NATIONAL MARINE FISHERIES SERVICE
ENDANGERED SPECIES ACT SECTION 7
BIOLOGICAL OPINION

Title:	Biological Opinion on Issuing an Incidental Take Permit (File No. 27551) to the Georgia Department of Natural Resources for Bycatch from Georgia's Commercial Shad Fishery in the Altamaha River and the Savannah River, Georgia
Consultation Conducted By:	Endangered Species Act Interagency Cooperation Division, Office of Protected Resources, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, U.S. Department of Commerce
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1 INTRODUCTION

The Endangered Species Act of 1973, as amended (ESA; 16 U.S.C. 1531 et seq.) establishes a national program for conserving threatened and endangered species of fish, wildlife, plants, and the habitat they depend on. Section 7(a)(2) of the ESA requires Federal agencies to insure that their actions are not likely to jeopardize the continued existence of endangered or threatened species or destroy or adversely modify their designated critical habitat. Federal agencies must do so in consultation with National Marine Fisheries Service (NMFS) for threatened or endangered species (ESA-listed), or designated critical habitat that may be affected by the action and that are under NMFS jurisdiction (50 C.F.R. §402.14(a)).

Section 7(b)(3) of the ESA requires that at the conclusion of consultation, NMFS provide an opinion stating whether the Federal agency is able to insure its action is not likely to jeopardize ESA-listed species or destroy or adversely modify designated critical habitat. If NMFS determines that the action is likely to jeopardize listed species or destroy or adversely modify critical habitat, NMFS provides those reasonable and prudent alternatives that allow that can be taken by the Federal agency or the applicant and allow the action to proceed in compliance with section 7(a)(2) of the ESA. If an incidental take is expected, section 7(b)(4) requires NMFS to provide an incidental take statement that specifies the impact of such incidental taking on the species and includes reasonable and prudent measures NMFS considers necessary or appropriate to minimize such impacts and terms and conditions to implement the reasonable and prudent measures. NMFS, by regulation, has determined that an incidental take must be identified when take is "reasonably certain to occur" as a result of the proposed action (50 C.F.R. §402.14(g)(7)).

The action agency for this consultation is the Endangered Species Conservation Division (ESCD), Office of Protected Resources, NOAA's National Marine Fisheries Service. The ESCD proposes the issuance of an Incidental Take Permit (ITP) under section 10(a)(1)(B) of the Endangered Species Act of 1973 (ESA; 16 U.S.C. 1531 et seq.) to the Georgia Department of Natural Resources (GADNR). The permit would authorize the incidental take of ESA-listed shortnose (*Acipenser brevirostrum*) sturgeon and Atlantic sturgeon (*A. oxyrinchus oxyrinchus*), the endangered South Atlantic, Carolina, Chesapeake, New York Bight, and threatened Gulf of Maine DPSs, associated with the otherwise lawful commercial shad fishery in Georgia (GA). The ITP would expire ten years after the date of issuance.

This formal consultation was conducted and this biological opinion (Opinion) and incidental take statement were prepared by NMFS, Office of Protected Resources, ESA Interagency Cooperation Division (hereafter referred to as "we") in accordance with section 7(a)(2) of the ESA and associated implementing regulations at 50 C.F.R. Part 402, and agency policy and guidance. A complete electronic record of this consultation is on file at the NMFS Office of Protected Resources in Silver Spring, Maryland.

Updates to the regulations governing interagency consultation (50 C.F.R. part 402) were effective on May 6, 2024 (89 Fed. Reg. 24268). We are applying the updated regulations to this consultation. The 2024 regulatory changes, like those from 2019, were intended to improve and clarify the consultation process, and, with one exception from 2024 (offsetting reasonable and prudent measures), were not intended to result in changes to the Services' existing practice in implementing section 7(a)(2) of the Act. 89 Fed. Reg. at 24268; 84 Fed. Reg. at 45015. We have considered the prior rules and affirm that the substantive analysis and conclusions articulated in this biological opinion and incidental take statement would not have been any different under the 2019 regulations or pre-2019 regulations.

This document represents the NMFS ESA Interagency Cooperation Division's Opinion on the effects of the issuance of the ITP (File No. 27551) on threatened and endangered species and critical habitat designated for those species (see Section 5) and has been prepared in accordance with section 7(b) of the ESA. The proposed permit would authorize the take of specified numbers of endangered and threatened Atlantic and shortnose sturgeon incidental to otherwise lawful commercial shad fishing in the state of GA, which is managed by the state under their revised commercial shad fishing regulations. This Opinion is based on our review of the State's application and draft Conservation Plan, draft categorical exclusion memo, most current shortnose sturgeon biological assessment, Atlantic sturgeon status review, Atlantic sturgeon listing documents, Atlantic sturgeon stock assessment reports, shortnose sturgeon recovery plan, scientific and technical reports from government agencies and peer-reviewed literature, biological opinions addressing similar forms of sturgeon take, and other sources of information that together represent the best available scientific and commercial information regarding effects to these species.

1.1 Background

On December 2, 2022, GADNR submitted a complete application for an ESA section 10(a)(1)(B) ITP, including a proposed Conservation Plan with an adaptive management program for the operation of the commercial shad fishery in GA. The application included a detailed description of the proposed action, take requested, and the proposed Conservation Plan. This action was covered by an ITP (File No. 16645) and a biological opinion between 12/20/12 and 12/20/22.

1.2 Consultation History

This consultation examines ESCD's proposed issuance of an ITP for take of Atlantic and shortnose sturgeon incidental to the otherwise lawful shad fishing activities, which result in unintended bycatch (i.e., capture) of shortnose and Atlantic sturgeon in Altamaha, and Savannah Rivers, GA, and in accordance with the monitoring, minimization and conservation measures in the GADNR's proposed Conservation Plan. The following dates are important to the history of this consultation:

- On March 14, 2023, ESCD provided a draft ITP renewal application for review.
- On October 19, 2023, ESCD requested initiation for consultation on the application package.
- On November 27, 2023, OPR initiated consultation.
- On March 28, 2024, ECSD provided 2014-2022 ITP Incidental Take Annual Reports.

2 THE ASSESSMENT FRAMEWORK

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

"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 recovery of an ESA-listed species in the wild by reducing the reproduction, numbers, or distribution of that species" (50 C.F.R. §402.02).

"Destruction or adverse modification" means a direct or indirect alteration that appreciably diminishes the value of critical habitat as a whole for the conservation of a listed species (50 C.F.R. §402.02).

An ESA section 7 assessment involves the following steps:

Description of the Proposed Action (Section 3): We describe the proposed action and those aspects (or stressors) of the proposed action that may have direct or indirect effects on the physical, chemical, and biotic environment. This section also includes any avoidance and minimization measures that have been incorporated into the project to reduce the effects to ESA-listed species and designated critical habitat.

Action Area (Section 4): We describe the action area with the spatial extent of the physical, chemical, and biological changes to land, water, and air from the action (stressors). Action area means all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action (50 C.F.R. 402.02).

Species and Critical Habitat Not Likely to be Adversely Affected (Section 5): We identify the ESA-listed species and designated critical habitat under NMFS' jurisdiction that may occur within the action area and could be affected by the proposed action but not likely to be adversely affected.

Status of Species and Critical Habitat Likely to be Adversely Affected (Section 6): We examine the status of the ESA-listed species and critical habitat that are likely to be adversely affected by the proposed action.

Environmental Baseline (Section 7): We describe the environmental baseline in the action area as the condition of the ESA-listed species and designated critical habitat in the action area, without the consequences to the listed species or designated critical habitat caused by the proposed action. The environmental baseline includes the past and present impacts of all Federal, State, or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of State or private actions which are contemporaneous with the consultation in process. The impacts to ESA-listed species from Federal agency activities or existing Federal agency facilities that are not within the agency's discretion to modify are part of the environmental baseline (50 C.F.R. 402.02).

Effects of the Action (Section 8): These are broken into analyses of exposure and response and, finally, combined and summarized. To characterize exposure, we identify the number, age (or life stage), and gender of ESA-listed individuals that are likely to be exposed to the stressors and the populations or sub-populations to which those individuals belong. We also consider whether the stressors caused by the action lead to exposure of designated critical habitat. This is our exposure analysis. We evaluate the available evidence to determine how individuals of those ESA-listed species are likely to respond given their probable exposure. We also consider how physical and biological features (PBFs) essential to the conservation of the species of critical habitat may respond to exposure to the stressors caused by this action. This is our response analysis. We summarize this process by combining the amount or extent of exposure with the probable responses given that exposure to produce a summary of the effects of the action on ESA-listed species and critical habitat.

Cumulative Effects (Section 9): Cumulative effects are the effects to ESA-listed species and designated critical habitat of future state or private activities that are reasonably certain to occur within the action area (50 C.F.R. §402.02). Effects from future Federal actions that are unrelated to the proposed action are not considered because they require separate ESA section 7 consultation.

Integration and Synthesis (Section 10): In this section, we integrate the analyses in the opinion to summarize the consequences to ESA-listed species and designated critical habitat under NMFS' jurisdiction.

With full consideration of the status of the species and the status of designated critical habitat, we consider the effects of the action within the action area on populations or subpopulations and on PBFs when added to the environmental baseline and the cumulative effects to determine whether the action could reasonably be expected to:

- Reduce appreciably the likelihood of survival and recovery of ESA-listed species in the wild by reducing its numbers, reproduction, or distribution, and state our conclusion as to whether the action is likely to jeopardize the continued existence of such species; or
- Appreciably diminish the value of designated critical habitat as a whole for the conservation of an ESA-listed species, and state our conclusion as to whether the action is likely to destroy or adversely modify designated critical habitat.

The results of our jeopardy and destruction or adverse modification analyses are summarized in the Conclusion (Section 11). If, in completing the last step in the analysis, we determine that the action under consultation is likely to jeopardize the continued existence of ESA-listed species or destroy or adversely modify designated critical habitat, then we must identify reasonable and prudent alternative(s) to the action, if any, or indicate that, to the best of our knowledge, there are no reasonable and prudent alternatives (See 50 C.F.R. §402.14).

In addition, if we conclude the action satisfies 7(a)(2) or a reasonable and prudent alternative satisfies 7(a)(2), we include an incidental take statement (Section 12) that specifies the impact of the take on the species, reasonable and prudent measures to minimize the impact of the take on the species, and terms and conditions to implement the reasonable and prudent measures (ESA section 7 (b)(4); 50 C.F.R. §402.14(i)). We also provide discretionary conservation recommendations (Section 13) that may be implemented by the action agency (50 C.F.R. §402.14(j)).

Finally, we identify the circumstances in which the action agency is required to request Reinitiation of Consultation (Section 14; 50 C.F.R. §402.16(a)).

2.1 Evidence Available for the Consultation

To comply with our obligation to use the best scientific and commercial data available, we collected information identified through searches of Google Scholar American Fisheries Society, Science Direct, BioOne, Conference Papers Index, JSTOR, and Aquatic Sciences and Fisheries Abstracts search engines and literature cited sections of peer-reviewed articles, species listing documentation, and reports published by government and private entities. This Opinion is based on our review and analysis of various information sources, including:

- Information submitted by the GADNR and the ESCD;
- Government reports (including NMFS biological opinions and stock assessment reports);
- National Oceanic and Atmospheric Administration (NOAA) technical memorandums
- Annual reports; and
- Peer-reviewed scientific literature.

These resources were used to identify information relevant to the potential stressors and responses of ESA-listed species and designated critical habitat under NMFS' jurisdiction that may be affected by the proposed action to assess risks the action may pose to the continued existence of these species and the value of designated critical habitat for the conservation of ESA-listed species.

3 DESCRIPTION OF THE PROPOSED ACTION

"Action" means all activities or programs of any kind authorized, funded, or carried out, in whole or in part, by federal agencies. The proposed action in this Opinion is ESCD's issuance of an ITP and approval of a Conservation Plan to monitor, minimize and mitigate, to the maximum extent practicable, impacts of incidental take of shortnose and Atlantic sturgeon during shad season.

Fishers participating in the commercial shad fishery deploy gill nets targeting shad, which result in the unintended bycatch or capture of these endangered and threatened sturgeon species. The State's operation of the commercial shad fishery is an otherwise lawful activity. ESCD is authorized to issue ITPs under section 10(a)(1)(B) of the Endangered Species Act of 1973, as amended (ESA; 16 U.S.C. 1531 et seq.), and its implementing regulations 50 C.F.R. §203.307, provided, among other things, an applicant submits and commits to implement a Conservation Plan that NMFS determines will monitor, avoid, minimize and mitigate the impacts of the take to the maximum extent practicable. The proposed activities involve incidental take of endangered shortnose sturgeon and Atlantic sturgeon from the endangered South Atlantic, Carolina, Chesapeake, New York Bight, and threatened Gulf of Maine DPSs. The proposed action considered here is the issuance of an ITP by ESCD, which includes review and implementation of a Conservation Plan and Monitoring Plan.

3.1 Background

The GA shad fishery operated under a previous ITP between 2013 and 2023. Since 2013, the GADNR has conducted fishery-dependent sampling to observe a minimum of 10% of the commercial shad trips occurring annually in both the Altamaha and Savannah rivers. In these efforts, GADNR staff observe active fishing activities and record information on captured sturgeon, including species identification; lengths (total and fork); and condition of the fish. Additionally, staff scan the fish for the presence of a Passive Integrated Transponders (PIT) tag, and if one is not found, staff insert a PIT tag into the fish. Staff also collect a fin-clip from captured sturgeon to provide to the USGS for genetic study. Additionally, commercial shad fishers are required to report any captures of sturgeon encountered during fishing activities on the trip tickets they submit to the GADNR each month. These self-reports provide the date of capture and the number and type of species captured.

During the last permit period (2013 – 2023), the GADNR exceeded the 10% observation threshold every year. In the Altamaha River, the percentage of observed trips based on commercial fisher-reported trips has ranged from 10.95% (GADNR 2013) - 26.03% (GADNR 2022a). During the 2013 – 2022 period, the GADNR observed 15.24% of the trips reported by commercial shad fishers in the Altamaha River. Catch rates of shortnose sturgeon reported by Altamaha commercial shad fishers via trip tickets between the 2013 – 2022 seasons ranged from 5 – 55 fish/year (GADNR Annual Incidental Take Reports). Fishing effort in recent years has declined from the 274 trips reported on the Altamaha River in 2013 to a low of 73 trips reported in 2022.

3.2 ITP File No. 27551 Requested Take

The ESCD proposed the following take of Shortnose and Atlantic sturgeon captured in the Altamaha and Savannah rivers incidental to the capture of shad (Table 1).

Table 1. Proposed take of Atlantic and Shortnose Sturgeon

Maximum No. Of Incidental Captures (Live Release) Per Year/ Over 3 Consecutive Years /Over Life Of Permit.			
Species	**Total Take File No. 27551**	**Altamaha River**	**Savannah River**
Shortnose sturgeon	**750**	**60/180/600**	**15/45/150**
Atlantic sturgeon[1]	**730**	**40/120/480**	**25/75/250**
[1]NMFS expects the maximum intercept rate for each Atlantic sturgeon DPS to be: SA DPS 95%, CB DPS 20%, CA DPS 15%, NYB DPS 10%, and GOM DPS 2% of the total incidental captures.			

The requested take for ITP 27551 is a significant decrease from the previous ITP as shown in Table 2. GADNR is not requesting any lethal takes with this application. While GADNR staff have observed sturgeon captured in both net types used and take may occur at any time while the gear is in the water, no sturgeon mortalities have been observed during the previous 10 year permit (2013 – 2023) of observation effort conducted (GADNR 2023). However, we will perform a full analysis on this requested take and breakdown by DPS and impacts to sturgeon incidentally caught by gill nets using best available commercial and scientific literature and data.

Table 2. ITP 27551 incidental take request compared to GADNR's previous ITP (File No. 16645)

Species	Maximum No. incidental captures (live release) over the life of the permit (10 years)	
	File No. 16645	File No. 27551
Shortnose sturgeon	2,800 + 15 lethal	750
Atlantic Sturgeon	2,004 +7 lethal	730

3.3 GA American Shad Fishery Sturgeon Bycatch ITP Monitoring Plan

The GADNR will continue to utilize a combination of a trip ticket system and direct observations to monitor the bycatch of Atlantic and shortnose sturgeon in the commercial shad fishery. GA regulations currently require commercial fishers to complete trip tickets to document species, sex, and pounds of shad harvested daily. In addition to the information on shad harvest, these tickets capture the fishers' name and license number, name of dealer who purchases the fish, river fished, gear type (set or drift net), length of net, total soak time, and number of net sets. Fishers and/or dealers are required to return completed trip tickets to the GADNR by the 10th of each following month (i.e., January tickets would be due by February 10). The current trip ticket will be modified to require fishers to record information on sturgeon bycatch (total numbers of sturgeon intercepted and released) and data will be utilized to monitor future sturgeon interactions with the shad fishery. Modified trip tickets will have rows and/or columns for fishermen to separately record incidental catches of shortnose and Atlantic sturgeon.

Each year, a list of names and addresses of commercial shad fishers will be compiled from prior trip tickets, the commercial fishing license database, those fishers possessing a shad endorsement from the current and past fishing season, and a list of cooperators in shad tagging studies. After generating this list, GADNR staff will send each shad fisher a set of trip tickets, self-addressed return envelopes, and information on how to obtain additional trip tickets. Informational packets will be sent to shad fishers prior to the start of the season in an effort to educate them on the importance of both accurately recording sturgeon incidental catches and returning the trip tickets by the 10th of each following month. These packets will provide guidance on sturgeon identification, proper handling (emphasizing the importance of fishers frequently checking their nets and immediately releasing any sturgeon that are incidentally caught), and the importance of reporting incidental sturgeon catches. In addition to these direct handouts and mailings, additional trip tickets will be supplied to known shad dealers and GADNR Law Enforcement (LE) staff to be provided to shad fishers that they may intercept.

GADNR will attempt to observe a minimum of 10% of the commercial shad fishing trips occurring annually on each river. To do this, GADNR staff will utilize the same aforementioned list of shad fishers to establish contact information (i.e., phone numbers) for a subset of individuals that commercially fish for shad on the Altamaha and Savannah rivers. GADNR staff will contact fishers to determine when they will be fishing and to establish a time and location to observe fishers pulling their nets. During observed efforts, GADNR staff will record fishing location, effort information (such as soak times), and gear information (e.g., net length, mesh size). For any sturgeon captured, data collected will include fish species, length (total and fork), fish condition, and presence or absence of PIT tag. In the event a captured sturgeon does not have a PIT tag, one will be inserted into the fish prior to its release. Finally, a small fin-clip will be taken and preserved for submission to the USGS to support their efforts to study the genetics of various sturgeon populations. The collection and preservation of fin-clips from all sturgeon encountered during fishery-dependent and fishery-independent efforts each year aid in studying and understanding the genetic diversity and conservation of sturgeon found in GA.

3.3.1 Monitoring and Sampling

GA DNR currently utilizes a shad monitoring program, which has been established for over 40 years, to concurrently estimate sturgeon catch rates. This portion of the monitoring program is conducted by sampling with drift nets of 4.5-5 inch (in) stretch mesh, as this is the primary fishing technique and gear used by commercial shad fishermen. GA DNR typically monitors the shad run 1-day/week the first three weeks in January, 2-days/week from late-January through mid-March, and then back to 1-day/week in late March when the run starts tapering off. GA DNR field staff average about 18 days of sampling/year during the shad spawning run. The two goals of this monitoring are to determine the size of the shad run and the approximate bycatch rate of shortnose and Atlantic sturgeon. As long as this shad monitoring protocol continues, GADNR proposes to PIT tag each sturgeon that lacks a PIT tag and to collect genetic samples from an estimated 15 fish each year. These two components will provide valuable information that can be used to enhance sturgeon conservation measures by ensuring that sturgeon take is not exceeded. PIT tagging will help determine the frequency at which individual sturgeon are handled per year or across years. If high recapture rates occur, appropriate mitigation measures can be implemented to ameliorate the effects of multiple recaptures. Genetic samples will provide information on which DPS Atlantic sturgeon are from. While annual sample rates are expected to be small, over time, a clear picture will likely develop and provide a better estimate of the effect the fishery is having on each DPS. GADNR does not currently have equipment to analyze genetic samples, but plans to have samples analyzed externally. Cost associated with the PIT tagging and genetic sampling components will be funded through the sources identified in Section VI(C)(3) of GADNR’s 10(a)(1)(b) application.

If unusually high bycatch rates of sturgeon are being observed, GADNR will immediately increase law enforcement presence and education efforts. Staff will also evaluate whether modifications to the commercial shad fishing regulations for the next year are needed. Data collected from the trip tickets and direct observations will be summarized and provided in an annual report to the ESCD no later than 30 days after the season ends.

3.4 Shad Fishing Activities

In GA, shad are typically harvested commercially via two types of gill nets: drift-nets and set-nets. Each of these gill net types is similar in structure, possessing a float line with corks spread 4 – 8 feet (ft) apart; a lead-line along the bottom of the net; and monofilament webbing that must be at least 4.5 in stretched Official Code of Georgia Annotated 391-2-4-.02 (OCGA 391-2-4-.02).

Both gill net types are designed to extend throughout most of, and in some circumstances, the entire vertical water column. Additional regulations include the following:

1. Set nets must be placed at least 600 ft apart and are limited to 100 ft in length. All set nets must have one end secured to the river bank and be buoyed at the outer (streamward) end.

2. Set nets and drift nets must be situated so as to allow half of the river width to be open and free for the passage of fish.

3. Drift nets must be fished at least 300 ft apart and shall be limited to a maximum of 1,000 ft in salt waters.

Though construction of the nets may be similar, the manner in which drift-nets and set-nets are fished is not.

