases in the atmosphere more energy is trapped, and the number of watts/m^2 increases. RCP2.6 and RCP8.5 represent the lowest and highest radiative scenarios, of 2.6 watts/m^2 and 8.5 watts/m^2, respectively. RCP4.5 and RCP6.0 assume intermediate levels of radiative forcing.

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 projects with high confidence that higher water temperatures and changes in extremes in the Southeast 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).

Sea-level rise is another consequence of climate change; it has already had significant impacts on coastal areas and these impacts are likely to increase. Since 1852, when the first topographic maps of the Southeastern United States were prepared, high tidal flood elevations have increased approximately 12 inches. During the 20th century, global sea level has increased 15 to 20 cm (NAST 2000). Sea level rise is also projected to extend areas of salinization of groundwater and estuaries. 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). Saltwater intrusion will likely exacerbate existing water allocation issues, leading to an increase in reliance on interbasin water transfers to meet municipal water needs, further stressing water quality. Similarly, saltwater intrusion is likely to affect local ecosystems. Analysts attribute the forest decline in the Southeast to saltwater intrusion associated with sea level rise. Coastal forest losses will be even more severe if sea level rise accelerates as is expected as a result of global warming.

The effects of future climate change will vary greatly in diverse coastal regions for the United States. Warming is very likely to continue in the United States during the next 25 to 50 years, regardless of reduction in greenhouse gases, due to emissions that have already occurred (NAST 2000). It is very likely that the magnitude and frequency of ecosystem changes will continue to increase in the next 25 to 50 years, and it is possible that they will accelerate. A warmer and drier climate would reduce stream flows and increase water temperatures. Expected consequences would be a decrease in the amount of DO in surface waters and an increase in the concentration of nutrients and toxic chemicals due to reduced flushing rate (Murdoch, Baron et al. 2000). Because many rivers are already under a great deal of stress due to excessive water withdrawal or land development, and this stress may be exacerbated by changes in climate, anticipating and planning adaptive strategies may be critical (Hulme 2005). A warmer, wetter climate could ameliorate poor water quality conditions in places where human-caused concentrations of nutrients and pollutants currently degrade water quality (Murdoch, Baron et al. 2000).

Increases in water temperature and changes in seasonal patterns of runoff will very likely disturb fish habitat and affect recreational uses of lakes, streams, and wetlands. Surface water resources in the Southeast are intensively managed with dams and channels and almost all are affected by human activities; in some systems water quality is either below recommended levels or nearly so. A global analysis of the potential effects of climate change on river basins indicates that due to changes in discharge and water stress, the area of large river basins in need of reactive or proactive management interventions in response to climate change will be much higher for basins impacted by dams than for basins with free-flowing rivers (Palmer, Reidy Liermann et al. 2008). Human-induced disturbances also influence coastal and marine systems, often reducing the ability of the systems to adapt so that systems that might ordinarily be capable of responding to variability and change are less able to do so. Because stresses on water quality are associated with many activities, the impacts of the existing stresses are likely to be exacerbated by climate change. Within 50 years, river basins that are impacted by dams or by extensive development, like the Savannah or Cooper River, will experience greater changes in discharge and water stress than unimpacted, free-flowing rivers (Palmer, Reidy Liermann et al. 2008).

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. 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 (Salwasser, Mealey et al. 1984, Belovsky 1987, Soulé 1987, Thomas 1990).

<u>Bycatch</u>

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 (NMFS 2010) and Altamaha (Bahn, Fleming et al. 2012) rivers. 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 restrictions on interbasin water transfers in South Carolina, the lack of ability to regulate non-point source pollution).

<u>Stochastic Events</u>

Stochastic events, such as hurricanes, are common throughout the range of shortnose sturgeon. These events are unpredictable and their effect on the survival and recovery of the species in unknown; however, they have the potential to impede the survival and recovery directly if animals die as a result of them, or indirectly if habitat, is damaged as a result of these disturbances. For example, in 2018, flooding from Hurricane Florence flushed significant amounts of organic matter into rivers supporting sturgeon. The DO levels in those rivers dropped so low (i.e., 0.2 mg/L) that thousands of fish suffocated, including multiple sturgeon.

4 ENVIRONMENTAL BASELINE

The environmental baseline describes the condition of the listed species or its designated critical habitat in the action area, without the consequences to the listed species or designated critical habitat caused by the proposed action. (50 C.F.R. 402.02). By regulation, the environmental baseline for Biological Opinions includes: the past and present impacts of all federal, state, or private actions and other human activities in the action area, the anticipated impacts of all proposed federal projects in the action area that have already undergone formal or early Section 7 consultation, and the impact of state or private actions that are contemporaneous with the consultation in process (50 CFR 402.02). The consequences to listed species or designated critical habitat from ongoing agency activities or existing agency facilities that are not within the agency's discretion to modify are part of the environmental baseline (84 FR 44976; August 27, 2019).

A wide range of activities funded, authorized, or carried out by federal agencies may affect endangered shortnose sturgeon and the endangered South Atlantic DPS of the Atlantic sturgeon. These include dredging, dock/marina construction, bridge/highway construction, shoreline stabilization, operation of hydroelectric facilities, construction and operation of nuclear facilities, and fishing activities. Climate change and drought are also affecting sturgeon in the Savannah River. Research on sturgeon may have a negative effect on individual sturgeon, but has an overall benefit to shortnose and Atlantic sturgeon conservation and recovery. The following information summarizes the primary human and natural phenomena in the Savannah River that are believed to affect the status and trend of endangered shortnose sturgeon and the endangered South Atlantic DPS of the Atlantic sturgeon in the action area, as well as their probable responses to these phenomena.

4.1 Status and Distribution of Atlantic Sturgeon in the Action Area

The Savannah River supports a reproducing population of Atlantic sturgeon (Collins and Smith 1997) that is a part of the South Atlantic DPS. Secor (2002) estimates that 8,000 adult females were present in South Carolina prior to 1890. 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 prior to 1890. Currently, the Savannah River population is estimated to be less than 1% of its historical population size, with fewer than 300 adults estimated to spawn annually (ASSRT 2007). Overharvesting of sturgeon in the 1890s led to a dramatic decline in the population, and continuing impacts, such as poor water quality, dredging, and blocked access to habitat by dams has not allowed populations to rebound, even with a moratorium on direct harvest.

According to NOAA's National Ocean Service, 70 Atlantic sturgeon were captured in the Savannah River between 1999 and 2006 (ASSRT 2007). Twenty-two of these fish have been YOY (<410 mm TL). Between 2007 and 2010, SCDNR marked and released 369 Atlantic sturgeon, ranging in size from 270 mm TL to 1,500 mm TL (J.E. Frampton, SCDNR, letter to NMFS dated January 4, 2011). From 2011-2013, SCDNR marked and released an additional 47 Atlantic sturgeon in the Savannah River were captured during research ranging in size from 445-1257 mm fork length (Post, Darden et al. 2014). Beginning in 2014 and continuing today, SCDNR began monitoring sturgeon distribution in the Savannah estuary as baseline monitoring to evaluate the effects of the SHEP project. During years 1-4 of monitoring, 195 Atlantic sturgeon have been marked and released. As of July 31, 2018, an additional 56 Atlantic sturgeon were marked and released (Post et al. 2018).

Bahr and Peterson (2016) estimated annual juvenile recruitment for Atlantic sturgeon in the Savannah River from 2013-2015. Using Huggins closed-capture models in RMark, they estimated abundance of each Age 1 (<15 in; 390 mm FL) and Age 2+ (15-19.5 in; 390–499 mm FL) age-class as 567 in 2013, 393 in 2014, and 432 in 2015 (Bahr and Peterson 2016). Based on those estimates, the authors concluded that the Savannah River population is likely the second largest within the South Atlantic distinct population segment (Bahr and Peterson 2016).

While spawning of Atlantic sturgeon is likely in the Savannah River based on the putative spawning runs detected via telemetry (SCDNR unpublished data) and the presence of young juveniles (Bahr and Peterson 2016), no spawning sites have been verified (Collins and Smith 1997). Atlantic sturgeon have been tracked from the lowest reaches of the Savannah River up to the NSBL&D (Post, Darden et al. 2014, Vine, Holbrook et al. 2019). They have likely been affected by the same conservation locking operations and JST Dam flow releases described previously for shortnose sturgeon. See Section 5.1 for discussion of those effects.

The fresh–brackish water interface area serves as the summer nursery habitat for Atlantic sturgeon (Smith, Collins et al. 1993, McCord 1998). Secor and Gunderson (1998) showed that juvenile Atlantic sturgeon are less tolerant of summer-time hypoxia than juveniles of other estuarine species. The recent extirpations and severe population depressions of these species in the Southeast are probably not coincidental; mortalities related to the synergistic effects of low DO levels and high summer temperatures would tend to affect southern populations to a greater extent than those further north.

4.2 Status and Distribution of Shortnose Sturgeon in the Action Area

It is likely that the total number of shortnose sturgeon within the action area is greatly decreased based on historical accounts. Bahr and Peterson (2017) conducted the most recent abundance estimate for shortnose sturgeon in Savannah River, looking at years 2013-2015. The authors estimated a total population in 2013 of 2,432 (1,025-6,102), 1,957 (1,261-3,133) in 2014, and 1,390 (890-2,257) in 2015 (Bahr and Peterson 2017). The authors stated the relatively low and varying annual abundance estimates seem to support the hypotheses that shortnose sturgeon populations in the southern end of their range tend to be smaller than those in the northern end of their range, (Kynard 1997, Peterson and Bednarski 2013), annual recruitment in the Savannah River is variable (Peterson and Bednarski 2013, Bahr and Peterson 2017), and there is rapid population turnover following years of high recruitment (Peterson and Bednarski 2013, Bahr and Peterson 2017). Ultimately, Bahr and Peterson (2017) concluded the Savannah River population is likely the second largest in the southern end of their range, identifying it as one of the most important populations in the South Atlantic DPS. However, the small size of the Savannah River population puts it at greater risk of extinction than larger populations due to several processes (McElhany, Ruchelshaus et al. 2000), which include (1) deterministic density effects including depensation (Allee effect) and increased predation; (2) inbreeding resulting in loss of diversity and accumulation of deleterious mutations; and, (3) increased susceptibility to catastrophic events.

