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Ms. Kimberly D. Bose, Secretary
Federal Energy Regulatory Commission
888 First Street, N.E.
Washington, D.C. 20426

Ref.: FERC Project No. 516-459, Dominion Energy, Biological Opinion for the Re-licensing of the Dominion Energy Hydroelectric Project on the Saluda River in Lexington, Richland, Newberry, and Saluda Counties, South Carolina

Dear Ms. Kimberly D. Bose,

The enclosed Biological Opinion responds to your request for consultation with us, the National Marine Fisheries Service (NMFS), pursuant to Section 7 of the Endangered Species Act of 1973, as amended (16 U.S.C. § 1531 et seq.) for the above referenced action. The Opinion has been given the NMFS tracking number SER-2010-3874. Please use the NMFS tracking number in all future correspondence related to this action.

The Opinion considers the effects to shortnose sturgeon from the Federal Energy Regulatory Commission's (FERC) proposed re-licensing of the Saluda Hydroelectric Project on the Saluda River in Lexington, Richland, Newberry, and Saluda Counties, South Carolina. The Opinion is based on information provided by the FERC, Dominion Energy (previously South Carolina Electric and Gas Company), South Carolina Department of Natural Resources, and the published literature cited within. NMFS concludes that the proposed action will have no effect on any distinct population segment of Atlantic sturgeon. NMFS also concludes that the proposed action is likely to adversely affect, but is not likely to jeopardize the continued existence of shortnose sturgeon.

NMFS is providing an Incidental Take Statement with this Opinion. The Incidental Take Statement describes Reasonable and Prudent Measures that NMFS considers necessary or appropriate to minimize the impact of incidental take associated with this action. The Incidental Take Statement also specifies Terms and Conditions, including monitoring and reporting requirements with which FERC and licensee must comply, to carry out the Reasonable and Prudent Measures.



We look forward to further cooperation with you on other projects to ensure the conservation of our threatened and endangered marine species and critical habitat. If you have any questions regarding this consultation, please contact Andrew Herndon, Consultation Biologist, by phone at 727-824-5367, or by email at Andrew.Herndon@noaa.gov.

Sincerely,

Andrew J. Strelcheck
Regional Administrator

Enclosure (s):
NMFS Biological Opinion SER-2010-3874
File: 1514-22.n.

**Endangered Species Act - Section 7 Consultation
Biological Opinion**

Action Agency: Federal Energy Regulatory Commission
Project No. 516-459

Applicant: Dominion Energy

Activity: Re-licensing of the Dominion Energy Hydroelectric Project on the Saluda River in Lexington, Richland, Newberry, and Saluda Counties, South Carolina

Consulting Agency: Protected Resources Division
Southeast Regional Office
National Marine Fisheries Service

Consultation Number SER-2010-3874

Approved by: _____
Andrew Strelcheck Regional Administrator
NMFS, Southeast Regional Office
St. Petersburg, Florida

Date Issued: _____



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ACRONYMS, ABBREVIATIONS, AND UNITS OF MEASURE

CFR	Code of Federal Regulations
CI	Confidence Interval
CWHP	Catawba-Wateree River Hydro Project
DDT	Dichlorodiphenyltrichloroethane
DNA	Deoxyribonucleic Acid
DO	Dissolved Oxygen
DPS	Distinct Population Segment(s)
E	A species listed as Endangered under the ESA
EA	Environmental Assessment
ESA	Endangered Species Act
FERC	Federal Energy Regulatory Commission
FPA	Federal Power Act
FR	Federal Register
IFIM	Instream Flow Incremental Methodology
IPCC	Intergovernmental Panel on Climate Change
ITS	Incidental Take Statement
LAA	A “Likely to Adversely Affect” determination
LIP	Low Inflow Protocol
MW	Megawatt
NE	A “No Effect” determination
NLAA	A “Not Likely to Adversely Affect” determination
NMFS	National Marine Fisheries Service
NPDES	National Pollutant Discharge Elimination System
PCB	Polychlorinated Biphenyl(s)
PCE	Primary Constituent Element
PDC	Project Design Criterion(ia)
PFC	Perfluorinated Compound
RCP	Representative Concentration Pathway
RPM	Reasonable and Prudent Measure(s)
SC	South Carolina
SCDHEC	South Carolina Department of Health and Environmental Control
SCDNR	South Carolina Department of Natural Resources
SCE&G	South Carolina Electric and Gas Company
SHP	Saluda Hydropower
T&C	Term(s) and Condition(s)
TPGT	Trout Put, Grow, and Take
U.S.	United States of America
USACE	U.S. Army Corps of Engineers
USFWS	U.S. Fish and Wildlife Service
USGS	United States Geological Survey
WUA	Weighted Usable Area
YOY	Young-of-the-year

UNITS OF MEAUREMENTS

°C	degrees Celsius
Cfs	cubic feet per second
cm	centimeter(s)
ft	foot/feet
km	kilometer(s)
m	meter(s)
mg/l	milligrams per liter
rkm	river kilometer

1 INTRODUCTION

1.1 Overview

Section 7(a)(2) of the ESA, requires that each federal agency ensure that any action authorized, funded, or carried out by such agency is not likely to jeopardize the continued existence of any endangered or threatened species or result in the destruction or adverse modification of critical habitat of such species. Section 7(a)(2) requires federal agencies to consult with the appropriate Secretary in carrying out these responsibilities. The NMFS and the USFWS share responsibilities for administering the ESA. Consultations on most ESA-listed marine species and their critical habitat are conducted between the federal action agency and NMFS (hereafter, may also be referred to as we, us or, our).

Consultation is required when a federal action agency determines that a proposed action “may affect” ESA-listed species or critical habitat and can be conducted informally or formally. Informal consultation is concluded after NMFS issues a Letter of Concurrence that concludes that the action is “not likely to adversely affect” ESA-listed species or critical habitat. Formal consultation is concluded after we issue a Biological Opinion (hereafter, referred to as an/the Opinion) that identifies whether a proposed action is “likely to jeopardize the continued existence of an ESA-listed species” or “destroy or adversely modify critical habitat,” in which case Reasonable and Prudent Alternatives to the action as proposed must be identified to avoid these outcomes. An Opinion often states the amount or extent of anticipated incidental take of ESA-listed species that may occur, develops Reasonable and Prudent Measures necessary to minimize the impacts, i.e., amount or extent, of the anticipated incidental take, and lists the Terms and Conditions to implement those measures. An Opinion may also develop Conservation Recommendations that help benefit ESA-listed species.

This document represents NMFS’s Opinion based on our review of potential effects of the FERC’s proposed relicensing of Saluda Hydropower Project (SHP) owned by Dominion Energy (previously South Carolina Energy and Gas [SCEG]), and located near Columbia, South Carolina, on shortnose sturgeon. Our Opinion is based on information provided by FERC, Dominion Energy and the published literature cited within.

On July 5, 2022, the U.S. District Court for the Northern District of California issued an order vacating the 2019 regulations that were revised or added to 50 CFR part 402 in 2019 (“2019 Regulations,” see 84 FR 44976, August 27, 2019) without making a finding on the merits. On September 21, 2022, the U.S. Court of Appeals for the Ninth Circuit granted a temporary stay of the district court’s July 5 order. On November 14, 2022, the Northern District of California issued an order granting the government’s request for voluntary remand without vacating the 2019 regulations. The District Court issued a slightly amended order two days later on November 16, 2022. As a result, the 2019 regulations remain in effect, and we are applying the 2019 regulations here. For purposes of this consultation and in an abundance of caution, we considered whether the substantive analysis and conclusions articulated in the Opinion and Incidental Take Statement would be any different under the pre-2019 regulations. We have determined that our analysis and conclusions would not be any different.

1.2 Consultation History

We received your letter requesting consultation on March 26, 2010. We responded to your request on April 23, 2010, indicating that: 1) we did not concur with the “not likely to adversely affect” determination for the shortnose sturgeon; 2) the proposed project may adversely affect shortnose sturgeon; 3) formal ESA Section 7 consultation would be required; and 4) a Biological Assessment should be prepared to address a number of potential project effects on shortnose sturgeon.

On June 16, 2010, staff from FERC and NMFS as well as staff from the South Carolina Department of Natural Resources (SCDNR), and the South Carolina Electric and Gas Company (SCE&G) held a teleconference to discuss the April 23, 2010 letter. Subsequently on June 25, 2010, NMFS presented additional information regarding the historical range of shortnose sturgeon in the Saluda River. A summary of that teleconference was provided by FERC on June 22, 2010.

On August 2, 2010, FERC provided to NMFS a final Environmental Assessment (EA), which was considered a Biological Assessment for the shortnose sturgeon.

On February 6, 2012, NMFS listed as endangered both the South Atlantic Distinct Population of Atlantic sturgeon, and the Carolina Distinct Population Segment of the Atlantic sturgeon (77 FR 5914).

On March 5, 2012, FERC requested formal consultation with NMFS for Atlantic sturgeon and indicated they expected a single Biological Opinion for the relicensing that would include both shortnose and Atlantic sturgeon.

After discussions with NMFS, on March 5, 2012, FERC sent a letter indicating the proposed project would affect Atlantic sturgeon in a similar way to shortnose sturgeon. FERC concluded the proposed action, with mandatory conditions and staff’s additional measures as appropriate, are likely to adversely affect the Atlantic sturgeon and its habitat and requested formal consultation.

On September 6, 2017, NMFS sent an information request to FERC. FERC staff identified SCE&G as appropriate responders and indicated they had contacted SCE&G with the request and direction.

On October 2, 2017, NMFS inquired with both FERC and SCE&G regarding the status of the September 6, 2017 information request.

On October 4, 2017, NMFS received additional information from SCE&G regarding: 1) water quality assessment investigating dissolved oxygen, and temperature downstream of the project, 2) anticipated frequency, timing and periodicity of decreased dissolved oxygen due to increase in generation to reduce lake level prior to storm events, 3) distribution and mixing of the cooler water released from the dam downstream to the Congaree National Park; and 4) other information regarding dissolved oxygen and water temperature. In addition to providing

information, SCE&G indicated that FERC in August 2016 had issued an Additional Information Request and one item was a high inflow event analyses, including a component to simulate pre-storm generation. SCE&G indicated that FERC had given a time extension to SCE&G until December 29, 2017, to file that requested information.

On October 18, 2017, NMFS inquired about the application of the Sturgeon Protection and Adaptive Management Program (Kleinschmidt 2009) as it was uncertain if the Program was a part of the proposed action, as the industry-based survey did not capture sturgeon in the lower Saluda River.

On January 8, 2018, NMFS requested from SCE&G the High Inflow Event Analysis due December 29, 2017, to FERC. SCE&G replied the same day indicating they had asked FERC for and received a time extension until February 28, 2018.

On February 7, 2018, SCE&G met with NMFS HCD and PRD to discuss the Parr Shoals Settlement Agreement and outstanding questions on Saluda operations.

On June 4, 2018, FERC requested that SCE&G demonstrate the difference in flood inundation using the original operations guide curve generated from the 1984 license order to the proposed change in project operation in the license application.

On December 17, 2018, SCE&G provided a response to FERC's Request for Additional Information regarding the application for the new license for the Saluda Hydroelectric Project. FERC requested additional information to determine the upstream and downstream flooding effects that may occur due to the proposed change in project operation, particularly during high flow events.

In January 2019, Dominion Energy and the SCANA Corporation completed a merger. The SCANA Corporation was the parent company of SCE&G. After the merger, SCE&G began operating under the name Dominion Energy. To avoid confusion, the biological opinion refers to just "the licensee".

On March 21, 2019, NMFS participated in a call to discuss the 2018 Report on Water Quality and Aeration Operations.

2 DESCRIPTION OF THE PROPOSED ACTION AND ACTION AREA

FERC proposes to relicense the Saluda Hydropower Project (SHP), which is owned and operated by the licensee, for a period of up to 50 years.

The licensee ensures cold water is released from the Saluda Dam to provide habitat for a non-native fishery of rainbow and brown trout in the lower Saluda River. This Trout Put, Grow and Take (TPGT) area, as classified by the South Carolina Department of Health and Environmental Control (SCDHEC) supports a coldwater sport fishery for stocked trout populations and is possible because of the cooler than normal water released from the Saluda powerhouse (FERC 2010). The river receives hypolimnetic (i.e., coldwater) flows from Lake Murray via the Saluda Hydro Project. This cold water has created the opportunity for the SCDNR to establish a successful fishery for brown trout and rainbow trout. Trout are not native to South Carolina and the TPGT program relies on annual stocking of brown trout (*Salmo trutta*) and rainbow trout (*Oncorhynchus mykiss*) as managed by the SCDNR Freshwater Fisheries Section. The TPGT fishery includes the Saluda River from the Lake Murray Dam to the confluence with Broad River and SCDHEC water regulations indicate dissolved oxygen (DO) is not less than daily average 5 mg/l, a running thirty day average of 5.5 mg/l, with a low of 4.0 mg/l.

FERC staff determined the fishery relates directly to project operations by including the provisions in their recommended alternative (FERC 2010). Included in the EA is a “Trout Program” where the licensee will conduct studies to enhance the fishery. NMFS acknowledges that the TPGT Fishery is not included as a purpose of the action. However, the fishery can only exist if the licensee provides the cold water entering the lower Saluda River via the Saluda Settlement and monitors the temperature of the water to ensure appropriate habitat for the trout TPGT fishery. Thus, NMFS determined the TPGT fishery would not occur but for the proposed action and is therefore an activity caused by the proposed action. We therefore consider the consequences of the TPGT fishery to be effects of the action.

2.1 Action Area

The EA determines that because the proposed action can affect resources differently, the geographic scope for each resource may vary. The EA identified the geographic scope of the proposed action for water quality to encompass the Saluda River from Lake Murray downstream to river mile 35 on the Congaree River (about 8 miles upstream from the Congaree National Park). The geographic scope of the proposed action for water quantity identified in the EA extends from Lake Murray downstream to the confluence of the Congaree and Wateree rivers. For fishery resources, the EA identifies the geographic scope of the proposed action as the Saluda River from the project dam downstream to the Atlantic Ocean, including the Congaree, Cooper and Santee rivers.