Drift-nets, as the name implies, "drift" with the river flow as they fish. Once at the fishing location, shad fishers deploy the drift-net from the bow of a vessel, with the net attached to the boat on one end and the other end extending into the river. Fishers then "drift" the net with the river flow for a short time (typically <30 minutes) before retrieving the net, removing all captured biota, and repeating the process. Upstream migrating biota swim into the net and are captured. The mesh size used in drift-nets varies, but typically is between 4.5 – 5.25 in, stretched. This smaller webbing allows for the capture of targeted shad.

Set-nets, as the name implies, are "set" or anchored as stationary nets. Set nets are typically anchored to a tree along the riverbank and stretched out, either perpendicular to or parallel with the bank, and anchored on the opposite end. Once "set," the net will remain in the water unattended for an extended period of time, typically from a few hours up to 24 hours. Upon retrieval of the net, set-net fishers remove its contents, and may deploy the net again to continue fishing or remove it from the water. Upstream migrating biota swim into the net and are captured. The mesh size used in set-nets varies, but typically is between 4.5 – 5.25 in stretched. This smaller webbing allows for the capture of targeted shad.

3.4.1 Shad Seasons

The commercial shad season in GA opens January 1 and runs through March 31 of each year, though the GADNR Commissioner may extend the season for up to 30 days after March 31 (OCGA 391-2-4-.02). Currently, commercial shad fishing is only permissible in two rivers in GA: the Altamaha River and the Savannah River. Per OCGA 391-2-4-.02, the specific times each river is open to commercial shad harvest are as follows:

Altamaha River: The Altamaha River system downstream from the Seaboard Coastline Railroad Bridge (at Altamaha Park) is open to commercial shad fishing Monday through Friday each week. Upstream of this point is open Tuesday through Saturday. The closures on Saturday (downstream); Sunday (everywhere); and Monday (upstream) protect fish during their upstream migration.

Savannah River: The Savannah River system downstream from the I-95 Bridge is open to commercial shad fishing Tuesday through Friday of each week. Upstream of the I-95 Bridge is open Wednesday through Saturday of each week.

3.4.2 Steps To Minimize Impacts

As previously discussed, the GADNR has taken several steps to minimize the impacts of the commercial shad fishery on Atlantic and shortnose sturgeon populations. Of highest importance is the closure of upstream waters in the Altamaha and Savannah rivers to fishing, which provides sturgeon with protected access to spawning grounds. Additionally, the small mesh (typically ≤ 5 in) used by shad fishers, as required by GA law, does not present the challenges to sturgeon that large-mesh webbing would. Regulations closing waters in each river for two days each week provide additional protection to sturgeon and other fish. Finally, regulations restricting the length of nets used and preventing nets from extending more than halfway across a river protect sturgeon and other fish.

Additional mitigation efforts include annual education and outreach efforts such as materials presented to commercial shad fishermen. These materials include detailed identification aids and specific instructions on proper handling of captured sturgeon. Regulations in GA require that all incidentally captured must be immediately released. GADNR has not observed mortalities of sturgeon during fishery-dependent sampling (2013-2023). The commercial shad regulations instituted on January 1, 2011 included closing the upriver portions of the Altamaha River (above US Hwy 1) and the Savannah River (above US Hwy 301), which has likely reduced incidental bycatch of sturgeon. On the Savannah River alone, these closures resulted in 35% less area open to commercial shad fishing. Furthermore, GADNR LE routinely and randomly patrols the open and closed sections of both rivers.

4 ACTION AREA

Action area means all areas affected directly, or indirectly, by the Federal action, and not just the immediate area involved in the action (50 C.F.R. §402.02). GADNR has defined specific areas where shad may be commercially harvested as per OCGA 391-2-4-.02. The proposed shad fishery will take place in the Altamaha River and the Savannah River, GA (Figure 1).

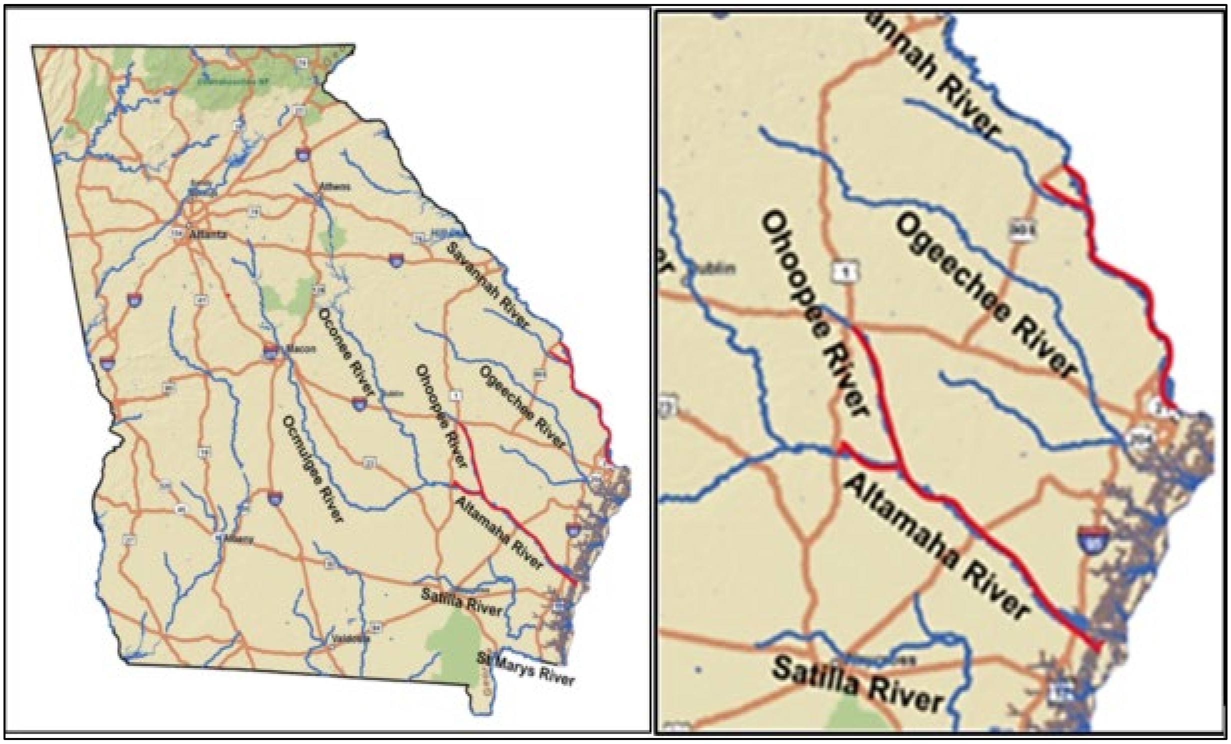

Figure 1. Map of the 2 river systems (Altamaha & Savannah) currently open to commercial shad fishing

4.1 Altamaha River

The Altamaha River System fishing grounds include the Ohoopee River upstream to the U.S. Highway 1 bridge; the Altamaha River downstream from the U.S. Highway 1 bridge including Cobb Creek Oxbow, Beards Creek from its mouth upstream to the Long-Tatnall County line (Big Lake), Sturgeon Hole from the Altamaha River to the lower mouth of Harper Slough, Old Woman's Pocket, South Branch, General's Cut, South Altamaha River, Champney River, Butler River, One Mile Cut, Wood Cut, Darien River upstream to the confluence of Darien Creek and Cathead Creek, Buttermilk Sound upstream to the mouth of Hampton River, Hampton River, Altamaha sound to the sound/beach boundary, Rockdedundy River, Little Mud River, South River, Back River, North River upstream to Hird Island Creek and Doboy Sound from the sound/beach boundary upstream to a line from range F1 R4 sec A across buoy R "178" to Sapelo Island. Old River and Mid Slough of the Penholoway River and Ellis Creek are closed to commercial shad fishing. All waters upstream of the US Highway 1 Bridge are closed to commercial shad fishing. These upstream waters include a significant portion of the preferred spawning area and habitat utilized by sturgeon.

4.2 Savannah River

Savannah River System fishing grounds include the Savannah River downstream of the U.S. Highway 301 bridge, Collis Creek, Albercorn Creek, Front River, Middle River, Steamboat River, McCoy's Cut, Housetown Cut, Back River upstream from Corps of Engineers New Savannah Cut, New Savannah Cut, North Channel Savannah River downstream to a line running due south of the easternmost tip of Oyster Bed Island, South Channel Savannah River downstream to a line running from the southeast tip of Cockspur Island to the mouth of Lazaretto

Creek, and Elba Island Cut between North and South Channels of the Savannah River. The waters upstream of the US Hwy 301 Bridge are considered to include a significant portion of the preferred spawning area and habitat utilized by sturgeon, hence their closure and protection by the GADNR.

5 SPECIES AND CRITICAL HABITAT LIKELY TO BE ADVERSELY AFFECTED

This section identifies the ESA-listed species and critical habitat within the action area (Figure 1) that would be adversely affected by the proposed issuance of an ITP to GADNR, pursuant to section 10(a)(1)(B) of the ESA and its implementing regulations (50 C.F.R. 222.307). All of the listed ESA species potentially occurring within the action area are listed in Table 3, along with their regulatory status and critical habitat.

Table 3. Species and Critical Habitat Likely to be Adversely Affected

Species	ESA Status	Critical Habitat	Recovery Plan
Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus)*			
Carolina DPS	E - 77 FR 5914	82 FR 39160	2018 Recovery Outline
Chesapeake Bay DPS	E - 77 FR 5880	82 FR 39160	
New York Bight DPS	E - 77 FR 5880	82 FR 39160	
South Atlantic DPS	E - 77 FR 5914	82 FR 39160	
Gulf of Maine DPS	T - 77 FR 5880	82 FR 39160	
Shortnose sturgeon *(Acipenser brevirostrum)*	E - 32 FR 4001 (39 FR 41370)	-- --	63 FR 69613 12/1998

5.1 Critical Habitat Not Likely To Be Adversely Affected

Atlantic sturgeon critical habitat was designated in known spawning rivers along the Atlantic coast of the United States. Within the action area of this Opinion, the designated critical habitat includes rivers in Georgia. There is overlap with the proposed action in both the Altamaha and Savannah Rivers. Critical habitat for Atlantic sturgeon identifies the PBFs essential to the conservation of the species and that may require special management considerations or protection. PBFs for South Atlantic DPS of Atlantic sturgeon include 1) Hard bottom substrate in low salinity waters, 2) Aquatic habitat with a gradual downstream salinity gradient, 3) Water of appropriate depth and absent physical barriers to passage, and 4) Water quality conditions with temperature and oxygen values that support spawning, survival, and growth of sturgeon.

The extent of habitat damage from gill net fishing can vary depending on several factors, including the type of habitat, the frequency and intensity of fishing activity, and the specific fishing practices used. The effects expected from gill net fishing in GA’s Commercial Shad Fishery are as follows:

- Alteration of Ecosystem Dynamics: Overfishing due to the use of gill nets can disrupt the balance of marine ecosystems by depleting certain species. This disruption can lead to cascading effects throughout the food web, affecting other species' abundance and behavior. GA’s Commercial Shad fishery has impacts from over fishing however continued fishery management plans are implemented to alleviate this impact and adaptive management provisions enacted to recover species and stocks.

- Ghost Fishing: Lost or abandoned gill nets, known as ghost nets, continue to trap and kill marine life even after they've been discarded. This ongoing entanglement contributes to habitat damage by causing mortality and disrupting the natural interactions within the ecosystem. Has potential impact no data from fishery to ascertain extent.
- Sedimentation and Pollution: Some fishing activities, including the use of gill nets, can result in increased sedimentation due to disturbance of the seafloor. Additionally, discarded or lost nets contribute to marine pollution and can smother sensitive habitats.
- Habitat Fragmentation: The deployment of gill nets might fragment habitats by restricting the movement of certain species, particularly those that migrate or rely on specific pathways for feeding or reproduction. This fragmentation can impact the genetic diversity and health of populations.

5.1.1 PBF 1. Hard Bottom Substrate in Low Salinity Water

Gill nets have the potential to be hauled along the substrate, and when used inappropriately or in sensitive habitats, can cause physical damage by getting tangled in seagrass beds or rocky structures. Laying and retrieving of gill nets can disturb the bottom substrate and benthic habitat. Hard bottom substrate is critical for the settlement of fertilized eggs and refuge, growth, and development of early life stages of Atlantic sturgeon. Altering or destroying this substrate can negatively affect sturgeon reproduction, survival, and growth.

Based on ITP annual reports, fishing pressure from 2014–2022 indicates that 1147 (70%) of gill net trips reported to GADNR were drift gill nets, while 459 trips were anchored gill nets. Drift gill nets are a low impact gear designed to fish the majority or entire vertical water column with minimal contact on the river bottom. Furthermore, while gill net fishing may cause scarring of the substrate, previous studies have determined that fixed gill nets have a minimal effect on the benthos (Kaiser 1996)(Carr 1988; Gislason 1995; Kaiser 1996; Stephan 2000). Any potential impact to the river bottom would be minor and temporary. Seabed contact with gill nets is limited to light contact from the footrope and minimum contact from the small anchors at each end. As the gear isn't hauled over the seabed there should be veritably little impact. Therefore, we expect effects of gill nets on substrate to be insignificant and not likely to adversely affect Atlantic sturgeon critical habitat.

5.1.2 PBF 2. Soft Substrate with a Gradual Downstream Salinity Gradient

We believe that there will be no effect to this PBF from any activity covered under this Opinion.

5.1.3 PBF 3. Unobstructed Water of Appropriate Depth

We believe that the activities covered under this Opinion will have an insignificant effect on PBF 3. The action area is limited to the river areas described in Section 4 of this opinion. Per OCGA 391-2-4-.02 the commercial shad fishing season includes timing restrictions to ensure fish can migrate upstream unimpeded. These adaptive management proclamations have been used to mitigate impacts to Atlantic Sturgeon, as well as other ESA listed species. Spawning can only be successful if adult Atlantic sturgeon are able to safely and efficiently move from downstream areas into upstream spawning habitats. In addition, larvae and juvenile Atlantic sturgeon must be able to safely and efficiently travel from the upstream spawning areas downstream to nursery and foraging habitat. Obstructions can be caused by: locks, dams, thermal plumes, turbidity, sound, reservoirs, gear, etc. Minimum water depths for Atlantic sturgeon are necessary to: (1) allow adult fish to access spawning substrate, (2) adequately hydrate and aerate newly deposited eggs, and (3) facilitate successful development and downstream movement of newly spawned Atlantic sturgeon. To accommodate the body depth and spawning behavior of adult Atlantic sturgeon, water depths no less than 1.2 m (4 ft) are likely necessary when animals are present. Together, these characteristics support: the 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; and staging, resting, or holding of sub-adults or spawning condition adults. We believe these potential impacts to be discountable and the critical habitat of Atlantic sturgeon will not be adversely modified.

5.1.4 PBF 4. Water quality conditions

We believe the activities covered under this Opinion will have no effect on PBF 4. Water quality conditions, will not be impacted. Gill net fishing will not change or influence the bottom meter of the water column temperatures or dissolved oxygen (DO) levels.

The action area overlaps with areas of critical habitat for the South Atlantic DPS of Atlantic sturgeon. Of the four critical habitat features listed above, only feature #1 (suitable hard bottom substrate) may be affected by stressors resulting from the proposed action. However, NMFS opinion is that Atlantic sturgeon critical habitat is not likely to be adversely affected by the issuance of ITP No. 27551. Therefore, we do not discuss effects to critical habitat further in this opinion.

6 Status Of Species And Critical Habitat Likely To Be Adversely Affected

This section identifies and examines the status of each species that is expected to be adversely affected by the proposed action. The status includes the existing level of risk that the ESA-listed species face, based on parameters considered in documents such as recovery plans, status reviews, and ESA-listing decisions. The species' status section helps to inform the description of the species' current "reproduction, numbers, or distribution," which is consideration in the jeopardy determination as described in 50 C.F.R. §402.02. More detailed information on the status and trends of these ESA-listed species, and their biology and ecology can be found in the listing regulations and critical habitat designations published in the *Federal Register*, status reviews, recovery plans, and on this NMFS website: https://www.fisheries.noaa.gov/species-directory/threatened-endangered among others.

Because there are not likely to be adverse effects to designated Atlantic sturgeon critical habitat (Section 5.1), only the status of the species likely to be adversely affected will be discussed in this section. One factor affecting the range-wide status of marine fish and aquatic habitat at large is climate change. The localized effects of climate change in the action area would be discussed in the Environmental Baseline (Section 7).

The following summarizes the biology and ecology of the threatened and endangered species in the action area that are relevant to the effects analysis in this Opinion.

6.1 Shortnose Sturgeon, *Acipenser Brevirostrum*

6.1.1 Description

Shortnose sturgeon are anadromous fish that live primarily in slower moving rivers or nearshore estuaries near large river systems. They are benthic omnivores that feed on crustaceans, insect larvae, worms and mollusks (NMFS 2010) but they have also been observed feeding off plant surfaces and on fish bait.

During the summer and winter, adult shortnose sturgeon occur in freshwater reaches of rivers or river reaches that are influenced by tides; as a result, they often occupy only a few short reaches of a river's entire length. During the summer, at the southern end of their range, shortnose sturgeon congregate in cool, deep, areas of rivers where adult and juvenile sturgeon can take refuge from high temperatures (Bahr 2017). Juvenile shortnose sturgeon generally move upstream for the spring and summer seasons and downstream for fall and winter; however, these movements usually occur above the salt- and freshwater interface of the rivers they inhabit (Hardy 2021).

Shortnose sturgeon in the northern meta-populations grow larger than southern SNS (Dadswell 1984). A maximum size of northern females (143 cm TL, 23.6 kg weight) and northern males (108 cm TL, 9.4 kg weight) was reported by Dadswell (1984). However, maximum size of northern males may be even larger in some Gulf of Maine and northeastern rivers, i.e., 128 cm TL for a MR male captured in 2011 and 10.7 kg for a downstream segment CR male captured in 1997 (Kynard 2016). Southern adult shortnose sturgeon also have a shorter maturity cycle between spawning than northern adults (Dadswell 1979; Kynard 1997). Shortnose sturgeon also exhibit sexually dimorphic growth patterns across latitude: males mature at 2-3 years in GA, 3-5 years in South Carolina, and 10-11 years in the Saint John River, Canada; females mature at 4-5 years in GA, 7-10 years in the Hudson River, and 12-18 years in the St. John River, Canada. Males begin to spawn 1-2 years after reaching sexual maturity and spawn every other year and perhaps annually in some rivers (Dadswell 1979; Kynard 1997; NMFS 1998b). Age at first spawning for females is about approximately 5 years post-maturation (NMFS 2010) with spawning occurring about every three years although spawning intervals may be as infrequent as every 5 years for some females (NMFS 2010). Female shortnose sturgeon apparently grow larger than and outlive males (Dadswell 1979; Kynard 2016).

6.1.2 Distribution

Shortnose sturgeon occur along the Atlantic Coast of North America, from the St. John River in Canada to the St. Johns River in Florida. The Shortnose sturgeon recovery plan (NMFS 1998a) describes 19 shortnose sturgeon population segments that exist in the wild (Figure 2). Two additional geographically separated populations occur behind dams in the Connecticut River (above the Holyoke Dam) and in Lake Marion on the Santee-Cooper River system in South Carolina (above the Wilson and Pinopolis Dams). The 2010 status review indicates that the Connecticut River shortnose sturgeon population is impeded, but not completely isolated, by the Holyoke dam. (Quattro 2002; Wirgin 2005).

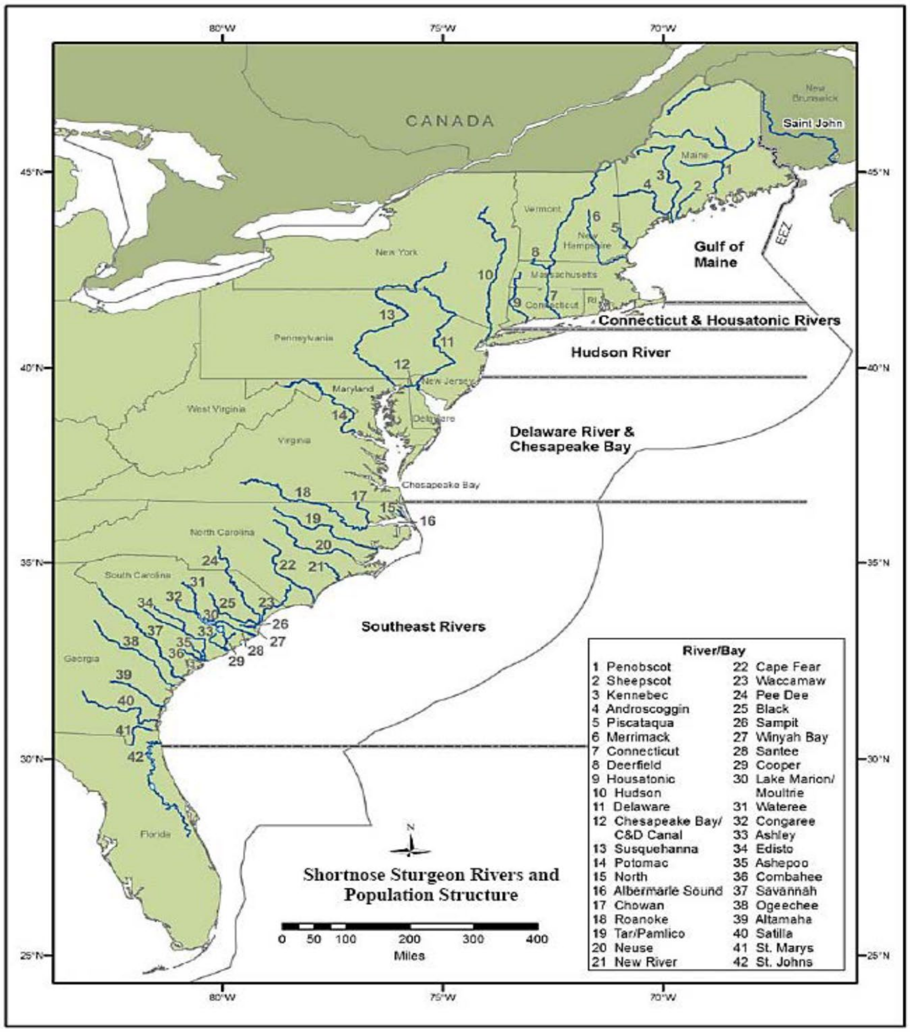

Figure 2. Shortnose sturgeon rivers and population structure

The distribution of shortnose sturgeon is disjointed across their range, with northern populations separated from southern populations. Coincidentally, at the geographic center of the shortnose sturgeon range, there is a 400 kilometer stretch of coast with no known populations occurring from the Delaware River, New Jersey to Cape Fear River, North Carolina (Kynard 2016). Wirgin (2005) concluded that rivers separated by more than 400 kilometers were connected by very little migration while rivers separated by no more than 20 kilometers experience high migration rates.