Historically, shortnose sturgeon likely utilized the entire Savannah River downriver of the fall line, which is located very close to the Augusta Canal Project area. Sturgeon are currently prohibited from reaching their historic spawning grounds by the NSBL&D (Figure 8), located downstream of the Augusta Canal Project at RKM 299.8 (RM 187.4). Shortnose sturgeon have been tracked from the lowest reaches of the Savannah River up to the NSBL&D (Post, Darden et al. 2014). Habitat located below the NSBL&D currently serves as spawning habitat for the shortnose sturgeon (Hall, Smith et al. 1991).

Figure 6. New Savannah Bluff Lock and Dam

In the late 1990s-early 2000s, USACE attempted 2 fish passage events at NSBL&D by increasing flows from the J. Strom Thurmond (JST) Dam to overtop the spill gates during the spawning season. This method of fish passage proved ineffective for shortnose sturgeon. The cold water released from JST Dam may have cooled the water at NSBL&D to the point where fish were no longer induced to spawn. In addition, it is doubtful that shortnose sturgeon were able to negotiate the 8-foot-high support walls at the bottom of the dam. The City of Augusta currently operates NSBL&D. As a requirement of the City of Augusta's lease, USACE required the City to lock fish through the dam twice a week during the spring spawning season. However, due to safety concerns with the aging lock structure, the USACE and the City of Augusta ended springtime operation of the lock for fish passage on May 14, 2014. Regardless, limited transmitter studies determined sturgeon had not successfully used the lock when it opened twice a week (unlike shad and herring).

When they are not migrating, shortnose sturgeon are found residing in the lower reaches of the Savannah River, congregating near the freshwater/saltwater interface or mixing zone. Juvenile and adult shortnose sturgeon use the areas in the lower Savannah River as a foraging area throughout the year. The location of the interface is positioned upriver immediately above the area to be deepened as part of Savannah Harbor Expansion Project (SHEP), but within areas that would be modified by flow rerouting. Historically, the interface was located much closer to the mouth of the river, but with the successive dredging events and deepening of the river channel, the interface has shifted further upriver. Each deepening event has further compressed the available habitat of the shortnose sturgeon. Collins et al. (2001) reported that habitat within the Kings Island Turning Basin, once used by juvenile sturgeon, as reported by Hall et al. (1991), no longer supported juvenile shortnose sturgeon, probably due to the harbor modifications that occurred after the earlier study, which resulted in higher salinity and caused the juveniles to avoid the area.

These habitat changes will likely prove significant, because Collins, W.C. Post et al. (2001) noted that during warm months both adults and juveniles were concentrated in a very small (less than 1.5 kilometer) section of the river and especially seemed to prefer the area within the RM 29.1 to 29.7 segment (RKM 46.5 to 47.5). During cool months, adults and juveniles used the area just below Houlihan Bridge (at RM 21.4; RKM 34.3) down to the confluence of Front and Middle rivers (RM 19.6; RKM 31.3), and during the coldest period they especially used the area at this confluence and up into the Middle River. During 1999 through 2000, shortnose sturgeon consistently utilized a 26-ft-deep (7.9 m) hole in the Middle River near the confluence with the Front River. Interestingly, researchers at the University of Georgia (UGA) sampled the lower reaches of the Savannah River, and found shortnose sturgeon no longer used this deep hole during summer months (University of Georgia, unpublished data). UGA sturgeon sampling from 2013-2017 found the density of shortnose sturgeon in and around that hole was much lower than surrounding areas. Regardless, on-going telemetry studies confirm the lower reaches of the Savannah River are still being used heavily for resting by adult and large juvenile shortnose sturgeon. Conversely, a second, deep hole (21 ft; 6.5 m deep) occurs at approximately RM 30.6 (RKM 49), just north of the confluence with Abercorn Creek. Collins, W.C. Post et al. (2001) noted this location was used frequently by sturgeon, especially during the summer and early fall, with individuals resting there over several hours to days. Unlike the deep hole near the Houlihan Bridge, UGA researchers also found shortnose sturgeon at high densities in this area during the summer months.

In the southern part of their range, shortnose sturgeon are known to take refuge from high water temperatures in the summer by congregating in cool, deep areas of rivers (Flournoy, Rogers et al. 1992, Rogers and Weber 1994, Rogers and Weber 1995, Weber 1996), likely to avoid warm temperatures and low DO. The data indicating shortnose sturgeon have been using this deep hole near Abercorn Creek consistently for years, appears to support the theory of summer aggregations in deep holes. Assuming they are using deep holes as refugia, it is noteworthy that the deep hole further down river no longer appears to be used by shortnose sturgeon. It is possible, if not likely, that habitat modifications in the lower Savannah River have caused changes that now preclude shortnose sturgeon from using this deep hole, reducing the refugia available to them. This is significant because summer water temperatures in southern estuaries commonly approach, and sometimes exceed, the maximum tolerable levels identified in the laboratory for early juvenile shortnose sturgeon (Jenkins, Smith et al. 1993). Unlike summer months, shortnose sturgeon range more widely during the cooler winter months (Hall, Smith et al. 1991, Collins, Post et al. 2002).

4.3 Factors Affecting Sturgeon in the Action Area

4.3.1 **Dams**

Dams and their operations are the cause of major instream flow alteration in the Southeast (USFWS, NMFS et al. 2001). Hill (1996) identified the following impacts of altered flow to anadromous fishes by dams (1) altered DO concentrations and temperature; (2) artificial destratification; (3) water withdrawal; (4) changed sediment load and channel morphology; (5) accelerated eutrophication and change in nutrient cycling; and (6) contamination of water and sediment. Activities associated with dam maintenance, such as dredging and minor excavations along the shore, can release silt and other fine river sediments that can be deposited in nearby spawning habitat. Dams may reduce the viability of sturgeon populations by removing free-flowing river habitat. Seasonal deterioration of water quality can be severe enough to kill fish in deep storage reservoirs that receive high nutrient loadings from the surrounding watershed (Cochnauer 1986). Important secondary effects of altered flow and temperature regimes include decreases in water quality, particularly in the reservoir part of river segments, and changes in physical habitat suitability, particularly in the free-flowing part of river segments. The most commonly reported factor influencing year-class strength of sturgeon species is flow during the spawning and incubation period (Jager, Van Winkle et al. 2002, Bednarski 2012 , Vine, Holbrook et al. 2019). Water temperature is another environmental factor that explains year-to-year variation in recruitment (Counihan and Chapman 2018).

The Savannah River is segmented by a series of dams and reservoirs (USFWS, NMFS et al. 2001). The construction of these dams and reservoirs has converted or blocked access to approximately half of the 384 miles of habitat on the Savannah River. The NSBL&D denies Atlantic and shortnose sturgeon access to 7% of its habitat historically available in the Savannah River (ASSRT 1998). However, that historical habitat at Augusta Shoals (Figure 9), represents an estimated 90 to 95% of the high quality, spawning habitat (rapids complex: boulder, bedrock, cobble and gravel substrate) in the Savannah River (Duncan, Freeman et al. 2003, USFWS 2003, Marcy, Fletcher et al. 2005, Wrona, Wear et al. 2007). Flow regime in the Augusta Shoals is largely controlled by flow release from the JST Dam, reregulation of flows at Stevens Creek Dam, and the diversion of water by the Augusta Diversion Dam (ADD). The NSBL&D is the first impediment encountered by all anadromous fish species migrating between estuarine/marine coastal waters into freshwater habitats of the Savannah River and currently impedes Atlantic and shortnose sturgeon from accessing the Augusta Shoals below the ADD. The USACE has proposed construction of a fish-passage-bypass facility at the dam as mitigation for the effects of the deepening in the lower Savannah River. Establishing fish passage at the NSBL&D would enhance spawning potential by providing access to sites located upstream of this structure, provided sufficient flow is available in the area to support associated life history requirements.

Figure 7. ADD and Augusta Shoals (Photo Credit: E. Bettross, GADNR)

In 1994, USFWS, NMFS, SCDNR, and the GADNR completed development of a plan to restore access to a portion of historical anadromous fish spawning habitat in the Savannah River. The plan was filed by USFWS on behalf of the resource agencies in 1994, and was adopted by The Federal Energy Regulatory Commission (FERC) as a Comprehensive Plan pursuant to Section 10(a)(2) of the FPA. The plan is a guide for resource agency efforts and would restore access to approximately 35 miles of spawning and maturation habitat. The plan includes the following elements (1) reliable passage of anadromous fish at the NSBL&D; (2) the design and implementation of an upstream fish passage mechanism and safe downstream (out-migrant) passage at the ADD; (3) the design and implementation of an upstream fish passage mechanism and safe downstream (out-migrant) passage at the Stevens Creek Dam; and (4) improvement of poor DO releases from the JST Dam during the summer months. In 2004, the NMFS and USFWS sent the FERC a joint prescription for fish passage at the ADD as well as minimum flow requirements necessary over the Augusta Shoals in regards to the proposed licensing of the Augusta Diversion Dam. When FERC issued the license for the Stevens Creek Hydropower Project in 1995, it reserved authority for USFWS to prescribe a fishway at that project once upstream passage was achieved at the ADD. Plans are in place to provide fish passage at the ADD and the Stevens Creek Hydroelectric Project (for species other than sturgeon) when fish passage is achieved at the NSBL&D.