The project site is located at latitude 34.05256°N, longitude -81.21732 °W (North American Datum 1983). Based on our analysis of the project effects in Section 5 of this opinion, we consider the action area for purposes of this consultation to include the Saluda Dam, the Saluda River below the Saluda Dam, and 16 miles of the Congaree River, South Carolina (

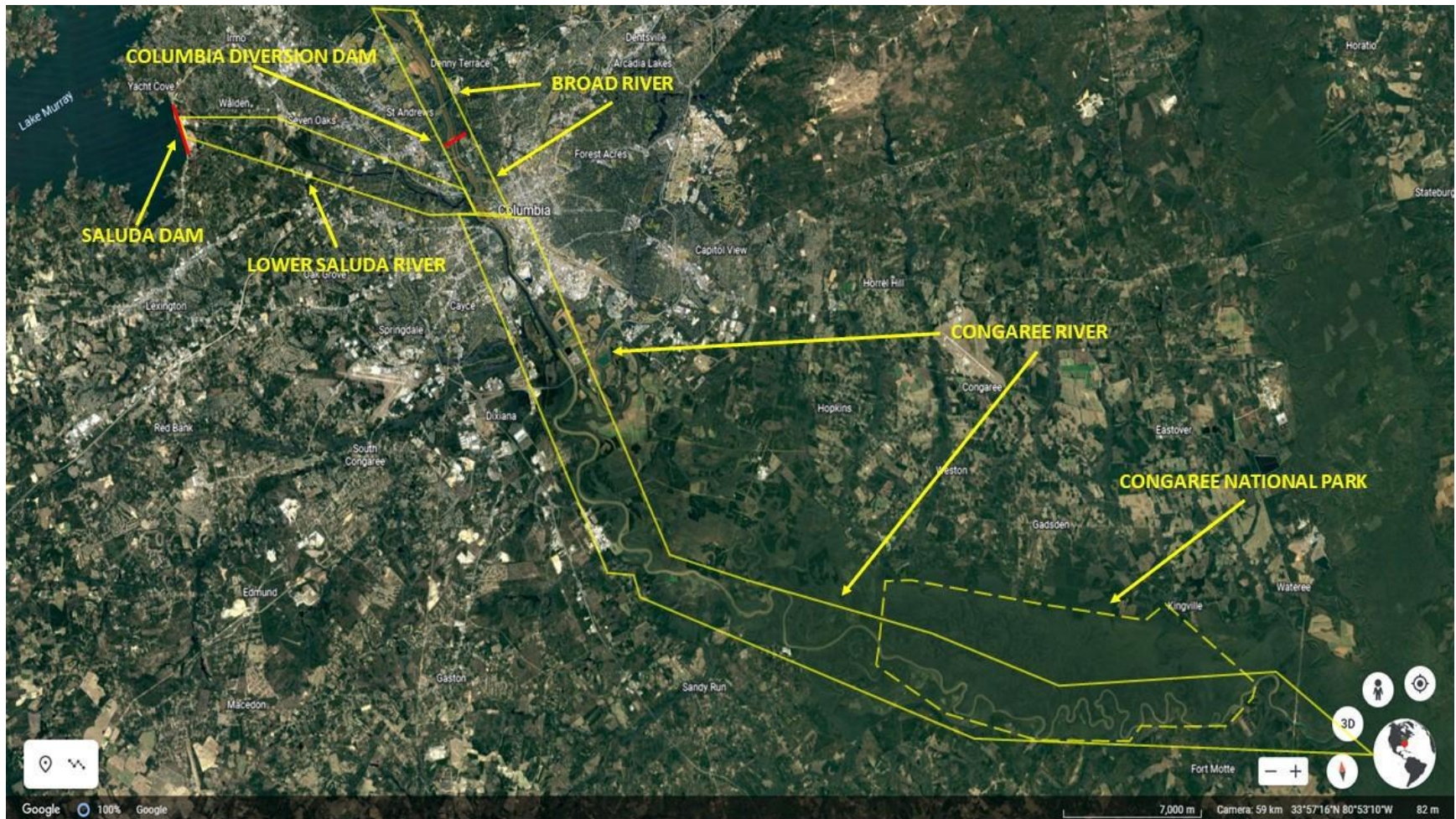


Figure 1. Location of the Saluda River and Lake Murray within South Carolina. The action area for the Saluda Hydroelectric Project consists of Lake Murray, the Saluda Dam, the Saluda River below the Saluda Dam, 16 miles of the Congaree River, and the Congaree National Park, South Carolina. (©2023 Google)

2.1.1. Saluda Dam

The original Saluda Dam is a 7,800 ft. (2,400 m) long, 213 ft.-high (65 m) earthen embankment dam. A state highway, SC Route 6, is built along the top of the dam. In 2005, a backup dam was completed at the toe of the original dam as a mechanism for preventing flooding if an earthquake similar to the 1886 Charleston earthquake was to occur again in South Carolina. The 2005 addition installed 2,300 ft. (700 m) of rock and reinforced concrete across the face of the original dam structure. Rock-fill embankment sections on the south and north ends of the dam extend the total length of the Saluda Dam by 5,700 ft. (1,700 m).

The Saluda Dam, officially the Dreher Shoals Dam, impounds the Saluda River and its tributaries to form the project reservoir (Lake Murray) to generate hydroelectric power to meet part of South Carolina's power requirement. The Saluda Hydropower Project (SHP) has an installed capacity of 207.3 megawatt (MW) and generates about 180,069 MW annually. Water from Lake Murray enters five separate intake towers. The intake towers for the original 4 turbines (Units 1- 4) draw water from near the bottom of Lake Murray at a depth of about 175 ft., while the newer turbine (Unit 5) installed in 1971 takes water from a depth of about 55 ft. All five-turbine runners are equipped with hub baffles and vent pipes through the head covers to improve DO concentration. All five turbines at the Saluda power station are vertical Francis turbines; three at 32.5 MW, one at 42.3 MW, and one at 67.5 MW. The SHP operates with one unit on line at a minimum to provide a downstream flow of at least 180 cfs in the Saluda River. Water released from the power station moves down a 150 ft. (46m) long tailrace tunnel before being discharged into the lower Saluda River.

Water can also be moved from Lake Murray through the Saluda Dam Spillway, which is located about 500 ft. from the south end of the Saluda Dam. The spillway was originally constructed in 1930 with six gates having a maximum discharge of 197,000 cfs. The 2,900-ft. long spillway allows the release of water from the reservoir without having it flow through the penstocks, which can relieve flood conditions. The spillway reconnects with the lower Saluda River approximately three quarters of a mile downstream of the powerhouse, which is located in middle of the Saluda Dam on the mainstem of the river. Two additional gates were added to the spillway between 1943 and 1946. All six spillways are equipped with steel Tainter gates.

The SHP is operated to manage the reservoir elevation with monthly target elevations. Generally, the elevation of Lake Murray is between 348.5 feet (ft.) in the winter and 356.5 ft. in the summer. Occasionally the level is drawn down to 343.5 ft. for maintenance. The current license allows a maximum operating water surface elevation of 358.5 ft.

2.1.2 Project Location

The Saluda Dam is located approximately 10 miles (15km) west of Columbia, South Carolina on the Saluda River in Richland, Lexington, Saluda and Newberry Counties. The dam was constructed at Dreher Shoal on the Saluda River. Construction of the dam began in 1927 and was completed in 1930. The purpose of the dam is flood control, hydroelectricity, recreation, and water supply.

The 10-mile segment of the lower Saluda River downstream of the Saluda Dam River was designated a Scenic River by the State of South Carolina on May 31, 1991. The lower Saluda River also supports a non-native trout fishery. The lower Saluda River converges with the Broad

River in Columbia, SC, and becomes the Congaree River. Flow in the lower Saluda River is primarily influenced by releases from the Saluda Project powerhouse, although there are some additional contributions from small tributaries such as Rawls, Twelvemile, Kinley, and Stoop creeks and Senn Branch, which collectively contribute approximately 100 square miles of additional drainage area (Kleinschmidt 2008).

The Congaree River is heavily influenced by upstream dams, including the Saluda Dam, the on the Broad River just above the confluence, and the Parr Shoals Dam forming Parr Shoals Reservoir about 25 miles higher upstream.

2.1.3 Project Operations Existing License

The Saluda Project obtained a 30-year license in 1984, retroactive to the date of the original license expiration in August 1977. On November 18, 2003, FERC extended the term of the license by 3 years based on some activities related to the construction of the backup project dam downstream of the original dam. The current license expired on August 31, 2010; however, the licensee has continued to operate in accordance with the terms of that license since 2010 (Kleinschmidt 2007).

2.1.4 Reservoir Elevations

The full pool elevation of Lake Murray is 358.65 ft. with a total usable storage of about 635,000 acre-feet. The Saluda Dam has a crest elevation of 372.0 ft. North American Vertical Datum of 1988.

The licensee operates the SHP to manage Lake Murray water surface elevations on a seasonal basis. Historically, Lake Murray's water surface has been maintained between elevation 348.5 ft. in the winter and 356.5 ft. in the summer. Occasionally the licensee draws down the reservoir to elevation of 353.5 ft. for project maintenance work or control of aquatic vegetation with the existing license allowing a maximum operating water surface elevation of 358.5 ft.

2.1.5 Existing Flow Regimes

There is no minimum flow under the most recent license terms. However, the Saluda powerhouse operates with one unit on line at a minimum gate to provide a downstream flow of at least 180 cfs under an informal agreement with the SCDHEC. Unit 5 is operated in a last-on, first-off mode because of environmental and operational factors including potential fish entrainment caused by the higher elevation (i.e., 55 ft.) of the Unit 5 intake opening versus other units (i.e., 175 ft.).

2.1.6 Water Quality

Dissolved Oxygen

SCDHEC determined the daily average DO concentration in Lake Murray shall not be less than 5.0 mg/l and the minimum concentration shall not be less than 4.0 mg/l. Data from 1989 to 1999 showed DO concentrations in the Saluda Dam tailwaters were below 5.0 mg/l about 82% of the time and below 4.0 mg/l about 70% of the time (FERC 2010). The specific DO standards for the lower Saluda River for the protection of the TPGT fishery are instantaneous DO of 4.0 mg/l minimum, daily average DO of 5.0 mg/l, and 30-day average DO of 5.5 mg/l minimum.

In 1999, the licensee installed turbine vents (Figure 2) and modified project operation to increase DO being released from the dam. The turbine vent adds oxygen to the turbine by drawing in atmospheric air. Median DO concentrations increased with the turbine vents. Hub baffles were installed in 2005-2007 to further enhance turbine aeration. Hub baffles (Figure 2) add aeration to water by creating a low-pressure zone that pulls air through the turbine vent and as the turbine spins, the air stream is broken up into bubbles. Following installation of the hub baffles, the DO concentrations measured in the Saluda Dam tailwaters had further improved and recorded as below 5.0 mg/l 6% of the time and below 4.0 mg/l about 4% of the time (FERC 2010). The licensee determined that these aeration systems currently in place reflect implementation of the best attainable turbine venting systems for the original units at the Saluda project (SCE&G 2017).

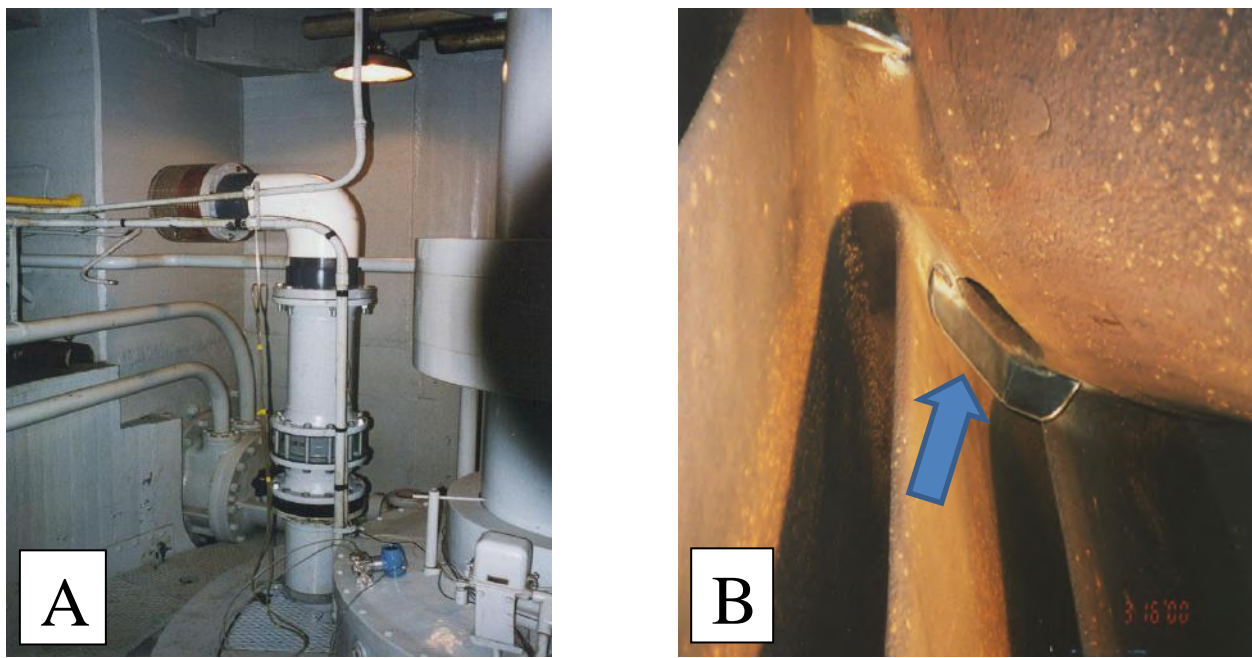


Figure 2. Images of physical modifications made to the Saluda dam turbines to increase DO concentrations. A. Image of air vent piping leading to the turbine. The air vent provides atmospheric oxygen into the turbine. B. Image of hub baffle at the base of the turbine runner as indicated by the arrow. Hub baffles create a low-pressure zone that pulls air through to break up the air stream from the vent piping into many bubbles.

Temperature

SCDHEC water quality criteria for freshwater include “temperature shall not vary from levels existing under natural conditions, unless determined that some other temperature shall protect the classified uses.”

Existing project operation does not include any standards for water temperature. Lake Murray is a cold-water monomictic lake (i.e., thermally stratified). The licensee released hypolimnetic water (from below the thermocline) from Lake Murray into the lower Saluda River. These coldwater releases from Lake Murray affect the thermal regime of the lower Saluda River and the upper Congaree River (FERC 2010).

The coldwater released by the licensee creates habitat at the lower Saluda River to support a hatchery-based sport fishery for trout (i.e., TPGT fishery). With the licensee providing the cold water, SCDNR annually stocks 30,000-40,000 fish, and SCDEHC has classified the area as a Put, Grow, and Take Trout Water to support this recreational fishery. Both rainbow and brown trout are non-native species and rely on stocked trout populations. This recreational fishery has occurred in the lower Saluda River since the early 1950s (Kleinschmidt 2008).

2.2 Project Operations – Proposed Action

2.2.1 License Term

FERC, under the authority of the Federal Power Act (FPA), may issue licenses for up to 50 years. FERC indicates that the term of the license will be between 30 and 50 years. The temporal scope of the EA looked 30 to 50 years into the future (FERC 2010). The Comprehensive Settlement Agreement submitted by the licensee requested that the Commission consider issuing a new license for a term of 50 years. The licensee has submitted arguments stating a 50-year license is appropriate. Therefore, this consultation assumes a license may be granted for a period of up to 50-years.

2.2.2 Reservoir Elevations

The licensee will operate Lake Murray between elevations of 356.5 and 352.5 ft. based on a guide curve. The maximum operating pool elevation will be 358.5 ft. with a minimum operation pool elevation of 343.5 ft. for periodic maintenance activities. Seasonal elevations will be:

1. 356.5 ft. between March 1 through September 1
2. 354.5 ft. on December 1;
3. 352.5 ft. on December 31;
4. Increasing to 356.5 ft. on March 1.

This proposed guide curve results in a higher and narrower range of lake water levels compared to the existing rule curve. In general, the water surface of Lake Murray will be maintained at an elevation of about 4 ft. higher than under the existing rule curve during the majority of the year. However, from March 15 to September 1 when the difference would be less than 4 ft.