At the northern end of the species' distribution, the highest rate of gene flow (which suggests migration) occurs between the Kennebec, Penobscot, and Androscoggin Rivers (Wirgin 2012). At the southern end of the species' distribution, populations south of the Pee Dee River appear to exchange between one and ten individuals per generation, with the highest rates of exchange between the Ogeechee and Altamaha Rivers (Wirgin 2005).

6.1.3 Critical Habitat

Critical habitat for shortnose sturgeon has not been designated.

6.1.4 Recovery

In 1998, NMFS approved the shortnose sturgeon recovery plan (ASSRT 1998). The plan identifies actions that would promote the recovery and delisting of shortnose sturgeon. Specific recovery activities are organized under four broad recovery actions:

1. Develop criteria for assessing the status of shortnose sturgeon populations
2. Protect shortnose sturgeon and their habitats
3. Rehabilitate shortnose sturgeon populations and habitats
4. Implement recovery tasks

The long-term recovery objective for the shortnose sturgeon is to recover all populations to levels of abundance at which they no longer require protection under the ESA. Downlisting can be considered when all populations:

1) Are large enough to prevent extinction and

2) The loss of any one population will have minimal effect to the genetic diversity of the species.

This minimum abundance for each population segment has not yet been determined. Therefore, establishing endangered and threatened population size thresholds is a priority. The best data available suggest that shortnose sturgeon can be separated into smaller groupings across their geographic range. These genetically obvious groups form regional clusters. To conserve this genetic diversity and preserve the recruitment opportunity, the Shortnose Sturgeon Status Review Team (SSRT) recommends approaching shortnose sturgeon conservation and recovery at both the riverine population scale and regionally depending on the action/ activity. To achieve and preserve minimum population sizes for each population segment, essential habitats must be identified and maintained, and mortality must be monitored and minimized. Accordingly, other key recovery tasks are to define essential habitat characteristics, assess mortality factors, and protect shortnose sturgeon through applicable federal and state regulations (ASSRT 1998).

6.1.5 Status and Trends of Shortnose Sturgeon Populations in GA

The current status of shortnose sturgeon in the southern meta-population depends on the river in which they live. Overall, populations within the southern meta-population are relatively small compared to their northern counterparts. The Altamaha and Savannah rivers support the largest known shortnose sturgeon population in the Southeast. Total population estimates for the Altamaha River ranged from 468 fish (1993) to over 5,550 fish (2006), more recent data from Ingram (2020) estimates the population of shortnose sturgeon in the Altamaha river at an estimated abundance of 2218 individuals (95% confidence interval [CI]: 1424-3350), including 725 (95% CI: 455-1192) juveniles and 1493 (95% CI: 954-2409) adults. Point estimates of group abundance indicate that the population is dominated by adults, although dynamic shifts in size structure following periods of high recruitment have been reported to occur (Ingram 2020).

Kleinhans (2023) observed age-1 cohorts in 7 of the 11 years of data collection 2012-2022. Point estimates of age-1 recruitment varied between 113 and 1,021 individuals, and total population size varied between 452 (95% confidence interval [CI]: 116–2,277) and 5,054 individuals (95% CI: 2,155–13,267), as shown in Figure 3.

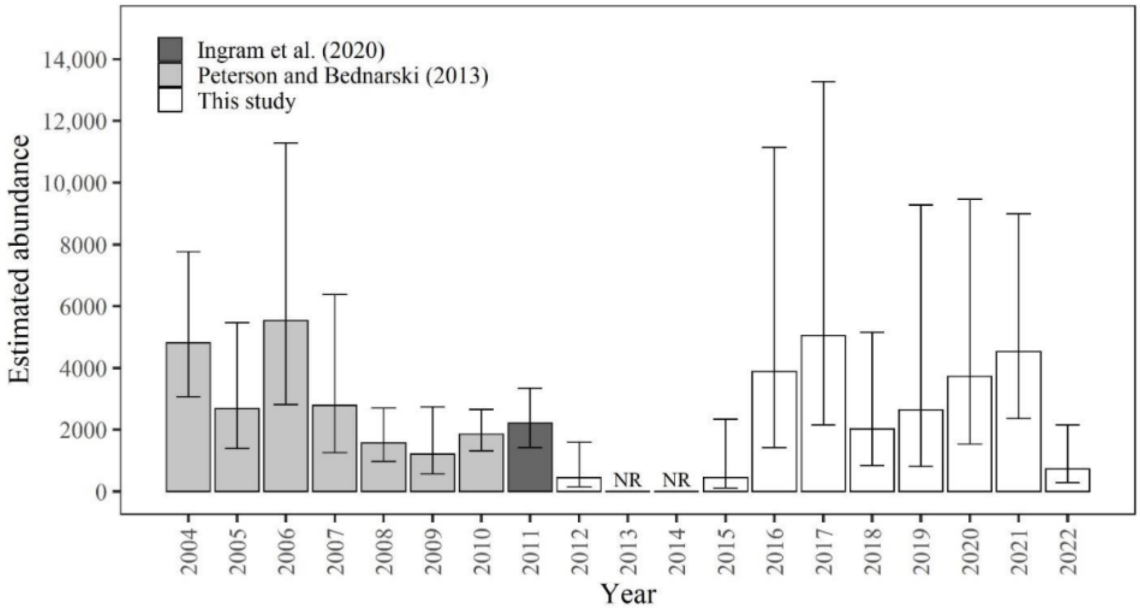

Figure 3. Total abundance of shortnose sturgeon in the Altamaha River, GA in 2004–2022 (Kleinhans 2023)

*Abundance estimates (with error bars indicating 95% confidence intervals) are included from this study as well as from Peterson (2013) as cited in Klienhans 2023; light gray bars and Ingram (2020) as cited in Klienhans 2023;dark gray bars. NR (no recaptures) indicates years in which netting and tagging efforts did not result in any recaptures of marked individuals, preventing the calculation of an estimate of abundance (Kleinhans 2023)

The best models estimated that the Savannah River contained 81 (95% CI = 27–264) age-1 juveniles in 2013, 270 (162–468) in 2014, and 245 (104–691) in 2015. The models also estimated the river to contain 486 (198–1,273) age-2+ juveniles in 2013, 123 (69–235) in 2014, and 187 (81–526) in 2015. Similarly, the adult population was estimated to be 1,865 (784–4,694) individuals in 2013, 1,564 (1,005–2,513) in 2014, and 940 (535–1,753) in 2015 (Bahr 2017).

6.2 Atlantic Sturgeon, *Acipenser Oxyrinchus*

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 and the Gulf of Maine DPS was listed as threatened. A maps of the distribution of the Atlantic Sturgeon DPSs and range can be seen in Figure 4 below.

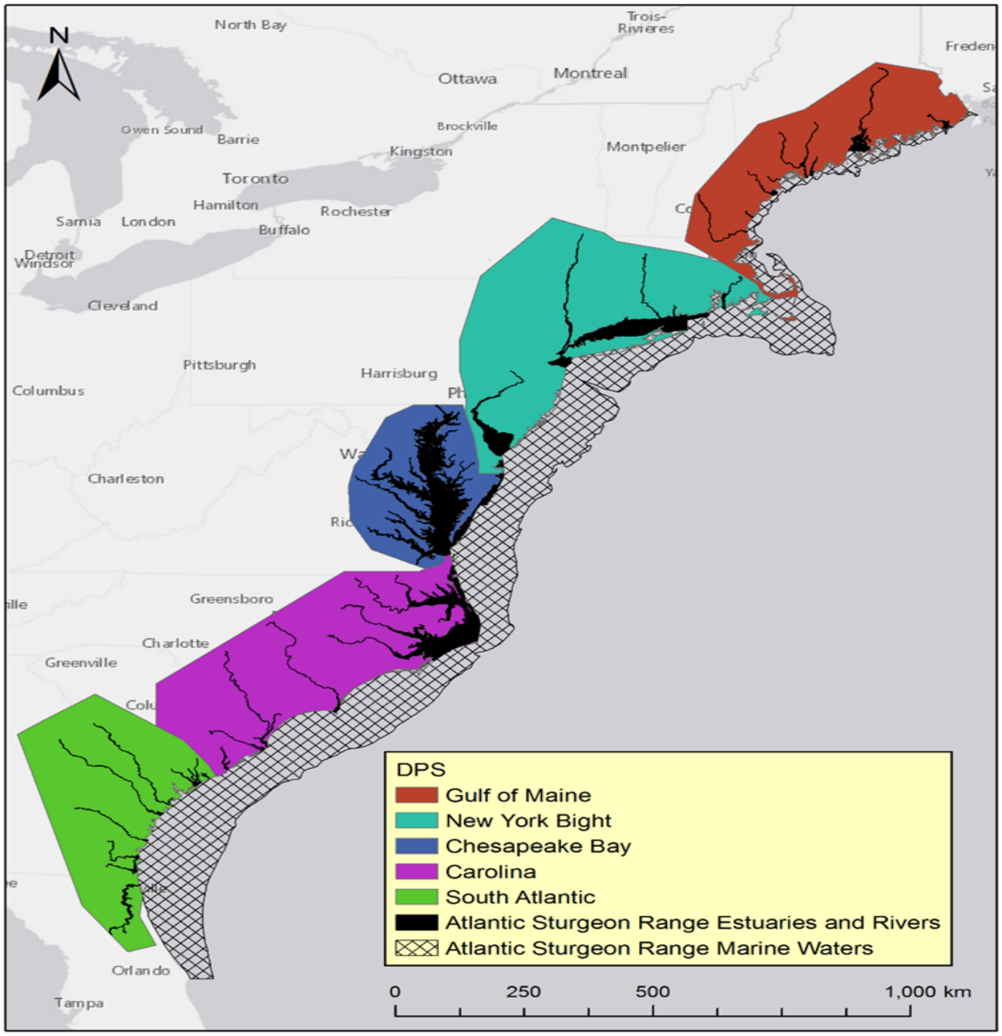

Figure 4. Geographic Range of Atlantic Sturgeon

6.2.1 Description

Atlantic sturgeon may live up to 60 years, reach lengths up to 14 ft, and weigh over 800 lbs (ASSRT 2007c; Collette 2002). 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 2002). Historically, sightings have been reported from Hamilton Inlet, Labrador, Canada, south to the St. Johns River, Florida (Murawski 1977; Smith 1997b). While adult Atlantic sturgeon from all DPSs mix extensively in marine waters, Atlantic sturgeon return to their natal rivers to spawn approximately 96% of the time (Kazyak 2021). Young sturgeon may spend the first few years of life in their natal river estuary before moving out to sea (Wirgin 2002). Atlantic sturgeon are omnivorous benthic (bottom) feeders. Diets of adult and subadult Atlantic sturgeon include mollusks, gastropods, amphipods, annelids, decapods, isopods, and fish such as sand lance (ASSRT 2007c; Bigelow 1953; Guilbard 2007; Savoy 2007). Juvenile Atlantic sturgeon feed on aquatic insects, insect larvae, and other invertebrates (ASSRT 2007c; Bigelow 1953; Guilbard 2007).

Genetic studies show that fewer than two adults per generation spawn in rivers other than their natal river (Waldman 2002b; Wirgin 2002) Young sturgeon spend the first few years of life in their natal river estuary before moving out to sea (Waldman 2002b). While few specific spawning locations have been identified, at least 21 rivers are known to support reproducing populations. White (2021a) showed there are a number of rivers, all located in the Chesapeake Bay and to the south, that have genetically distinct spawning populations within the same river. When that occurs, spring spawning populations from neighboring rivers appear to be more closely related to one another than to the fall spawning populations from the same river (White 2021a). Otherwise, the typical spawning pattern along the coast is for spring spawning in the Delaware River and all rivers to the north and for fall spawning in the Chesapeake Bay and all rivers to the south.

6.2.2 Life History Information

Smith (1985a) reported that the timing of the arrival of mature adults into estuaries was temperature dependent and varied with latitude: February in Florida, Georgia, and South Carolina; April in the Delaware and Chesapeake Bay systems; and May-June in the GOM and Gulf of St. Lawrence systems. Traditionally, it was believed that spawning within all populations occurred during the spring and early summer months. More recent studies, however, suggest that spawning occurs from late summer to early autumn in two tributaries of the Chesapeake Bay (James River and York River, Virginia) and in the Altamaha River, GA (Balazik 2012a; Hager 2014). A recent study by Balazik (2015) indicates that two races of Atlantic sturgeon repeatedly spawn during two different times (spring and fall) and places in the James River, and possibly the groups have become genetically distinct from each other. Based on a combination of telemetry data and historical documentation Balazik et al. hypothesize that a dual spawning strategy likely occurs in various degrees throughout the Atlantic sturgeon's range. Smith (2015) identified fall spawning in the Roanoke River. These studies suggest that adult Atlantic sturgeon that show up in the southern estuaries spend the summer in the estuary before making a spawning run in the fall. Farrae (2017a) found genetically distinct fall- and spring-spawned Atlantic sturgeon in the Edisto River.

Sturgeon eggs are highly adhesive and are deposited on the bottom substrate, usually on hard surfaces (Gilbert 1989; Smith 1997a). Following spawning in northern rivers, males may remain in the river or lower estuary until the fall; females typically exit the rivers within four to six weeks after spawning (Savoy 2003). Hatching occurs approximately 94-140 hours after egg deposition at temperatures of 20° and 18° Celsius, respectively (Theodore 1980). The yolk sac larval stage is completed in about 8-12 days, during which time larvae move downstream to rearing grounds over a six- to twelve-day period (Kynard 2002). During the first half of their migration downstream, movement is limited to nighttime. During the day, larvae use benthic structure (e.g., gravel matrix) as refuge (Kynard 2002). The larvae grow rapidly and are 4 to 5 ½ in long at a month old (MSPO 1993). At this size, the young sturgeon bear teeth and have sharp, closely spaced spine-tipped scutes. As growth continues, they lose their teeth and the scutes get larger, overlapping along the edges.

Atlantic sturgeon undertake long marine migrations and utilize habitats up and down the East Coast for rearing, feeding, and migrating (Bain 1997; Dovel 1983; Stevenson 1997). Migratory subadults and adults are normally located in shallow (10-50 meters) nearshore areas dominated by gravel and sand substrate (Stein 2004b). During the latter half of migration when larvae are more fully developed, movement to rearing grounds occurs both day and night. Juvenile sturgeon continue to move further downstream into brackish waters ranging from zero to up to 10 parts per thousand salinity. Older juveniles are more tolerant of higher salinities as juveniles typically spend two to five years in freshwater before eventually becoming coastal residents as sub-adults (Boreman 1997b; Schueller 2010b; Smith 1985b).Tagging and genetic data indicate that subadult and adult Atlantic sturgeon may travel widely once they emigrate from rivers (Bartron 2007b; Wirgin 2015b). Once in marine waters, subadults undergo rapid growth (Dovel 1983; Stevenson 1997).

Atlantic sturgeon have been aged to 60 years (Mangin 1964), but this should be taken as an approximation because the age validation studies conducted to date show ages cannot be reliably estimated after 15 to 20 years (Stevenson 2000). Vital parameters of sturgeon populations generally show clinal variation with faster growth, earlier age at maturation, and shorter life span in more southern systems. Spawning intervals range from one to five years for male Atlantic sturgeon (Collins 2000c; Smith 1985b) and three to five years for females (Schueller 2010b; Stevenson 2000). Fecundity of Atlantic sturgeon is correlated with age and body size, ranging from approximately 400,000 to 2 million eggs (Dadswell 2006; Smith 1982; Van Eenennaam 1998). The average age at which 50 percent of Atlantic sturgeon maximum lifetime egg production is achieved is estimated to be 29 years, approximately three to ten times longer than for most other bony fish species (Boreman 1997b).

6.2.3 Status

Atlantic sturgeon were once present in 38 river systems and, of these, spawned in 35 of them. Individuals are currently present in 36 rivers, and spawning occurs in at least 20 of these (ASSRT 2007c). The decline in abundance of Atlantic sturgeon has been attributed primarily to the large U.S. commercial fishery that existed for the Atlantic sturgeon from the 1870s through the mid-1990s. The fishery collapsed in 1901 and landings remained at between one to five percent of the pre-collapse peak until the Atlantic States Marine Fisheries Commission placed a two generation moratorium on the fishery in 1998 (ASMFC 1998a). The majority of the populations show no signs of recovery, and new information suggests that stressors such as bycatch, ship strikes, and low DO can and do have substantial impacts on populations (ASSRT 2007c). Additional threats to Atlantic sturgeon include habitat degradation from dredging, damming, and poor water quality (ASSRT 2007c). Climate change related impacts on water quality (e.g., temperature, salinity, DO, contaminants) have the potential to impact Atlantic sturgeon populations using impacted river systems. These effects are expected to be more severe for southern portions of the U.S. range of Atlantic sturgeon (Carolina and South Atlantic DPSs). None of the spawning populations are currently large or stable enough to provide any level of certainty for continued existence of any of the DPSs.

The Carolina and South Atlantic DPSs were estimated to have declined to less than three and six percent of their historical population sizes, respectively (ASSRT 2007c). Both of these DPSs were listed as endangered in 2012 due to a combination of habitat curtailment and alteration, bycatch in commercial fisheries, and inadequacy of regulatory mechanisms in ameliorating these impacts and threats. The largest estimated adult Atlantic sturgeon populations are currently found in the Hudson (3,000), Altamaha (1,325), Delaware (1,305), Kennebec (865), Savannah (745), and James (705) Rivers (NMFS 2017). Published estimates of Atlantic sturgeon juvenile abundance are available in the following river systems: 4,314 age 1 fish in the Hudson in 1995

(Peterson 2000); 3,656 age 0-1 fish in the Delaware in 2014 (Hale 2016); between 1,072 to 2,033 age 1-2 fish on average from 2004-2007 in the Altamaha (Schueller 2010b); and 154 age 1 fish in 2010 in the Satilla (Fritts 2016).

The Altamaha River supports the healthiest Atlantic sturgeon populations in the South Atlantic DPS. In a telemetry study by Peterson (2008), most tagged adult Atlantic sturgeon were found between river kilometer 215 and 420 in October and November when water temperatures were appropriate for spawning. Seventy-six Atlantic sturgeon were tagged in the Edisto River during a 2011 to 2014 telemetry study (Post 2014). Fish entered the river between April and June and were detected in the saltwater tidal zone until water temperature decreased below 25° C. They then moved into the freshwater tidal area, and some fish made presumed spawning migrations in the fall around September to October. Atlantic sturgeon in the Savannah River were documented displaying similar behavior three years in a row—migrating upstream during the fall and then being absent from the system during spring and summer. Forty three Atlantic sturgeon larvae were collected in upstream locations (river kilometer 113 to 283) near presumed spawning locations (Collins 1997b).

6.2.4 Designated Critical Habitat

NMFS designated critical habitat for each ESA-listed DPS of Atlantic sturgeon in August of 2017 (Figure 5; 82 FR 39160). PBFs determined to be essential for Atlantic sturgeon reproduction and recruitment include (1) suitable hard bottom substrate in low salinity waters for settlement of fertilized eggs, refuge, growth, and development of early life stages, (2) transitional salinity zones for juvenile foraging and physiological development, (3) water of appropriate depth and absent physical barriers to passage, (4) unimpeded movement of adults to and from spawning sites, and (5) water quality conditions that support spawning, survival, growth, development, and recruitment.