4.3.2 Water Quantity and Quality

Water Quantity

The headwaters for the project area originate in the Blue Ridge Mountains of North Carolina, pass through Georgia, and drain into the Atlantic Ocean through the Savannah River. Water flows have been drastically changed through the construction of dams and reservoirs, and from the removal of water for industrial, agricultural, and municipal uses. Wrona, Wear et al. (2007) reports that under the dam management regime of the last 50 years, the 100-year flow is approximately the same size as the pre-dam 2-year flow, and that the current 2-year flow (approximately 35,000 cfs) is one-third the size of the pre-dam 2-year flow (approximately 90,000 cfs). Water flow is regulated by USACE through dams at Lake Hartwell, Lake Richard B. Russell and Clarks Hill Lake (known as J. Strom Thurmond Lake in South Carolina). Flow in the Savannah River is primarily controlled by releases from JST Dam. The gates at the NSBL&D are controlled remotely at the Thurmond Reservoir.

Two nuclear sites – Plant Vogtle in Georgia and the U.S. Department of Energy's Savannah River Site in South Carolina – withdraw water for their facilities. The Savannah River Site no longer operates its nuclear reactors. However, it continues to withdraw water from the Savannah River. The Savannah River Site used a total of 3,550 million gallons (mg) in 2018 (SCDHEC 2019). The Vogtle Electric Generating Plant currently consists of 2 nuclear reactors (Units 1 and 2). These units are authorized to withdraw up to 127 millions of gallons/day (mgd) of water from the Savannah River to cool the reactors and generate power (GADNR 2018) (https://epd.georgia.gov/watershed-protection-branch-lists). An additional 2 nuclear reactors are under construction at the site (Units 3 and 4). Upon completion, the Southern Nuclear Operating Company will operate these units, which are permitted to use up to 74 mgd (GADNR 2018) (https://epd.georgia.gov/watershed-protection-branch-lists).

Numerous other large facilities positioned along the river also withdraw water for industrial uses. Up to 100 mgd (379,000 cubic meters per day) of Savannah River water may be withdrawn to support the growth of South Carolina communities located outside of the Savannah River basin, such as Greenville and Beaufort County (Spencer and Muzekari 2002). In 2011, the State of South Carolina established a system and rules for permitting and registering the withdrawal and use of surface water. The program requires permitting, registration, use, and reporting for surface water withdrawals in excess of 3,000,000 gallons during any 1 month (S.C. Code Sections 49-4-10 et seq.) The most recent statewide report on surface water use is from 2018 (SCDHEC 2019). It states non-power-related surface water withdrawals from the Savannah River by the State of South Carolina was 47,238 mg in 2018. Water withdrawals to support public water supplies accounted for the majority (37,295 mg; 79%) of the water pulled from the Savannah River in 2018 (SCDHEC 2019). Edgefield and Aiken Counties in South Carolina, abut the Savannah River where the Augusta Canal Project is located. In 2018, Edgefield County drew approximately 1,613 mg for the year to support irrigation (33.1 mg) and its public water supply (1,579.5 mg) needs (SCDHEC 2019). This use included a significant reduction in water withdrawals for irrigation, which reached 1,840.5 mg in 2016 (SCDHEC 2017). In 2018, Aiken County withdrew a total of approximately 12,189 mg in support of: golf courses (166.8 mg), industry (6,795 mg), and its public water supply (5,227.5 mg) (SCDHEC 2019). Of note is the significant drop in water withdrawn in Aiken County to support irrigation, dropped from 1,295 mg in 2016 (SCDHEC 2017) to 0 in 2018 (SCDHEC 2019).

In Georgia, permitted surface water withdrawals are limited by either a maximum daily withdrawal limit or a monthly average withdrawal limit (GADNR 2018). The largest non-municipal water user in Georgia is Richmond County, where the Augusta Canal Project is located, is the Graphic Packaging International, LLC - Augusta Mill (72 mgd of water) (GADNR

2018) (https://epd.georgia.gov/watershed-protection-branch-lists). Augusta-Richmond County is the largest municipal permittee in the Savannah River basin, with both the Augusta Canal (50 mgd) and the Savannah River (21 mgd) as the sources (GADNR 2018). Duncan et al. (2003) note that pre-dam low flows in the Augusta Shoals ranged from 2,840 cfs in September to 6,410 cfs in April. Based on 1984-2001 data, low flows over the Augusta Shoals below the ADD average 1,870 cfs and 3,431cfs for March and October, respectively. The Augusta Shoals are also subject to fluctuations in flow governed largely by the periodicity of upstream hydropower generation.

Water Quality
In October 2006, the EPA finalized a total maximum daily load (TMDL) for Savannah Harbor and concluded that the Savannah River cannot withstand the introduction of anthropogenic, oxygen-demanding substances and still provide acceptable habitat for critical aquatic life that reside in the reaches of the river (NMFS 2011). The finding meant that South Carolina and Georgia would have to revise their permits for point source discharges as they expire and come up for renewal. As part of its analysis, EPA evaluated the DO requirements for several fish species and for natural conditions of the river. At that time, the applicable DO site-specific criteria for the Savannah Harbor, as established by Georgia, was a minimum instantaneous DO criterion of no less than 3.0 milligrams per liter (mg/L) in June, July, August, September, and October; no less than 3.5 mg/L in May and November; and no less than 4.0 mg/L in December, January, February, March, and April. However, Georgia revised its DO standard for the Savannah Harbor in 2009 and it now requires a daily average of no less than 5.0 mg/L throughout the year, with an instantaneous minimum of 4.0 mg/L throughout the water column. The new standard matches the South Carolina standard for waters of the same use classification and applies throughout the water column. Average sensitivity of sturgeons to hypoxia is higher than in other fishes (Niklitschek and Secor 2009). As discussed above, DO levels below 5 mg/L can be physiologically stressful, impair animal growth and the complete lack of oxygen (anoxia) will kill animals.

The lower Savannah River is heavily industrialized, and nursery habitat for many species of fish in the lower river has been significantly impacted by diminished water quality and channelization. Contaminants in the Savannah River include those from both municipal and industrial effluents. The area adjacent to Savannah Harbor is especially heavily developed by a wide variety of industries. Other contaminants arise from 2 nuclear facilities farther upriver; nuclear isotopes have been detected in the sediment downriver in the estuary. Point source discharges and compounds associated with discharges contribute to poor water quality and may affect the health of adult sturgeon. Poor water quality can have substantial deleterious effects on aquatic life, including production of acute lesions, growth retardation, and reproductive impairment (Cooper 1989, Sindermann 1994). Ultimately, toxins introduced to the water column become associated with the benthos and can be particularly harmful to benthic organisms like sturgeon (Varanasi 1992). Available data suggest that early life stages of fish are more susceptible to environmental and pollutant stress than older life stages (Rosenthal and Alderdice 1976).

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 conditions. The 2016 list of impaired waters published by GADNR as required by Section 303(d) of the Clean Water Act indicated 90 reaches of the Savannah River are not supporting their designated uses (https://epd.georgia.gov/sites/epd.georgia.gov/files/related_files/site_page/303d_Draft_Streams_Y2016.pdf). Waters were listed as impaired for low DO, impacted fish and macroinvertebrate communities, and the presence of toxins (copper, cadmium, zinc, and mercury). Impairment was attributed to municipal facilities, non-point source pollution and urban runoff, and industrial facilities.

4.3.3 **Dredging**

Dredging of navigation channels can adversely affect shortnose and Atlantic sturgeon due to their benthic nature. The Savannah River is home to one of the busiest ports on the Atlantic Coast and is maintenance dredged regularly up to the Garden City Terminal.

During the study conducted by Hall et al. (1991) in 1985-1991, juvenile shortnose sturgeon were found to be concentrated in the Kings Island Turning Basin (RKM 29.9; RM 18.7). No juvenile stages were found in that area during a study conducted later in 1999-2000 (Collins, W.C. Post et al. 2001). Collins, W.C. Post et al. (2001) surmised that the harbor modifications (e.g., harbor deepening from 38 to 42 ft) occurring after 1992 changed the hydrographic conditions and caused the fish to move from the area.

The Savannah Harbor Expansion Project (SHEP) began in 2015 and is ongoing as of May 2021. The project includes deepening the outer and inner harbor, as well as several projects designed to mitigate for impacts to water quality, sturgeon, and loss of freshwater wetlands anticipated during and after the project's construction. The outer harbor portion of the project, completed in 2018, deepened the channel to 47 ft and extended the existing channel 7.1 miles. Hopper dredges and cutter suction dredges conducted the work. Relocation trawling was used in conjunction with hopper dredging to reduce impacts to sturgeon. During all dredging operations, 2 endangered species observers (ESOs), approved by the NMFS, provided 24-hour monitoring of impacts to T&E species, particularly sea turtles, sturgeon, and right whales. Sturgeon captured during relocation trawling were relocated at least 3 nautical miles from the channel in a direction that provided for the least likelihood of recapture. During the now complete outer harbor dredging, dredges killed 7 Atlantic sturgeon; 137 were located.

4.3.4 **Commercial and Recreational Fisheries**

Directed harvest of sturgeon is currently prohibited; however, sturgeon are taken incidentally in fisheries occurring within Georgia and South Carolina, as well as offshore, and are likely targeted by poachers throughout their range (Dadswell 1979, Dovel, Pekovitch et al. 1992, Collins, Rogers et al. 1996). Impacts from poaching are unknown.

4.3.5 **State Fisheries**

The incidental capture of sturgeons in the Georgia and South Carolina gillnet fishery for American shad (*Alosa sapidissima*) and the trawl fishery for penaeid shrimp (*Penaeus* spp.) was summarized by Collins, Rogers et al. (1996): the commercial shad fishery was active from approximately mid-January through mid-April along the South Atlantic coast; shortnose sturgeon captured in the shad gillnet fishery were primarily adults, while captured Atlantic sturgeon were primarily juveniles; the shad gillnet fishery accounted for 52% and 89% of Atlantic and shortnose sturgeon bycatch, respectively; and, the shrimp trawl fisheries accounted for 39% and 8% of Atlantic and shortnose sturgeon bycatch, respectively. Collins, Rogers et al. (1996) reported that 2 commercial fishermen captured 189 shortnose sturgeon and 14 Atlantic sturgeon over the period of 1990-1992.