2.2.3 Reservoir Drawdowns

The licensee also includes a Reservoir Drawdown Program for water quality maintenance, sediment transport, and aquatic vegetation management. Every third year the reservoir elevation will be reduced to 348.5 ft. if the average flow in November is greater than 1,500 cfs. The drawdown is to occur in December and held for 28 days. Following the drawdown, the water elevation in the reservoir would be allowed to return as fast as inflow permits, while minimum flows are maintained.

2.2.4 Flow

The licensee proposes a Flow Release Program that would, in normal years, release from the project powerhouse into the Saluda River a minimum flow of:

1. 700 cfs from January 1 through March 31;
2. 1,000 cfs minimum flow release from April 1 through May 31; and
3. 700 cfs minimum flow release from June 1 – December 31.

Exceptions to these flows are recreational flows, low inflow protocol, and high inflow protocol as detailed below.

Recreational Flows

Flows to accommodate recreational activities are scheduled as part of the settlement agreement. Recreational flows can be either higher or lower than the required minimum instream flows identified above. The licensee meets annually with recreational stakeholders to set specific dates for the following year's flows. The licensee also hosts triennial meetings for comprehensive reviews of the reeration flow schedule to review recreational trends, trout reproduction and holdover, etc. The licensee makes reasonable efforts to provide the requested flow releases and no more than five recreational days per year can be lost to operational or maintenance emergencies before make up days will be required to be scheduled and make up days must occur within three months of the scheduled flow (SCE&G 2009).

Low Inflow Protocol

The licensee identified a Low Inflow Protocol (LIP) that is triggered by a drop in elevation of Lake Murray and the 14-day average inflow into Lake Murray. The licensee indicated the LIP is intended to conserve water stored in Lake Murray and to allow the project to fulfill its three primary functions of reserve electric generation, municipal water supply, and critical downstream flows for as long as possible (FERC 2010). FERC recognizes that recreational use and water supply are also being considered and could lower minimum flows to the lower Saluda River.

The licensee identified a LIP that is triggered by a 1-foot drop in targeted reservoir elevation using a 14-day inflow average in order to conserve the water stored in Lake Murray. The FERC staff Alternative (FERC 2010) upped the trigger for the LIP to 2-ft below the proposed guide curve elevation. The FERC License will specify which trigger (i.e., 1 or 2 ft. below) will initiate the LIP. SCDNR and the Department of Interior recommended that a 4-ft. drop as the trigger and the Lake Murray Association recommended a 6-inch trigger. The minimum average net inflow varies by the time of year:

1. Between May 11 – March 31:
 - a. If 14-day average net inflow is less than 1,000 cfs, then minimum release from Lake Murray into the lower Saluda will be reduced from 1,000 cfs to 700 cfs.
 - b. If 14-day average net inflow is less than 700 cfs, then minimum release from Lake Murray into the lower Saluda River will be reduced from 1,000 cfs to 400 cfs.
2. Between April 1 – May 10: The minimum flow during this period may be 400 cfs if the 14-day average net inflow is less than 700 cfs to accommodate striped bass.

The frequency of initiating the LIP was investigated by the licensee by modelling historical inflow values and reservoir levels from 1981 – 2008 for a drop in reservoir elevation of both one and 2-ft below guide curve elevation. At the 1-ft trigger, the modeling indicated downstream flow would have been reduced in 17 of the 28 years including the 10 “drought years”, or 61% of the time (FERC 2010). With a 2-ft trigger, flow would have been reduced only during the 10 drought years or 36% of the time (FERC 2010). Duration of the reduced flow ranged between 29 and 193 days (FERC 2010).

At any point should Lake Murray fall below elevation 352.5 ft., minimum flow from Lake Murray will be reduced to a target flow of 500 cfs with a minimum of 400 cfs, and would remain at that level regardless of any increase of inflow until Lake Murray has risen above elevation 353.5 ft. (FERC 2010).

High Inflow Protocol

The spillway is also used to release water in anticipation of high inflow. Water can be released using all five-intake towers in Lake Murray to quickly reduce the lake level. The licensee reported in the EA that it is rare to use the spillway for reservoir level management; however, FERC issued an Additional Information Request for a high inflow event analysis, including a component to simulate pre-storm generations. The licensee submitted a report to FERC in December 2018 with results of a model showing the differences in flood inundation using the proposed operational guide curve filed as part of the new FERC license.

Five prior events were simulated under the conditions of the proposed guide curve and associated high inflow protocol to investigate potential downstream flooding. Four of the event simulations showed marginally more extensive downstream flooding when starting on the proposed curve compared to the existing curve (SCE&G 2018); there was no flooding under either protocol for one event. The proposed curve is generally higher than reservoir levels observed over the last decade and the proposed procedures include many exceptions to the minimum flow to reduce lake levels thereby reducing potential impact from flooding with slow-moving precipitation events (SCE&G 2018).

2.2.5 Proposed Project Improvements

The licensee proposes to upgrade turbines to increase capacity from 207.3 to 247 MW. The licensee also proposes to include nine new upland park sites, located on 662 acres of land located outside the existing project boundary, for future development. The licensee will expand SHP boundary as individual sites are developed.

Maintenance and Emergency Protocol

As part of its normal operations, the SHP will require scheduled and emergency maintenance. These periodic drawdowns are permitted for water quality maintenance, sediment transport, aquatic vegetation management, dock maintenance, shoreline stabilization, excavations, and other lake user maintenance activities. These drawdowns are to occur in December and held for 28 days.

Water Quality

Site-specific water quality standards for the lower Saluda River have been identified by SCDHEC to maintain the TPGT fishery that occurs in the lower Saluda River: DO not less than daily average 5.0 mg/l, a running thirty day average of 5.5 mg/l, with a low of 4.0 mg/l (SCDEHC 2012). There are no specific standards for water temperature and the licensee is not proposing any in the license renewal. The licensee is not proposing any upgrades or operational changes that are expected to substantially change temperatures in the lower Saluda River or the Congaree River, downstream of the project, from those existing conditions.

Dissolved Oxygen Management and Monitoring

During the period of the new license, the licensee plans to install new runners on the turbines to increase the downstream DO levels (FERC 2010). These turbine runners create a zone of localized low pressure and draw atmospheric air into the turbine. Unit 5 will first receive new runners within three years from issuance of the license. The upgrade is expected to take three years to account for the need to accommodate the extensive design and testing necessary to assure the new runner meets the performance objectives. Installation of the new runners on the other four units will be based on an adaptive management program: once DO levels are such that 100% support of the DO standard (daily average 5 mg/l, a running thirty day average of 5.5 mg/l, with a low of 4.0 mg/l in the tail race) is achieved, the remaining hub baffles will be installed on a purely economics-driven schedule extending the upgrade schedule to as long as 25 years after the issuance of the license (Appendix A of Settlement Agreement, 2009). Further, within one year after completion of Unit 5 upgrades, the licensee will consult with project stakeholders to evaluate Unit 5 operational scenarios to aid in preservation of the cool-water refuge habitat necessary for the trout put and grow fishery in the lower Saluda River. The licensee also operates Unit 5 as “last on- first off” during the low DO period until the lake turns over in the winter. This occurs when the surface water cools and circulates with the deeper water thus increasing the DO at depth.

Low DO conditions in Lake Murray during the summer are a result of nutrient loading from the upper Saluda River watershed and thermal stratification in the lake. Annual reports on water quality and aeration operations at the Saluda Project are published: these cover the period June 1 through November, which is the timeframe when low DO near the lake bottom can result in low DO releases in the lower Saluda River. These annual reports summarize each occurrence when the DO measured by the United States Geological Survey (USGS) gage 02168504 just downstream the SHP powerhouse was less than 4 mg/l. The most recent report (2021) identified 2 low DO events (Dominion Energy 2022). The effectiveness of the new aeration systems on Units 1 through 4 (the hub baffles and reduces headcover seal leakage) was noted in the 2021 report (Dominion Energy 2022). In general, the DO levels in the tailrace were similar to those previously observed since 2006 and are attributed to the installation of the hub baffles and the operational look up tables (Dominion Energy 2022).¹ The first low DO period was attributed to a period when inflow was greater than flow levels at which the turbine aeration could perform. The

¹ Look-up Tables present the best practices for aerating water passing through the turbines at the Saluda Hydro Project, as they are currently configured. These tables describes how the turbines at can be operated to enhance downstream DO levels and still obtain target MW outputs, given the inflow DO and temperature conditions (Dominion Energy 2022).

second incident occurred when flow was reduced to allow environmental sampling on the Lower Saluda River (Dominion Energy 2022).

The licensee has indicated they will comply with the DO standard for the Saluda River downstream the Saluda Project to the “extent practicable” (Dominion Energy 2022). In addition to the potential for generators to fail, the licensee identified the following factors that affect their ability to comply with the DO standards:

1. Limited capability for aeration of water released thorough the turbine units;
2. Requirement to manage water levels in Lake Murray for project safety and other reasons;
3. Need for special operating needs specified under Item 9.3 of Settlement Agreement;
4. Settlement Agreement; and
5. Need to reserve obligation to maintain electric load-generation balancing and management of local voltages and system frequency in real time.

The “Settlement Agreement” mentioned above as reasons 3 and 4 is a series of resolutions, reached among the agreement’s signatories, of issues raised during the relicensing process for the project. The resolutions were submitted to FERC for incorporation into the new license without material modification, and FERC incorporated these elements into their EA. The licensee indicated with the submittal of the Settlement Agreement that it viewed the Agreement as representing the best balances of upstream and downstream resources while ensuring project operational flexibility. The licensee also requested that the FERC adopt without material change the recommendations and programs contained in the Settlement Agreement. While NMFS participated in the process and was an integral member of the process, we were not a signatory to the Settlement Agreement. Specific Agreements by the licensee in the Settlement Agreement included reservoir elevations, required flow releases, low inflow protocols and high inflow protocols.

2.3 Rare and Threatened Species Protection Plan

As part of the relicensing requirements for SHP, and to meet consultation requirements of the ESA, the licensee prepared a Sturgeon Protective and Adaptive Management Plan. In response to the licensee’s Draft License Application, NMFS noted that Saluda and other Santee Basin projects potentially affect important historical spawning and maturation habitat for a number of diadromous fish species, including the federally endangered shortnose sturgeon, and Atlantic sturgeon, at the time a candidate for federal listing.² NMFS also requested that the licensee develop “practical and specific measures to mitigate continuing Project impacts” on these species. In response, the licensee implemented the following protection and enhancement measures (Kleinschmidt 2009):

1. Continue turbine aeration measures to optimize DO;

² During this time NMFS did not have information regarding the presence of Atlantic sturgeon above the Santee Cooper project.

2. Implement minimum flows;
3. Establish a Sturgeon Technical Advisory Team with NMFS, USFWS, and SCDNR to collaboratively participate in design and implementation of a sturgeon study;
4. Implement agency-recommended studies on the shortnose sturgeon associated with the Santee Basin Accord (where NMFS is not a signatory); and
5. Publish and make available a brochure with species known to occur in the project area including the shortnose sturgeon.

2.4 Fish Passage

Section 18 of the FPA provides that FERC shall require the construction, maintenance, and operation by a licensee of such fishways as may be prescribed by the Secretary of the U.S. Department of Commerce, through NMFS, and the U.S. Department of Interior, through USFWS. NMFS and USFWS filed, on September 29 and 25, 2009, respectively, reservations of authority to prescribe fishways under Section 18.

2.5 Trout Put, Grow and Take (TPGT) Fishery

The cold water released from Lake Murray provides habitat for a trout sport fishery in the lower Saluda River. Consequently the state of South Carolina has classified the mainstem of the Saluda River (from the Lake Murray Dam to the confluence with Broad River) as a Trout Put, Grow and Take area (SCDEHC 2012). To support the sport fishery, site-specific water quality standards for the waterbody have also been established: DO not less than daily average 5.0 mg/l, a running thirty day average of 5.5 mg/l, with a low of 4.0 mg/l.

The licensee proposes to implement the final Trout Evaluation and Monitoring Program (Kleinschmidt 2009) that includes five types of studies to be conducted that may identify ways to enhance the recreational TPGT fishery in the lower Saluda River. The Trout Program also calls for the release of waters from the project that would provide an appropriate coldwater habitat for the non-native fish.

Trout are not native to the Saluda River or South Carolina, and the fishery is only possible due to SHP cold-water releases from Lake Murray. SCDNR maintains the fishery by stocking trout produced at the Walhalla State Fish Hatchery into the lower Saluda River. Approximately 30,000-40,000 trout are stocked annually by sub-adult brown trout (*Salmo trutta*) each November or December; and catchable-sized rainbow trout (*Oncorhynchus mykiss*) stocked monthly November through April. This fishery has existed since the 1960s. A survey indicates significant carryover from previous stocking years, where stocked fish survive from one year to next, attributed to higher DO levels (Kleinschmidt 2009).

2.6 Summary of Proposed Action

FERC proposes to relicense the SHP for a period of 30 to 50 years. The licensee proposes minimum flows of 700 or 1,000 cfs dependent on time of year. At any time of year, flow may be reduced to 400 cfs, if the low inflow protocol is triggered. The licensee has identified measures to increase the amount of DO; however, they have also identified the conditions that limit the ability of these measures to meet minimum DO levels. Physical modifications made to the Saluda Dam turbines have improved DO levels. However, the SHP still periodically releases

pulses of water from Lake Murray with low DO concentrations, particularly during warmer summer months. The temperature of the water released from Lake Murray is not controlled; the cold water creates habitat for a non-native TPGT fishery in the lower Saluda River.

3 STATUS OF LISTED SPECIES

Table 1 provides a list of the ESA-listed species under the jurisdiction of NMFS that may occur in or near the action area. The project is not located in designated critical habitat.

Table 1. Effects Determination(s) for Species the Action Agency or NMFS Believes May Be Affected by the Proposed Action

Species	ESA Listing Status	Action Agency Effect Determination	NMFS Effect Determination
Shortnose sturgeon	E	LAA	NLAA
Atlantic sturgeon (Carolina DPS)	E	LAA	NE

On March 5, 2012, FERC sent a letter indicating the proposed project would affect Atlantic sturgeon in a similar way to shortnose sturgeon due to the possibility of sturgeon being passed above the Santee Cooper Hydroelectric Project. FERC concluded the proposed action, with mandatory conditions and staff’s additional measures as appropriate, is likely to adversely affect Atlantic sturgeon and its habitat and requested formal consultation. NMFS has reviewed available information and does not expect that Atlantic sturgeon will be present within the action area over the course of the proposed license for the Saluda Dam. Extensive sampling by SCDNR of the Congaree and Catawba Rivers indicate the presence of a lake spawning population of shortnose sturgeon, and Atlantic sturgeon have not been captured. Atlantic sturgeon can be found below the Santee Cooper Hydroelectric Project in the Santee and Cooper Rivers. However, as described in NMFS’ biological opinion for the Santee Cooper Hydroelectric Project dams (Santee Dam and Pinopolis Dam) (SERO-2018-00325), sturgeon passage above the Santee Cooper dams is not currently required, nor is it reasonably certain to occur over the course of the Saluda Dam license. On January 24, 2020, NMFS filed a Second Modified Prescription for Fishways Pursuant to Section 18 of the Federal Power Act, for the Santee Cooper Hydroelectric Project. NMFS’ prescription does not require immediate passage of Atlantic or shortnose sturgeon at the Santee or Pinopolis dams, but instead implements a “phased approach,” that first requires additional study of the suitability of habitat above those dams for sturgeon spawning and feeding. The prescription then provides that:

“When the NMFS determines that it is warranted, subsequent phases of the Santee Gateway Option may require upstream and downstream passage for both sturgeon species at the Santee Dam, further improving sturgeon use of the Santee River system and health of the populations of both sturgeon species. Any environmental measures that require modification(s) that may affect project facilities and/or operation will be filed with the FERC for its review and approval for incorporation into the articles of the license.”