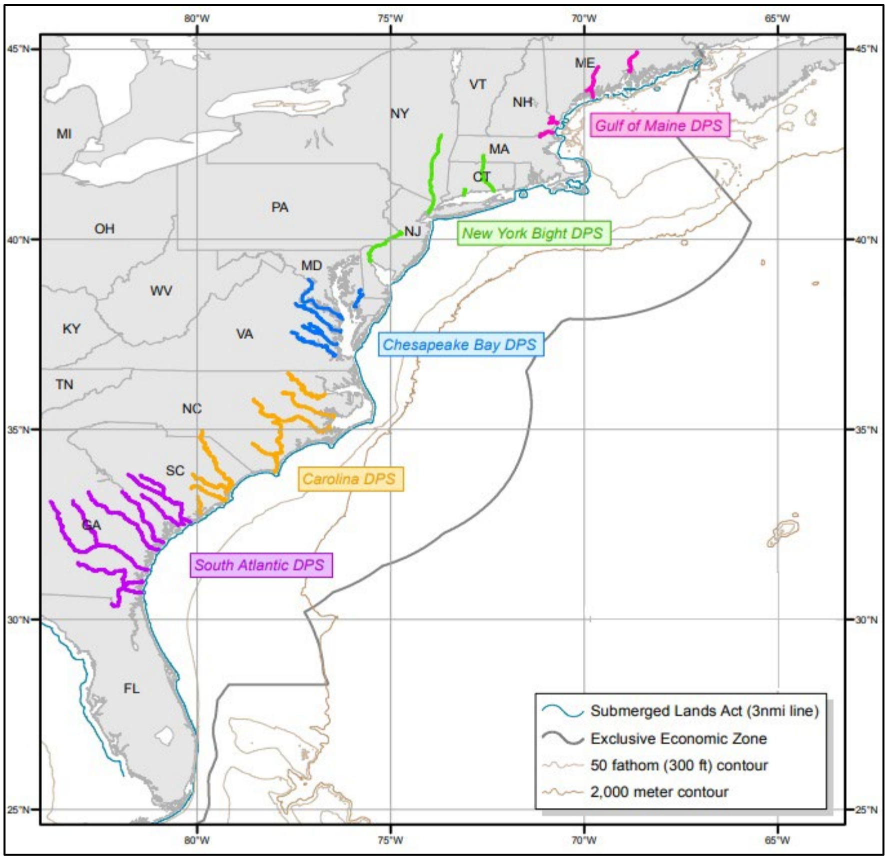

Figure 5. General map of critical habitat for each DPS of Atlantic sturgeon.

Recovery Goals

Recovery Plans have not yet been drafted for any of the Atlantic sturgeon DPSs. A recovery outline was produced for Atlantic sturgeon (NMFS 2018). The goal for recovery is to have reproductive populations across their historic range of sufficient size and diversity to support reproduction and recovery from mortality events.

Based on the 1990 recovery priority ranking guidelines, the recovery priority number for each of the Gulf of Maine, New York Bight, Chesapeake Bay, Carolina, and South Atlantic DPSs is five (55 FR 24296; June 15, 1990). This number is based on three criteria: magnitude of threat, recovery potential, and conflict. These DPSs face a moderate threat of extinction if recovery is temporarily held off, although there continue to be threats to their habitat. Recovery potential is high for these DPSs because the major threats affecting these DPS (i.e., water quality/quantity alterations, vessel strike, bycatch in state/commercial fisheries, and impeded access to historical habitats) are relatively well understood and necessary management actions are known. These DPSs also conflict with construction or other developmental projects or other forms of economic activity (NMFS 2018).

Subpopulations of all five Atlantic sturgeon DPSs must be present across the historical range. These subpopulations must be of sufficient size and genetic diversity to support successful reproduction and recovery from mortality events. The recruitment of juveniles to the sub-adult and adult life stages must also increase and that increased recruitment must be maintained over many years. Recovery of these DPSs will require conservation of the riverine and marine habitats used for spawning, development, foraging, and growth by abating threats to ensure a high probability of survival into the future (NMFS 2018).

The ASMFC completed an Atlantic Sturgeon Benchmark Stock Assessment in 2017 that considered the status of each DPS individually, as well as all five DPSs collectively as a single unit (ASMFC 2017a). The assessment concluded all five DPSs of Atlantic sturgeon, as well as each individual DPS remain depleted relative to historic abundance. The assessment also concluded that the population of all five DPSs together appears to be recovering slowly since implementation of a complete moratorium in 1998. However, there were only two individual DPSs, the New York Bight DPS and Carolina DPS, for which there was a relatively high probability that abundance of the DPS has increased since the implementation of the 1998 fishing moratorium. In addition, there was a relatively high probability that mortality for animals of the Gulf of Maine DPS and the Carolina DPS exceeded the mortality threshold used for the assessment.

6.2.5 Status and Trends of Atlantic Sturgeon Populations

Prior to 1890, Atlantic sturgeon populations were at or near carrying capacity. Between 1890 and 1905, Atlantic sturgeon (and shortnose sturgeon) populations were drastically reduced as a result of overfishing for sale of meat and caviar. Between 1920 and 1998, the harvest level remained very low due to small remnant populations. Prompted by research on juvenile production between 1985 and 1995 Peterson et al. 2000), the Atlantic sturgeon fishery was closed by the Atlantic States Marine Fisheries Commission in 1998, when a coast wide fishing moratorium was imposed for 20-40 years, or at least until 20 year classes of mature female Atlantic sturgeon were present (ASMFC 1998b).

Since the closure of the Atlantic sturgeon fishery in 1998, the only assessments of adult spawning populations have been made in the Hudson, Delaware, York, and Altamaha Rivers. While Atlantic sturgeon have been captured, tagged, and tracked through estuaries and rivers along the East Coast, no other estimates of spawning run size or juvenile population sizes have been made. Estimating the number of spawning adults relies on the assumptions that (1) all adults that migrate into the freshwater portion of a river are native to that river and (2) all adults are making that upstream migration with the intention of spawning.

6.2.6 South Atlantic DPS

The South Atlantic DPS was listed as endangered under the ESA on February 6, 2012. This DPS historically supported eight spawning subpopulations but currently supports five extant spawning subpopulations (ASSRT 2007b). At the time of listing only six 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. Of these subpopulations, the Altamaha and Ashepoo, Combahee, and Edisto (ACE) Basin support the largest number of spawning adults, and are considered the second and third largest Atlantic sturgeon subpopulations within the United States, respectively

The Edisto and Ogeechee Rivers appear to have a spring and a fall run (White 2021b). When exploring the possibility of spring and fall spawning migrations, without any knowledge of the reproductive condition of the individuals, Vine (2019)identified temperature as a primary driver of upriver movement in both the spring and fall. In the spring, Atlantic sturgeon moved upriver as temperatures increased between 11 and 15 °C and in the fall, as temperatures were descending, between 29 and 24 °C (Vine 2019). For Atlantic sturgeon, discharge did not influence upriver movement (Vine 2019).

In 2017, the Atlantic States Marine Fisheries Commission (ASMFC) completed an Atlantic Sturgeon Benchmark Stock Assessment ASMFC (2017a). The purpose of the assessment was to evaluate the status of Atlantic sturgeon along the U.S. Atlantic coast (ASMFC 2017a). The assessment considered the status of each DPS individually, as well as all five 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 4). Additional estimates of N_e have been conducted since the completion of the assessment, including for additional river systems; Table 4 reports those estimates. White (2021b) cautions that, because the populations they considered were sampled at varying temporal scales and intensities and represented a mixture of single and mixed-cohort samples, the N_e estimates they report should be interpreted with reservation as they technically represent a value between true N_e and the effective number of breeders. They also state that, while their estimates are valuable for comparing the general magnitude of difference among populations, they should not be used to make inferences about long-term population viability (White 2021a).

Table 4. Available Estimates of Effective Population Sizes in the Rivers of the South Atlantic DPS

River	Effective Population Size (N_e) (95% CI)	Sample Size	Collection Years	Reference
Edisto	55.4 (36.8-90.6)	109	1996-2005	ASMFC (2017b)
	Fall Run – 48.0 (44.7-51.5)	1,154	1996-2004	Farrae (2017a)
	Fall Run (82 (60.3-122.1)	373	1996, 1998, 2001-2003, 2005	White (2021b)
	Spring Run – 13.3 (12.1-14.6)	198	1998, 2003	Farrae (2017a)
	Spring Run – 16.4 (12.8-20.6)	123	1998, 2003	White (2021b)
	60.0 (51.9-69.0)	145	1996, 1998, 2005	Waldman (2018)
Savannah	126.5 (88.1-205)	98	2000-2013	ASMFC (2017b)
	123 (103.1-149.4)	161	2013, 2014, 2017	Waldman (2018)

River	Effective Population Size (N_e) (95% CI)	Sample Size	Collection Years	Reference
	154.5 (99.6-287.7)	134	2000, 2007, 2208, 2013, 2017, 2018	White (2021b)
Ogeechee	32.2 (26.9-38.8)	115	2003-2015	ASMFC (2017b)
	26 23.9–28.2	200	2007-2009, 2014-2017	Waldman (2018)
	23.9 (22.2-25.7)	197	2007-2009, 2014-2017	Fox (2019a)
	Spring Run – 31.1 (24.3-40.2)	92	2003, 2007, 2009, 2014, 2015, 2016	White (2021b)
	Fall Run – 56.5 (36.3-103.6)	55	2003, 2004, 2008, 2009, 2015, 2016	White (2021b)
Altamaha	111.9 (67.5-216.3)	186	2005-2015	ASMFC (2017b)
	149 (128.7–174.3)	245	2005, 2011, 2014, 2016-2017	Waldman (2018)
	142.1 (124.2-164.0)	268	2005, 2011, 2014-2017	Fox (2019a)
	141.7 (73.4-399)	189	2005, 2010, 2011, 2018	White (2021b)
Satilla	21 (18.7–23.2)	68	2015-2016	Waldman (2018)
	11.4 (9.1-13.9)	74	2010, 2014, 2016	White (2021b)
St. Mary's	1 (1.3–2.0)	14	2014-2015	Waldman (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 (ASMFC 2017a; Frankham 2014). Effective population size is useful for defining abundance levels where populations are at risk of loss of genetic fitness (ASMFC 2017a). While not inclusive of all the spawning rivers in the South Atlantic DPS, the population estimates reported in Table 4 suggest there is a risk for inbreeding depression (N_e < 100) in four of those rivers (Edisto, Ogeechee, Satilla, and St. Mary's 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. However, White (2021b), stated that while historic comparisons are currently not available, all 18 populations surveyed showed reasonably high levels of contemporary genetic diversity and low inbreeding despite relatively recent and severe demographic bottleneck events.

A census estimate was produced for the upper 20 km of the Savannah River (river kilometers 281-301) to estimate the number of purported spawning adults in that stretch on a given day over 50 sampling occasions. The maximum estimate of daily abundance in those 20 km was 35 to 55 adults of unknown sex (Vine 2019). Effective population estimates were also produced for many rivers in the South Atlantic DPS. The Edisto River (n = 145) was estimated to have an effective population of 60 (95% CL, 51.9-69.0; (Waldman 2019), but was broken into two spawning populations by (White 2021a)following the identification of two distinct spawning groups (Farrae et al. 2017) for estimates of a spring run (n = 123) of 16.4 (12.8-20.6) and a fall run (n = 373) of 47.9 (25.3-88.8). The Savannah River was estimated to have an effective population size (n = 161) of approximately 123 (103.1-149.4) and also (n = 134) of approximately 154.5 (99.6-

287.7) by White (2021a)and Waldman (2019), respectively. The Ogeechee River (n = 200) was estimated to have an effective population of 26 (23.9-28.2; Waldman et al. 2019), but was also broken into two spawning populations by White (2021a) for estimates of a spring run (n = 92) of 31.1 (24.3-40.2) and a fall run (n = 55) of 56.5 (36.3-103.6). The Altamaha River appears to support the largest Atlantic sturgeon population in the South Atlantic DPS, and one of the largest on the East Coast, with effective population estimates of 149 (128.7-174.3; n = 245; (Waldman 2019) and 141.7 (73.4-399; n = 189; (White 2021a). The effective population estimates for the Satilla River population are 21 (18.7-23.2; n = 68; Waldman et al. 2019) and 11.4 (9.1-13.9; n = 74; White et al. 2021a). Work in the St. Mary's River on the Florida-Georgia border captured 25 fish including 14 river resident juveniles. Analysis of those individuals reveals an effective population size of 1 (1.3-2.0), but this is a known under-estimate because those individuals were from a single spawning event (Fox 2018; Waldman 2019). The St. Johns River in Florida does not appear to support an extant population (Fox 2018). Survival within the entire DPS was estimated to be approximately 86% (54-99%; (ASMFC 2017b).

The relatedness of the populations reveals three groups of related clusters within this DPS. The first cluster includes the Edisto spring run, the Ogeechee Spring run, and the Satilla River populations; the second includes the Edisto River fall run and Ogeechee River fall run; and the third includes the largest populations of the Savannah and Altamaha Rivers, but also the Ogeechee River fall run (White 2021a). As was seen with other rivers with dual spawning populations, the spring and fall runs are genetically differentiated.

Kazyak (2021) presented the first comprehensive mixed stock analysis of Atlantic sturgeon in the Southeast and confirmed that while Atlantic sturgeon are making long-distance migrations, stock composition is best assessed at a regional level. The mixed stock analysis identified relatively little mixing of stocks in the Southeast. Of the 513 samples assigned to the "South" region (Cape Hatteras, NC to FL) the most common DPS was South Atlantic (91.2%, n=468) followed by Carolina DPS (6.2%; n=32), with only 2.6% (n=13) of the samples originating from other DPSs (Kazyak 2021).

South of Cape Hatteras, Kazyak (2021) showed that 91.2% of fisheries bycatch was from the South Atlantic DPS. In terms of population level distribution and susceptibility to commercial fisheries, 35.7% were from the Altamaha River, 21.4% from the Edisto River fall-run, 18.9% from the Savannah River, 7.2% from the Ogeechee River (both spring and fall), 5.5% Satilla, 3.7% Pee Dee (both spring and fall), and 2.0% Edisto spring-run. In the south, most offshore fish were from the Altamaha, followed by the Savannah (Kazyak et al. 2021). Within river movement studies also revealed that age-1 fish that were tagged in the summer remained in the rivers and overwintered before out-migrating between December and March (Fox 2019b). When observing the likelihood of becoming a coastally wandering sub-adult or remaining a river resident for another year, Fox (2019b)found that 36.7% returned as age 2 fish while 30.4% out-migrated as age 2. The St. Johns River, the furthest south in the South Atlantic DPS, has periodic use by sub-adults and adults, but is no longer spawning or rearing habitat.

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, and 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 (King 2001; Waldman 2002a; Wirgin 2000). The persistence of individual populations, and in turn the DPS, depends on successful spawning and rearing within the freshwater habitat, the immigration into marine habitats to grow, and then the return of adults to natal rivers to spawn.

6.2.7 Gulf of Maine DPS

Since 2017, there were several updates about reproduction, numbers, and distribution in the Gulf of Maine DPS. An open population estimate of marine-oriented Atlantic sturgeon (sub-adult and adult) foraging in the Saco River from May to November is between 1,400 and 6,800 individuals annually (Flanigan 2021). The Kennebec River effective population size and 95% confidence limits (CL) were estimated at 67.0 (52.0-89.1) and 79.4 (60.3-111.7) by Waldman (2019); n = 62) and White (2021b); n = 48). Effective population size is essentially an estimate of the number of breeding individuals in a population required to maintain the amount of genetic variability observed within samples from that population. Furthermore, two larval Atlantic sturgeon were captured just above the Kennebec River estuary between 24 and 25 °C in mid-July, confirming successful reproduction in this location (Wippelhauser 2017). It is thought the Penobscot may have historically supported a spawning population, but it is possibly extirpated (ASMFC 2017b). Wippelhauser (2017) suggest Atlantic sturgeon use the upper Kennebec River, the Kennebec River estuary, and the Androscoggin River estuary for reproduction. It is unknown whether the Merrimack River supports a reproductive population of Atlantic sturgeon (ASMFC 2017b). And while the Androscoggin represents an additional known spawning location for this DPS, non-spawning individuals were observed to use the Penobscot, Androscoggin, Saco, Merrimack, St. John, and Minas Passage (Altenritter 2017; Novak 2017; Wippelhauser 2017). Survival rates of all ages is estimated to be approximately 74% annually (95% confidence limits, 15-99%; ASMFC 2017a).

6.2.8 New York Bight DPS

There have been minimal updates to the underlying information regarding reproduction. The Connecticut, Hudson, and Delaware Rivers all support reproductive populations while the Taunton River population appears to be extirpated. A recent assessment of relatedness of these populations to others along the coast reveals, as was the case at the time of listing, that the Hudson and Delaware populations appear to be a separate group from other populations but also different from one another (White 2021b). The Connecticut River was not included in that study. A recent study using acoustic telemetry to estimate spawning duration and return intervals shows that Hudson River adults return much more frequently than previously thought; females every 1.66 years and males every 1.28 years (Breece 2021). This is in agreement with recent studies conducted in the York River (Hager 2020), both suggesting females, in particular, spawn more often than previously thought. In the Hudson River, males were on spawning grounds on average from May 27 through July 11 and females from June 8 through June 29. The average male is also more likely to travel further upriver than the average female (Breece 2021).

There are a number of updated abundance estimates for each river. The Hudson River most likely supports the largest population of Atlantic sturgeon in the United States. Effective population estimates for the Hudson River are 156 (95% CL, 138.3-176.1; n = 459; Waldman (2019) and 145.1 (82.5-299.4; n = 307; White (2021b). Kazyak (2020) produced an abundance estimate of the 2014 adult spawning run size of 466 individuals (95% CL, 310-745). While this spawning run size is nearly identical to that estimated by Kahnle (2007), monitoring of relative abundance of juveniles from 2004 through 2019 has shown production may have doubled during those 16 years (Pendleton 2021).

In the Delaware River, the effective population size has been estimated to be 40 (95% CL, 34.7-46.2; n = 108) and 60.4 (42-85.6; n = 488) by Waldman (2019) and White (2021b), respectively. The significant difference between estimates is likely due to sample size. Therefore, White (2021b) estimate is likely most accurate. Additionally, a recent close-kin mark-recapture estimate was produced for the Delaware River and suggests there are fewer than 250 adults (census) in the Delaware River population (White 2021b).

In the Connecticut River, despite only limited collection of juvenile sturgeon (n = 47), there is an estimate of effective population size of two (95% CL, 2-2.7; Waldman 2019). This would suggest there has been a single spawning event in the Connecticut River that produced all of the juvenile fish collected or the spawning adults were so closely related as to be indistinguishable from a single pair. Either way, it is clear there is limited genetic diversity in this population and, unless these adults continue returning to the Connecticut River, it could take approximately 20 years to learn whether these juveniles have survived in sufficient numbers to sustain this new population.

Recent survival estimates do not suggest much of an improvement since the last estimates made during the commercial fishery (Boreman 1997a; Kahnle 1998). Melnychuk (2017) provided an updated estimate of survival of Hudson River Atlantic sturgeon of approximately 88.22%, while for similar life stages over a longer time frame, ASMFC (2017b) estimated survival of the entire New York Bight to be 91% (95% confidence limits, 71-99%).

The range of Atlantic sturgeon can be measured from north to south or inshore to offshore. While there has been no change to the range along the East Coast, there are detection data of acoustic transmitters much further offshore than had previously been documented.

To understand movement along the coast, White (2021a) assessed the river of origin of Atlantic sturgeon harvested during the commercial fishery. This was a duplication of a study done by Waldman (1996), but showed fish harvested in the Hudson River were from many locations other than the Hudson. The makeup of the harvested fish in the 1990s was 82.3% Hudson, 7.3% Delaware, 4.7% James River spring run, 2.4% St. Lawrence, 2.1% Kennebec, 1.3% Pee Dee spring run, rather than 98% Hudson as had been estimated during the fishery. The reasons for the difference are likely a more thorough baseline consisting of 18 known populations rather than only nine (White 2021b) and the use of microsatellite DNA rather than mitochondrial. However, Wirgin (2018) sampling 148 sub-adult sturgeon in the Hudson River estuary and relying on microsatellite DNA, found 142 of those were of Hudson River origin with additional contributions from the Kennebec (2), Delaware (2), Ogeechee (1), and James (1) Rivers. This may suggest adults are more likely to enter estuaries than sub-adults.

In terms of nearshore habitat use, Breece (2018) showed habitat selection is driven by depth, time of year, sea surface temperature, and light absorption by seawater, while sex and natal river do not seem to be important predictors of habitat selection. Therefore, regardless of the makeup of the mixed populations in these estuarine areas, the drivers of where the fish are located affect all sexes and populations similarly. Inshore and offshore movement is highly dependent on photoperiod and temperature, with fish residing offshore from November to January and inshore from June to September (Ingram 2019). Fish gradually move inshore from February to May but rapidly move offshore during October (Ingram 2018; Ingram 2019). In the Delaware Bay, when fish have moved inshore for the spring and summer months, Breece (2018) showed Atlantic sturgeon prefer shallow water and warmer bottom temperatures primarily in the eastern portion of the bay during residency but that this preference changes to deep, cool water and the western edge of the bay during migration.

Kazyak (2021) studied the offshore composition of sturgeon between Cape Hatteras and Cape Cod (mid-Atlantic, which comprises the New York Bight, Chesapeake Bay, and part of the Carolina DPSs) and found that 37.5% and 30.7% of all bycaught fish in this region were from the New York Bight and Carolina DPSs, respectively. This was primarily driven by 27.3% of fish from the Albemarle complex and 26.2% from the Hudson River. Estuarine bycatch in this area was primarily from Albemarle Complex, with many of the samples being obtained in waters of North Carolina, and most offshore fish were from the Hudson and James Rivers.

6.2.9 Chesapeake Bay DPS

Much like the New York Bight DPS, there have been minimal updates on reproduction in the Chesapeake Bay DPS. There are still only three known spawning populations for this DPS in the James, York, and Nanticoke Rivers. Edwards (2020) noted an adult male Atlantic sturgeon was detected at the saltwater interface of the Patuxent River, which may indicate potential spawning. However, Kahn (2019a) noted that telemetry detections are not a meaningful indicator of whether a male is spawning. Because males are often in spawning condition during non-spawning situations Van Eenennaam (1996), even if this individual had been captured and observed in spawning condition, that would not have been enough to suggest spawning was occurring in the Patuxent River.