Entanglement of sturgeon in gillnets can result in injury and mortality, reduced fecundity, and delayed or aborted spawning migrations of sturgeon (Moser and Ross 1993, Moser and Ross 1995, Weber and Jennings 1996, Collins, Smith et al. 2000, Moser 2000). In the Savannah River from 1984-1992, adult sturgeon were common as bycatch from the lowest point in the river at which gillnet fishing was allowed (about river km 43) up to river km 278 (the uppermost location of several sturgeon spawning areas), as reported by Collins and Smith (1993). Immediate bycatch mortality of sturgeon in set gill nets was 16%, with another 20% of sturgeon having varying degrees of injuries (Collins, Rogers et al. 1996). No estimates of post-release mortality are available.

Mandatory reporting of sturgeon bycatch was initiated in 2000 by ASMFC; a summary of self-reported shortnose and Atlantic sturgeon bycatch via the South Carolina shad gillnet fishery is presented in Table 9 and Table 10. South Carolina's primary shad fishery areas include Waccamaw River, Pee Dee River, Winyah Bay, Santee River, Edisto River, Savannah River, and the Atlantic Ocean intercept fishery. In most cases, shortnose sturgeon captured as bycatch of the shad gillnet fishery are returned to the river uninjured; survival is expected to be greater early in the shad season when waters are cooler. There are no data to separate total number of sturgeon into unique and recaptured individuals.

Table 9. Self-Reported Bycatch of Shortnose by South Carolina Commercial Shad Fishermen, by River System, with Estimated Catch-Per-Unit- Effort (CPUE) (Source: SCDNR)

Year	Winyah Bay System*	CPUE	Santee River	CPUE	Edisto River	CPUE	Combahee River	CPUE	Savannah River	CPUE	Annual Total
2000	6	0.00000656	10	0.0000073	3	0.0000078	0	0.0000000	4	0.0000296	23
2001	27	0.00001848	2	0.0000011	0	0.0000000	0	0.0000000	16	0.0001040	45
2002	41	0.00002343	9	0.0000036	0	0.0000000	0	0.0000000	26	0.0004258	76
2003	1	0.00000035	1	0.0000010	0	0.0000000	0	0.0000000	1	0.0000187	3
2004	0	0.00000000	3	0.0000023	0	0.0000000	0	0.0000000	23	0.0001406	26
2005	0	0.00000000	0	0.0000000	0	0.0000000	0	0.0000000	7	0.0000808	7
2006	3	0.00000078	6	0.0000022	0	0.0000000	0	0.0000000	3	0.0000662	12
2007	0	0.00000000	8	0.0000054	0	0.0000000	0	0.0000000	17	0.0001433	25
2008	6	0.00000286	25	0.0000127	0	0.0000000	0	0.0000000	12	0.0002979	43
2009	5	0.00000202	11	0.0000042	0	0.0000000	0	0.0000000	25	0.0002619	41
2010	4	0.00000221	2	0.0000013	0	0.0000000	0	0.0000000	8	0.0000963	14
2011	0	0.00000000	3	0.0000008	0	0.0000000	0	0.0000000	18	0.0001949	21
2012	7	0.00000296	12	0.0000037	0	0.0000000	0	0.0000000	16	0.0001291	35
2013	6	0.00000345	1	0.0000006	0	0.0000000	0	0.0000000	0	0.0000000	7
2014	2	0.00000256	1	0.0000005	0	0.0000000	0	0.0000000	0	0.0000000	3
2015	7	0.00000923	0	0.0000000	0	0.0000000	0	0.0000000	0	0.0000000	7
2016	0	0.00000000	8	0.0000065	0	0.0000000	0	0.0000000	0	0.0000000	8
2017	11	0.00001203	19	0.0000121	0	0.0000000	0	0.0000000	0	0.0000000	30
2018	2	0.00000233	4	0.0000025	3	0.0000519	0	0.0000000	0	0.0000000	9

*Winyah Bay includes the Waccamaw River, Pee Dee River, and Winyah Bay

Table 10. Self-Reported Bycatch of Atlantic Sturgeon by South Carolina Commercial Shad Fishermen, by DPS, with Estimated Catch-Per-Unit- Effort (CPUE) (Source: SCDNR)

Year	Carolina DPS		South Atlantic DPS		Annual Total (Both DPSs)
	(Waccamaw River, Pee Dee River, Winyah Bay, and Santee River)	CPUE	(Edisto River, Combahee River, and Savannah River	CPUE	
2000	40	0.0000175	5	0.0000089	45
2001	128	0.0000383	20	0.0000406	148
2002	74	0.0000175	5	0.0000166	79
2003	16	0.0000041	3	0.0000071	19
2004	11	0.0000027	0	0.0000000	11
2005	0	0.0000000	1	0.0000027	1
2006	226	0.0000342	2	0.0000051	228
2007	162	0.0000632	6	0.0000156	168
2008	76	0.0000187	0	0.0000000	76
2009	186	0.0000364	3	0.0000108	189
2010	12	0.0000036	3	0.0000135	15
2011	173	0.0000297	8	0.0000332	181
2012	194	0.0000345	11	0.0000422	205
2013	157	0.0000454	1	0.0000047	158
2014	14	0.0000049	0	0.0000000	14
2015	10	0.0000031	0	0.0000000	10
2016	15	0.0000084	0	0.0000000	15
2017	66	0.0000265	0	0.0000000	66
2018	138	0.0000566	0	0.0000000	138

NMFS (2013) issued the State of Georgia an ESA Section 10 permit for its commercial shad fishery in December 2012. Georgia amended its commercial shad fishing regulations to minimize incidental capture of shortnose sturgeon. Fishing is restricted to the lower portions of the Savannah River. Georgia's conservation plan also reduced the number of days per week that certain areas are open to shad fishing. The Section 10 permit issued to the State of Georgia estimates that incidental capture of shortnose sturgeon by commercial shad fisheries will not exceed 70 shortnose sturgeon and 35 Atlantic sturgeon per year in the Savannah River. NMFS (2013) estimated a mortality rate of 2.3% for incidentally captured shortnose sturgeon Georgia's commercial shad fisheries based on estimate provided in Bahn, Fleming et al. (2012); Bahn, Fleming et al. (2012) did not estimate Atlantic sturgeon mortality. NMFS (2013) estimated a 1% mortality rate for Atlantic sturgeon based on observed mortality in drift nets reported by shad fishermen and researchers.

4.3.6 Other Federal Actions

Interagency Consultation (ESA Section 7)

In recent years, NMFS has undertaken a number of ESA Section 7 consultations to address the effects of federal actions on endangered shortnose and Atlantic sturgeon in the Savannah River system (Table 11). For most of the projects listed in Table 11, the primary source of potential impacts to shortnose and Atlantic sturgeon were from in-water construction activities and, based on the action agencies' willingness to adopt seasonal in-water construction moratoria or other special construction conditions, adverse effects were not likely. NMFS determined several projects were likely to adversely affect Atlantic and shortnose sturgeon. These include: (1) the Savannah Harbor Federal Navigation Project (SHEP) (SER-2017-18749, SER-2017-19015, SER-2018-19057), (2) the Savannah District COE field study of bed levelers with hopper dredges in Savannah and Brunswick Harbors that we determined could result in the injury or mortality of 2 Atlantic sturgeon over the course of the project (SER-2017-18749, SER-2017-19015, SERO-2017-00596, SER-2018-19057, SERO-2021-00185), (3) the issuance of the ESA Section 10 permit for the Georgia commercial shad fishery, discussed in greater detail in Section 4.3.5 (NMFS (2013)), and (4) the Southern LNG Berth Maintenance that we determined could result in the non-lethal captures of up to 20 Atlantic sturgeon (SER-2014-15939). The Savannah District COE requested re-initiation in 2017 of the SHEP biological opinion to address the potential impacts of the project to Atlantic sturgeon critical habitat and a South Carolina District Court enjoined the selected fish passage alternative in November 2020.

Table 11. ESA Section 7 Consultations for Sturgeon in the Savannah River 2002-2020.

Date	Project
5/28/2003	USFWS grant to GADNR CRD for marine fisheries surveys
7/03/2003	Chatham County dock construction for water ferry
12/07/2004	GPA Berth 8 construction
12/30/2004	USACE advance maintenance dredging Savannah Entrance Channel
02/05/2005	Amendment 6 to Shrimp Fishery FMP
08/02/2005	GADOT repair of Back River bridge-Chatham County
03/12/2007	Savannah Economic Development Authority- North Port Project
08/02/2007	Southern LNG & Elba Express Elba III project
12/10/2007	NPS/FHWA repair of Fort Pulaski bridge
08/05/2008	Southern Nuclear – Vogtle Electric Plant license renewal
01/12/2009	GADOT replacement of Back River bridge-Chatham County
01/28/2009	Drought Contingency Plan Savannah River
03/16/2009	SAS Non-capture relocation trawling demo project
07/15/2009	Bank stabilization at Cockspur Island Lighthouse
11/06/2009	Fall/Winter Flow Reduction- Savannah River (Thurmond Reservoir)
04/08/2011	SCDOT - Road Widening and Bridge Widening on US 17 in Jasper County, South Carolina
05/19/2011	NRC - Vogtle Electric Generating Plant, Units 3 and 4 Combined Licenses Application
11/04/2011	Savannah Harbor Federal Navigation Project
02/15/2012	Continued Authorization South Atlantic Coral, Dolphin-Wahoo, Golden Crab, Snapper-Grouper, and Sargassum Fisheries and the Gulf of Mexico/South Atlantic Spiny Lobster Fishery FMPs (reinitiation for Atlantic sturgeon)
05/16/2012	King Mill Hydroelectric Project
08/01/2012	GADOT replacement of Back River bridge-Chatham County (reinitiation for Atlantic sturgeon)
11/27/2012	GADOT Fort Pulaski Bridge Project in Chatham County, Georgia
12/04/2012	Savannah District COE - Field Study of Bed Levelers with Hopper Dredges in Savannah and Brunswick Harbors, Chatham/Glynn Counties, Georgia
12/20/2012	Georgia Shad Fishery Section 10 Permit
02/22/2013	Georgia Department of Natural Resources' Request to Amend ESA Section 6 Cooperative Agreement
03/01/2013	Savannah River Berth Maintenance
04/23/2013	Southern LNG Berth Maintenance
05/17/2013	GADOT Replacement of the CR 787/Islands Expressway Bridges over the Wilmington River, Chatham County, Georgia
04/07/2015	SCDOT - Spanish Well Road (S-79) - Bridge Replacement Project (PIN 39102) - BA for Shortnose/Atlantic Sturgeon
07/01/2015	Army Permit No. SAS-2014-363 (201400363) - Biological Assessment for Shortnose and Atlantic Sturgeons - City of Savannah - Plant Riverside Riverwalk (Riverfront Plaza)
03/29/2017	SCDOT & GDOT - U.S. Route 17 Widening and Bridge Over Back River Biological Assessment for the Atlantic and Shortnose Sturgeons And West Indian Manatee
12/15/2017	Reinitiation of SCDOT - U.S. Route 17 Widening and Bridge Over Back River Biological Assessment for the Atlantic and Shortnose Sturgeons And West Indian Manatee
2/19/2020	SERO-2019-03308 SR-25 Bridge Middle River Project – Bridge Replacement
3/30/2020	SERO-2019-03488 FFP-Garden City Terminal Berth Project
5/12/2020	SERO-2020-00368 Georgia Kaolin Dock – Dock Construction