Thus, passage of sturgeon at the Santee Cooper dams would not occur until studies are complete and NMFS determines passage is warranted. Additionally, the timeframe and details of operation of any passage at the Santee Cooper Project, if it occurs, remain uncertain. NMFS therefore

concludes that Atlantic sturgeon are not reasonably expected to occur within the action area during the Saluda Dam license. Reinitiation of consultation may be required if passage for sturgeon is implemented at Santee Cooper over the course of the Saluda Dam license.

3.1 Status of Shortnose Sturgeon

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

Species Description and Distribution

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

Historically, shortnose sturgeon were found in the coastal rivers along the east coast of North America from the Saint John River, New Brunswick, Canada, to the St. Johns River, Florida, and perhaps as far south as the Indian River in Florida (Evermann and Bean 1898; Gilbert 1989). Currently, the distribution of shortnose sturgeon across their range is disconnected, with northern populations separated from southern populations by a distance of about 250 miles (400 km) near their geographic center in Virginia (see Figure 3). In the southern portion of the range, they are currently found in North Carolina, South Carolina, and Georgia. Within North Carolina, sampling found shortnose in the Roanoke River, Albemarle Sound, and Cape Fear Rivers, while fishers have reported the species in Neuse River and Pamlico Sound (NMFS 2010). Females bearing eggs have been collected in the Cape Fear River (Moser and Ross 1995). In South Carolina, shortnose sturgeon have been captured and tagged in Winyah Bay system, which includes the Winyah Bay proper, the Sampit River, the Black River, the Great Pee Dee River, the Waccamaw River, the Little Pee Dee River, the Lynches River and all connecting creeks (Post et al. 2014). Shortnose have also been captured and tagged in the Santee, Cooper and Savannah rivers, as well as the ACE Basin (Ashepoo, Combahee, and Edisto rivers) (Post et al. 2014). The majority of animals occur in the Winyah Bay System and the Cooper and Savannah rivers (Post et al. 2014). In Georgia, shortnose sturgeon are found in the Oconee, Ocmulgee, and Altamaha rivers (Ingram and Peterson 2018).

³ Meaning they are born in freshwater, then live primarily in their natal river, making short feeding or migratory trips into salt water, and then return to freshwater.

In South Carolina, shortnose sturgeon spawning in the Cooper River (NMFS 2010; Ruddle 2018), the Congaree River (Collins et al. 2003; Post et al. 2017), and the Pee Dee River (NMFS 2010). In Georgia, spawning occurs in the Altamaha (Ingram and Peterson 2018) and Savannah (Bahr and Peterson 2017) rivers. Shortnose sturgeon were believed to be extirpated from the Satilla River in Georgia and the St. Marys River along the Florida and Georgia border but targeted surveys in both the Satilla (Fritts and Peterson 2010) and St. Marys (Fox and Peterson 2017; Fritts and Peterson 2010) have captured shortnose sturgeon. A single specimen was found in the St. Johns River by the Florida Fish and Wildlife Conservation Commission during extensive sampling of the river in 2002 and 2003 (NMFS 2010).

Life History Information

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

Adult shortnose sturgeon spawn in the rivers where they were born. Initiation of the upstream movement of shortnose sturgeon to spawn is likely triggered partially by water temperatures. Shortnose sturgeon captured in 5 coastal river systems of South Carolina all spawned during temperatures ranges from 5–18°C (Post et al. 2014), which is similar to what has been documented throughout the range (Duncan et al. 2004; Hall et al. 1991; Kieffer and Kynard 1996; NMFS 1998; Taubert 1980). In the Altamaha River, Georgia, adults began their upstream migrations during likely spawning runs during the late-winter months when water temperatures declined to 11.6–16.9 °C (Ingram and Peterson 2018; Post et al. 2014). Water depth and flow are also important at spawning sites (Kieffer and Kynard 1996). Spawning sites are characterized by moderate river flows with average bottom velocities between 1-2.5 ft. (0.4-0.8 m) per second (Hall et al. 1991; Kieffer and Kynard 1996; NMFS 1998). Shortnose sturgeon tend to spawn on rubble, cobble, or large rocks (Buckley and Kynard 1985; Dadswell 1979; Kynard 1997; Taubert 1980), timber, scoured clay, or gravel (Hall et al. 1991). Southern populations of shortnose sturgeon usually spawn at least 125 miles (200 km) upriver (Kynard 1997) or throughout the fall line⁵ zone if they are able to reach it. Adults typically spawn in the late winter to early spring

⁴ A gradual change in a character or feature across the distributional range of a species or population, usually correlated with an environmental or geographic transition

⁵ The fall line is the boundary between an upland region of continental bedrock and an alluvial coastal plain, sometimes characterized by waterfalls or rapids.

(December-March) in southern rivers (i.e., North Carolina and south) and the mid to late spring in northern rivers. They spend the rest of the year in the vicinity of the saltwater/freshwater interface (Collins and Smith 1993).

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

Status and Population Dynamics

The 1998 shortnose sturgeon recovery plan identified 19 distinct shortnose sturgeon populations based on natal rivers (NMFS 1998). Since 1998, significantly, more tagging/tracking data on straying rates to adjacent rivers has been collected, and several genetic studies have determined where coastal migrations and effective movement (i.e., movement with spawning) are occurring. For example, a 2017 report by the South Carolina Division of National Resources and Georgia Department of National Resources stated shortnose sturgeon were detected as far as 20 km from shore, though of the animals detected in the marine environment, most were detected within 11 km from shore (Arendt et al. 2017). Similarly, in 2020, two telemetered shortnose sturgeon were detected moving from the Winyah Bay to the Savannah River to make presumptive spawning runs, before returning (SCDNR 2021).

Genetic analyses aided in identifying population structure across the range of shortnose sturgeon. Several studies indicate that most, if not all, shortnose sturgeon riverine populations are statistically different ($p < 0.05$) (King et al. 2014; Waldman et al. 2002; Wirgin et al. 2005; Wirgin et al. 2010; Wirgin et al. 2000). Gene flow is low between riverine populations indicating that while shortnose sturgeon tagged in one river may later be recaptured in another, it is unlikely the individuals are spawning in those non-natal rivers. This is consistent with our knowledge that adult shortnose sturgeon are known to return to their natal rivers to spawn (NMFS 1998). However, Fritts et al. (2016) provide evidence that greater mixing of riverine populations occurs in areas where the distance between adjacent river mouths is relatively close, such as in the Southeast.

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

al. (2010) note that genetic differentiation among populations within the Carolinian Province was considerably less pronounced than among those in the other 2 metapopulations (i.e., Virginian Province and Acadian Province) and contemporary genetic data suggest that reproductive isolation among these populations is less than elsewhere. In other words, the shortnose sturgeon populations within the Carolinian Province are more closely related to each other, than the populations that make up either the Virginian or Acadian Provinces.

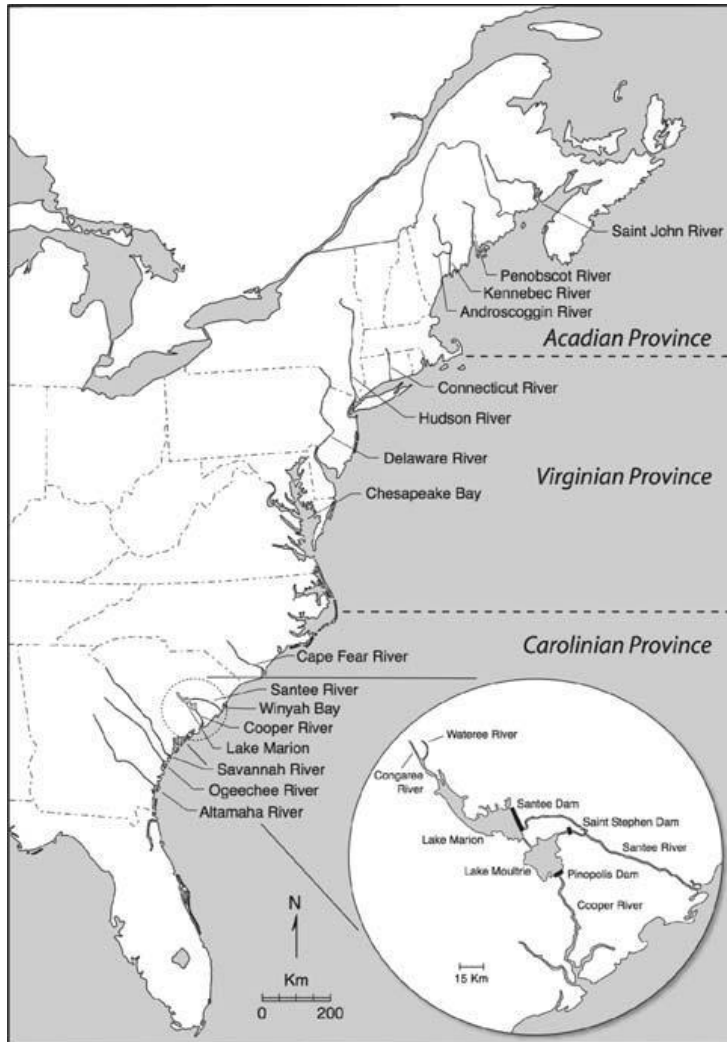


Figure 3. The North American Atlantic coast depicting 3 shortnose sturgeon metapopulations based on mitochondrial DNA control region sequence analysis (Wirgin et al. 2010).

Each shortnose sturgeon metapopulation is reproductively isolated from the others and constitutes an evolutionarily (and likely an adaptively) significant lineage. Loss of the Carolinian Province (“southern”) metapopulation of shortnose sturgeon would result in the loss of the southern half of the species’ range (i.e., there is no known reproduction occurring between the Delaware River and Winyah Bay, SC). Loss of the Virginian Province (“mid-Atlantic”) metapopulation would create a conspicuous discontinuity in the range of the species from the Hudson River to the northern extent of the southern metapopulation. The Acadian Province

(“northern”) metapopulation constitutes the northernmost portion of the U.S. range. Loss of the mid-Atlantic metapopulation (Virginian Province) would create a conspicuous discontinuity in the range of the species from the Hudson River to the northern extent of the Southern metapopulation. The northern metapopulation constitutes the northernmost portion of the U.S. range. Loss of this metapopulation would result in a significant gap in the range that would serve to isolate the shortnose sturgeon that reside in Canada from the remainder of the species’ range in the United States. The loss of any metapopulation would result in a decrease in spatial range, biodiversity, unique haplotypes, adaptations to climate change, and gene plasticity. Loss of unique haplotypes that may carry geographic specific adaptations would lead to a loss of genetic plasticity and, in turn, decrease adaptability. The loss of any metapopulation would increase species’ vulnerability to random events.

The status of the shortnose sturgeon in the Southeast is variable. Populations within the southern metapopulation are relatively small compared to their northern counterparts. Table 2 shows available abundance estimates for rivers in the Southeast. The Altamaha River supports the largest known shortnose sturgeon population in the Southeast with successful self-sustaining recruitment. Total population estimates in the Altamaha show large interannual variation is occurring; estimates have ranged from as low as 468 fish in 1993 to over 5,550 fish in 2006 (NMFS 1998; Peterson and Bednarski 2013). Abundance estimates for the Ogeechee River indicate the shortnose sturgeon population in this river is considerably smaller than in the Altamaha River. The highest point estimate since 1993 occurred in 2007 and resulted in a total Ogeechee River population estimate of 404 shortnose sturgeon (95% confidence interval [CI]: 175-633) (Peterson and Farrae 2011). However, subsequent sampling in 2008 and 2009 resulted in point estimates of 264 (95% CI: 126-402) and 203 (95% CI: 32-446), respectively (Peterson and Farrae 2011). Spawning is also occurring in the Savannah, Cooper, Congaree, and Yadkin-Pee Dee Rivers. The Savannah River shortnose sturgeon population is possibly the second largest in the Southeast with the highest point estimate of the total population occurring in 2013 at 2,432 (95% CI: 1,025-6,102). Mean population estimates were lower in 2014 and 2015, reaching an estimated 1,390 (95% CI: 890-2,257) total individuals in 2015 (Bahr and Peterson 2017). Animals in the Savannah River face many environmental stressors and spawning is likely occurring in only a very small area. While active spawning is occurring in South Carolina’s Winyah Bay complex (Black, Sampit, Yadkin-Pee Dee, and Waccamaw Rivers) the population status there is unknown. The most recent estimate for the Cooper Rivers suggests a population of approximately 220 spawning adults (Cooke et al. 2004). Status of the other riverine populations supporting the southern metapopulation is unknown due to limited survey effort, with capture in some rivers limited to fewer than five specimens.

Table 2. Shortnose Sturgeon Populations and Their Estimated Abundances

Population (Location)	Data Series	Abundance Estimate (CI) ^a	Population Segment	Reference
Cape Fear River (NC)		>50	Total	
Winyah Bay (SC)		unknown		
Santee River (SC)		unknown		
Cooper River (SC)	1996-1998	220 (87-301)	Adults	Cooke et al. (2004)
Lake Marion (SC)	2016	287	Adults	SCDNR (2017b)
ACE Basin (Ashepoo, Combahee, Edisto Rivers) (SC)		unknown		
Savannah River (SC, GA)		1,000 - 3,000	Adults	B. Post, SCDNR 2003; NMFS unpublished
	2013	2,432 (1,025-6,102)	Total	Bahr and Peterson (2017)
	2014	1,957 (1,261-3,133)	Total	
	2015	1,390 (890-2,257)	Total	
Ogeechee River (GA)	1993	361 (326-400)	Total	Rogers and Weber (1994);
	1999-2000	147 (104-249)	Total	Fleming et al. (2003)
	2007	404 (175-633)	Total	Peterson and Farrae (2011)
	2008	264 (126-402)	Total	
	2009	203 (32-446)	Total	
Altamaha River (GA)	1988	2,862 (1,069-4,226)	Total	NMFS (1998)
	1990	798 (645-1,045)	Total	NMFS (1998)
	1993	468 (316-903)	Total	NMFS (1998)
	2006	5,551 (2,804-11,304)	Total	Peterson and Bednarski (2013)
	2009	1,206 (566-2,759)	Total	Peterson and Bednarski (2013)
	2011	2,218 (1,424-3,350)	Total	Ingram et al. (2020)
Satilla River (GA)		N/A		
Saint Marys River (FL)		N/A		
St. Johns River (FL)		unknown	Total	Fox et al. (2017)

^a Population estimates (with confidence intervals [CIs]) from different studies should not be directly compared because they are generated using different techniques, consider disparate life stages, and cover different periods. Some estimates (e.g., those without CIs or those that are depicted by ranges only) are the “best professional judgment” of researchers based on their sampling effort and success.