Monitoring in the York River reveals that males return to spawn every 1.13 years and females every 2.19 years (Hager 2020). Males in the Nanticoke River system return to spawn every 1.68 years (calculated from Table 2 in Secor et al. 2022) but there is insufficient information to estimate female return intervals. Hager (2020) show spawning in the York River occurs on descending temperatures from 25.1 °C to 21.5 °C. This narrow temperature window is bounded by increased egg mortality at 25 °C and peak bioenergetic growth around 22 °C. Secor (2022) similarly show adults present on Nanticoke River spawning grounds from 26.7 °C down to 17.8 °C with most fish leaving the system by 20 °C. Spawning in both systems appears to be driven by temperature and photoperiod with a peak of spawning around the autumn equinox (Hager 2020; Secor 2022). Sex ratios when spawning range from approximately 64 to 75% male in the York River, though the overall population appears to be approximately 51% male (95% CL, 43-58%; (Kahn 2019b).

A recent assessment of relatedness of all Atlantic sturgeon populations showed that, when all populations along the coast are grouped, the James River (spring and fall runs) is most closely related to rivers in the northeast, while the York River is most closely related to rivers in the southeast (White 2021b). The York River population was distinct when compared to those southeastern rivers; the James River, meanwhile, when compared to northeastern rivers, remains closely related to a group of rivers in Canada and Maine but is differentiated from the Hudson and Delaware Rivers. At this point in the analysis, Program COLONY (a computer program to estimate likelihood of genealogical relationships from genotype data), which was used to estimate closeness of relationships, could have identified three clusters (James spring and fall, Hudson and Delaware, and Maine/Canada), but did not. When compared only with rivers from Maine and Canada (White 2021b), the James River spring and fall runs both appear to be unique but can be further separated from each other when compared to one another (Balazik 2017b; White 2021b). This analysis shows that the York River population (and Nanticoke River population, which appear to form an upper Chesapeake Bay meta-population [J. Kahn, NMFS, unpublished data]) is significantly different from the two James River populations at the most basic level of comparison.

Considerable advances have been made in understanding the abundance of each of these populations. There are no estimates of abundance for any life stage in the James River. The York River has estimates of adult abundance on spawning runs from 2014 through 2019 (Table 5). Census estimates of adult Atlantic sturgeon on spawning runs in the Nanticoke River in 2020 and 2021 are 36 (25-55) and 74 (52-109; Nick Coleman, University of Maryland, personal communication, email 11/29/2022 to Jason Khan, NMFS). Effective population size of the James River (as a single spawning population) was estimated from 116 samples to be 32 (28.8-35.5; Waldman (2019) and White (2021b) assessed the James River spring (n = 45) and fall (n = 131) spawning adults separately and identified effective population sizes of 24.7 (21-29.4) and 85.5 (61.1-127.5), respectively. The lone effective population estimate for the York River (n = 203) is 9.3 (6.9-11.8; (White 2021a) and for the Nanticoke River (n = 32) is 12.2 (6.7-21.9; (Secor 2022).

Table 5. Estimated abundance of spawning runs in the Pamunkey River, the primary spawning tributary of the York River, derived from a model relying on capture probability (Kahn et al. 2021) and a mark recapture heterogeneity model (Kahn et al. 2019)

Year	Male*	Female*	Spawning abundance*	95% CL*	Jackknife model**	95% CL†
2014	117	41	158	127-189	152	115-215
2015	125	68	192	154-230	182	145-243
2016	112	38	149	120-179	219	166-298
2017	150	68	218	175-260	215	167-292
2018	92	30	122	98-145	154	112-222
2019	153	86	239	192-286	330	257-434

*estimates from Kahn (2021), **estimates from (Kahn 2019b); jackknife is a statistical cross-validation technique using resampling, useful for variance estimation

Several recent survival estimates have been produced. At the DPS level, the Chesapeake Bay DPS is estimated to have an apparent annual survival of approximately 88% (95% CL, 46-99%; ASMFC 2017). A recent estimate for adult York River Atlantic sturgeon by Kahn (2023) shows much higher survival than other estimates with an annual apparent survival of 99.2% (97.9-99.7%). Kahn (2023) estimate was higher because it accounted for different detection probabilities between sexes and identified tag loss rates of 12.8% through concurrent mark recapture research.

Oceanic distribution of the Chesapeake Bay DPS is best known from the analysis by Kazyak (2021). This is the same information as presented for the New York Bight DPS because both populations occupy waters between Cape Hatteras and Cape Cod. Rothermel (2020), like Ingram (2019), noted an inshore movement in the spring and offshore movement in the fall and winter. And, like Breece (2018) observed, Atlantic sturgeon appear to prefer warmer, shallower water while residing offshore.

A recovery outline was produced for Atlantic sturgeon (NMFS 1998b). The goal for recovery is to have reproductive populations across their historic range of sufficient size and diversity to support reproduction and recovery from mortality events. The invasive blue catfish has become a more notable threat to native fish in the Chesapeake Bay region. A recent analysis of stomach contents reveals that 22 of 560 fish sampled (4%) comprising 27 species consumed Atlantic sturgeon during the fall spawning period (Bunch 2021). The primary consumers of Atlantic sturgeon were striped bass (1 of 8 guts, 12.5%), carp (6 of 52 guts, 11.5%), and blue catfish (8 of 131 guts, 6%). No hard parts were present and the assumption is that the Atlantic sturgeon DNA was either from eggs or larvae that were quickly digested (Bunch 2021).

6.2.10 Carolina DPS

The Carolina DPS is likely the least studied. Spawning likely occurs in the Roanoke, Tar/Pamlico, Neuse, Cape Fear, Pee Dee, Santee, and Cooper Rivers. Census abundance is not available for any system. The effective population size of juveniles collected in the Albemarle Sound is approximately 19 (95% CL, 16.5-20.6; n = 88; Waldman et al. 2019) to 29.5 (24.2-36.3; n = 71; White et al. 2021a). There is also a new effective population size estimate for the Pee Dee River spring (n = 66) and fall (n = 50) spawning runs, amounting to 13.5 (11.9-15.3) and 82 (60.3-122.1), respectively (White 2021b). Also, updating Hightower (2015), the ASMFC (2017a) produced an updated survival estimate for the entire Carolina DPS, suggesting Atlantic sturgeon survival rates are approximately 78% (95% CL, 39-99%).

Relatedness of known spawning populations was also assessed for the Carolina DPS, both in terms of its relationships to other populations outside of the DPS and within. Once the York River is isolated as being unique and different from all other southeastern populations, those populations then break into two groups with a bit of overlap. One group is the Albemarle Complex, Pee Dee spring run, Pee Dee fall run, Edisto spring run, Ogeechee spring run, and Satilla river populations while the other group is the Albemarle Complex, Pee Dee fall run, Edisto fall run, Savannah, Ogeechee fall run, and Altamaha populations (White 2021b). When compared amongst each other further, those groupings break out into the Albemarle Complex, Pee Dee spring run, and Pee Dee fall run separate from the rest of the southeastern rivers (White 2021b).

As mentioned in the discussion of the New York Bight DPS sturgeon distribution, the Carolina DPS made up 30.7% of detections between Cape Cod and Cape Hatteras. This DPS also makes up 6.2% of detections south of Cape Hatteras (Kazyak 2021). From Cape Cod to Florida, Carolina DPS fish were most likely to be encountered in nearshore waters. Rulifson (2020), relying on acoustic telemetry, showed that, similar to what has been documented for New York Bight and Chesapeake Bay DPS fish, Carolina DPS sturgeon move inshore and offshore seasonally. The greatest number of detections along the North Carolina Atlantic Coast occur from November to April (Rulifson 2020).

7 Environmental Baseline

Environmental baseline is defined as, "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. The environmental baseline includes the past and present impacts of all Federal, State, or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of State or private actions which are contemporaneous with the consultation in process. The impacts to listed species or designated critical habitat from Federal agency activities or existing Federal agency facilities that are not within the agency's discretion to modify are part of the environmental baseline." (50 C.F.R. 402.02). The environmental baseline for this Opinion includes the effects of several activities that affect the survival and recovery of the listed species in the action area. The following information summarizes the primary human and natural phenomena in the action area that are believed to affect the status and trends of Atlantic and shortnose sturgeon and the probable responses of the sturgeon to these phenomena.

7.1 Bycatch

Overutilization of Atlantic sturgeon from directed fishing caused initial severe declines in Atlantic sturgeon populations in the Southeast, from which they have not rebounded. Further, continued overutilization of Atlantic sturgeon as bycatch in commercial fisheries is an ongoing impact to the South Atlantic DPS of Atlantic sturgeon; bycaught sturgeon have a 95% probability of being from this DPS. Shrimpers are responsible for 50% of all bycatch in GA waters. Atlantic and shortnose sturgeon can also be caught in gill nets, but gill nets and purse seines account for less than 2% of the annual bycatch. There are approximately 1.15 million recreational anglers in the state and recreational fishing also contributes to bycatch. 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 (1997a) calculated that Atlantic sturgeon can only withstand the annual loss of up to 5% of their population to bycatch mortality without suffering population declines. Kahnle (1998) calculated 3% annual loss to a population before the population is unable to remain at stable or increasing population levels. Stein (2004a) investigated fishing records collected by onboard observers to calculate Atlantic sturgeon bycatch and mortality rates for each fishing gear. Atlantic sturgeon bycatch was highest for sink gill nets in specific areas of the coast. The observed immediate mortality rates of Atlantic sturgeon captured in sink gill nets and drift gill nets were 22% and 10%, respectively. Fisheries using this type of gear account for a high percentage of Atlantic sturgeon bycatch. 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.

Directed harvest of Atlantic and shortnose sturgeon is prohibited by the ESA. Shortnose sturgeon have not been subject to a commercial fishery since 1967 and Atlantic sturgeon have not been commercially fished since ASMFC (inshore) and NMFS (offshore) moratoria on their harvest in 1998 and 1999, respectively (Figure 6). However, sturgeon are captured incidentally in various fisheries along the east coast (ASSRT 2007a; Beardsall 2013).

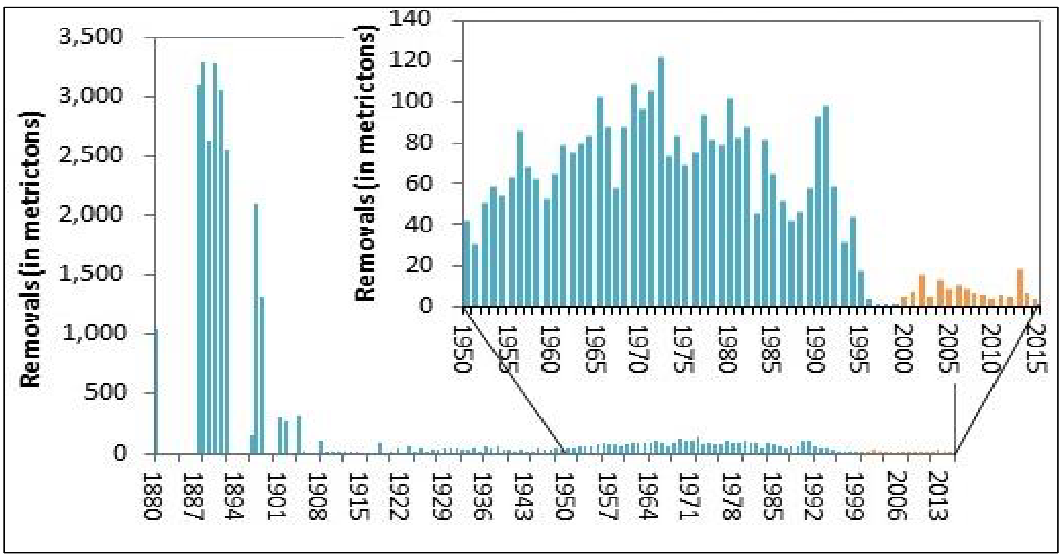

Figure 6. Atlantic sturgeon landings over time (ASMFC 2017a).

In most cases, fish are returned to the river, presumably unharmed; however, some reports of mortality indicate it ranges from 8 to 20% (Bahn 2012; Collins 2000a; Kynard 2016). Bahn (2012) found that captures of shortnose sturgeon in commercial shad nets had implications for spawning migrations in the Cape Fear River, and Collins (2000a) reported that these incidental captures caused abandonment of spawning migrations in the Ogeechee River, GA. The GA rivers provide unimpeded migratory corridors for many commercially important species.

Bycatch in the Savannah River commercial shad fishery has been substantial, with one fisherman catching at least 123 adult sturgeon by himself in a single shad season that, unfortunately, coincided with the shortnose sturgeon spawning migration (NMFS 2010). During a three-year study 2007-2009 (Bahn 2010), the total estimated bycatch of shortnose sturgeon was 71, 53, and 498 fish, respectively.

7.2 Poaching

Both species of sturgeon are likely targeted by poachers throughout their range. Poaching's impact to individual population segments is unknown. Poaching may be more prevalent where legal markets for sturgeon exist from importations, commercial harvest, or commercial culture. One such market exists at the mouth of the Altamaha River. Incidents of poaching have been documented by law enforcement in Virginia, South Carolina and New York (ASSRT 2007c). In some cases, the fish were killed for personal consumption and, in others, they were intended for the black market. The magnitude of removals due to poaching is unknown but, because the 50% egg-per-recruit (EPR) rates are so low, even small levels of poaching could hinder stock recovery.

7.3 Ship Strike

Historical accounts of Atlantic sturgeon vessel interactions date back 150 years (Lossing 1866; Ryder 1890) and involved sturgeon jumping out of the water and primarily impacting sailing vessels or slow-moving steam ships. In recent years, there has been increased attention on the mortality of marine megafauna resulting from vessel strikes. Ship-related deaths have been identified as a significant source of mortality for Atlantic sturgeon (NOAA 2012). Sturgeon are generally benthically-oriented unless they are migrating. Regardless of orientation in the water column, they are vulnerable to vessel strike from large vessels and are most vulnerable to strike from recreational vessels when migrating. As Atlantic sturgeon first move into a spawning river, they tend to follow the thalweg (the line that connects the lowest points in a valley or river channel, and thus the line of fastest flow or deepest water along a river's course) and be near the surface. Shortnose sturgeon also migrate upriver for spawning and back downriver after spawning. Recreational vessel strike is less likely during times of the year when sturgeon would be intentionally benthically-oriented (foraging, spawning). The likelihood of recreational vessel strike is always relatively small; however, the cumulative volume of vessels increases the risk to a point where those strikes are major threats to the species. There are numerous documented sturgeon deaths from encounters with large vessel propellers (Balazik 2012b; Brown 2010; Demetras 2020) and many documented injuries from recreational vessel strikes (J. Kahn, NMFS, unpublished data). In an analysis of vessel interactions with acoustically tagged Atlantic sturgeon, Balazik (2012b) showed that ship strike deaths were due to deep ocean cargo vessels in narrow up-estuary sections of the James River, particularly in an area with an engineered shipping lane, which large sturgeon used as movement corridor.

Multiple studies have shown that Atlantic sturgeon may not move away from vessels or avoid areas with vessel activity (Balazik 2020; Balazik 2017a; Barber 2017; DiJohnson 2019; Reine 2014). The best available information indicates that sturgeon are struck by small (e.g., recreational) as well as large vessels. However, examination of the salvaged carcasses suggest that most fatalities are the result of the sturgeon being struck by a large vessel causing either blunt trauma injuries (e.g., broken scutes, bruising, damaged soft tissues) or propeller injuries (e.g., decapitation, complete transection of other parts of the sturgeon body, or deep slices nearly through the body depth of large sturgeon) (Balazik 2012b). Balazik (2012b) 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 2012b). Under the assumption that Atlantic sturgeon do not modify their behavior as a result of vessel noise, Balazik (2012b) 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 2012b).

At present, we understand that ship strike mortality is a problem in some systems (e.g., important spawning rivers such as the Savannah, James, York, Delaware, and Hudson Rivers); however, understanding of the true population level impacts (e.g., the extent and magnitude) remains limited due to our reliance on carcass reports in most systems. Reported ship strike deaths in the James River have numbered more than 10 in some years, which could represent a significant fraction of the adult population. The factors relevant to determining the risk to sturgeon from vessel strikes are currently unknown, but are likely related to size and speed of the vessels, navigational clearance (i.e., depth of water and draft of the vessel) in the area where the vessel is operating, and the behavior of sturgeon in the area (e.g., foraging, migrating, etc.).

7.4 Aquatic Invasive Species

Introduced aquatic invasive species are one of the main sources of risk to ESA-listed species, second only to habitat loss (Wilcove 1998). They have been implicated in the endangerment of 48% of the species listed under ESA (Czech 1997). The USFWS considers invasive species to be a significant contributing factor in determining the “threatened” or “endangered” status of many native species (OTA 1993; Ruiz 1997). Invasive species affect aquatic environments in many different ways. They can reduce native species abundance and distribution, and reduce local biodiversity by out-competing native species for food and habitat. They may displace food items preferred by native predators, disrupting the natural food web. They may also replace depleted food resources and improve condition of listed species. They may alter ecosystem functions. Exotic plants can clog channels and interfere with recreational fishing and swimming. Introduced non-native algal species combined with nutrient overloading may increase the intensity and frequency of algal blooms. An overabundance of algae can lead to depleted DO.

GA has identified a number of aquatic invasive fish species that compete with native species and degrade ecological communities. Blueback herring (*Alosa aestivalis*), Alabama bass (*Micropterus henshalli*), Northern Snakehead (*Channa argus)* and Asian tiger shrimp (*Penaeus monodon*) were introduced. The aquatic plants Giant Salvinia (*Salvinia molesta*) and Hydrilla (*Hydrilla verticillata*) impair GA waterways as does the Island Apple Snails (*Pomacea insularum*), which devours wetland vegetation. Blue catfish (*Ictalurus furcatus*), flathead catfish (*Pylodictis olivaris*), Asian swamp eel (*Monopterus albus*) and Oriental weather loach (*Misgurnus anguillicaudatus*) have all been reported in GA waters including the rivers of the action area.

7.5 Aquatic Impairments

GA’s most recent EPA-approved 303(d) list of impaired waters is for the year 2022. At that time 10,092 miles out of 16,630 miles of assessed rivers and streams were identified as threatened or impaired, with the top five impairment causes being pathogens; heavy metals, including mercury; impaired fish communities attributed to an unknown stressor; low DO; and impaired benthic macroinvertebrate communities attributed to an unknown stressor. One hundred six out of 520 total miles of coastal streams and rivers were also listed as impaired by pathogens and/or low DO (GADNR 2022b). The assessments that generate the 303(d) list of impaired waters do not include all possible substances that may impair a water body. The pollution impact on GA streams has radically shifted over the last several decades. Streams are no longer dominated by untreated or partially treated sewage discharges that resulted in little or no oxygen and little or no aquatic life. The sewage is now treated, oxygen levels have returned, and fish have followed. However, another source of pollution affecting GA streams is nonpoint sources that include mud, litter, bacteria, pesticides, fertilizers, metals, oils, detergents, and a variety of other pollutants being washed into rivers and lakes by stormwater. Even stormwater runoff itself can detrimentally alter a stream's hydrology, flow rate, temperature, and other physical and biological characteristics.

7.5.1 Water Quality and Contaminants

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 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 Atlantic sturgeon in the Southeast. Sturgeon are more highly sensitive to low DO than other fish species (Niklitschek 2010; Niklitschek 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 (Gunderson 1998; Niklitschek 2010; Niklitschek 2005; Niklitschek 2009). Low DO is modifying sturgeon habitat in the Savannah River due to dredging, and nonpoint source inputs are causing low DO in the Ogeechee River and in the Saint Mary's River, which completely eliminates juvenile nursery habitat in summer. Low DO has also been observed in the Saint 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 (ASSRT 2007c; Cooper 1989; Sindermann 1994).

Heavy metals and organochlorine compounds accumulate in sturgeon tissue, but their long-term effects are not known (Ruelle 1992; Ruelle 1993). Elevated levels of contaminants, including chlorinated hydrocarbons, in several other fish species are associated with reproductive impairment (Cameron 1992; Drevnick 2003; Hammerschmidt 2002; Longwell 1992), reduced egg viability (Billsson 1998; Giesy 1986; Mac 1991; Matta 1997; Von Westernhagen 1981), reduced survival of larval fish (Berlin 1981; Giesy 1986), delayed maturity (Jorgensen 2004), and posterior malformations (Billsson 1998). Pesticide exposure in fish may affect antipredator and homing behavior, reproductive function, physiological development, and swimming speed and distance (Beauvais 2000; Moore 2001; Scholz 2000; Waring 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 2007c). 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 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 (female hormone medications) 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 (Culp 2000; Folmar 1996; Wallin 2002; Wildhaber 2000) and settle to the bottom, affecting benthic foragers to a greater extent than pelagic (Geldreich 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 1996). Although the effects of these contaminants are unknown in shortnose and Atlantic sturgeon, Omoto (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.

7.5.2 Water Quantity

Water allocation issues are a growing threat in the action area and exacerbate existing water quality problems. Taking water from a river basin fundamentally and irreversibly alters natural water flows, which can affect DO levels, temperature, and the ability of the basin of origin to assimilate pollutants. 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 GA 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 GA rivers and will likely be compounded in the future by population growth and potentially by climate change which is further explored in section 7.7.