Cooperation with States (ESA Section 6)

Through an ESA Section 6 cooperative agreement with Georgia and South Carolina, NMFS has supported numerous research projects within the project area to investigate the life history of the shortnose and Atlantic sturgeon. For example, a multi-year, multi-state project looking at movement, migration, and genetics of Atlantic and shortnose sturgeon in North Carolina, South Carolina, and Georgia was funded in 2010 (NOAA award #NA10NMF4720036). Other projects funded through the Section 6 program have investigated sturgeon genetics, diet, habitat use, and population dynamics. ESA Section 10 research permits were issued to researchers studying shortnose and Atlantic sturgeon as part of their Section 6-funded work.

Research, Enhancement, and Incidental Take Permits (ESA Section 10)
Through issuance of ESA Section 10(a)(1)(A) permits, scientific and enhancement studies are conducted by researchers on captive shortnose sturgeon maintained at various quarantined research facilities. Currently, only researchers employed by USFWS are authorized to study captive shortnose sturgeon from stocks in the Southeast. These captive individuals are periodically conditioned and spawned and the resulting gametes and progeny are used for scientific studies, such as cryogenics, disease transmission, nutrition, genetics, toxicology, fish passage, and fish culture techniques.

Between 1985-1992, 97,483 shortnose sturgeon raised at USFWS' Bears Bluff National Fish Hatchery were released into the Savannah River. The hatchery-produced individuals were stocked at various ages (most were larvae and early juveniles), locations, and across all seasons. Only 18,210 individuals were large enough to be tagged in some fashion. Survival of the very young sturgeon is unknown, but likely low. Population estimates of adult shortnose sturgeon pre- and post-stocking suggest that the numbers had increased substantially, but many tags were shed, few fish were marked, and these estimates were never published, as statistical assumptions were violated and the estimates were biased. Some believe the stocking event was successful; however, without information on the survivability and emigration of both the wild and stocked fish, impacts and effects of the stocking event cannot be assessed. Shortnose sturgeon that retained their tags have been found in other rivers, suggesting they emigrated and may have been released at an age too late to imprint on the Savannah River (Smith, McCord et al. 2002). Smith, McCord et al. (2002) reported that shortnose sturgeon stocked into the Savannah River emigrated and colonized the Edisto River, and that they also substantially supplemented the Ogeechee River population. Other stocked shortnose sturgeon from the Savannah River have been detected in the Cooper River and Winyah Bay, South Carolina.

Two Section 10(a)(1)(A) scientific research permits are currently issued to study shortnose sturgeon in the Southeast (Table 12). Two Section 10(a)(1)(A) scientific research permits are currently issued to study Atlantic sturgeon from the South Atlantic DPS (Table 13). Each permit approves sampling methodology and authorizes take. Permit 17861 authorizes mortalities of up to 3 adult and 3 juvenile shortnose sturgeon annually, and up to 4 adult/subadult and 4 juvenile Atlantic sturgeon annually. Similarly, Permit 20528 authorizes up to 1 adult and 1 juvenile shortnose sturgeon annually, and 1 adult/subadult and 1 juvenile Atlantic sturgeon annually. The way the permit is structured, all of those authorized mortalities could occur in the Savannah River, some mortalities could occur in the Savannah while others occurred in different rivers, or all of the mortalities could occur in rivers other than the Savannah. The specific stressors to fish subject to NMFS-issued ESA permit conditions are capture in nets; handling and restraint during examinations; measuring and weighing; tagging using passive integrated transponder (PIT), internal, and external tags; tissue sampling; anesthetizing; laparoscopy; blood sampling; and gonad biopsy.

Table 12. Current Shortnose Sturgeon ESA Section 10 (a)(1)(A) Research Permits

Permit No.	Location	Authorized Take	Research Activity
17861 Expires: 3/31/2027	Savannah, Ogeechee, Canoochee, Altamaha, Oconee, Ocmulgee, Satilla, St. Marys, St. Johns, and Nassau rivers, and all Georgia/Florida rivers, estuaries, and coastal marine areas	855 adult/juv. (lethal – 3 juv. and 3 adult); 250 ELS	Capture, handle, measure, weigh, PIT tag, tissue sample, fin-ray section, anesthetize, laparoscopy, gonad biopsy, blood collection, radio tag, collect ELS
20528 Expires: 3/31/2027	Santee, Cooper, Edisto, and Savannah rivers.	260 adult/juv. (lethal – 1 juv. and 1 adult); 150 ELS	Capture, handle, measure, weigh, PIT tag, tissue sample, fin-ray section, anesthetize, laparoscopy, gonad biopsy, blood collection, radio tag, collect ELS

Early life stage (ELS) individuals

Table 13. Current Atlantic Sturgeon ESA Section 10 (a)(1)(A) Research Permits

Permit No.	Location	Authorized Take	Research Activity
17861 Expires: 3/31/2027	Savannah, Ogeechee, Canoochee, Altamaha, Oconee, Ocmulgee, Satilla, St. Marys, St. Johns, and Nassau rivers, and all Georgia/Florida rivers, estuaries, and coastal marine areas	2480 adult/sub-adult/juv. (lethal – 4 juv. and 4 adult); 300 ELS	Capture, handle, measure, weigh, PIT tag, tissue sample, fin-ray section, anesthetize, laparoscopy, gonad biopsy, blood collection, radio tag, collect ELS
20528 Expires: 3/31/2027	Santee, Cooper, Edisto, and Savannah rivers.	1020 adult/sub-adult/juv. (lethal – 1 juv. and 1 adult); 150 ELS	Capture, handle, measure, weigh, PIT tag, tissue sample, fin-ray section, anesthetize, laparoscopy, gonad biopsy, blood collection, radio tag, collect ELS

Early life stage (ELS) individuals

4.3.7 Climate Change/Sea Level Rise

Threats to sturgeon from climate change and sea level rise in the Savannah River are very similar to those describe previously in Section 3.2: Status of Species Likely To Be Adversely Affected.

4.3.8 Drought

Large-scale factors impacting riverine water quality and quantity that likely exacerbate habitat threats to shortnose and Atlantic sturgeon include drought, and intra- and inter-state water allocation. Changes in the climate are very likely be associated with more extreme precipitation and faster evaporation of water, leading to greater frequency of both very wet and very dry conditions. For example, while annual precipitation in the Southeast has increased by 0.19 in (0.48 cm) per decade since 1950 (NCDC 2019), the southeastern United States has experienced several years of drought since 2007. During this time, Georgia and South Carolina experienced drought conditions that ranged from moderate to extreme. Between March 2007 and December 2008, 50-100% of the State of Georgia and the State of South Carolina experienced some level of drought ranging in intensity from "abnormally dry" to "exceptional," based on the drought intensity categories used by the U.S. Drought Monitor (NDMC 2018). That drought was surpassed just a few years later. Both states again experienced "abnormally dry" to "exceptional" drought conditions across 50-100% of those states again from September 2010-March 2013, https://droughtmonitor.unl.edu/Data/Timeseries.aspx (NDMC 2018).

Abnormally low stream flow can restrict access to habitat areas, reduce thermal refugia, and exacerbate water quality issues such as high temperature, low DO, and elevated nutrient and contaminant levels. Further reduction in flow would likely disrupt spawning cues, and upstream migration may occur earlier; a disparity between prey availability and demand by larvae could ensue. NMFS believes that reduced flow down the rivers coupled with rising sea level will push the salt wedge further upriver and may constrict available shortnose sturgeon foraging habitat. Data from gauging stations indicate that periods when river flows are inadequate to protect the riverine environment from saltwater intrusion are becoming more frequent. Human-induced modifications to free-flowing rivers also influence coastal and marine systems, often reducing the ability of the system to adapt to natural variability and change.

Drought and water allocation issues and their associated impacts on water quality will likely work synergistically with climate change impacts. While debated, researchers anticipate (1) the frequency and intensity of droughts and floods will change across the Nation; (2) a warming of about 0.2°C per decade; and (3) a rise in sea level (NAST 2000). A warmer and drier climate will reduce stream flows and increase water temperature, resulting in a decrease of DO and an increase in the concentration of nutrients and toxic chemicals due to reduced flushing. Sea level is expected to continue rising. During the 20^{th} century, global sea level has increased 6-8 in (15-20 cm), and between 1985 and 1995 more than 32,000 acres of coastal salt marsh was lost in the southeastern United States due to a combination of human development activities, sea level rise, natural subsidence and erosion. Rising sea level will likely drive the salt wedge further upstream, possibly affecting the survival of drifting larvae and constricting available foraging habitat as well as the habitat available for the physiological transformation of freshwater larvae into salt-tolerant juveniles.