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

Threats

The shortnose sturgeon was listed as endangered under the ESA as a result of a combination of habitat degradation or loss (resulting from dams, bridge construction, channel dredging, and pollutant discharges), mortality (from impingement on cooling water intake screens, turbines, climate change, dredging, and incidental capture in other fisheries), and the inadequacy of

regulatory mechanisms in ameliorating these impacts and threats. The primary threats to the species today are described below.

Dams

Dams for hydropower generation, flood control, and navigation adversely affect shortnose sturgeon habitat by impeding access to spawning, developmental, and foraging habitat, modifying free-flowing rivers to reservoirs, physically damaging fish on upstream and downstream migrations, and altering water quality in the remaining downstream portions of spawning and nursery habitat.

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

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

Fish passage devices have shown limited benefit to shortnose sturgeon as a means of minimizing impacts of dams because these devices have been historically designed for salmon and other water-column fish rather than large, bottom-dwelling species like sturgeon. However, NMFS continues to evaluate ways to effectively pass sturgeon above and below man-made barriers. For example, large nature-like fishways (e.g., rock ramps) hold promise as a mechanism for successful passage. Dams have separated the shortnose sturgeon population in the Cooper River, trapping some above the structure while blocking access upstream to sturgeon below the dam. Telemetry studies indicate that some shortnose sturgeon do pass upriver through the vessel lock

in the Pinopolis Dam on the Cooper River in the Santee Cooper Lakes (NMFS et al. 2019; Post et al. 2014). In 2011, 2 tagged shortnose sturgeon used the vessel lock in the Pinopolis Dam to pass upstream of the dam. One of the sturgeon was still inhabiting the lakes as of 2013, while the other sturgeon entered Lake Moultrie in March and returned to the Cooper River in April, either through the Pinopolis Lock or through the turbines at Jefferies Power Station (Post et al. 2014). Shortnose sturgeon inhabit only Lake Marion, the upper of the 2 reservoirs. Shortnose sturgeon inhabit only Lake Marion, the upper of the 2 reservoirs. Based on survey of the Brown's Lake area (upper Lake Marion), the best available information on the abundance of this dam-locked shortnose sturgeon population is approximately 287 adults (SCDNR 2017b); this is the minimum number thought to exist, and is likely an underestimate as a thorough survey of the entire reservoir area has not been conducted.

Additional impacts from dams include the Kirkpatrick Dam (aka Rodman Dam) located about ~12.9 km upstream from the St. Johns River, Florida on the Ocklawaha River (the largest tributary) as part of the Cross Florida Barge Canal. The Ocklawaha River has been speculated as the location within the St. Johns River where shortnose sturgeon spawning may have occurred (NMFS 2010). The New Savannah Bluff Lock and Dam located on the Savannah River on the South Carolina and Georgia border also impedes shortnose sturgeon from accessing upstream shoal areas (NMFS 2010).

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

Dredging

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

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

The USACE has successfully used this technique to relocated Atlantic sturgeon, but only two shortnose sturgeon (1992 and 2004) have been captured in the Southeast.

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

Water Quality

Shortnose sturgeon rely on a variety of water quality parameters to successfully carry out their life functions. Low DO and the presence of contaminants modify the quality of sturgeon habitat and, in some cases, restrict the extent of suitable habitat for life functions. Secor (1995) noted a correlation between low abundances of sturgeon during this century and decreasing water quality caused by increased nutrient loading and increased spatial and temporal frequency of hypoxic (low oxygen) conditions.

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

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

These studies highlight concerns regarding the high occurrence of low DO coupled with high temperatures in the river systems throughout the range of the shortnose sturgeon in the Southeast. For example, shallow waters in many of the estuaries and rivers in North Carolina and South Carolina will reach temperatures nearing 30°C in the summer months. Both low flow and high water temperatures can cause DO levels to drop below 3.0 mg/l. Sturgeon are more

sensitive to low DO than other fish species (Niklitschek and Secor 2009a; Niklitschek and Secor 2009b), and low DO in combination with high temperature is particularly problematic.

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

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

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

Water Quantity

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

Climate Change

Large-scale factors affecting riverine water quality and quantity that likely exacerbate habitat threats to shortnose sturgeon include drought, and intra- and inter-state water allocation. Changes in the climate are very likely be associated with more extreme precipitation and faster evaporation of water, leading to greater frequency of both very wet and very dry conditions.

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 smallest of any other region of the United States (Vose et al. 2017). The temperature of the hottest day in any given year has decreased by 1.49°F since 1900 in the Southeast (Vose et al. 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). Aside from observation, climate modeling also projects future increases in temperatures in the Southeast. Table 3 summarizes the increases projected for the Southeast by the mid-century (2036–2065) and late-century (2071–2100). These are projections from the Representative Concentration Pathway (RCP) model scenarios RCP8.5 and RCP4.5, used by the Intergovernmental Panel on Climate Change (IPCC), relative to average from 1976–2005 (Hayhoe et al. 2017).⁶ The Southeast is also projected experience a greater frequency of both heat waves⁷ and extreme heat waves⁸ in the future (Vose et al. 2017).

⁶ RCPs make predictions based on changes, if any, in future greenhouse gas emissions. Specifically, they evaluate radiative forcing, or the amount of energy stored at the Earth’s surface in watts/m². As the amount of greenhouse gases increases in the atmosphere more energy is trapped, and the number of watts/m² increases. RCP2.6 and RCP8.5 represent the lowest and highest radiative scenarios, of 2.6 watts/m² and 8.5 watts/m², respectively. RCP4.5 and RCP6.0 assume intermediate levels of radiative forcing.

⁷ *Heat waves* are 6-day periods with a maximum temperature above the 90th percentile.

⁸ *Extreme heat waves* are 5-day periods experiencing 1-in-10 year high temperatures events

Table 3. Projected Temperature Increase in the Southeast Under Two Model Projections and Time Series (Hayhoe et al. 2017)

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

Annual precipitation in the Southeast has increased by 0.46 inches 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 et al. 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 et al. 2017). However, even in locations where greater precipitation is projected, those increases are expected to be relatively small relative to natural variation already observed (Easterling et al. 2017).

Within the Southeast Region, higher resolution consideration of climate change on a state level has also been conducted. In the state of South Carolina temperatures have risen more than 1°F since the beginning of the 20th century (Runkle et al. 2022). Under a higher emission scenario (RCP8.5), historically unprecedented warming is projected for South Carolina during this century (Runkle et al. 2022). Even under a lower emission scenario (RCP4.5), the annual average temperatures are projected to most likely exceed historical record levels by the middle of this century. However, a large range of temperature increases is projected under both scenarios, and under the lower emissions scenario, a few projections are only slightly warmer than historical records (Runkle et al. 2022). Increases in the number of extremely hot days and decreases in the number of extremely cold days are projected to accompany the overall warming (Runkle et al. 2022).

In South Carolina, there is no overall trend in changes of annual precipitation in South Carolina since the beginning of the 20th century. However, the total annual precipitation has been below average during most years since 2000 (Runkle et al. 2022). 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). Yet, periods of high rainfall have also been observed. Runkle et al. (2022) reported above average rainfall during the 2015–2020 period, noting some recent years (notably 2015, 2018, and 2020) have been very wet. Seasonal changes in precipitation are also projected. Easterling et al. (2017) report 5-15% decreases in seasonal precipitation in South Carolina during the winter, spring, and summer, followed by a 15-20% *increase* in precipitation during the summer. However, any increases in temperature will accelerate the loss of soil moisture during dry spells, increasing the intensity of naturally occurring droughts in the future. The resulting decreases in water availability, exacerbated by population growth, will continue to increase competition for water (Runkle et al. 2022).

For South Carolina, Runkle et al. (2022) also report the number of extreme precipitation events was below average from 2000-2015 but has been above average from 2015-2020. Of the last 21

years (2000-2020) in South Carolina, 15 have been characterized by warm-season drought conditions (Runkle et al. 2022). Regardless of the emission scenario, little change in total annual precipitation is projected over this century for the state of South Carolina (Runkle et al. 2022).

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

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

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

Shortnose sturgeon are already susceptible to reduced water quality resulting from dams, inputs of nutrients, contaminants from industrial activities and nonpoint sources, and interbasin transfers of water. The IPCC projects with high confidence that higher water temperatures and

changes in extremes in the Southeast region, including floods and droughts, will affect water quality and exacerbate many forms of water pollution from sediments, nutrients, dissolved organic carbon, pathogens, pesticides, and salt, as well as thermal pollution, with possible negative impacts on ecosystems (IPCC 2007).

Sea-level rise is another consequence of climate change; it has already had significant impacts on coastal areas and these impacts are likely to increase. Since 1852, when the first topographic maps of the Southeastern United States were prepared, high tidal flood elevations have increased approximately 12 inches. Since 1900, global sea level has increased 7-8 inches, with an additional increase of 12-48 inches projected by 2100 (Frankson et al. 2022). Sea level rise is also projected to extend areas of salinization of groundwater and estuaries. Some of the most populated areas of this region are low-lying; the threat of saltwater entering into this region's aquifers with projected sea level rise is a concern (USGRG 2004). Saltwater intrusion will likely exacerbate existing water allocation issues, leading to an increase in reliance on interbasin water transfers to meet municipal water needs, further stressing water quality. Similarly, saltwater intrusion is likely to affect local ecosystems. Analysts attribute the forest decline in the Southeast to saltwater intrusion associated with sea level rise. Coastal forest losses will be even more severe if sea level rise accelerates as is expected because of global warming.

Bycatch

Overutilization of shortnose sturgeon from directed fishing caused initial severe declines in shortnose sturgeon populations in the Southeast, from which they have never rebounded. Further, continued collection of shortnose sturgeon as bycatch in commercial fisheries is an ongoing impact. Shortnose sturgeon are incidentally caught in state shad gillnet fisheries occurring in the Ogeechee (NMFS 2010) and Altamaha (Bahn et al. 2012) rivers. Shortnose sturgeon are sensitive to bycatch mortality because they are a long-lived species, have an older age at maturity, have lower maximum reproductive rates, and a large percentage of egg production occurs later in life. In addition, stress or injury to shortnose sturgeon taken as bycatch but released alive may result in increased susceptibility to other threats, such as poor water quality (e.g., exposure to toxins and low DO). This may result in reduced ability to perform major life functions, such as foraging and spawning, or even post-capture mortality.

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

Stochastic Events

Stochastic events, such as hurricanes, are common throughout the range of shortnose sturgeon. These events are unpredictable and their effect on the survival and recovery of the species is unknown; however, they have the potential to impede the survival and recovery directly if animals die because of them, or indirectly if habitat is damaged because of these disturbances. Hurricane impacts are primarily caused by low DO, or hypoxia, in floodwaters caused by the entrainment and decomposition of organic matter transported into rivers from the floodplain, saturated soils, and wastewater and septic inputs (Mallin and Corbett 2006; USFWS and NMFS 2022). For example, in 2018, flooding from Hurricane Florence flushed significant amounts of organic matter into rivers supporting sturgeon in South Carolina and North Carolina. The DO levels in those rivers dropped so low (i.e., 0.2 mg/l) that thousands of fish suffocated, including multiple sturgeon. Harm to benthic invertebrate communities by hurricanes has also been documented (Poirrier et al. 2008) and may lead to indirect effects on shortnose sturgeon populations through temporary loss of prey. The severity of impacts to shortnose sturgeon may be related to the strength of the hurricane and geographic aspects of its landfall.

4 ENVIRONMENTAL BASELINE

This section describes the effects of past and ongoing human and natural factors contributing to the status of shortnose sturgeon, their habitats, and ecosystem within the action area without the additional effects of the proposed action. In the case of ongoing actions, this section includes the effects that may contribute to the projected future status of the species, their habitats, and ecosystem. The environmental baseline describes the species' health based on information available at the time of the consultation.

By regulation, the environmental baseline for an Opinion refers to 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 that are contemporaneous with the consultation in process. The consequences to listed species or designated critical habitat from ongoing agency activities or existing agency facilities that are not within the agency's discretion to modify are part of the environmental baseline (50 CFR 402.02).

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

4.1 Status of Species within the Action Area

Historical written accounts document diadromous fish ascending through the entire Santee River Basin, including upstream the Congaree River into the Broad River, clearly indicating that sturgeon migrated above the fall line to access extensive bedrock, cobble, and gravel shoal areas in the upper regions that provided high quality spawning habitat (USFWS et al. 2001). In the Santee River Basin, the fall line shoal areas are located inland at roughly river mile 175 to 250 at the head of the Congaree and Wateree Rivers with the shoals continuing up to Columbia, SC. With the completion of the Santee Cooper Diversion Dam and Canal Project in 1942, anadromous fish migrations were completely confined to the lower 87 miles of the Santee Basin and created a dysfunctional segmented population of dam-locked shortnose sturgeon in the Santee and Cooper Rivers and Lake Marion (Kynard et al. 2016).

This dam-locked population of shortnose sturgeon inhabits the area above the Santee Cooper project lakes (Collins et al. 2003; Collins et al. 2006; Collins and Smith 1997). These dam-locked fish (Kynard and Horgan 2002) move upstream into the Congaree River to spawn, but poor water quality, coupled with the physical obstruction posed by the remnants of the Granby Lock and Dam, have constrained this population from moving further up the Congaree River. Below the Santee Cooper dams reside two other partially isolated groups of shortnose sturgeon, likely descendants of the dam-locked reservoir-fish that are blocked from accessing historic spawning areas (Kynard et al. 2016). Juveniles and adults spawned in the Congaree River that move downstream past the reservoir and dams are believed to maintain the shortnose sturgeon population in the lower Santee River, Cooper River, and the estuary (Kynard et al. 2016).

Shortnose sturgeon spawning has been verified in the Congaree River near the I-77 Bridge by egg collection and capture of a small juvenile, presumed to be a YOY, downstream in Lake Marion (Collins et al. 2003). Recent information confirms shortnose continue to utilize that area of the Congaree River for spawning (SCDNR 2017a; SCDNR 2018a; SCDNR 2019). While some individual shortnose sturgeon have previously been tracked during the spawning season upriver of the Granby Lock and Dam (NMFS 2010), more recently, telemetry tagged shortnose sturgeon have not been detected above Granby Dam (SCDNR 2017a; SCDNR 2018a; SCDNR 2019). This suggests that if spawning occurs upriver of the I-77 Bridge, it is unlikely to happen regularly, or only a small portion of the spawning adult population use these upstream habitats.

The licensee funded two fish surveys to provide information about shortnose sturgeon downstream of the Saluda Dam in their FERC application. Neither survey collected shortnose or Atlantic sturgeon adults, juvenile, larvae, or sturgeon eggs. A summary of both licensee-funded surveys is below:

1. In Spring 2006 (February 9 – June 27) the South Carolina Cooperative Fish and Wildlife Research Unit surveyed fish at four locations: Saluda Shoals Park, Radio Tower Fish Camp, Riverbanks Zoo, and Rosewood Boat Ramp. Three of these locations are in the Saluda River with the Rosewood Boat Ramp located on the Congaree River. These locations were 10 – 200 m downstream natural shoal habitat in pool or run habitat. Methods included:
 - a. Gill nets of two and 5 inch stretch each were fished twice weekly at each of the four sampling locations.

b. A 0.5 m plankton net with 0.505 mm mesh was concurrently fished with the gill nets midway between the surface and the bottom at each sampling location for 3 minutes during daylight hours.

c. Monthly electrofishing was conducted for approximately 30 minutes at each location when water levels permitted.