7.5.3 Human Alterations of Surface Waters

Almost all lakes in GA are artificially made reservoirs. An EPA estimate of over 4,400 dams exceeding 6 ft makes GA the state with the highest density of dams in the southeast. There are also many other smaller dams throughout the state, so it is difficult to estimate the aggregate impact of fragmented riverine systems and the attendant disruptions in biogeochemical processes, biological communities, and ecological function. For example, only four dams on the Oconee River are large enough to be included in the EPA National Dam Inventory, but there are actually 83 impoundments in the river basin. The University of GA River Basin Science and

Policy Center (UGA River Basin Science and Policy Center 2002) describes the detrimental impacts of reservoirs as including:

1. Reservoirs increase water loss through evaporation, resulting in a net loss of water from the river system.
2. Reservoirs disrupt downstream transport of sediment. This effect can have localized benefits but can also result in degradation of aquatic habitat for fish, downstream erosion, and loss of property.
3. Reservoirs can decrease a river system's capacity to assimilate waste and thereby cause downstream water quality problems.
4. Dams block flows and create conditions that most native fish cannot tolerate within reservoirs and downstream of them.
5. Reservoirs impede movement of migratory species and prevent natural recolonization of streams by other fish and organisms after droughts or other disturbances.
6. Reservoirs alter highly productive floodplain forests and reduce their contribution to the food base, water quality, and habitat of adjacent rivers and streams.

The most critical impacts on the imperiled Atlantic sturgeon and shortnose sturgeon discussed in this opinion is the restriction of migration pathways and impacts on water quality. PBFs of the designated critical habitat for Atlantic sturgeon include water quality conditions, especially in the bottom meter of the water column, between the river mouths and spawning sites with temperature and oxygen values that support spawning, annual and inter-annual adult, subadult, larval, and juvenile survival, and larval, juvenile, and subadult growth, development, and recruitment. Specifically, appropriate temperature and oxygen values will vary interdependently, and depending on salinity and temperature in a particular habitat. For example, 6.0 mg/L DO or greater likely supports juvenile rearing habitat, whereas DO less than 5.0 mg/L for longer than 30 days is less likely to support rearing when water temperature is greater than 25°C. In temperatures greater than 26 °C, DO greater than 4.3 mg/L is needed to protect survival and growth. Temperatures of 13 to 26 °C are likely to support spawning 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. 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 2003; Marcy 2005; USFWS 2003; Wrona 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 the fish need is inaccessible as a result of the NSBL&D.

7.6 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 2000). According to Smith (1997b), 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 DO and upriver movement of the salt wedge, restricting spawning habitat. Dredging is also modifying nursery and foraging habitat in the Saint 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 US Army Corps of Engineers (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 16 Atlantic sturgeon were killed by dredging from 2016-2018 and, as of March 2023, an additional 19 (4 [FY 2021], 9 [FY 2022], and 6 [to date in FY 2023]) have been killed in dredging operations authorized under the South Atlantic Regional Biological Opinion (SARBO) (NMFS 2020). 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 areas captured and relocated 215 Atlantic sturgeon from 2016-2018. As of March 2023, an additional 109 Atlantic sturgeon (17 [FY 2021], 39 [FY 2022], and 53 [to date in FY 2023]) have been relocated via relocation trawlers authorized under the SARBO. Seasonal restrictions on dredging operations have been imposed in some rivers for some species; for 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. Additional restrictions on dredging in specific rivers apply during summer months when water temperatures increase and DO concentrations decrease. These restrictions are specifically intended to protect sturgeon.

7.7 Climate Change

Ocean temperature in the U.S. Northeast Shelf and surrounding Northwest Atlantic waters has increased faster than the global average over the last decade (Pershing 2015). New projections for the U.S. Northeast shelf and Northwest Atlantic Ocean suggest that this region will warm two to three times faster than the global average (Saba 2016). Global climate change affects all components of marine ecosystems, including human communities. Physical changes that are occurring and will continue to occur to these systems include sea-level rise, changes in sediment deposition; changes in ocean circulation; increased frequency, intensity and duration of extreme climate events; changing ocean chemistry; and warming ocean temperatures. A first-of-its-kind climate vulnerability assessment, conducted on 82 fish and invertebrate species in the Northeast U.S. Shelf, concluded that Atlantic sturgeon from all five DPSs were among the most vulnerable species to global climate change (Hare 2016). Increased water temperatures as a result of climate change could mean a decrease in the amount of DO in surface waters. Atlantic and shortnose 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 et al. Secor (1995) noted a correlation between low abundances of sturgeon during this century and decreasing water quality caused by increased nutrient loading and increased spatial and temporal frequency of hypoxic (low oxygen) conditions. Of particular concern is the high occurrence of low DO coupled with high temperatures in the river systems throughout the range of the Carolina DPS in the Southeast. Sturgeon are more highly sensitive to low DO than other fish species and low DO in combination with high temperature is particularly problematic for Atlantic sturgeon. Studies have shown that juvenile Atlantic sturgeon experience lethal and sublethal (metabolic, growth, feeding) effects as DO drops and temperatures rise (Niklitschek 2005). Sturgeon are already susceptible to reduced water quality resulting from various factors: inputs of nutrients; contaminants from industrial activities and non-point sources; and interbasin transfers of water and climate change is likely exacerbating the challenges to sturgeon.

Regionally, the Southeast has experienced an annual average increase in temperature of 0.46°F when comparing the present (1986-2016) to the first half of last century (1901-1960). This increase is smaller than any other region in the United States (Vose 2017). The temperature of the hottest day in any given year has decreased by 1.49°F since 1900 in the Southeast (Vose 2017). Long-term observations illustrate changes in temperature can occur 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).

Annual precipitation in the Southeast has increased by 0.46 in per decade since 1950 (NCDC 2022). The number of extreme rainfall events is increasing, with a large increase in the number of such events reported in the Southeast during the fall (Easterling 2017). Mean precipitation in the Southeast is projected to increase between 0-20% relative to mean precipitation from 1976-2005, depending on the season (Easterling 2017). However, even in locations where greater precipitation is projected, those increases are expected to be relatively small in comparison to natural variation already observed (Easterling 2017).

Temperatures in GA have risen by 0.8°F, about half of the warming for the contiguous United States since the beginning of the 20th century, but the warmest consecutive 5-year interval was 2016–2020 (Frankson 2022). GA has recently experienced several warm years: 2016, 2017, and 2019 were the three hottest on record (Frankson 2022). Under a higher emissions scenario

(RCP8.5[1]), historically unprecedented warming is projected during this century (Frankson 2022). Even under a lower emissions scenarios (RCP4.5), annual average temperatures are projected to most likely exceed historical record levels by the middle of the century (Frankson 2022). However, a large range of temperature increases is projected under both pathways and, under the lower pathway, a few projections are only slightly warmer than historical records.

GA receives abundant precipitation throughout the year, with totals ranging from >70 in in the mountainous northeastern corner of the state to around 45 in in the southeastern and central portions (Frankson 2022). The state has experienced periods of drought since 2000. Periods of notable drought occurred in 2000-2003, 2007-2008, and 2010-2013, where between 50-100% of the state experienced drought ranging in intensity from "abnormally dry" to "exceptional" (NDMC 2018). Another, shorter, period of drought struck in 2016-2017, again with 50-100% of the state experienced drought ranging in intensity from "abnormally dry" to "exceptional (NDMC 2018).

While GA has periodically undergone periods of drought, drought frequency appears to be increasing (Ruhl 2003). Future precipitation projections for GA are uncertain (Frankson 2022). Even if annual precipitation remains constant, higher temperatures will increase evaporation rates and decrease soil moisture during dry spells, leading to greater drought intensity (Frankson 2022). 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.

Increases in water temperature and changes in seasonal patterns of runoff will very likely disturb Atlantic Sturgeon critical habitat and affect habitats in 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. 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 2008).

7.8 Incidental Take Permits/ Research Permits

ITP are included in the ESA Section 10(a)(1)(b) permits for taking of endangered or threatened species incidental to (not the purpose of) an otherwise lawful activity. Current and active ITP for shortnose and Atlantic sturgeon are listed below:

Atlantic and shortnose sturgeon have been the focus of field studies since the 1970s. The primary purposes of most studies are for monitoring populations and gathering data for physiological, behavioral and ecological studies. Over time, OPR has issued dozens of permits for take of shortnose sturgeon within its range for a variety of activities, examples of which include capture, handling, biopsy sampling, lavage, laparoscopy, attachment of scientific instruments, and

[1]RCP or representative concentration pathways are climate change scenarios to project future greenhouse gas concentrations. These pathways (or trajectories) describe future greenhouse gas concentrations (not emissions) and have been formally adopted by the IPCC.

release. Research on sturgeon in the U.S. is carefully controlled and managed so that it does not operate to the disadvantage of the species. As such, all scientific research permits are also conditioned with mitigation measures to ensure that the research impacts target and non- target species as minimally as possible.

The following table (Table 6) is a list of currently active scientific permits for Atlantic sturgeon and shortnose sturgeon.

Table 6. Scientific permits for Take of Sturgeon SP in GA

23096	Life history, population dynamics, and seasonal habitat use of Atlantic and Shortnose Sturgeon in the Southeastern US.	University of GA
	Date Issued: 2020-02-01 **Date Expired:** 2030-01-31	
	Location: Savannah River / Mouth to the New Savannah Bluff Lock and Dam, plus the 12 miles upstream to the Augusta diversion dam. **Species:** Atlantic Sturgeon, South Atlantic (Egg/ Larvae; Juvenile; Subadult/ Adult);Shortnose Sturgeon (Egg/ Larvae; Juvenile; Subadult/ Adult) **Take Actions:** Capture/Handle/Release; Import/export/receive only; Intentional (Directed) Mortality; Unintentional mortality **Capture Methods:** Egg mat; Net, Gill **Procedures:** Anesthetize (e.g. MS-222); Collect eggs (wild); Export; Instrument, internal (e.g., VHF, sonic); Laparoscopy ; Mark, Floy T-bar; Mark, PIT tag; Measure; Photograph/Video; Sample, blood; Sample, fin clip (genetic); Sample, fin ray clip (leading ray); Sample, fin ray clip (second ray); Sample, gonad biopsy; Sample, other tissue ; Sample, scute; Unintentional mortality; Weigh	
	Location: Ogeechee River / Ogeechee River: Mouth to RM 150, including Canoochee River at its confluence with the Ogeechee upstream 50 miles. **Species:** Atlantic Sturgeon, South Atlantic (Egg/ Larvae; Juvenile; Subadult/ Adult);Shortnose Sturgeon (Egg/ Larvae; Juvenile; Subadult/ Adult) **Take Actions:** Capture/Handle/Release; Intentional (Directed) Mortality; Unintentional mortality **Capture Methods:** Egg mat; Net, Gill **Procedures:** Anesthetize (e.g. MS-222); Collect eggs (wild); Instrument, internal (e.g., VHF, sonic); Laparoscopy ; Mark, Floy T-bar; Mark, PIT tag; Measure; Photograph/Video; Sample, blood; Sample, fin clip (genetic); Sample, fin ray clip (leading ray); Sample, fin ray clip (second ray); Sample, gonad biopsy; Sample, other tissue ; Sample, scute; Unintentional mortality; Weigh	
	Location: Altamaha River / Altamaha River system, including major tributaries: - Mainstem Altamaha River, from mouth to the confluence of the Oconee River and	

	Ocmulgee River (at RKM 215) -Oconee River, from confluence to Sinclair Dam - Ocmulgee River, from confluence to Juliette D **Species:** Atlantic Sturgeon, South Atlantic (Egg/ Larvae; Juvenile; Subadult/ Adult);Shortnose Sturgeon (Egg/ Larvae; Juvenile; Subadult/ Adult) **Take Actions:** Capture/Handle/Release; Import/export/receive only; Intentional (Directed) Mortality; Unintentional mortality **Capture Methods:** Egg mat; Net, Gill **Procedures:** Anesthetize (e.g. MS-222); Collect eggs (wild); Export; Instrument, internal (e.g., VHF, sonic); Laparoscopy ; Mark, Floy T-bar; Mark, PIT tag; Measure; Photograph/Video; Sample, blood; Sample, fin clip (genetic); Sample, fin ray clip (leading ray); Sample, fin ray clip (second ray); Sample, gonad biopsy; Sample, other tissue ; Sample, scute; Sample, scute spine; Unintentional mortality; Weigh
	Location: Satilla River / Satilla River from mouth to RKM 150 **Species:** Atlantic Sturgeon, South Atlantic (Egg/ Larvae; Juvenile; Subadult/ Adult);Shortnose Sturgeon (Egg/ Larvae; Juvenile; Subadult/ Adult) **Take Actions:** Capture/Handle/Release; Intentional (Directed) Mortality; Unintentional mortality **Capture Methods:** Egg mat; Net, Gill **Procedures:** Anesthetize (e.g. MS-222); Collect eggs (wild); Instrument, internal (e.g., VHF, sonic); Laparoscopy ; Mark, Floy T-bar; Mark, PIT tag; Measure; Photograph/Video; Sample, blood; Sample, fin clip (genetic); Sample, fin ray clip (leading ray); Sample, fin ray clip (second ray); Sample, gonad biopsy; Sample, other tissue ; Sample, scute; Unintentional mortality; Weigh
	Location: St. Mary's River / St. Mary's River from mouth to RKM 125, including Cumberland Sound and Kings Bay **Species:** Atlantic Sturgeon, South Atlantic (Egg/ Larvae; Juvenile; Subadult/ Adult);Shortnose Sturgeon (Egg/ Larvae; Juvenile; Subadult/ Adult) **Take Actions:** Capture/Handle/Release; Intentional (Directed) Mortality **Capture Methods:** Egg mat; Net, Gill **Procedures:** Anesthetize (e.g. MS-222); Collect eggs (wild); Instrument, internal (e.g., VHF, sonic); Laparoscopy ; Mark, Floy T-bar; Mark, PIT tag; Measure; Photograph/Video; Sample, blood; Sample, fin clip (genetic); Sample, fin ray clip (leading ray); Sample, fin ray clip (second ray); Sample, gonad biopsy; Sample, other tissue ; Sample, scute; Weigh
	Location: St. Johns and Nassau Rivers / St. Johns River: from mouth to Welaka, FL Nassau River: Mouth to RKM 65 **Species:** Atlantic Sturgeon, South Atlantic (Egg/ Larvae; Juvenile; Subadult/

	Adult);Shortnose Sturgeon (Egg/ Larvae; Juvenile; Subadult/ Adult) **Take Actions:** Capture/Handle/Release; Intentional (Directed) Mortality **Capture Methods:** Egg mat; Net, Gill **Procedures:** Anesthetize (e.g. MS-222); Collect eggs (wild); Instrument, internal (e.g., VHF, sonic); Laparoscopy ; Mark, Floy T-bar; Mark, PIT tag; Measure; Photograph/Video; Sample, blood; Sample, fin clip (genetic); Sample, fin ray clip (leading ray); Sample, fin ray clip (second ray); Sample, gonad biopsy; Weigh
	Location: Fisheries Independent Studies Locations: US waters from the VA/NC border south to the GA/FL border (Directed Research, Capturing and Sampling Atlantic Sturgeon and Sea Turtles) **Species:** Atlantic Sturgeon (Subadult/ Adult);Green sea Turtle (Juvenile/ Subadult/ Adult);Hawksbill sea Turtle (Juvenile/ Subadult/ Adult);Kemp's ridley sea Turtle (Juvenile/ Subadult/ Adult);Leatherback sea Turtle (Juvenile/ Subadult/ Adult);Loggerhead sea Turtle, Northwest Atlantic Ocean DPS (Juvenile/ Subadult/ Adult);Unidentified Sea Turtle (Juvenile/ Subadult/ Adult) **Take Actions:** Capture/Handle/Release; Unintentional mortality **Capture Methods:** Net, Gill; Net, Tangle; Net, trawl; Other **Procedures:** Mark, flipper tag; Mark, PIT tag; Measure; Photograph/Video; Sample, fin clip (genetic); Sample, skin biopsy; Unintentional mortality; Weigh

Permitted researchers are required to notify the appropriate NMFS Regional Office at least two weeks in advance of any planned field work so that the Regional Office can facilitate this coordination and take other steps to minimize disturbance from multiple permits. A no jeopardy opinion was issued for each research permit, which are described above in Table 6.

8 EFFECTS OF THE ACTION

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 but that are not part of the 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 C.F.R. 402.02).

This section of the biological opinion considers the stressor of bycatch in commercial gill nets where exposure is the interaction of sturgeon with the net and the response is the probable outcome, including live releases, injuries, and mortalities of the sturgeon that are caught.

In this section of the Opinion, we assess the probable effects resulting from the proposed issuance of the ITP under 10(a)(1)(B) of the ESA and possible implementation of the Conservation Plan and other permit conditions, which would allow the incidental take of Atlantic and shortnose sturgeon in the action area associated with the commercial shad fishery. We also summarize the results of studies that have examined effects of various fisheries on Atlantic and shortnose sturgeon. We rely on these summaries of the literature to determine how individual sturgeon are likely to respond upon being captured in commercial shad gill nets. Based on this body of information, we then assess the risks posed first to particular sturgeon populations, then to the species as it is listed (shortnose sturgeon species or Atlantic sturgeon DPSs).

The following sections provide estimates of the number of shortnose and Atlantic sturgeon expected to interact with gill nets, estimates of the DPSs to be affected, a discussion of the stress caused by bycatch, and the probability of harm and harassment.

8.1 Exposure Analysis

The specific stressors associated with the proposed action result from incidental capture in drift gill nets and set gill nets, handling and release of captured individuals, and monitoring to include PIT tagging and genetic sampling of captured individuals prior to release. Adult shortnose sturgeon are vulnerable to incidental capture by the GA commercial shad fishery because their upstream spawning migration, from late January to March in southern rivers, coincides with the shad fishing season. Juvenile and sub-adult Atlantic sturgeon are vulnerable to incidental capture in the commercial fishery because estuaries of major East Coast rivers become their preferred foraging habitat during spring months.

However, spawning shortnose and Atlantic sturgeon are not likely to be intercepted by the fishery because of the size of gill nets used, the timing, and the location of the nets. Pre-spawn shortnose sturgeon move upstream to spawning grounds before the shad season begins (Bahr 2015). The adult shortnose sturgeon that are captured during the shad season are, therefore, non-reproductive or post-reproductive individuals. Only juvenile or sub-adult Atlantic sturgeon will be captured by the shad fishery due to the small mesh sizes used in the shad fishery.

Thorough research aimed at identifying the amount of bycatch of shortnose and Atlantic sturgeon in GA's shad fishery has only been conducted in the Altamaha River. To estimate the number of sturgeon impacted by the shad fishery in the Ogeechee and Savannah Rivers, conservative estimates must be made based on the size of the sturgeon population in the other rivers and the amount of fishing that will take place.

During the last permit period (2013 – 2022), the GADNR exceeded the 10% observation minimal threshold every year. In the Altamaha River, the percentage of observed trips based on commercial fishers reported trips has ranged from 10.95% (GADNR 2013) to 26.03% (GADNR 2022a). Over the entire 2013 – 2022 period, the GADNR observed 15.24% of the trips reported by commercial shad fishers in the Altamaha River. Catch rates of shortnose sturgeon reported by Altamaha commercial shad fishers via trip tickets between the 2013 – 2023 seasons ranged from 5 – 55 fish/year according to the GADNR Annual Incidental Take Reports (GADNR 2013; GADNR 2014; GADNR 2015; GADNR 2016; GADNR 2018; GADNR 2019; GADNR 2020; GADNR 2021; GADNR 2022a).

Since 2013, GADNR LE has issued 19 citations pertaining to shad. Of these, only one citation was issued for "fishing in closed waters," a violation that occurred in the permanently closed Ogeechee River. Collectively, the observed survival rates of sturgeon that are incidentally captured and released; the upriver closure of a significant portion of preferred sturgeon spawning habitat; and continued policing of waters by GADNR LE personnel are aiding the sustainment of sturgeon populations in GA.

Though no current estimates of Atlantic sturgeon populations for the Altamaha River are available, Bahn (2012) observed extremely low catch rates of Atlantic sturgeon in the commercial shad fishery during a 2007-2009 study, with only six Atlantic sturgeon being captured over the entire 3-year study. Due to the low catch rates an accurate estimate of total Atlantic sturgeon incidental capture could not be produced from the 2007-2009 study (GADNR 2023). Catch rates of Atlantic sturgeon reported by Altamaha commercial shad fishers via trip tickets during the 2013 – 2023 seasons ranged from 7 – 36 fish/year.

Commercial shad fishers report captured shortnose and Atlantic sturgeon monthly to the GADNR via trip tickets, and GADNR staff also record observations of Atlantic sturgeon encountered during fishery-dependent observation efforts. Fishing effort in recent years has declined dramatically from the 274 trips reported on the Altamaha River in 2013 to 37 trips reported in 2023. However, this high variability in fishing effort and associated shortnose and Atlantic sturgeon bycatch rates may continue as market conditions and other variables change. Consequently, GADNR once again proposes utilizing 3-year running averages to monitor shortnose and Atlantic sturgeon bycatch. Considering the variability in effort over the last 10 years, GADNR estimates that 3-year averages of incidental shortnose sturgeon bycatch will not likely exceed 60 fish/year in the Altamaha River. GADNR estimates that 3-year averages of incidental Atlantic sturgeon bycatch will not likely exceed 40 fish/year in the Altamaha River. This is a reduction from the 140 fish/year approved under the last permit for each species.

While the Altamaha River has historically seen the largest commercial shad fishing effort for any of GA's rivers, a smaller effort does occur on the Savannah River. Effort on the Savannah River has dramatically declined during the last permit period (2013 – 2022) from a high of 73 reported trips in 2015 to <20 trips each of the last five years (2019 – 2023). This reduction in effort is due to several factors, including reductions in available fish markets and attrition in the fishing community, among others. Catch rates of shortnose sturgeon reported by Savannah commercial shad fishers via trip tickets between the 2013– 2023 seasons ranged from 0 – 10 fish/year. The captures of 7-10 fish have been reported three times in the last five years, even with historically low levels of reported fishing effort. As such, it is estimated that 3-year averages of shortnose sturgeon incidental bycatch by GA shad fishers will not exceed 15 fish/year in the Savannah River (45 fish every three years). This is a reduction from the 70 fish/year approved in the last permit.