Maintenance of adequate flow in spawning areas is especially crucial to the survival of sturgeon populations. Longer periods of adequate flows are necessary in the Savannah River, where early life-stage (larval and juvenile) sturgeon make longer downstream migrations than sturgeon in other rivers. A study on larval dispersal patterns compared behavior of shortnose sturgeon larvae collected from the Connecticut River to those spawned from Savannah River stock (Parker 2007). Dispersal rates differed as fish from the Connecticut River peaked on days 7–12 after hatching. Savannah River individuals had a longer dispersal period with multiple, prolonged peaks, and a low level of downstream movement that continued over the entire larval and early juvenile phases, which lasts at least 4 months.

4.3.9 Impingement and Entrainment

Rates of impingement and entrainment are not known, but the death of 1 tagged adult in the intake structure of a factory in the Port of Savannah has been documented. Larvae have been recorded from the intake canals at the Savannah River Site, a federal nuclear facility.

4.3.10 Conservation and Recovery Actions Benefitting Sturgeon

Many measures have been implemented to protect the sturgeon in the Savannah River estuary. Overharvesting of sturgeon in directed fisheries has been eliminated as a causative factor in the decline of the Savannah River sturgeon populations. Since its ESA listing in 1967, it has been illegal to kill or possess shortnose sturgeon. In 1998, the Atlantic States Marine Fisheries

Commission (ASMFC) instituted a coast-wide moratorium on the harvest of Atlantic sturgeon, which is to remain in effect until there are at least 20 protected age classes in each spawning stock (anticipated to take up to 40 or more years). NMFS followed the ASMFC moratorium with a similar moratorium for federal waters. Sturgeon that are caught incidentally as bycatch in shrimp trawls are to be released alive. The phasing out of the traditional method of catching American shad (gillnets in a coastal intercept fishery) has greatly reduced the number of sturgeon inadvertently caught by shad fisherman. In turn, this has greatly reduced the interruption of sturgeon migrations in the late winter and early fall.

As listed species, the ESA provides protections that lead to the conservation and recovery of Atlantic and shortnose sturgeon. Section 7(a)(1) of the ESA charges all federal agencies to utilize their authorities in furthering the purposes of the ESA by carrying out programs for the conservation of threatened and endangered species. Under Section 7(a)(2) of the ESA, any action funded, authorized, or undertaken by a federal agency that may affect either species would require consultation with NMFS. During consultation, NMFS evaluates the anticipated level of take associated with the action, evaluates whether it would jeopardize the continued existence of the species, and determines RPMs that would reduce the anticipated effects of the incidental take on the species. Recovery may be facilitated through incorporating conservation measures into activities that potentially affect shortnose and Atlantic sturgeon through Section 7(a)(2) consultations and Section 10(a)(1)(B) permitting.

NMFS finalized the Recovery Plan for the shortnose sturgeon in 1998 with the following recovery objective “to recover shortnose sturgeon populations to levels of abundance at which they no longer require protection under the ESA, and for each population segment, the minimum population size will be large enough to maintain genetic diversity and avoid extinction.” The Recovery Plan identified 19 discrete populations of shortnose sturgeon and determined the Savannah River population to be discrete (NMFS 1998). The 1998 shortnose sturgeon Recovery Plan also identified 4 main recovery actions: 1) establish listing criteria for shortnose sturgeon population segments, 2) protect shortnose sturgeon and their habitats, 3) rehabilitate shortnose sturgeon populations and habitats, and 4) implement recovery tasks. To rehabilitate shortnose sturgeon habitats and population segments, the Recovery Plan calls for actions to restore access to habitats, spawning habitat and conditions, and foraging habitat. In 2007, NMFS convened a team of experts on shortnose sturgeon biology, genetics, and life history to conduct a biological assessment of shortnose sturgeon. In 2013, NMFS released the “Biological Assessment of Shortnose Sturgeon,” which represents the best available information regarding shortnose sturgeon throughout its range.

Through ESA Section 6 cooperative agreements, NMFS has supported numerous research projects within the South Atlantic to investigate the life history of the shortnose and Atlantic sturgeon. Researchers have worked to fill in knowledge gaps to better inform conservation and recovery of Atlantic and shortnose sturgeon. Studies include population dynamics and migration of Atlantic sturgeon captured in South Carolina rivers and coastal waters through mark-recapture and telemetry techniques; abundance, population dynamics, seasonal movement, diet, general ecology and environmental tolerance of Atlantic sturgeon captured in Georgia rivers and coastal waters; presence, population status, movement patterns, and habitat use of Atlantic sturgeon in Florida and Georgia coastal rivers.

Section 8 of the ESA permits the United States to cooperate internationally in conserving threatened and endangered species and implemented Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) protections in the United States. Shortnose sturgeon were listed in Appendix I by CITES in 1975. Appendix I species are considered threatened by extinction and trade is permitted only in exceptional circumstances. Atlantic sturgeon were listed in CITES Appendix I in 1975 and transferred to Appendix II in 1979. Appendix II includes species not necessarily threatened with extinction, but in which trade must be controlled in order to avoid utilization incompatible with their survival. Both Atlantic and shortnose sturgeon were added to the International Union for Conservation of Nature and Natural Resources (IUCN) Red List in 1986 as vulnerable. Shortnose sturgeon continue to be classified by the IUCN as vulnerable, while Atlantic sturgeon were reclassified in 2006 as near threatened.

Point source discharges in the Savannah River are regulated under the National Pollutant Discharge Elimination System (NPDES) program by the GADNR Environmental Protection Division in coordination with the EPA. The EPA published a draft revised TMDL for the Savannah River to improve DO conditions in the Savannah Harbor in 2010. If finalized, the TMDL would require a reduction in oxygen demanding substances over time as the various NPDES permits come up for renewal, in point source discharges. This TMDL would impact NPDES permit holders in the Augusta, Georgia, area as well, since their waste loads contribute to the DO deficiencies in Savannah Harbor.

Designation of Atlantic Sturgeon Critical Habitat

On August 17, 2017, NMFS issued a final rule to designate critical habitat for the threatened Gulf of Maine 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 (82 FR 39160). The rule was effective on September 18, 2017. Seven units were designated to protect the South Atlantic DPS, including a unit for the Savannah River.

The conservation objective identified in the final rule is to increase the abundance of each DPS by facilitating increased successful reproduction and recruitment to the marine environment. The final rule identified 4 physical features essential to the conservation of the species and achieving the conservation objective that generally refer to: 1) hard bottom substrate in freshwater; 2) transitional habitat between freshwater riverine habitat and marine habitat; 3) waters of appropriate depth that are free of obstruction; and 4) water quality conditions (specifically temperature and DO) that support growth, development, survival, recruitment, and spawning.

4.3.11 Summary and Synthesis of Environmental Baseline for Sturgeon

In summary, several factors are presently adversely affecting shortnose and Atlantic sturgeon in the action area. These factors are ongoing and are expected to occur contemporaneously with the proposed action:

- The operation of hydroelectric dams will continue to modify hydrology and water quality, and block access to spawning and foraging sites above dams;
- The use of reservoirs for municipal and industrial purposes will continue to impact downstream flow rate, which leads to reduced spawning and foraging habitat, reduced DO, and altered water temperatures;
- Municipal and industrial intakes will reduce water quantity in the river, while effluents will continue to reduce water quality by adding excess nutrients and contaminants;
- The creation, expansion, and maintenance of inlets and channels will continue to destabilize sediments; decrease water clarity and transparency; and modify salinity regimes;
- Commercial fishing will continue to take sturgeon as bycatch through incidental capture; and,
- Climate change will likely exacerbate the continuing effects of reduced water quality and quantity.

These activities are expected to combine to adversely affect the recovery of shortnose and Atlantic sturgeon in the Savannah River.

5 EFFECTS OF THE ACTION ON SPECIES

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

As discussed in Section 2.1 of this Opinion, relocation trawling/and or gillnetting will be carried out prior to the blasting activity covered under this Opinion. While relocation trawling is intended to reduce lethal take from blasting events, the process of relocating ESA-listed species is, in and of itself, a form of take under the ESA. Relocation trawling is monitored by PSOs trained to handle these species to minimize the risk of harm to them. Relocation trawling is required only when it can be done safely, as a means to reduce sturgeon mortalities. It is a proven method of reducing sturgeon density prior to potentially fatal species impact and very likely results in reduced sturgeon/blasting interactions (NMFS 2020).

In this section of the Opinion, we consider the proposed action's effect on the SA DPS of Atlantic sturgeon and shortnose sturgeon. The analysis in this section forms the foundation for jeopardy analysis in Section 7.

Our relocation trawling/gillnetting analysis approach is based on total number of net hours over several years of Savannah River sturgeon population research efforts (Fox (2020). Between 2013 to 2020, 1546.4 net-hours of trawling effort between river kilometer (rkm) 20 through 50 on the Savannah River yielded 3,459 Atlantic sturgeon and 1,620 shortnose sturgeon catches (Table 14). This equates to an average of 2.24 Atlantic sturgeon and 1.05 shortnose sturgeon caught per net-hour of trawling effort in any given year (Table 15). In order to estimate a conservative non-lethal take for the pre-blasting relocation trawling efforts described in this Opinion, we will use the highest capture rate cited for each species. Specifically, the 2015 rate for Atlantic sturgeon (4 Atlantic sturgeon caught per net hour, rounded up from 3.08) and the 2017 rate for shortnose sturgeon (2 shortnose sturgeon caught per net hour, rounded up from 1.42). The applicant states that pre-blasting relocation trawling will occur within the action area for up to 3 hours (trawls will be towed at an average speed of up to 3 knots for up to 15 minutes at a time) before a blasting event. Further, the applicant estimates that up to 4 blasting events may be required in order to effectively remove the existing bridge pile for demolition. Therefore, we estimate a total of 48 Atlantic sturgeon (4 Atlantic sturgeon per net hour of trawling effort × 3 hours for relocation trawling × 4 relocation trawling events = 48 non-lethal Atlantic sturgeon take) and 24 shortnose sturgeon (2 shortnose sturgeon per net hour of trawling effort × 3 hours for relocation trawling × 4 relocation trawling events = 24 non-lethal shortnose sturgeon take) non-lethally taken in the potential pre-blasting relocation trawling efforts.