2. In late winter and spring of 2007 (February – April) 100 ft.-long monofilament gillnets with alternating 25-ft-long panels of 5-inch and 7-inch stretch mesh were soaked from daybreak for approximately 8 hours. The gillnets were set weekly during the three month period in the same location at four sites: 1) downstream the Saluda Dam near the USGS gage; 2) near the Gardendale canoe landing on the lower Saluda River; 3) upstream the Granby Lock and Dam on the Congaree River; and 4) Rosewood Boat Landing on the Congaree River. Ichthyoplankton nets were fished in conjunction with gillnets to sample for sturgeon larvae and eggs.

Other telemetry studies summarized below indicate that individuals translocated from the Cooper River around the Pinopolis Dam into Lake Marion move upstream into the project area:

1. In 2002, two pre-spawning adult shortnose sturgeon captured at the known spawning site below the Pinopolis Dam were tagged with transmitters and released above the dam in Lake Moultrie. Within two weeks, both fish had traversed Lake Moultrie, the Diversion Canal, Lake Marion, and the Congaree River to Columbia, SC, near rkm 161 just downstream of the confluence of the Broad and Saluda rivers. The two fish remained in the area for 14 days (Finney et al. 2006). This movement suggests adults were homing to the river reach where they were spawned (Kynard et al. 2016).
2. In 2003, a total of ten shortnose sturgeon were tagged in Lake Marion and Lake Moultrie and released (Collins et al. 2003). Two of the tagged shortnose sturgeon moved up into the Congaree River in March and spawning was confirmed with the collection of two viable eggs (Collins et al. 2003). Substrate at this spawning site, located at rkm 75.2 below the I-77 overpass just south of Columbia, SC, consists of sand, gravel, and rock (hard substrate necessary for egg adhesion) with depth at sites occupied by sturgeon between 3.0 – 7.3m. Water temperature during the period ranged from 9.0 – 17.3°C.
3. Of a total of 87 shortnose sturgeon tagged by SCDNR between 2012 and 2015, 47 fish were detected in the dam-locked area of the Santee Cooper Basin: Lakes Marion, Moultrie and upper Santee River (SCDNR 2017a). Twenty of those 47 fish moved upstream on presumed spawning runs, mostly (14/20) up the Congaree River to the verified spawning ground at rkm 75.2 (SCDNR 2017a). Some of those tagged shortnose sturgeon in the Congaree River moved upstream (SCDNR 2017a) past the Granby Dam (an old low-head dam with an open lock).

In early March 2011, SCDNR captured 19 adult shortnose sturgeon in the tailrace of the Pinopolis Dam in the Cooper River. Eighteen of those shortnose sturgeon were tagged with an acoustic telemetry tag and released; the other fish had been tagged previously. Two of the tagged shortnose sturgeon moved through Pinopolis Lock, through Lakes Marion and Moultrie, and into the Wateree River. One shortnose sturgeon was recorded on the receiver at the Wateree Tailrace (approximately ¼ mile downstream from the Wateree Dam) on both March 16 and 18, 2011, and spent a total of 8 days in the Wateree River. Another shortnose sturgeon entered the Wateree

River, was recorded within 4 miles of the Wateree Dam, and spent a total of 14 days in the Wateree River (B. Post, SCDNR, pers. comm. to K. Reece, NMFS, 2011). Both of these fish then moved out of the Wateree River and into the headwaters of the Congaree River for 18 and 19 days, respectively, before returning to Lakes Marion and Moultrie. Subsequently, one sturgeon remained in the Lake Moultrie and the other passed safely downstream into the Cooper River either via the Pinopolis lock or through the Pinopolis Dam turbines. The remaining 16 shortnose sturgeon have been repeatedly located in the Cooper River. During April and May 2011, 17 of the tagged shortnose sturgeon, including the one that passed upstream and downstream of Pinopolis Dam, were found residing in the Cooper River.

SCDNR initiated a 5-year shortnose sturgeon study in 2012 focused on the dam-locked population of shortnose sturgeon that inhabit the Santee Cooper lake system, below the action area, and its tributaries as part of the Santee Accord. Three patterns of movement were identified by the telemetry data:

1. Shortnose sturgeon were found to primarily inhabit the Brown's Lake area of Lake Marion. Brown's Lake is a small section of Lake Marion that prior to the construction of the Santee-Cooper Project was an oxbow of the Santee River located north of the I-95 Bridge.
2. Over 21 tagged shortnose sturgeon moved up into the Wateree River. A single fish moved upstream 11 miles while the other 20 stayed in the lowest river mile (NMFS et al. 2019).
3. A great number of shortnose sturgeon made presumed spawning runs into the Congaree River. Over the five-year study 82% (or 71 individuals) of the tagged fish were detected by receivers in the area of the previously verified spawning grounds. These spawning movements occurred annually February through April in 2012, 2013, 2014, 2015, and 2016 (SCDNR 2016). Some fish were detected by receivers at Rosewood Landing and Granby Park located 4.8 and 6.0 miles upstream of the known spawning site, respectively. Shortnose sturgeon utilized the Congaree River during winter and spring (SCDNR 2016).

SCDNR continued to monitor shortnose sturgeon in Congaree and Wateree rivers beyond 2016. From 2017-2019, SCDNR continued to report detections of shortnose sturgeon making apparent spawning movements annually (SCDNR 2017a; SCDNR 2018a; SCDNR 2019). However, during this period no shortnose sturgeon were detected above Granby Dam and none were detected further than 1 mi (1.6 km) into the Wateree River.

Collectively these telemetry studies indicate shortnose sturgeon have moved upstream in the Congaree River up to the Blossom Street Bridge in Columbia, South Carolina (Finney et al. 2006; SCDNR 2016); however, their presence above Granby Lock and Dam is not common. Notably, the best available data do not consistently depict fish moving upstream of known spawning habitat before encountering the Granby Lock and Dam and coming back; a behavior that would be indicative of individuals unsuccessfully trying to pass above the lock and dam. Data indicates shortnose sturgeon distribution is primarily in areas downstream of Granby Lock and Dam (SCDNR 2016; SCDNR 2017a; SCDNR 2018a; SCDNR 2019). Granby Lock and Dam is located approximately one mile downstream of the Blossom Street Bridge and approximately five miles downstream of the Columbia Hydroelectric Project Fishway.

As discussed in Section 4.2.1, the Granby Dam will be removed per a 2007 settlement agreement decree. The removal of this physical barrier will provide, fully-unobstructed access to additional riverine habitat. The available movement data suggests once the dam is removed some individuals may occasionally pass upstream of its current location. However, we anticipate the vast majority of individuals will continue to use the spawning habitat below the I-77 bridge based on the current habitat use data.

Collins et al. (2003) observed that dam-locked shortnose sturgeon collected above the Santee-Cooper dams in Lakes Marion and Moultrie have poor body condition compared to those below the dam (i.e., in the Cooper River). This suggests poor foraging habitat quality in the lakes (e.g., inadequate food or lack of access to physiologically important habitat). In addition, a relatively high number of shortnose sturgeon were captured on hooks baited with “minnows” or cut fish (Collins et al. 2003). Other fish are not generally considered to main component of shortnose sturgeon diets. Capture via baited hooks suggests a degree of piscovry by dam-locked shortnose sturgeon not previously recognized (Collins et al. 2003) and not generally seen in other populations of shortnose sturgeon. Collins et al. (2003) hypothesized piscovry by shortnose sturgeon may be a result of limited food availability. A diet study of shortnose sturgeon collected in Lake Marion indicated a diet predominated by insects and polychaetes (Collins et al. 2006). The absence of amphipods in the guts of these shortnose sturgeon was further investigated, as shortnose sturgeon collected from river systems are known to have a specialized diet of amphipods. Periodic sediment grabs in Lake Marion were conducted; results of the sediment grabs and shortnose sturgeon gut contents were both consistently predominated by mayfly larvae (Collins et al. 2006).

Abundance

Relative to historical abundance, the shortnose sturgeon population within the watershed has significantly decreased in number, mostly attributed to overfishing and habitat modification due to construction of dams. The major rivers along the East Coast, of which the Congaree River is a part of, historically supported the largest commercial sturgeon fishery in the South. Records show no differentiation between shortnose and Atlantic sturgeon noted in landings records (NMFS 1998). Fisheries for the shortnose sturgeon have been closed since 1967, followed by the closure of the Atlantic sturgeon fishery in South Carolina in 1985. Because habitat accessibility and dams are inseparably linked, fish passage at one facility determines the passage potential at other dams. The accessibility to, and condition of, habitat throughout the river system continues to be negatively impacted by dams.

While it is difficult to ascertain the number of sturgeon in the basin prior to 1942 and the construction of the Santee-Cooper Project, there is no doubt the abundance of shortnose sturgeon in the Santee Basin has been significantly reduced. Sturgeon were abundant enough to sustain a fishery within the Santee Basin in the late nineteenth century (Secor 2002). Relative to historical abundance, the sturgeon population within the Santee Basin has significantly decreased, mostly attributed to overfishing and habitat modification due to construction of dams. Fisheries for the shortnose sturgeon closed in 1973 concurrent with the ESA listing. The total number of shortnose sturgeon within the action area is greatly decreased from historic accounts.

Telemetry work indicates that in the summer these dam-locked shortnose tend to concentrate in the part of Lake Marion known as Brown's Lake – a short section of the lake that prior to project construction was a river oxbow. Based on survey of the Brown's Lake area, the best available information on the abundance of this dam-locked shortnose sturgeon population is approximately 287 adults (SCDNR 2017b); this is the minimum number thought to exist, and is likely an underestimate as a thorough survey of the entire reservoir area has not been conducted.

Summary Status of Shortnose Sturgeon in the Action Area

Shortnose sturgeon occur and spawn in the action area. It is likely that the total number of shortnose sturgeon within the action area is greatly decreased from historic accounts. The only available abundance estimate for the dam-locked population in Lake Marion is 287 adults. Data suggests there may be minimal movement of shortnose sturgeon from below the dams Pinopolis Dam into Lake Moultrie (potentially 2 fish or less a year). However, the population of dam-locked shortnose sturgeon appears to be stable and therefore we do not expect that this movement, to the extent it occurs in any given year, has a measurable impact on the size of the dam-locked population.

Shortnose sturgeon eggs have been collected on the Congaree River at the city of Columbia, SC, (rkm 70), and a single small juvenile, presumed YOY, was recorded downstream in Lake Marion (Collins et al. 2003). Telemetry data indicate that some individuals have been detected to at least the Blossom Street Bridge adjacent to the city of Columbia, SC, on the Congaree River, but are primarily found in the areas downstream of Granby Lock and Dam (Finney et al. 2006; SCDNR 2016).

4.2 Factors Affecting Shortnose Sturgeon within the Action Area

The action area includes the area from the Saluda Dam at Lake Murray downstream to Congaree National Park. This includes the lower Saluda River, and the Congaree River from the confluence downstream approximately 16 miles. Numerous activities have been identified as threats and may affect shortnose sturgeon in the action area. The following analysis examines actions that may affect these species' environment within the action area.

4.2.1 Federal Actions

ESA-related Activities

Through ESA Section 6 cooperative agreement with South Carolina, NMFS has supported numerous research projects within or adjacent to the action area to investigate the life history of shortnose sturgeon.

There is currently one Section 10(a)(1)(A) scientific research permits issued to study shortnose and Atlantic sturgeon in the action area. This five-year permit, issued in 2022, approves sampling methodology and authorizes both non-lethal and lethal take. The permit authorizes the unintentional mortality of one adult or subadult Atlantic sturgeon, one juvenile Atlantic sturgeon, one adult or subadult shortnose sturgeon, and one juvenile shortnose sturgeon, annually. Ongoing research involves river survey, genetic tissue sampling. Tagging and telemetry is occurring to identify movement patterns. The specific stressors to fish subject to NMFS-Issued ESA permit conditions are capture in nets, handling and restraint during examination, internal

tagging including passive integrated transponder and acoustic tags, tissue sampling and gastric lavage to determine diet. NMFS finalized a Recovery Plan for shortnose sturgeon in 1998 (NMFS 1998) as required by the ESA Section 4, with the following recovery objective:

“To recover shortnose sturgeon populations to a level of abundance at which they no longer require protection under the ESA, and for each population segment, the minimum population size will be large enough to maintain genetic diversity and avoid extinction.”

The 1998 Shortnose Sturgeon Recovery Plan also identified four main recovery actions: establish listing criteria for shortnose sturgeon population segments; protect shortnose sturgeon and their habitats; rehabilitate shortnose sturgeon populations and habitats; and implement recovery tasks. To rehabilitate shortnose sturgeon habitats and population segments, the Recovery Plan specifically calls for actions to restore access to habitats, spawning habitats, and foraging habitat.

NMFS published a Shortnose Sturgeon Biological Assessment in 2010 (NMFS 2010). This assessment was conducted by a team of nine experts on shortnose sturgeon biology and life history that provided data as well as individual expert input to ensure the report contained the best available information. The report presents information on a river-by-river basis, summarizing published information regarding abundance and distribution (both historic and current), river-specific natural history and habitat information, stressors impacting the riverine system, and current and recommended research. This is the most current complete biological assessment of shortnose sturgeon across its range.

In recent years, NMFS has undertaken several ESA Section 7 consultations (Table 4) to address the effects of federal actions in the Santee River Basin, with impacts to the action area.

Table 4. Summary of ESA Section 7 consultations in the Santee Basin.

Date	Area	Project	Action Agency
3/11/2002	Broad River	Columbia Hydroelectric Project	FERC
7/8/2013	Catawba/Wateree	Re-licensing of Hydroelectric Project	FERC
1/22/2020	Santee-Cooper	Re-licensing of the South Carolina Public Service Authority Hydroelectric Project	FERC

Federal Energy Regulatory Commission – FERC

There are numerous FERC projects in the Santee Basin that influence the status of shortnose sturgeon in the action area. The management of water release and the passage of fish through hydropower facilities licensed by FERC impact both the habitat and status of fish.

Columbia Canal Hydropower Facility

Immediately upstream in the Broad River is the Columbia Canal Hydropower Facility located just north of Columbia, SC. Columbia Canal Hydro is owned by the city of Columbia, SC, and operated to generate hydroelectric power by the Lockhart Power Company. Construction started on this canal in 1820 to navigate the rapids where the Broad River and the Saluda River form the Congaree River. The Columbia Canal was very profitable navigation system until the mid - 1800’s when the lower Congaree River was opened to navigation. The Columbia Canal was redesigned as an industrial power source in 1891 with a diversion dam across the Broad River to

allow access from the Saluda Canal. A vertical fish slot ladder, designed for American shad and yes blueback herring, was installed in the Diversion Dam at the Columbia facility in 2006. The fishway does not accommodate sturgeon.