Captures of Atlantic sturgeon also occur on the Savannah River. Catch rates of Atlantic sturgeon reported by Savannah commercial shad fishers via trip tickets between the 2013 – 2023 seasons ranged from 0 – 23 fish/year. Similar to the aforementioned scenario observed for shortnose sturgeon, the high capture of 23 fish occurred recently, even with historically low levels of reported fishing effort. As such, it is estimated that no more than 75 Atlantic sturgeon will be captured during any 3-year period in the Savannah River. This is a reduction from the 35 fish/year approved in the last permit.

Additionally, the commercial shad regulations that were instituted January 1, 2011, including closing the upriver portions of the Altamaha River (above US Hwy 1) and the Savannah River (above US Hwy 301), have likely reduced incidental bycatch of sturgeon. On the Savannah River alone, these closures resulted in 35% less area open to commercial shad fishing.

8.2 Response Analysis

In all types of fisheries, injury and stress caused during the capture-escape process contribute significantly to post-escape mortality (Uhlmann 2015; Veldhuizen 2018). Direct and indirect mortality may occur at the time of escape (immediate mortality) or later (delayed mortality) as a result of an inability to recover from injuries or stress (Kraak 2019; Penny 2023).

In order to create and carry out efficient fisheries management plans, knowledge of the effects of fisheries capture on the physiology and post-release state of fished organisms is critically needed (Coggins Jr 2007; Frick 2010; Haxton 2019). This knowledge is necessary for the proper accounting of the total mortality associated with different fishing activities on target and non-target species.

Understanding how fish respond to various types of stressors such as gear and methods of fishing and handling the gear, is especially important for mitigation efforts (Cook 2019). Fish discarded from commercial fisheries are subjected to a variety of acute stressors, regardless of capture method. Cook (2019) defined a number of stressors related to capture and escape, such as hypoxia/air exposure, fatigue, damage, confinement and barotrauma as the fishing gear is retrieved, and predation. Among these factors, injury and exhaustion are the most damaging and common stressors encountered by sturgeon in gill net fisheries, with few options for mitigating their effects. Regardless of capture method, fish discarded from commercial fisheries are exposed to multiple acute stressors. The initial contact with fishing gear may lead to entanglement, physical trauma and/or confinement. Attempts to escape can lead to exhaustion during both capture and handling and, when on-board a vessel following capture, fish are often air-exposed and face additional trauma (e.g., crushing, mechanical injury, inexperienced handlers).

The general stress response has been described in detail for fish (Barton 2002; Ganias 2023; Tort 2011). Adaptive neuroendocrine responses are initiated the moment a stressful encounter is perceived and physiological adjustments are required at all levels of biological organization, from the molecular level to changes affecting whole-organism function (Bonga 1997; Kassahn 2009). Barton (2002) categorized this progression of responses as primary, secondary and tertiary; primary responses encompass the initial neuroendocrine changes, secondary responses relate to tissue-level adjustments (e.g., changes to respiration, osmoregulation, immune function and cellular processes), and tertiary responses involve aspects of whole-animal performance.

Acute stress in fish initially causes a rapid release of catecholamine and activates the hypothalamic–pituitary–interrenal (HPI) axis, which culminates in an increase in circulating concentrations of glucocorticoid hormones. These immediate hormonal changes then mobilize the energy required for secondary responses (Barton 2002). Increases in glucose and lactate are observed along with decreases in tissue glycogen, and changes to ion concentrations and hematological features (Barton 2002; Bonga 1997).

At this stage, the innate immune system can also become activated, increasing lysozyme activity and antibody production (Tort 2011). At the cellular level, concurrent molecular damage initiates a cellular stress response that enables the individual to temporarily tolerate or counteract the stress and shifts energy allocation from cellular growth to cellular repair (Kassahn 2009). Tertiary stress responses extend to both the organismal- and population-level. A stressed animal will modify its behavior, and lasting changes to growth, performance, reproductive potential, and disease resistance can occur (Barton 2002). This complex cascade of processes is considered an adaptive mechanism that facilitates escape from challenging situations, promotes immediate survival and enables the reestablishment of a homeostatic state (Wingfield 1998).

For fish caught as bycatch in fisheries, behavioral impairment due to stress and/or a failure to recover from the stress event can have fitness effects both directly (e.g., increased probability of predation and indirectly (e.g., impaired foraging or swimming abilities). Extensive comparative physiology research has established that the duration and magnitude of physiological disturbance following acute stress, such as a capture event, are proportional to the severity of the stressor (Wingfield 1998). Therefore, the type and duration of a stressor have consequences for the severity of response exhibited by the fish and recovery time required. Ultimately, mortality results when the magnitude and duration of the stressor overcomes the adaptive stress-coping mechanisms available to the individual.

Water quality conditions can stress sturgeon, making them more vulnerable to in-net mortality, as well as post-release mortality. Atlantic and shortnose sturgeon are sensitive to high water temperatures and low DO concentrations (Niklitschek 2009). Additionally, shortnose sturgeon and juvenile Atlantic sturgeon are sensitive to high salinities (Niklitschek 2010). These environmental conditions can also compound their response to the stress of being captured. Between January and April, water temperatures in GA rivers and along the coast should remain below 10°C, DO should be at or near saturation, and adult shortnose and juvenile Atlantic sturgeon are not expected to be captured in highly saline water. Therefore environmental conditions are not expected to affect survival of bycaught sturgeon.

Net set duration is another factor, apart from environmental factors, that may affect survival of sturgeon caught as bycatch. Set gill nets are nets that are anchored and left in the river, and checked at a later time. The GA shad fishing regulations allow nets to be set for up to five days in the Altamaha River, four days in the Savannah River, and one day in the Ogeechee River. Once a sturgeon is captured, the longer the nets remain in the water, the greater the probability of injury or mortality. Set nets are generally fished upstream and do not appear to capture many Atlantic sturgeon with six captures reported over three years (Bahn 2012). Drift nets are limited by the tide cycles and generally fished for two to four hours at a time.

Regulations in GA require that all sturgeon incidentally captured must be immediately released. Because GADNR has not observed mortalities of sturgeon during fishery-dependent efforts (2013-2023), it is anticipated that these takes will result in the temporary “harassment” of captured sturgeon but will not be detrimental to their collective long-term survival or sustainability as a population.

Capture in gill net gear can result in injury, mortality, reduced fecundity, and delayed or aborted spawning migrations of sturgeon (Collins 2000b; Ganias 2023; Moser 2000; Moser 1995; Smith 1990). Historically, when sturgeon are captured in gill nets, either for research or as unintended bycatch, adverse effects are caused by numerous factors including water temperature, low DO concentration, soak time, mesh size, net composition, and handling care.

Between 2003 and 2012, approximately 75% of the nets in these rivers were drift nets, while the other 25% were set nets. Shortnose sturgeon are primarily caught in set gill nets, which are primarily used upstream, where shortnose sturgeon are more common. Both species are captured in drift gill nets, which are used in estuaries as well as within the mainstem rivers. In monitoring between 2007 and 2009, approximately 208 shortnose sturgeon were captured in set nets each year in the Altamaha River. Because half of the river will be closed, an estimated 90 shortnose sturgeon per year will be captured in set nets. The observed mortality rate of shortnose sturgeon in shad nets has been reported as being between 2.3 and 16% (Bahn 2012; Collins 1996b). Bahn (2012) found that the annual mortality rate of shortnose sturgeon in the Altamaha River as a result of shad fishing was 2.3%, which includes a single year rate of 8% one year. Based on mortality rates reported by shad fishers and scientific researchers, approximately 1% of sturgeon caught in drift nets die.

Handling and restraining sturgeon may cause short-term stress responses, but those responses are not expected to result in pathologies because commercial fishers release sturgeon immediately after they are removed from their nets. Sturgeon may inflate their swim bladder when held out of water (Moser 2000) and if they are not returned to neutral buoyancy prior to release, they will float and be susceptible to sunburn and predation. Collins (1997a) note that as much as 20% of the shortnose sturgeon bycatch in the shad fishery are injured during capture. Bahn (2012) discussed post-release mortality without mentioning any injuries; therefore, we assume there were likely no injuries observed because they would have been an important consideration in the post-release mortality discussion. Under some conditions, pre-spawning adults will interrupt or abandon their spawning migrations after being handled (Moser 1995). While GADNR staff have observed sturgeon captured in both net types (set and drift) and a take may occur at any time while the gear is in the water, no sturgeon mortalities have been observed during the 10-year (2013 – 2023) observation effort associated with the previous ITP (GADNR 2023). This can likely be attributed to the cooler water temperatures occurring during fishing activities, which reduce the likelihood of oxygen issues for stressed fish that can occur with warm water temperatures.

We anticipate the number of sturgeon injured as bycatch to be between the number observed by Collins (1996a)in South Carolina (20%) and the number reported during monitoring of the Altamaha River by Bahn et al. (2012; 0%), resulting in no more than 10% of the sturgeon bycatch being injured.

During monitoring activities, GADNR will take genetic samples of all Atlantic sturgeon captured and PIT tag all shortnose and Atlantic sturgeon that do not have PIT tags in them. GADNR will take a small (1 cm^2) genetic tissue sample, clipped with surgical scissors from a section of soft fin rays of captured sturgeon. This sampling technique does not appear to impair the sturgeon's ability to swim and is not thought to have any long-term adverse impact (Kahn 2010). Many tissue samples have been removed according to this same protocol with no adverse effects (Wydoski 1983); therefore, NMFS does not anticipate any long-term adverse effects to the sturgeon from this activity.

PIT tags have been used with a wide variety of animal species that include fish (Brattey 2004; Clugston 1996; Dare 2003; Skalski 1998), reptiles (Cheatwood 2003; Germano 2005), birds (Boisvert 2000; Green 2004) and mammals (Wright 1998). When PIT tags are inserted into animals that have large body sizes relative to the size of the tag, empirical studies have generally demonstrated that the tags have no adverse effect on the growth, survival, reproductive success, or behavior of individual animals (Bonga 1997; Brännäs 1994; Clugston 1996). There has been reported shortnose sturgeon mortality as a result of PIT tags being too large for the fish or inserted too deeply. Golde (2012) found that 14-mm tags inserted into smaller shortnose sturgeon (150 to 220 mm total length TL) caused 40% mortality after 48 hours; however, no mortality occurred in a larger group of juvenile sturgeon measuring 250 to 330 mm TL using smaller 11.5 mm PIT tags.

GADNR is not likely to encounter small sturgeon because of the size of the mesh used in the shad fishery. However, to avoid any unintended mortality to small fish, GADNR will not PIT tag sturgeon <300 mm TL, the same size animals that have been authorized to be tagged for over 10 years in research permits resulting in no mortality. As such, the tagging of shortnose or Atlantic sturgeon with PIT tags is unlikely to have significant adverse impacts on sturgeon.

8.3 Summary

The monitoring, avoidance, and minimization measures contained in the ITP and required Conservation Plan will reduce the number of shortnose sturgeon captured by 75% from 2010 shad fishing regulation levels and prevent spawning adult shortnose sturgeon from being captured. However, due to the risks posed by capture in set and drift gill nets, 10% of fish that are captured are expected to be injured and 2.3% to suffer mortality for both shortnose and Atlantic sturgeon incidentally captured in the GA shad fishery.

Incidental capture of sturgeon in the shad fishery may have a negative impact on the individual fish captured. Reproduction or survival may be affected if there is a net reduction in the number of individuals in the entire population of the species.

In order for the proposed action to have an adverse effect on the species, the take of individual fish by the fishery would need to result in:

1. Direct mortality
2. Serious injury that would lead to mortality
3. Disruption of essential behaviors such as feeding or spawning to a degree that the individual's likelihood of successful reproduction or survival is substantially reduced.

With the fishing restrictions in the Conservation Plan and measures imposed by the permit, we anticipate, during any consecutive three-year period, no more than 180 shortnose sturgeon will be captured in the Altamaha, and 45 in Savannah River. This level of take equates to a maximum possible take during the 10-year permit period of 750 shortnose sturgeon. We anticipate, during any consecutive three-year period, no more than four shortnose sturgeon to be injured in the Altamaha, and one in Savannah Rivers. This level of take equates to a maximum possible take during the 10-year permit period of 17 shortnose sturgeon.

Using the mortality rates of 2.3% in set nets and 1% in drift nets, we expect no more than two in the Altamaha River, and one shortnose sturgeon mortality in the Savannah River during any consecutive three years. During the 10-year permit period and implementation of the Conservation Plan, that would amount to a maximum of eight shortnose sturgeon mortalities in the Altamaha and Savannah Rivers, total.

The Altamaha River has a population of approximately 6,300 shortnose sturgeon, of which, we believe as many as two or .0003%, may die during any consecutive three-year period. The

Savannah River has a shortnose sturgeon population of approximately 1,000 individuals, of which we believe as many as one, or 0.001%, will be killed by commercial shad fishing during any consecutive three-years. As many as four from the Altamaha and one shortnose sturgeon from the Savannah River will be injured by capture or handling activities but survive to be released. An unknown proportion of the injured shortnose sturgeon may succumb to post-release mortality. Post-release mortality of injured fish is not measureable because the definition of an injury is unclear and often a cut to the skin that is less severe than surgical procedures. Post-release mortality, while not measureable, is thought to be very low based on documented recaptures of previously injured sturgeon (Collins 2008).

With the fishing restrictions in the Conservation Plan and additional measures in the permit to benefit Atlantic sturgeon, during any consecutive three-year period, no more than 120 and 75 Atlantic sturgeon are expected to be captured in the Altamaha and Savannah Rivers, respectively. This level of take equates to a maximum possible take during the 10-year Conservation Plan and permit period of 730 juvenile and sub-adult Atlantic sturgeon. The juvenile and sub-adult population of Atlantic sturgeon varies from year to year. The juvenile sturgeon will be from the South Atlantic DPS while the sub-adult sturgeon may be from the South Atlantic, Carolina, Chesapeake Bay, New York Bight, or Gulf of Maine DPSs. In the only study conducted on the mixed stock relationships in GA estuarine waters comes from the St. Mary's River along the GA-FL border. Nine Atlantic sturgeon were captured, with 89% being from the South Atlantic DPS and 11% from the Chesapeake Bay DPS. Because of the fishing locations where Atlantic sturgeon will be encountered (at the mouths of rivers), the limited information available on mixed stock make up in these locations, and the variability in mixed stock composition both seasonally and annually, it is only possible to estimate a likely range for the proportions of each DPS to be encountered during this permit. The monitoring measures to be implemented as part of the Conservation Plan and permit will provide us with a better understanding of this range.

The entire shad fishery is expected to account for bycatch of no more than 750 shortnose sturgeon during the 10 years of the Conservation Plan and permit. During any consecutive three-year period, no more than 225 shortnose sturgeon will be captured.

The shad fishery is also likely to capture up to 694 South Atlantic, 146 Chesapeake Bay, 110 Carolina, 73 New York Bight, or up to 15 Gulf of Maine DPS Atlantic sturgeon during the 10-year Conservation Plan.

During any consecutive three-year period of the Conservation Plan and permit period, no more than 182 South Atlantic DPS, 39 Chesapeake Bay DPS, 39 Carolina DPS, 20 New York Bight DPS, or 4 Gulf of Maine DPS Atlantic sturgeon will be captured.

During any consecutive three-year period in the permit, we expect the breakdown of Atlantic sturgeon to be caught on Altamaha and Savannah Rivers to breakdown as detailed in Table 7. Assessing the maximum numbers that may be intercepted, no more than 195 Atlantic sturgeon will be captured during any consecutive three-year period.

We anticipate, during any consecutive three-year period, no more than 14 shortnose sturgeon to be injured in the Altamaha, and 3 in the Savannah River. This level of injurious take equates to a maximum possible injurious take during the 10-year Conservation Plan implementation under the permit period of 17 shortnose sturgeon.

Because nearly all Atlantic sturgeon are captured in drift nets, we expect no more than 1 of the 73 captured Atlantic sturgeon injured will be killed. Thus, at most, 1 South Atlantic DPS, 1 Chesapeake Bay DPS, 1 Carolina DPS, 1 New York Bight DPS, or 1 Gulf of Maine DPS Atlantic sturgeon may be killed. The total mortality during the 10-year Conservation Plan and permit period would, therefore, not exceed 1 Atlantic sturgeon.

In the Savannah River, no more than 75 Atlantic sturgeon from the South Atlantic DPS will be captured during any consecutive three-year period. The estimated mixed population proportions would be the same as for the Altamaha River represented in Table 7. No more than one mortality in each river is anticipated during any three consecutive years. While it is possible that a sturgeon from outside the South Atlantic DPS could be killed during the life of this Conservation Plan and permit period, there are no population estimates for rivers in other DPSs The loss of one juvenile or small sub-adult individual per DPS over a three-year period is not likely to have a significant impact on the future spawning population size of the affected Atlantic sturgeon DPS because of the number of juveniles produced by a single successful spawning event and the natural mortality rate being so much higher than anticipated by this ITP.

No more than 11 Atlantic sturgeon from the Altamaha and 6 from the Savannah River will be injured during any consecutive three-year period by capture or handling activities but survive to be released. The same mixed population estimates from above would apply to injured fish. Therefore, in the Altamaha River, up to 10 South Atlantic DPS, 2 Chesapeake Bay DPS, 1 Carolina DPS, 1 New York Bight DPS, and 1 Gulf of Maine DPS could be injured as incidental bycatch in the shad fishery.

As many as 2 South Atlantic DPS, 1 Chesapeake Bay DPS, 1 Carolina DPS, 1 New York Bight DPS, and 1 Gulf of Maine DPS Atlantic sturgeon may be injured in the Savannah River. An unknown proportion of the injured Atlantic sturgeon will succumb to post-release mortality.

No more than 17 South Atlantic DPS, 4 Chesapeake Bay DPS, 4 Carolina DPS, 2 New York Bight DPS, and 1 Gulf of Maine DPS Atlantic sturgeon may be injured during any three consecutive years of commercial shad fishing. No more than 2 South Atlantic DPS, 1 Chesapeake Bay DPS, 1 Carolina DPS, 1 New York Bight DPS, or 1 Gulf of Maine DPS Atlantic sturgeon would die during any consecutive three year period.

Table 7. Maximum Number of Sturgeon Incidental Captures and Distribution of Take

Species	**Total Take File No. 27551**	
Shortnose sturgeon	**750**	
Injury /mortality during catch and release	*18/7*	
Atlantic sturgeon	**730**	
Injury /mortality during catch and release	*17/8*	
Break Down By River and DPS*	**Altamaha River**	**Savannah River**

Atlantic sturgeon (*Acipenser oxyrinchus)***	**40/120/480**	**25/75/250**
Injured during catch and release	*1/3/11*	*1/2/6*
Killed during catch and release	*1/1/5*	*1/1/3*
South Atlantic DPS*	**38/114/456**	**24/71/238**
Injured during catch and release	*1/3/10*	*1/2/5*
Killed during catch and release	*1/1/5*	*1/1/2*
Chesapeake Bay DPS*	**8/24/96**	**5/15/50**
Injured during catch and release	*1/1/2*	*1/1/1*
Killed during catch and release	*1/1/1*	*1/1/1*
Carolina DPS*	**6/18/72**	**4/11/38**
Injured during catch and release	*1/1/2*	*1/1/1*
Killed during catch and release	*1/1/1*	*1/1/1*
New York Bight DPS*	**4/12/48**	**3/8/25**
Injured during catch and release	*1/1/1*	*1/1/1*
Killed during catch and release	*1/1/1*	*1/1/1*
Gulf of Maine DPS*	**1/2/10**	**1/2/5**
Injured during catch and release	*1/1/1*	*1/1/1*
Killed during catch and release	*1/1/1*	*1/1/1*
Shortnose sturgeon *(Acipenser brevirostrum)*	**60/180/600**	**15/45/150**
Injured during catch and release	*2/4/14*	*1/1/3*
Killed during catch and release	*1/2/6*	*1/1/2*
**NMFS expects the maximum intercept rate for each Atlantic sturgeon DPS to be: SA DPS 95%, CB DPS 20%, CA DPS 15%, NYB DPS 10%, And GOM DPS 2% of the total incidental captures* ***We estimate that during any three-year period, no more than 120 or 75 Atlantic sturgeon will be incidentally captured by shad fishers; however, due to the uncertainty addressed above, take estimates analyzed here represent the maximum expected contribution from any single DPS. This upper confidence estimate is based on the 9 fish assessed in the St. Mary's River, and by using information from other mixed stock locations (Bartron 2007b; Wirgin*		

2011). Sturgeon tend to migrate up and down the coast, but there is a greater concentration of sturgeon from a particular DPS in the areas nearby those spawning rivers. The further from any DPS, there is less contribution to the mixed stock composition. Using this best available science and understanding there is no equation to provide an absolute mixed stock contribution,

9 CUMULATIVE EFFECTS

Cumulative effects include the effects of future State, tribal, local or private actions that are reasonably certain to occur in the action area considered in this Opinion. Future Federal actions 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. Water withdrawal, recreation, commercial shipping, urbanization, and changes in watershed use will continue in the Altamaha and Savannah Rivers in the future. In some cases, Federal permits will be required for these impacts, but in others these actions will be at the state, tribal, or local level. As the human population grows and is expected to continue to increase within the state of GA, water withdrawal will increasingly be required for agriculture, drinking water, and vessel ballast, among others.