Table 14. Sturgeon catch for 2013-2020 adapted from Fox et al. 2020

Year	Sampling Period	Effort (net-hours)	Total Atlantic sturgeon catch	Total shortnose sturgeon catch
2013	May 15 – July 3	174.3	568	154
2014	May 12 – July 18	225.8	554	270
2015	May 28– July 30	164.1	505	218
2016	May 13 – August 2	234.2	588	236
2017	May 8 – July 27	165.1	419	234
2018	April 17 – July 27	256.6	485	295
2019	May 7- July 31	203.9	230	134
2020	May 19 – August 5	122.4	110	79
Total		1546.4	3459	1620

Table 15. Sturgeon catch per effort (net-hour) adapted from Fox et al. 2020

Year	Atlantic sturgeon catch per net-hour	Shortnose sturgeon catch per net-hour
2013	3.26	0.88
2014	2.45	1.20
2015	3.08	1.33
2016	2.51	1.01
2017	2.54	1.42
2018	1.89	1.15
2019	1.13	0.66

Year	Atlantic sturgeon catch per net-hour	Shortnose sturgeon catch per net-hour
2020	0.90	0.65
Average	2.24	1.05

We do not believe there will be lethal take of Atlantic or shortnose sturgeon from the relocation trawling or the blasting required for this project. First, sturgeon mortality resulting from relocation trawling is extremely rare. The purpose of the relocation effort is to identify and safely remove all Atlantic and shortnose sturgeon in the area before the blasting activities, which would otherwise cause lethal adverse effects. Additionally, the likelihood of injury to Atlantic and shortnose sturgeon during relocation trawling, or evasion of capture, is low because the personnel will be trained and experienced sturgeon handlers.

6 CUMULATIVE EFFECTS

ESA Section 7 regulations require NMFS to consider cumulative effects in formulating its Opinions (50 CFR 402.14). Cumulative effects include the effects of future state, tribal, local, or private actions that are reasonably certain to occur in the action area considered in this Opinion (50 CFR 402.02). Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to Section 7 of the ESA.

Within the action area, major future changes in human activities are not anticipated. The present human uses of the action area, such as commercial shipping, boating, and fishing, are expected to continue at the present levels of intensity in the near future as are their associated risks of injury or mortality to sea turtles posed by incidental capture by fishermen, vessel collisions, marine debris, chemical discharges, and man-made noises. Except for a commercial shoreline facility in the southwest portion of the action area, the remainder of the action area is undeveloped. We are not aware of any planned development or changes in land use in the action area.

7 JEOPARDY ANALYSIS

7.1 Jeopardy Analysis

To “jeopardize the continued existence of…” means to “engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and the recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species” (50 CFR 402.02). Thus, in making this determination for each species, we must look at whether the proposed action directly or indirectly reduces the reproduction, numbers, or distribution of a listed species. Then if there is a reduction in one or more of these elements, we evaluate whether it would be expected to cause an appreciable reduction in the likelihood of both the survival and the recovery of the species.

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

The analyses conducted in the previous sections of this Opinion serve to provide a basis to determine whether the proposed actions would be likely to jeopardize the continued existence of Atlantic sturgeon (SA DPS) and shortnose sturgeon. In Section 5.0, we outlined how the proposed action can affect these species. Now we turn to an assessment of the species response to these impacts, in terms of overall population effects, and whether those effects of the proposed action, when considered in the context of the status of the species (Section 3.0), the environmental baseline (Section 4.0), and the cumulative effects (Section 6.0), will jeopardize the continued existence of the affected species. For any species listed globally, our jeopardy determination must find the proposed action will appreciably reduce the likelihood of survival and recovery at the global species range. For any species listed as DPSs, a jeopardy determination must find the proposed action will appreciably reduce the likelihood of survival and recovery of that DPS.

Atlantic Sturgeon (SA DPS)

The proposed action (relocation trawling) covered under this Opinion may result in the following take of Atlantic sturgeon (SA DPS):

- Nonlethal take= 48 observed

7.1.1 Atlantic Sturgeon SA DPS Survival

The proposed action may result in 48 Atlantic sturgeon takes from the SA DPS over the project duration. We estimate all 48 takes would be nonlethal. The nonlethal capture of 48 individuals from the SA DPS during pre-blasting relocation trawl events are not expected to have any measurable impact on the reproduction, numbers, or distribution of this DPS. We anticipate these individuals will fully recover such that no reductions in reproduction or numbers are anticipated. Since these captures may occur at the discrete action area and would be released within the general area where caught, no change in the distribution of Atlantic sturgeon is anticipated.

Based on the information provided above, the nonlethal takes expected of up to 48 individuals from the SA DPS Atlantic sturgeon during the relocation trawling authorized in this Opinion project will not appreciably reduce the likelihood of survival of the DPS (i.e., they will not decrease the likelihood that the species will continue to persist into the future with sufficient resilience to allow for the potential recovery from endangerment). The action will not affect SA DPS Atlantic sturgeon in a way that prevents the species from having a sufficient population, represented by all necessary age classes, genetic heterogeneity, and number of sexually mature individuals producing viable offspring, and it will not result in effects to the environment which would prevent Atlantic sturgeon from completing their entire life cycle or completing essential behaviors including reproducing, foraging and sheltering. Therefore, we do not believe the anticipated takes will appreciably reduce the likelihood that the SA DPS of Atlantic sturgeon will survive in the wild.

7.1.2 Atlantic Sturgeon SA DPS Recovery

A Recovery Plan for the SA DPS has not yet been developed. However, NMFS completed a recovery outline for Atlantic sturgeon in 2017 (NMFS 2018). The final listing rule (77 FR 5914; Publication Date February 6, 2012) identified threats to all 5 DPSs as including: dams, dredging, water quality, climate change, and overutilization for commercial purposes. The recovery outline indicates those threats are still largely of concern and further identifies habitat changes, impeded access to historical habitat by dams and reservoirs, degraded water quality, reduced water quantity, vessel strikes, and bycatch in commercial fisheries as on-going threats. The severity of those threats varies by DPS.

We do not anticipate the effects from the proposed action will impede recovery. In general, to recover, a listed species must have sustained population growth. For the SA DPS to exhibit sustained population growth, there must be enough suitable habitat for spawning, foraging, resting and migrations of all individuals. Environmental conditions must be suitable for the successful development and growth of all life stages, particularly the most vulnerable early life stages. Mortality rates at all life stages must be low enough to ensure successful recruitment of individuals into subsequent age classes so that successful spawning can continue over time and over generations. For the SA DPS, habitat conditions must be suitable both in the natal river and in other rivers and estuaries where foraging by subadults and adults will occur and in the ocean where subadults and adults migrate, overwinter and forage. Habitat connectivity must also be maintained so that individuals can migrate between important habitats without delays that impact their fitness.

We believe the proposed action will not result in mortalities leading to a subsequent reduction in future reproductive output. Accordingly, we do not believe the proposed action will impede the recovery of the SA DPS, by significantly exacerbating the dredging effects or any of the other remaining major threats identified in the final listing rules, even when considered in the context of the Status of the Species, the Environmental Baseline, and Cumulative Effects discussed in this Opinion. Therefore, we conclude the proposed action will not appreciably reduce the likelihood of recovery of the SA DPS.

Conclusion

While the proposed action will result in adverse effects to individuals from the SA DPS of Atlantic sturgeon, the nonlethal take of 48 individuals from the SA DPS of Atlantic sturgeon associated with the proposed action is not expected to cause an appreciable reduction in the likelihood of either the survival or recovery of the DPS in the wild.

Shortnose Sturgeon

The proposed action (relocation trawling) covered under this Opinion may result in the following take of shortnose sturgeon:

- Nonlethal take= 24 observed

7.1.3 Shortnose Sturgeon Survival

The proposed action may result in 24 shortnose sturgeon takes over the project duration. We estimate all 24 takes would be nonlethal. The nonlethal capture of 24 individual shortnose sturgeon during pre-blasting relocation trawl events is not expected to have any measurable impact on the reproduction, numbers, or distribution of this species. We anticipate these individuals will fully recover such that no reductions in reproduction or numbers are anticipated. Since these captures may occur at the discrete action area and would be released within the general area where caught, no change in the distribution of Atlantic sturgeon is anticipated.

Based on the information provided above, the nonlethal takes expected of up to 24 individual shortnose sturgeon during the relocation trawling authorized in this Opinion project will not appreciably reduce the likelihood of survival of the species (i.e., they will not decrease the likelihood that the species will continue to persist into the future with sufficient resilience to allow for the potential recovery from endangerment). The action will not affect the shortnose sturgeon in a way that prevents the species from having a sufficient population, represented by all necessary age classes, genetic heterogeneity, and number of sexually mature individuals producing viable offspring, and it will not result in effects to the environment which would prevent shortnose sturgeon from completing their entire life cycle or completing essential behaviors including reproducing, foraging and sheltering. Therefore, we do not believe the anticipated takes will appreciably reduce the likelihood that the shortnose sturgeon species will survive in the wild.