Santee Cooper

The Santee Cooper Project, owned and operated by South Carolina Public Service Authority, located downstream from the SHP, is the first hydroelectric project in the Santee River basin and blocks passage of sturgeon in the lower Santee and Cooper Rivers. We completed a biological opinion on the effects of the Santee Cooper Project on shortnose sturgeon in 2020 (SERO-2018-00325). In that biological opinion, we determined that the continued operation of the Santee-Cooper Project was not likely to jeopardize the continued existence of shortnose sturgeon. However, the South Carolina Public Service Authority is required to move spawning shortnose sturgeon from a place they cannot successfully reproduce (below the Pinopolis Dam) to an area where recruitment is possible (below the Santee Dam). Additionally, South Carolina Public Service Authority is required to increase flows into the Santee River and establish adaptive management procedures to create/restore reproductive habitat below the Santee Dam in the Santee River, thereby improving population recruitment, demographics, numbers, survival and recovery. Any passage above the Santee-Cooper project Dams will be based on the need for such passage as determined by a working group consisting of NMFS, Santee-Cooper and SCDNR. At this time, we do not expect that an increase of shortnose sturgeon or presence of any Atlantic sturgeon in the action area is reasonably foreseeable because of this project.

A 2007 settlement agreement between the South Carolina Public Service Authority ("Santee-Cooper"), the USFWS, and the SCDNR, requires Santee-Cooper to remove the Granby Dam within 6 months from the issuance date of the license. Following execution of the 2007 settlement agreement approximately 40,000 tons of tar like material was discovered in the Congaree River upstream from the Granby Dam. Efforts are underway to remove the coal tar but work is not expected to be completed until 2025. Santee-Cooper sought, and received, permission from the parties to the settlement agreement to delay the removal of dam until after coal tar clean up is complete. Removal of the Granby Dam will eliminate the last manmade obstruction between the Saluda Dam on the Saluda River and the Columbia Dam on the Broad River.

Catawba-Wateree

Duke Energy was issued a new 40-year operating license for the Catawba-Wateree River Hydro Project (CWHP) on November 20, 2015. The existing Catawba-Wateree Hydroelectric Project is located on the Catawba-Wateree River that flows through both South Carolina and North Carolina. The project encompasses more than 300 river miles as measured from the confluence of the Wateree and Congaree Rivers, and a total of 81,688 reservoir surface acres at full pond (FERC 2009).

The Wateree Dam is located at river mile 76.9. This dam is concrete gravity and semi-hydraulic fill earth with a concrete spillway.⁹ The dam measures 76 ft. high and 1,753 ft. long and the

⁹ Gravity dams are designed and shaped such its weight alone is sufficient to ensure stability; a concrete gravity dam is a type of gravity dam. Semi-hydraulic fill earthen dams refers to the practice of dumping earthen fill material directly into the dam location. However, at least some portion of material is moved into its final position using

spillway is about 1,450 ft. long with a crest elevation of 225.5 ft. msl (mean sea level). The 13,025-acre reservoir (Lake Wateree) has a full pond elevation of 225.5 ft. msl and a usable storage capacity of 65,568 acre-feet. The intake and powerhouse are integral structures, constructed from reinforced and mass concrete. There are five separate intakes, one for each turbine. Each intake has two sets of structural steel trash racks, five 18 ft. wide by 22 ft. high and five 12 ft. wide by 22 ft. high. The powerhouse contains five vertical Francis turbine-generator units with a total installed capacity of 82 MW (FERC 2009).

Duke Energy operates the project to meet the peak and load-following energy demands of their transmission and distribution systems in coordination with their other generating facilities. Consistent with meeting electrical demands, the project developments are operated according to development-specific downstream flow requirements, including the minimum average daily flow license requirements; and development-specific continuous minimum flow releases. Operations of project developments are in accordance with the reservoir level guide curves which are not required under the current license (FERC 2009).

The CWHP maintains its reservoir level within its normal operating range by generating electricity as needed. Additionally, one unit is operated at efficiency load at least once each day, generating about 60 MWh to meet the minimum average daily flow license requirement of 446 cfs. In the spring, the station continuous release is increased to support fish spawning as part of the voluntary Spring Lake Level Stabilization Program. From March 15 to May 31, the station releases a continuous flow to support fish spawning, though it is sometimes reduced depending on water availability. Additional daily voluntary releases are made as needed throughout the year to support several large industrial water users downstream including a large steam-electric generating station. Except for continuous releases, generation from the Wateree Development is dispatched primarily for peaking energy needs (FERC 2009).

The normal operating target elevation for the Wateree Reservoir varies during the year from elevation 220.5 ft. msl in December and January to 222.5 ft. msl for most of the year excepting a 3-week fill period in January to February and a 6-week drawdown period in November to December. At any given time, the reservoir level may fluctuate within a normal operating range from 2 ft. below to 2 ft. above the normal operating target elevation (FERC 2009).

NMFS reserved its authority under §18 of the Federal Power Act, as amended, to prescribe fishways, or such additional fishways, or to modify existing fishways at CWHP. In the biological opinion for the relicensing of the CWHP, NMFS expected the numbers of shortnose and Atlantic sturgeon accessing and using the riverine habitats within the action area below the CWHP to increase throughout the life of the license.

Congaree National Park

Congaree National Park is located 20 miles downstream of Columbia, SC. This Park covers more than 26,000 acres and protects the largest contiguous area of old-growth bottomland hardwood forest remaining in the United States. This unique and increasingly rare forest ecosystem depends on the health of the Congaree River for providing periodic seasonal flooding that

water. Generally, water jets are used to move the earthen materials to their desired locations within the dam foot print (https://allaboutcivil.org/earthen-dams-types-of-earthen-dams/#3_Semi-hydraulic_fill_earth_dams).

provide nutrients and sediments to rejuvenate the ecosystem. It was designated South Carolina's first national park in 2003.

4.2.2 State or Private Actions

A number of activities that may directly or indirectly affect shortnose sturgeon within the action area include impacts from fisheries, wastewater systems, stormwater systems, and residential or commercial developments adjacent to waterways. The direct and indirect impacts from some of these activities are difficult to quantify. However, where possible, conservation actions through the ESA Section 7 processes, ESA Section 10 permitting, ESA Section 6 cooperative agreements, and state permitting programs are being implemented to monitor or study impacts from these sources. In general, SCDNR and SCDEHC are the state entities provide oversight of the health of the Saluda River Basin; private organizations include the Congaree Riverkeeper, Saluda River Trout Unlimited and American Rivers.

SCDNR and SCDHEC developed surface-water quality models for each of the eight major watersheds in South Carolina (Figure 4). The Saluda River Basin Simplified Water Allocation Model (SWAM) was developed to support future permitting, policy, and planning efforts (<https://hydrology.dnr.sc.gov/swam-models.html>). Within the model, the Surface Water Availability Assessment was included to focus on the development of surface water quantity to represent the impacts of water withdrawals, return flows, and storage. The developed models are available for use by water utilities, energy producers, river basin organizations and other stakeholders to support development of regional water plans. Current users (permitted or registered withdrawals or significant discharge) were represented and equaled 3 million gallons of withdraw in any month.

In 2011, the State of South Carolina began established a system and rules for permitting and registering the withdrawal and use of surface water. The program requires permitting, registration, use, and reporting for surface water withdrawals in excess of 3 million gallons during any 1 month (S.C. Code Sections 49-4-10 et seq.). The most recent statewide report on surface water use is from 2020 (SCDHEC 2021). For the Saluda River, total permitted water withdrawals at, and downstream of, the Saluda Dam, are 6,800 mg; allocated across only three entities: Dominion Energy for power generation at the Saluda Dam (5,175 mg; 76%), Shaw Industries for industrial water use (1,365 mg; 20%) and the city of West Columbia for public water supplies (261 mg; 4%) (SCDHEC 2021). In the Congaree River, total permitted water withdrawals are 10,155 mg. Water withdrawals to support public water supplies accounted for the 4,597 mg (45%) of the water used in 2020 (SCDHEC 2021). While industrial water use accounted for the majority (5,491 mg; 54%) followed mining (67 mg; 1%) (SCDHEC 2021).

Lower Saluda River

This lowest section of the Saluda River flows out of the Lake Murray dam and merges downstream with the Broad River near the city of Columbia, SC, to form the Congaree River. The lower Saluda River is protected under the SC Scenic Rivers Act. However, SCDHEC information indicate water quality in the lower Saluda River does not always meet the state DHEC aquatic quality criteria. In addition, some waters in the lower Saluda River Basin have been identified by SCDHEC as impaired as they do not meet recreational and aquatic life water quality criteria. High fecal coliform levels impair recreational use; poor macroinvertebrate

assemblages, high turbidity and low DO affect aquatic life. Fish flesh analysis for certain species below Lake Murray Dam indicate high levels of mercury. Consequently, SCDHEC has issued public health advisory for consumption of certain fish species in the lower Saluda River.

There are 10 permitted wastewater dischargers in the lower Saluda River. Most are small domestic treatment facilities, four are industrial and one is municipal. In 2017, a court found that the Carolina Water Service I-20 sewage plant was discharging pollution into the Saluda River illegally; they were ordered to pay \$15million and to connect to the municipal sewage system and were permanently prohibited from any future discharges into the river. *Congaree Riverkeeper Inc v. Carolina Water Service Inc*, No. 3:2015-cv-00194 (D.S.C. March 29, 2017). In 2018, Carolina Water Service transferred ownership of the I-20 plant to the town of Lexington and discharge from the I-20 wastewater plant ceased.

SCDHEC information, indicates there are 3 permits for surface water withdrawal in the lower Saluda River (SCDHEC 2021). Most are for agricultural; the largest withdrawals are associated with the Saluda Hydroelectric Project and McMeekin Electric Generating facilities.

TMDLs were developed by SCDHEC and approved by EPA for the lower Saluda River and tributaries Kinley Creek and Twelvemile Creek. There is a NPDES facility permitted to discharge fecal coliform bacteria on Twelvemile Creek and one on the Saluda River. Possible sources of fecal coliform bacteria are leaking sewers, SSOs, failing septic systems, improper land application of manure, cattle watering in the creeks, wildlife, and urban runoff. The TMDLs require reductions of 89% to 92% in fecal coliform loading for these streams to meet the recreational use standard.

Congaree River

Flow characteristics in the Congaree River are a combination of the regulated releases from the SHP and the more natural flows in the Broad River; local tributary streams contribute to a much lower extent. Daily flows are dependent on the releases from the SHP with the greatest flows occurring in the winter and the lowest in the summer. The Congaree River is classified “freshwater” by SCDHEC indicating the waters are suitable for primary (swimming) and secondary (boating and fishing) recreation, as well as the survival and propagation of a balanced indigenous aquatic plant and animal community.

Water quality monitoring indicate the recreation use is impaired in numerous locations due to elevated fecal coliform levels. Elevated mercury levels were found in at numerous locations on the Congaree River and subsequently SCDHEC issued a fish consumption advisory for largemouth bass, chain pickerel, and bowfin (mudfish) to one meal per week. In 2010, tar like material (i.e., coal tar) was detected in the sediments of the Congaree River just downstream of the Gervais Street Bridge in Columbia, South Carolina. After years of project design and permitting, removal of the material began in earnest in 2022 and is expected to take 3 years to complete.

SCDHEC indicates there are 28 individual permitted wastewater dischargers on the Congaree River: 12 domestic dischargers, 12 industrial dischargers, and 4 municipal. The major municipal dischargers include the city of Columbia, city of Cayce, and the city of West Columbia.

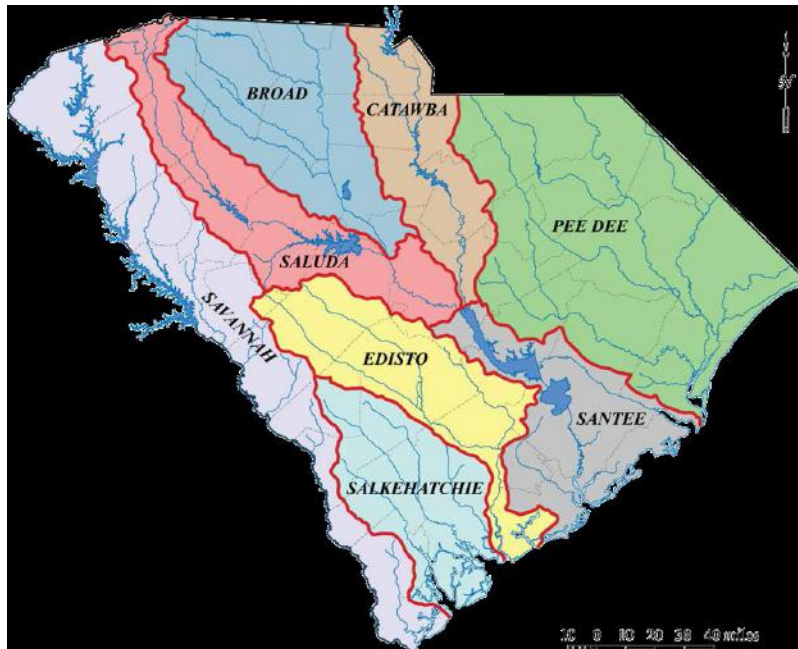


Figure 4. The eight major river basins of South Carolina. Figure taken from http://www.dnr.sc.gov/water/waterplan/pdf/Major_Basins_of_South_Carolina.pdf.

4.3 Other Potential Sources of Impacts to the Environmental Baseline

The Saluda River Basin transects the Blue Ridge and Piedmont of South Carolina and extends southeast to the fall line in the central part of the State (Figure 4). With a northwest-southeast orientation, the basin shares a common northern boundary with North Carolina on the north and encompasses parts of 13 South Carolina counties, including most of Greenville, Greenwood, Laurens, Newberry, and Saluda Counties, and smaller parts of Abbeville, Aiken, Anderson, Calhoun, Edgefield, Lexington, Pickens, and Richland Counties. The basin is the fourth largest in the State, encompassing an area of approximately 3,210 square miles, or 10.3% of the land area of the State. The Saluda River is the major watercourse in the basin and streams from this river provide water-use needs for the cities of Greenville, Greenwood, and Laurens. Second is the Congaree River, formed by the confluence of the Saluda and Broad Rivers at Columbia. The Saluda River Basin and the Catawba River Basin join to form the Santee River Basin and the Saluda and Catawba rivers converge to become the upper Santee River upstream of Lake Marion (Figure 4).

There are two thermoelectric power plants operating in the basin: the licensee's McMeekin Station is a coal-fired power plant located adjacent to the Lake Murray Dam in Lexington County, and the Lee Steam Station is a coal-fired power plant owned and operated by Duke Energy located on the Saluda River in Anderson County. Collectively these two power plants used a total of 82,721 gallons of water in 2006 (SCDNR 2013).

4.3.1 Climate Change

Due to the size of the action area, and the scope of impacts potentially caused by climate change and the threats it poses to shortnose sturgeon are anticipated to be same as those describe previously in *Section 3: Status of Species*.

4.3.2 Water Quality

Waterborne contaminants may affect the aquatic environment. SCDEHC published in 2011 a Watershed Water Quality Assessment for the Saluda River Basin (SCDEHC 2011). Impaired sites within the project area included the: 1) lower Saluda River did not support aquatic life standards due to DO; and 2) Congaree River as it does not support aquatic life uses due to occurrences of copper in excess of the aquatic life chronic criterion coupled with significant increasing trends in five-day biochemical oxygen demand, total nitrogen concentration and fecal coliform bacteria excursions; and 3) some tributaries that flow into the lower Saluda River had elevated levels of fecal coliform. Point sources within the Saluda River Basin are from both municipal and industrial discharges.