Several highly publicized water disputes between GA and Florida have occurred during drought conditions in the past and are likely to occur in the future.

10 INTEGRATION AND SYNTHESIS OF EFFECTS

This Opinion includes a jeopardy analysis for the endangered New York Bight DPS, Chesapeake Bay DPS, Carolina DPS, and South Atlantic DPS Atlantic sturgeon, and endangered shortnose sturgeon. As discussed, the PBFs for designated critical habitats for these DPSs of Atlantic sturgeon are not likely to be adversely affected by this action. Section 7(a)(2) of the Act and its implementing regulations require every federal agency, in consultation with and with the assistance of the Secretary, to insure that any action it authorizes, funds, or carries out, in whole or in part, in the United States or upon the high seas, is not likely to jeopardize the continued existence of any listed species. The jeopardy analysis therefore relies upon the regulatory definition of "jeopardize the continued existence of," which means "to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species" (50 C.F.R. §402.02). Recovery, used in that definition, means "improvement in the status of 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" (50 C.F.R. 402.02).

The Integration and Synthesis section is the final step in our jeopardy analysis. In this section, we add the effects of the action (Section 8) to the environmental baseline (Section 7) and the cumulative effects (Section 9), taking into account the status of the species and recovery planning (Section 6), to formulate the agency's biological opinion as to whether ESCD has insured the issuance of an ITP for GA's commercial shad gill net fishery is not likely to reduce appreciably the likelihood of both the survival and recovery of a listed sturgeon species in the wild by reducing their numbers, reproduction, or distribution.

10.1 South Atlantic DPS of Atlantic Sturgeon

The South Atlantic DPS of Atlantic sturgeon is listed as endangered and includes 10 river systems. Currently, this DPS supports six known spawning subpopulations: ACE Basin, Savannah, Ogeechee, Altamaha, Satilla, and St. Mary's. Farrae (2017b) found genetically distinct fall- and spring-spawned Atlantic sturgeon in the Edisto River (part of the ACE Basin), and genetic diversity of both groups was on the higher end of published population diversity values. The Savannah and Altamaha subpopulations are rated as health category "high" for the proposed ITP based on the following health index criteria: average adult survival rate; regular spawning; juveniles present and progressing through age classes; and relatively large estimated effective population sizes. The ACE, Ogeechee, and Satilla subpopulations are rated as health category "medium" as these systems are somewhat smaller compared to the Altamaha and Savannah, and juvenile progression through age classes has not been confirmed in these systems. There are no known major threats in any of the ten river populations within this DPS; several face minor threats, mainly water quality and bycatch. Recent studies indicate that genetically distinct populations of spring and fall-run Atlantic sturgeon can exist within a given river system (Balazik 2015; Farrae 2017b). It has yet to be determined how widespread this dual spawning strategy is among sturgeon populations coast-wide. These initial findings suggest that at least some Atlantic sturgeon populations have a higher genetic diversity and may be more resilient to environmental perturbations than originally thought. In addition, Atlantic sturgeon adult population sizes, either based on empirical census data or derived from effective population size, could be underestimates if they do not account for the dual populations that may exist in some river systems.

10.2 Gulf of Maine DPS of Atlantic Sturgeon

The GOM DPS of Atlantic sturgeon is listed as threatened and includes six river systems. The Kennebec River is the primary spawning and nursery area for GOM Atlantic sturgeon. The removal of the Edwards Dam in 1999 resulted in 17 additional miles of historical spawning habitat accessible to Kennebec River Atlantic sturgeon and improved water quality. For purposes of the proposed ITP. the Kennebec River was rated as health category "high" based on the following health index criteria: regular spawning; juveniles present and progressing through age classes; no major ongoing threats; two minor threats (water quality and impingement/entrainment); and a relatively large estimated effective population size.

10.3 The New York Bight DPS of Atlantic Sturgeon

The New York Bight DPS of Atlantic sturgeon is listed as endangered and includes seven river systems, only three of which are known spawning subpopulations: Delaware, Hudson River, with intermittent spawning in the Connecticut. Long-term surveys indicate that the Hudson River subpopulation has been stable and/or slightly increasing since 1995 in abundance (ASSRT 2007c). Some of the stressors to New York Bight DPS Atlantic sturgeon, while still present, have been reduced over the past few decades. Water quality in the Hudson has improved markedly since the 1980s and is no longer considered a major threat to this subpopulation (ASSRT 2007c). Similarly, restrictions on dredging in the upper portions of the Delaware have likely had beneficial impacts on Atlantic sturgeon spawning success. For purposes of the proposed ITP, the Hudson and Delaware populations were both rated as health category "high" based on the following health index criteria: regular spawning; juveniles present and progressing through age classes; no major ongoing threats; a few minor threats including water quality and impingement/entrainment; and relatively large estimated effective population sizes. The

10.4 Chesapeake DPS of Atlantic Sturgeon

Chesapeake DPS of Atlantic sturgeon is listed as endangered and includes seven river systems, only two of which are known spawning subpopulations (James and York rivers). A study by Balazik (2015) indicates that two races of Atlantic sturgeon repeatedly spawn during two different times (spring and fall) and places in the James River, and possibly the groups have become genetically distinct from each other. For purposes of the proposed Program, the James subpopulation is rated as health category "medium" based on the following health index criteria: regular spawning; juveniles present; one major ongoing threat due to invasive species; two minor threats (impingement/entrainment, bycatch); and a relatively large estimated effective population size. The York subpopulation is rated as health category "low" primarily for having a negative (-3 percent) population trend. Given its low health rating and small population size, a very small maximum mortality limit (five-year average of 1.24) would be initially authorized in the York River system under the proposed action. The initial maximum mortality limit could change over time with changes in population health rating or population size.

10.5 Carolina DPS of Atlantic Sturgeon

The Carolina DPS of Atlantic sturgeon is listed as endangered and includes eight river systems, only one of which is a known spawning subpopulation (Roanoke River). Smith (2015) identified fall spawning in the Roanoke River, suggesting there may be two populations (spring and fall) of spawners in this system. The Roanoke subpopulation is rated as health category "medium" for the proposed ITP based on the following health index criteria: average adult survival rate (84%); regular spawning; juveniles present and progressing through age classes; one major ongoing threat (bycatch); one minor threat (water quality); and a relatively small estimated effective population size.

10.6 Atlantic Sturgeon

We estimate that, during any three-year period, no more than 195 Atlantic sturgeon will be incidentally captured, 120 in the Altamaha and 75 in the Savannah respectively, by shad fishermen; however, due to uncertainty, take estimates analyzed here represent the maximum expected contribution from any single DPS. This upper confidence estimate is based on the nine fish assessed in the St. Mary's River and information from other mixed stock locations (Bartron 2007a; Wirgin 2015a). Sturgeon tend to migrate up and down the coast, but there is a greater concentration of sturgeon from a particular DPS in the areas nearby those spawning rivers. The further from any DPS, there is less contribution to the mixed stock composition. Using this best available science and understanding there is no equation to provide an absolute mixed stock contribution, NMFS expects the maximum intercept rate in GA waters of South Atlantic DPS sturgeon to be 95% of the total catch; the maximum intercept rate of Chesapeake Bay DPS sturgeon to be 20% of the total catch; the maximum intercept rate of Carolina DPS sturgeon to be 15% of the total catch; the maximum intercept rate of New York Bight DPS sturgeon to be 10% of the total catch; and the maximum intercept rate of Gulf of Maine DPS sturgeon to be 2% of the total catch.

Bahr (2016) estimated the Savannah River to contain 528 age-1 juveniles in 2013, 589 in 2014, and 597 in 2015. The results from that study indicate that the Savannah River population is likely the second largest within the South Atlantic distinct population segment. Within the South Atlantic DPS, the Altamaha River is widely recognized as containing the healthiest population, the estimated juvenile abundance in the Altamaha River is approximately 2,000 Atlantic sturgeon (Schueller 2010a). And in the downstream portion of the river, there are many more sub-adult Atlantic sturgeon from the Altamaha River as well as other spawning rivers along the East Coast.

As discussed in Section 8.3 and summarized in Table 7, we anticipate a low number of captured Atlantic sturgeon, largely from the South Atlantic DPS, to die as a result of capture in the GA shad fishery. In addition, we anticipate captured Atlantic sturgeon, largely from the South Atlantic DPS, will be injured or experience stress as a result of bycatch and release, as well as associated tagging and tissue sampling (Table 7). These individuals, if sexually mature, may experience a loss of reproductive potential while recovering from exposure to stressors. Thus, there will be a permanent loss in reproductive potential if individuals are killed and a temporary loss if individuals captured and released by the fishery are adults. The death of a male would have less effect on the population than the death of a female. Loss of a sexually mature females will have an immediate effect on reproductive potential, while the effects on reproductive potential, while the effects on reproductive potential from the loss of a juvenile female might not be realized for several years. However, the amount of unintentional lethal take resulting from bycatch in the GA shad fishery would not would not affect spawning populations for several years (until that mortality would have become reproductively mature) and even then, the effect would be minimal because the natural mortality rate is so much higher, especially for non-adult sturgeon. The loss of one juvenile or small sub-adult individual per DPS over a three-year period is not likely to have a significant impact on the future spawning population size of the affected Atlantic sturgeon DPS because of the number of juveniles produced by a single successful spawning event and the natural mortality rate being so much higher than anticipated by this Incidental Take Permit.

The take of individuals, largely resulting in capture and release or harassment, is not expected to produce measureable effects on the geographic distribution of Atlantic sturgeon. Given that the majority of individuals likely to be taken by the fishery will be from the South Atlantic DPS in the Altamaha and Savannah rivers, which have high numbers and healthy populations within this DPS, and the small amount of take resulting in mortality over the 10 years of the ITP, we do not anticipate that the proposed action will reduce appreciably the likelihood of survival in the wild of Atlantic sturgeon from any of the DPSs considered in this consultation.

The vision statement in the recovery outline for Atlantic sturgeon notes that subpopulations of all five Atlantic sturgeon DPSs must be present across the historic range of the species. These subpopulations must be of sufficient size and genetic diversity to support successful reproduction and recovery from mortality events. The recruitment of juveniles to the sub-adult and adult life stages must also increase and increased recruitment must be maintained over multiple years. The action plan in the recovery outline identifies actions that include research and monitoring of human-caused sources of injury or mortality such as fisheries bycatch and vessel strikes with the goal of minimizing those impacts. Given the existing information on population trends for Atlantic sturgeon in the action area and the Conservation Plan associated with the proposed permit, including the information to be gained regarding populations of Atlantic sturgeon from sampling of bycaught fish, we do not expect the proposed ITP to impede the recovery goals for Atlantic sturgeon. Therefore, we believe the effects of the proposed action will not result in an appreciable reduction in the likelihood of recovery of the DPSs of Atlantic sturgeon considered in this opinion.

10.7 Shortnose sturgeon

We anticipate a maximum possible take during the 10-year ITP period of 750 shortnose sturgeon. The distribution of this take is projected to be 600 and 150 shortnose sturgeon incidentally bycaught by the shad fishery on the Altamaha and Savannah Rivers respectively. Some of those fish will be injured capture in a gill net or during the subsequent catch and release handling which has been estimated at 14 injuries for the Altamaha River and 3 for the Savannah River. The expected level of take will also lead to some mortality as a result of bycatch interactions beyond injury. We expect a total mortality for the life of the ITP to be no greater than 8 shortnose sturgeon. During the 10-year ITP, that would amount to a maximum of 6 and 2 shortnose sturgeon mortalities in the Altamaha and Savannah Rivers, respectively.

For shortnose sturgeon, the largest adult subpopulations are found in the Northeastern rivers (i.e., Hudson, Delaware, Kennebec and St. John). Shortnose sturgeon subpopulations in southern rivers are considerably smaller by comparison with the largest in this region occurring in the Altamaha and Savannah Rivers. Population trend estimates are available for six shortnose sturgeon spawning stocks: St John, Kennebec, Hudson, and Satilla are all decreasing slightly (-1%); Delaware and Ogeechee are stable (0%). The SSSRT evaluated the extinction risk for three shortnose subpopulations (Hudson, Cooper, and Altamaha) and concluded that the estimated probability of extinction was zero for all three under the default assumptions, despite the long (100-year) horizon and the relatively high year-to-year variability in fertility and survival rates. Regular spawning is known to occur in 12 river systems. Major threats to shortnose sturgeon, defined as threats that if altered could lead to recovery, are currently identified for four river systems: dams in the Connecticut, Santee, and Cooper rivers, and water quality in the St. Mary's River. The most prevalent minor threats to shortnose sturgeon are water quality (ten populations), bycatch (eight populations), and impingement/entrainment (six populations). Based on information from the status matrices developed in the *Biological and Conference Opinion on Proposed Implementation of Program for the Issuance of Permits for Atlantic and Shortnose Sturgeon Research and Enhancement Activities Pursuant to Section 10(a) of the ESA* (NMFS 2023), a health category rating of "high" was assigned to six shortnose sturgeon river populations: Kennebecasis, Androscoggin, Connecticut, Delaware, Savannah, and Altamaha. A "medium" health category rating was assigned to seven shortnose sturgeon river populations: St. John, Kennebec, Merrimack, Hudson, Cape Fear, Cooper, and Ogeechee rivers. Only the Satilla River was assigned a "low" health rating, based primarily on a very low estimated adult population size (100) and a slight decreasing population trend (-1%).

The Altamaha and Savannah rivers, both received a health category rating of "high" meaning the shortnose sturgeon populations of these rivers are the most able to absorb the 8 mortal takes over the next 10 years.

The Altamaha River has a population of approximately 6,300 shortnose sturgeon, of which, 600 are expected to be incidentally caught which will be approximately 9.52% of the population of the river. Of those as many as 6 or 0.095% may die during the life of the ITP but no more than 2 dead shortnose sturgeon per 3 year period or 1 dead shortnose sturgeon per year maximum.

The Savannah River has a shortnose sturgeon population of approximately 1,000 individuals, of which we believe as many as 150 or 0.15%, will be caught as incidental bycatch during the life of the ITP. Of those 4 will be injured by capture or handling activities but survive to be released. There is an expectation that incidental bycatch will result in 2 shortnose sturgeon from the Savannah River will succumb to death during the life of the ITP, with no more than 1 being killed by commercial shad fishing during any consecutive three-years.

An unknown proportion of the injured shortnose sturgeon may succumb to post-release mortality. Post-release mortality of injured fish is not measureable because the definition of an injury is unclear and often a cut to the skin that is less severe than surgical procedures. Post-release mortality, while not measureable, is thought to be very low based on documented recaptures of previously injured sturgeon (Collins 2008).

With the incidental catch of shortnose sturgeon distribution of take shown in Table 7 and noted above, the mortality of ESA listed shortnose sturgeon, when combined with the GADNR fishing restrictions in the Conservation Plan, measures undertaken by GADNR leading to a significantly reduced amount of take and their request for no lethal take in ITP application, continued monitoring of at least 10% by GADNR LE, the historical rate of observed mortality from previous ITP annual take reports, the healthy populations of shortnose sturgeon in the action area and rates for sturgeon population growth and recovery reported in the literature and estimated natural mortality rates, we determine that this action will not reduce appreciably the likelihood of both the survival and recovery of shortnose sturgeon.

11 CONCLUSION

It is NMFS's biological opinion that the issuance of ITP No. 27551 to the state of GA is not likely to jeopardize the continued existence of or adversely modify or destroy the critical habitat of shortnose sturgeon, or South Atlantic, Carolina, Chesapeake Bay, New York Bight, or Gulf of Maine DPSs Atlantic sturgeon.

NMFS determined Atlantic sturgeon critical habitat for the Gulf of Mexico DPS, New York Bight DPS, Chesapeake Bay DPS, Carolina DPS, and South Atlantic DPS is not likely to be adversely affected by the issuance of ITP No. 27551.

12 INCIDENTAL TAKE STATEMENT

Section 9 of the ESA and Federal regulations pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species, respectively, without special exemption. "Take" is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. "Harm" is further defined by regulation to include significant habitat modification or degradation that results in death or injury to ESA-listed species by significantly impairing essential behavioral patterns, including breeding, spawning, rearing, migrating, feeding, or sheltering (50 C.F.R. §222.102). NMFS has not defined "harass" under the ESA in regulation. On May 1, 2023, NMFS adopted, as final, the previous interim guidance on the term "harass," defining it as to "create the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding or sheltering." "Incidental take" is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity (50 C.F.R. §402.02). Section 7(b)(4) and section 7(o)(2) provides that taking that is incidental to an otherwise lawful agency action is not considered to be prohibited taking under the ESA if that action is performed in compliance with the terms and conditions of this incidental take statement.

12.1 Amount or Extent of Take

Section 7 regulations require NMFS to specify the impact of any incidental take of endangered or threatened species; that is, the amount or extent of such incidental taking on the species (50 C.F.R. §402.14(i)(1)(I)). For the proposed action, take is exempted for shortnose sturgeon and South Atlantic, Carolina, Chesapeake Bay, New York Bight, and Gulf of Maine DPSs Atlantic sturgeon in the Altamaha and Savannah Rivers incidental to the State of GA's otherwise lawful commercial shad fishery, as described in Table 7.

12.2 Reasonable and Prudent Measures

The measures described below are nondiscretionary, and must be undertaken by the NSF and the ESCD so that they become binding conditions for the exemption in section 7(o)(2) to apply. Section 7(b)(4) of the ESA requires that, when a proposed agency action is found to be consistent with section 7(a)(2) of the ESA and the proposed action may incidentally take individuals of ESA-listed species, NMFS will issue a statement that specifies the impact of any incidental taking of endangered or threatened species. To minimize such impacts, reasonable and prudent measures, and term and conditions to implement the measures, must be provided. Only incidental take resulting from the agency actions and any specified reasonable and prudent measures, and terms and conditions identified in the incidental take statement are exempt from the taking prohibition of section 9(a), pursuant to section 7(o) of the ESA.

Reasonable and prudent measures refer to those actions the Director considers necessary or appropriate to minimize the impact of the incidental take on the species (50 C.F.R. §402.02). NMFS believes the reasonable and prudent measures described below are necessary and appropriate to minimize the impacts of incidental take on the ESA-listed sturgeon discussed in detail in this opinion:

1. The ESCD must ensure that the GA DNR implements the Conservation Plan to mitigate and report the potential effects of the shad fishery on Atlantic and shortnose sturgeon as part of the proposed ITP for the incidental taking of fish of these species. In addition, the ESCD must ensure that the provisions of the ITP are carried out, and inform the ESA Interagency Cooperation Division if take is exceeded.

12.3 Terms and Conditions

To be exempt from the prohibitions of section 9 of the ESA and regulations issued pursuant to section 4(d), the ESCD must comply with the following terms and conditions, which implement the RPM described above. These include the take minimization, monitoring and reporting measures required by the section 7 regulations (50 C.F.R. §402.14(i)). If the ESCD fails to ensure compliance with these terms and conditions to implement the RPM applicable to their authority, the protective coverage of section 7(o)(2) may lapse.

The terms and conditions detailed below include monitoring and minimization measures where needed:

- Monitor the State of GA's compliance with the monitoring, minimization, and mitigation requirements detailed in the Conservation Plan and included in the ITP; and
- Monitor the extent of incidental take occurring under the ITP to ensure that the amount or extent of take set forth in the ITP is not exceeded. A copy of any reports on shad fishery activities and monitoring results must be provided to the ESA Interagency Cooperation Division via email at nmfs.hq.esa.consultations@noaa.gov, with the subject line "ITP 27551, OPR-2023-02969, Report."

13 Conservation Recommendations

Section 7(a)(1) of the Act directs Federal agencies to utilize their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information.

1. We recommend that the ESCD continue to prioritize research that will assist with species recovery. In particular, the ESCD should prioritize the authorization of sturgeon research that can be used to populate and/or update information in the proposed ITP's status matrices that are used to establish sturgeon maximum mortality limits. Researchers should also be encouraged to conduct research on under-studied sturgeon populations and river systems for which there is currently little available information.
2. We recommend the ESCD consider modifying the required reporting form for research permits to collect additional information that can further assist managers in protecting and conserving ESA-listed species. For example, the ESCD could request researchers provide population abundance estimates as they become available (e.g., unpublished data). Such information would not only better inform the ESCD's future issuance of research permits, but could also be used in recovery plans and five-year species status reviews.
3. We recommend that the ESCD work to establish protocols for data sharing among permitted researchers. While many researchers in the community collaborate, having a national standard for data sharing among researchers could improve the quality of research produced. Data sharing may also reduce adverse impacts to ESA-listed species and critical habitat by minimizing duplicative research efforts.
4. We recommend that the ESCD continue to work collaboratively with the NMFS's Regional Offices to organize meetings and workshops to ensure that the results of all research programs or other studies on specific threatened or endangered species are communicated and coordinated among the different investigators and other interested parties. Such meetings may also be a venue to discuss the details outlined in our reporting and data sharing conservation recommendations (# 3 and 4 above). Meeting participants should include regional species recovery coordinators, academic institutions, researchers, USFWS species experts, state agencies, and other stakeholders.

14 REINITIATION NOTICE

Under 50 CFR 402.16(a): Reinitiation of consultation is required and shall be requested by the Federal agency, where discretionary Federal involvement or control over the action has been retained or is authorized by law and:

(1) If the amount or extent of taking specified in the incidental take statement is exceeded;
(2) If new information reveals
effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not previously considered;
(3) If the identified action is subsequently modified in a manner that causes an effect to the listed species or critical habitat that was not considered in the biological opinion or written concurrence; or
(4) If a new species is listed or critical habitat designated that may be affected by the identified action."

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