7.1.4 Shortnose Sturgeon Recovery

The long-term recovery goal for shortnose sturgeon focuses on recovering each population independently. An increase in the population to a size that maintains a steady recruitment of individuals representing all life stages would provide population stability and enable the population to sustain itself in the event of unavoidable impacts. Goals listed in the 1998 shortnose sturgeon recovery plan (NMFS 1998) that could be affected by the proposed action include:

> *2.1 Ensure agency compliance with the ESA*
> *All federal agencies funding, authorizing or conducting activities where shortnose sturgeon occur must fulfill their responsibilities under Section 7(a)(1) and Section 7(a)(2) of the ESA. As a co-administrator of the ESA, the NMFS should insure that the protective actions and regulatory requirements of the ESA safeguard against impacts and mortalities to shortnose sturgeon. The NMFS should inform federal agencies of their responsibilities under the ESA and encourage federal agencies to adopt programs that support shortnose sturgeon recovery.*

This should include supporting research that identifies potential impacts (to shortnose sturgeon) resulting from specific development projects.

2.4 Mitigate/eliminate impact of adverse anthropogenic actions on shortnose sturgeon population segments.

2.4.1 Mitigate impacts of modifications to important habitat and other destructive activities.

Activities such as dredging… affect shortnose sturgeon both directly and indirectly (see Factors Affecting Recovery). These activities should be mitigated or eliminated (if possible) … While dredging and in-river disposal cannot be eliminated in rivers with ACOE Federal Navigation Projects, a number of mitigation alternatives exist: 1) limit dredging windows to non-critical periods, 2) restrict use of in-river disposal sites, and/or 3) use equipment or techniques that minimize impact to sturgeon and their habitat… Researching all of these impacts will refine and increase the number of mitigation alternatives.

The proposed action does not impede any of these recovery goals from being achieved. This Opinion ensures that FHWA is complying with the ESA, specifically by consulting with NMFS to analyze and minimize the effects of the action. The proposed action would have an adverse impact on shortnose sturgeon via relocation trawling. However, as discussed in Section 5 of this Opinion, we do not expect this will cause any mortalities. The proposed action is unlikely to have any significant negative influence on recovery goals, even when considered in the context of the Status of the Species, the Environmental Baseline, and Cumulative Effects discussed in this Opinion. Therefore, we conclude that the proposed action will not appreciably reduce the likelihood of recovery for shortnose sturgeon.

Conclusion
While the proposed action will result in adverse effects to shortnose sturgeon, it will not result in an appreciable reduction in the likelihood of either the survival or recovery of the shortnose sturgeon in the wild.

8 CONCLUSION

After reviewing the current status of the species, the environmental baseline, the effects of the proposed action, and cumulative effects, it is NMFS's Biological Opinion that the proposed action is not likely to jeopardize the continued existence of Atlantic sturgeon (SA DPS) or shortnose sturgeon.

9 INCIDENTAL TAKE STATEMENT

Section 9 of the ESA and protective regulations issued pursuant to Section 4(d) of the ESA prohibit the take of endangered and threatened species, respectively, without a special exemption.

Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or attempt to engage in any such conduct. *Incidental take* is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of Section 7(b)(4) and Section 7(o)(2), taking that would otherwise be considered prohibited under Section 9 or Section 4(d), but which is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the ESA provided that such taking is in compliance with the RPMs and the terms and conditions of the incidental take statement (ITS) of the Opinion.

Take is authorized for Atlantic sturgeon (SA DPS) and shortnose sturgeon from relocation trawling. If any takes of species under NMFS's purview are taken during in-water construction authorized using this Opinion as the Section 7 consultation, it shall be immediately reported to takereport.nmfsser@noaa.gov (include Opinion issue date, and the NMFS ECO identifier number [SERO-2020-02530]).

The FHWA has a continuing duty to regulate the activity covered by this incidental take statement. If the FHWA (1) fails to assume and implement the terms and conditions or (2) fails to require the terms and conditions of the incidental take statement through enforceable terms that are added to the permit or grant document, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, the FHWA must report the progress of the action and its impact on the species to NMFS as specified in the Incidental Take Statement (50 CFR §402.14(i)(3)).

9.1 Anticipated Incidental Take

NMFS has determined that the proposed project will result in observed take of up to 48 Atlantic sturgeon (SA DPS) and 24 shortnose sturgeon. Of these 48 Atlantic sturgeon (SA DPS) and 24 shortnose sturgeon, NMFS has determined that all take will be non-lethal. NMFS does not authorize the lethal take of any species as a result of the project construction effects or relocation trawl events.

9.2 Effect(s) of the Take

NMFS has determined that the anticipated take specified in Section 9.1 is not likely to jeopardize the continued existence of Atlantic sturgeon (SA DPS) and shortnose sturgeon if the project is implemented as proposed.

9.3 Reasonable and Prudent Measures (RPMs)

Section 7(b)(4) of the ESA requires NMFS to issue to any agency whose proposed action is found to comply with Section 7(a)(2) of the ESA, but may incidentally take individuals of listed species, a statement specifying the impact of that taking. It also states that RPMs necessary to minimize the impacts from the agency action, and terms and conditions to implement those measures, must be provided and followed. Only incidental taking that complies with the specified terms and conditions is authorized.

The RPMs and terms and conditions are required, per 50 CFR 402.14 (i)(1)(ii) and (iv), to document the incidental take by the proposed action and to minimize the impact of that take on ESA-listed species. These measures and terms and conditions are non-discretionary, and must be implemented by the FHWA for the protection of Section 7(o)(2) to apply. The FHWA has a continuing duty to regulate the activity covered by this ITS. If it fails to adhere to the terms and conditions of the ITS through enforceable terms, and/or fails to retain oversight to ensure compliance with these terms and conditions, the protective coverage of Section 7(o)(2) may lapse. To monitor the impact of the incidental take, the FHWA must report the progress of the action and its impact on the species to SERO PRD as specified in the ITS [50 CFR 402.14(i)(3)].

NMFS has determined that the following RPMs are necessary and appropriate to minimize impacts of the incidental take of ESA-listed species related to the proposed action. The following RPMs and associated terms and conditions are established to implement these measures, and to document incidental takes. Only incidental takes that occur while these measures are in full implementation are authorized. These restrictions remain valid until reinitiation and conclusion of any subsequent Section 7 consultation.

1. The federal action agency must ensure that the applicant provides take reports regarding all interactions with ESA-listed species throughout the bridge replacement project.

2. FHWA must require that GDOT ensures that sturgeon are safely removed (to the greatest extent practicable) from the area near the blast site prior to blasting. FHWA must require that GDOT ensures that any groups/persons moving the sturgeon have the proper experience and permits (i.e., NMFS Endangered Species Act Section 10 Permit).

9.4 Terms and Conditions

To be exempt from take prohibitions established by Section 9 of the ESA, the FHWA must comply with the following terms and T&Cs and conditions are mandatory.

The following T&Cs implement RPM No. 1.:

a. If and when the applicant becomes aware of any known reported take, the applicant must notify NMFS SERO PRD by email: takereport.nmfsser@noaa.gov.
    i. Emails must reference this Opinion by the NMFS tracking number (SERO-2020-02530 SR 25 US Highway 17) and date of issuance.
    ii. The email must state the species, date and time of the incident, general location and activity resulting in capture (e.g., relocation trawling), condition of the species (i.e., alive, dead, returned to water as directed in the conservation measures listed in section 2.1), size of the individual, behavior, identifying features (i.e., presence of tags, scars, or distinguishing marks), and any photos that may have been taken.

The following T&Cs implement RPM No. 2.:

a. GDOT must ensure that any groups/persons capturing or relocating sturgeon have the proper experience and a NMFS Section 10 Permit.

a. This Opinion serves as the permitting authority for any NMFS-approved endangered species capture, relocation, holding and handling, genetic tissue sampling, tagging, and anesthetization as outlined in this Opinion. However, it may be done only by personnel covered by a valid sturgeon research permit (obtained pursuant to Section 10 of the ESA, from NMFS Office of Protected Resources, Permits Division).
    a. GDOT must ensure any groups/persons capturing or relocating sturgeon follows all provisions, requirements, and methodologies described in the Section 10 Permit.
b. Only NMFS-approved observers or observer candidates-in-training under the direct supervision of a NMFS-approved observer shall monitor for ESA-listed species during blasting.
c. Any ESA-listed species injured during, or as a consequence of, relocation trawling, gill netting or blasting shall count toward the incidental take quota. Minor skin abrasions resulting from trawl capture are considered non-injurious. Any lethal take of ESA-listed species will trigger reinitiation of formal consultation.
d. GDOT must utilize 100% shipboard observer monitoring of all relocation trawling, gill netting and blasting.
e. Shoreline observers cannot be used in place of shipboard observers for relocation trawling, gill netting, and blasting operations.
f. The GDOT shall arrange for protected species observers to maintain watch on the bridge of all relocation trawlers for protected species and keep a logbook noting the date, time, location, species, number of animals, distance and bearing from the vessel, and direction of travel.

10 CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the ESA directs federal agencies to utilize their authority to further the purposes of the ESA by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations identified in Biological Opinions can assist action agencies in implementing their responsibilities under Section 7(a)(1). Conservation recommendations (CRs) are discretionary activities designed to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information. NMFS has not identified any CRs as discretionary measures consistent with this obligation to be carried out by the federal action agency.

11 REINITIATION OF CONSULTATION

This concludes formal consultation on the proposed action. As provided in 50 CFR 402.16, reinitiation of formal consultation is required where discretionary federal action agency involvement or control over the action has been retained, or is authorized by law, and if: (1) the amount or extent of incidental take is exceeded, (2) new information reveals effects of the agency action on listed species or designated critical habitat in a manner or to an extent not considered in this Opinion, (3) the agency action is subsequently modified in a manner that causes an effect on the listed species or critical habitat not considered in this Opinion, or (4) a new species is listed or critical habitat designated that may be affected by the action. In instances where the amount or extent of incidental take is exceeded, the FHWA must immediately request reinitiation of formal consultation and project activities may only resume if the FHWA establishes that such continuation will not violate sections 7(a)(2) and 7(d) of the ESA.

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