4.3.3 Dams

Dams and their operations are also the cause of major instream flow alteration in the Southeast (USFWS et al. 2001), including the action area. As identified above, there are numerous FERC-licensed dams, including the Saluda Dam, in the Santee Basin that have historically affected the environmental baseline in the action area. Additionally, the Granby Lock and Dam on the Congaree River is a historic dam located between the city of Columbia and the known sturgeon spawning location on the Congaree.

Dams restrict sturgeon movement in and around the action area (Figure 5): the Saluda Dam at Lake Murray restricts upstream movement in the Saluda River, the Columbia Diversion Dam impedes sturgeon movement up the Broad River, and the Wilson Dam and the Pinopolis Dam restrict downstream movement and access to saltwater habitat. Effects of the Wilson and Pinopolis Dams, located downstream, were assessed under a separate consultation for the South Carolina Public Service Authority Hydroelectric Project (FERC #199-205) with a biological opinion issued on January 22, 2020.

The Granby Lock and Dam was constructed at the beginning of the 20th Century to provide at least a 4-foot navigation depth in the Congaree River up to the city of Columbia. While the Granby Dam is no longer used to aid navigation up to the city of Columbia, the structure remains in place as a short dam and an open-lock passage that is used by boaters to bypass the dam when river levels are low. The dam spans 85% of the river's width and has two significant effects on the hydraulics of the Congaree River: 1) the impoundment of water, resulting in deeper, slower water upstream of the dam; and 2) the diversion of the river's flow into the relatively narrow but unobstructed lock which causes water to pool up behind the dam. During low flows, the Granby Dam has a significant effect on the Congaree River, but during high flows, the dam's presence is almost negligible. Shortnose sturgeon have occasionally been detected upstream of the Congaree River past the Granby Lock and Dam. It is unknown if these tagged sturgeon moved up through the open lock or over the sill. It is more likely that the fish used the open lock due to their benthic nature.

The Santee Cooper dams have blocked upstream access to coastal sturgeon residing below the dams, creating the dam-locked population of shortnose sturgeon population that utilize the action area. These three dams below the action area are located at the extreme lower end of the coastal plain and are the first impediments encountered by all anadromous fish species migrating

between estuarine/marine coastal waters into freshwater habitats of the Santee River Basin. Jointly, the Cooper and Santee Rivers are the keystone corridors used by diadromous fish to access habitats in the Santee River Basin (NMFS et al. 2019), including upstream into the Congaree River.

Collectively the dams further upstream prohibit sturgeon from moving upstream and the dams downstream prohibit sturgeon from accessing estuarine foraging habitat. While the sturgeon in the action area are not able to access traditional nursery and foraging areas, the habitat available for foraging (i.e., Congaree River, and Lakes Marion and Moultrie) provides prey for this dam-locked population to survive. However, these fish tend to be less healthy than fish that can access traditional nursery and foraging areas (Bill Post, SCDNR Pers. Com.).

Translocated adult sturgeon (i.e., moved from Cooper River around Pinopolis Dam) have successfully migrated upstream and many fish entered other river systems (Cooke and Leach 2004). Ninety-three percent of these survived subsequent downstream passage and were later relocated below the dams (Cooke and Leach 2004).

In short, the action area provides spawning habitat for sturgeon residing in Lakes Marion and Moultrie. The origin of these reservoir fish is unknown. Based on genetic evaluation of limited samples from the Cooper River and the reservoir system, Collins et al. (2003) proposed two hypotheses for the origin of the reservoir fish: 1) the reservoir fish, and perhaps the Cooper River group, are derived from the Santee River population segment that was trapped above the dams at construction with minimal augmentation by fish that pass upstream via St. Stephen fish lift and Pinopolis Lock; or 2) the reservoir population is derived from the Cooper River, but the founder event and near (or total) lack of continued recruitment from that river has resulted in altered haplotype frequencies in the reservoir population segment. Cooke et al. (2004) later argued that it was unlikely that the Cooper River historically hosted a reproducing population given the short river length. Wirgin et al. (2010) concluded the shortnose sturgeon in Lake Marion and Lake Moultrie are likely a remnant population with Santee River ancestry. Regardless of origin, the action area provides the only known spawning habitat for the shortnose sturgeon that currently reside in the Saluda and Santee River Basins. Only fish residing above the dams of the Santee-Cooper project have access to the spawning habitat, they produce progeny that migrate downstream past the dams (likely in small numbers as YOY or juveniles) into the Cooper and Santee Rivers. These shortnose sturgeon (the spawners) captured in Lakes Marion and Moultrie are in poor condition compared to those in the Cooper River below the Pinopolis Dam (Collins et al. 2003).

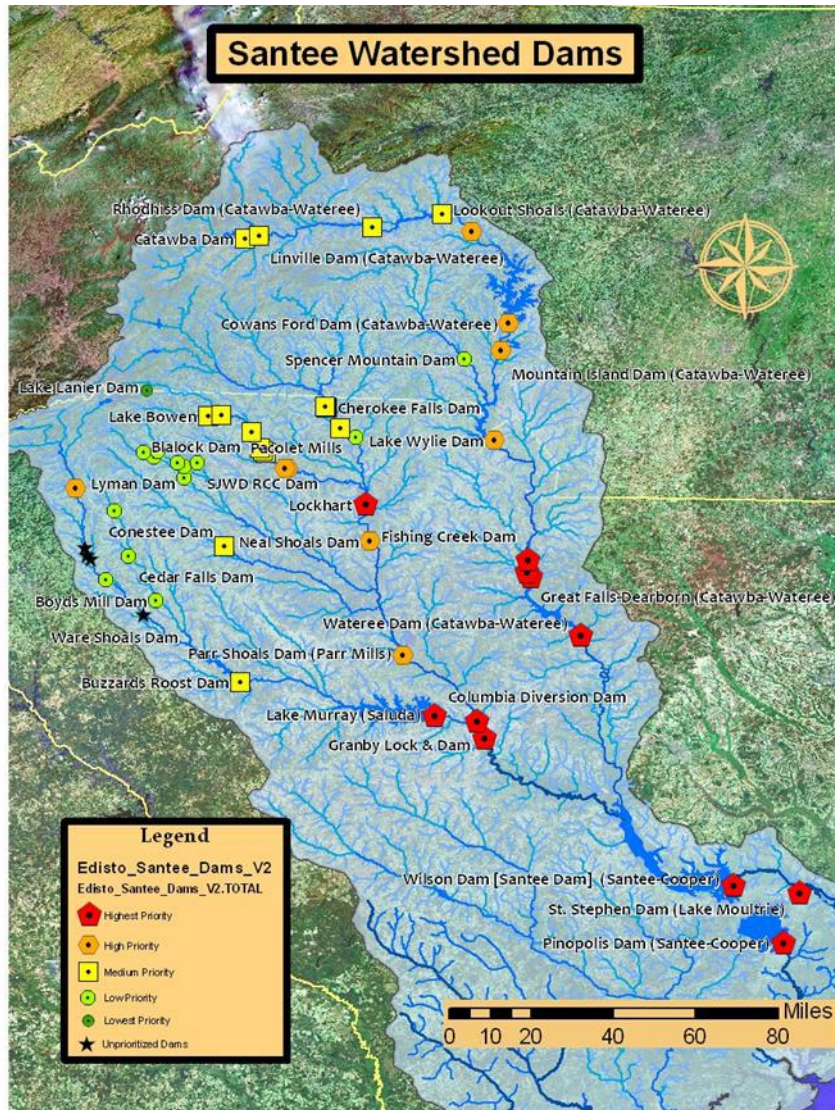


Figure 5. Existing in-water facilities within the Saluda and Catawba river basins, South Carolina, that limit or prohibit sturgeon migration. Most facilities are scheduled to be relicensed by FERC within the next decade. Major mainstem impediments are indicated in red.

4.4 Conservation and Recovery Actions Shaping the Environmental Baseline

FERC Relicensing of Catawba-Wateree

When the CWHP was relicensed in 2015 for the next 40-years, NMFS reserved its authority under §18 of the Federal Power Act, as amended, to prescribe fishways, or such additional fishways, or to modify existing fishways at CWHP. In the biological opinion for the relicensing of the CWHP, NMFS expected the numbers of shortnose and Atlantic sturgeon accessing and using the riverine habitats within the action area below the CWHP to increase throughout the life of the license. Meanwhile, CWHP agreed to:

1. Share any information about shortnose sturgeon occurrences or collection in the Wateree River downstream of the Wateree Dam;
2. Provide enhanced flow releases to enhance habitat suitability; and
3. Continue ongoing discussions with other hydropower facilities to explore potential cooperative measures for the enhancement and restoration of diadromous fish species, including shortnose sturgeon, in the Santee River Basin.

5 EFFECTS OF THE ACTION

As discussed in the baseline section, hydropower dams, including the Saluda Dam, have blocked passage to spawning areas, created barriers to natural water flow, and contributed to poor downstream water quality in the Santee Basin. These effects have combined to significantly reduce and suppress sturgeon populations in the action area. In this section of the biological opinion, we assess the effects of the proposed action on the shortnose sturgeon by using the best available information to analyze proposed license articles and their effects on the following factors: 1) water quantity and quality; 2) habitat loss or restriction; and 3) blocked access to upstream habitat. The analysis in this section forms the foundation for the jeopardy analysis in Section 7. A jeopardy determination is reached if we would reasonably expect a proposed action to cause reductions in numbers, reproduction, or distribution that would appreciably reduce a listed species' likelihood of surviving and recovering in the wild. Shortnose sturgeon are likely to be adversely affected by the proposed action.

5.1 Effects on Hydrologic Conditions Under the Terms of the License

The licensee operates the SHP to manage Lake Murray water surface elevations on a seasonal basis, which affects hydrologic conditions below the dam. Historically, Lake Murray's water surface has been maintained between elevation 348.5 ft. in the winter and 356.5 ft. in the summer. The licensee would occasionally draw down the reservoir to elevation of 353.5 ft. for project maintenance work or control of aquatic vegetation with the existing license allowing a maximum operating water surface elevation of 358.5 ft. Under the previous license, no minimum flow was required. However, the Saluda powerhouse operates with one unit on line at a minimum gate to provide a downstream flow of at least 180 cfs under an informal agreement with the SCDHEC. This has resulted in highly variable daily flows. Flow also varies seasonally with the greatest flow historically occurring in the winter months and the lowest in the summer.

The licensee proposes to increase the maximum and minimum reservoir elevations in Lake Murray, which will allow greater minimum flows releases to the lower Saluda River. The licensee also proposes to implement a LIP with a trigger at 1 ft. below the proposed guide curve elevation that would reduce flows to the lower Saluda River during low inflow conditions.

Within the project area, numerous USGS water gages record streamflow data (Table 5;

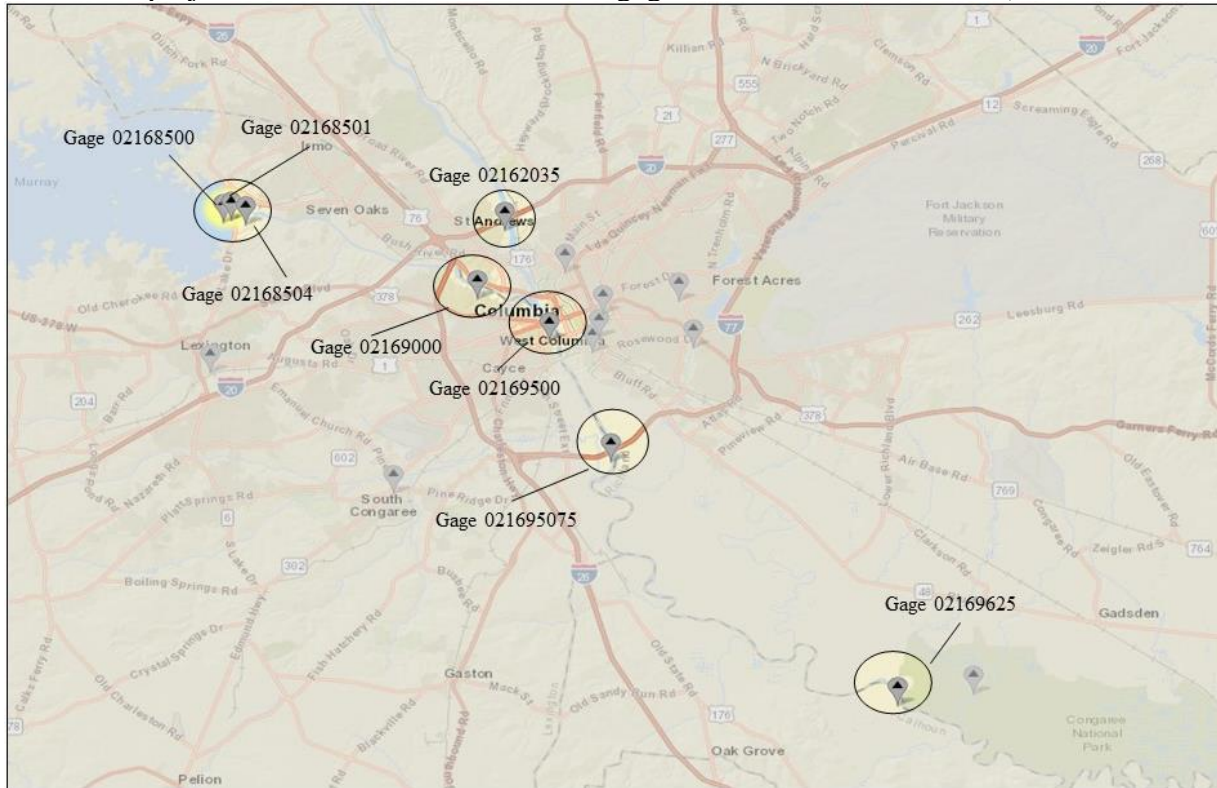


Figure 6). Water quality parameters recorded at each gage vary because individual cooperators provide funding for each gage. We primarily rely on the two gages within the action area that record temperature and DO: USGS gage 02168504 (lower Saluda River just below Lake Murray) and USGS gage 02169000 (12.5 km downstream in the lower Saluda River).

Table 5. Summary of water gages in the action area starting from Lake Murray and moving downstream. Gages in italics are no longer active. For a map of the locations, see <https://maps.waterdata.usgs.gov/mapper/index.html>.

Gage #	Location	Parameters available
02168500	Lake Murray near water intakes	Water temperature, elevation, dissolved oxygen, wind speed and direction
02165801	Lake Murray tailrace	Gage height
02168504	Lower Saluda River just below Lake Murray	Water temperature, gage height, precipitation, discharge, and dissolved oxygen
<i>0216900</i>	<i>Lower Saluda River at I-20</i>	<i>Discharge and gage height</i>
02169000	Lower Saluda River 12.5 km downstream of the Saluda Dam and 2.5 km upstream of the confluence with Broad River	Water temperature, discharge, gage height, and dissolved oxygen
02168501	Broad River at I-20	Water temperature, discharge, gage height, and dissolved oxygen

Gage #	Location	Parameters available
02169300	<i>Confluence of Saluda and Broad River above Columbia, SC</i>	<i>Gage height</i>
02169500	Congaree River at Columbia, SC	Discharge and gage height
021695075	Congaree River at I-77 below Cayce, SC	Gage height
02169624	<i>Congaree River at Sandy Run</i>	<i>Discharge and gage height</i>
02169625	Congaree River at Congaree National Park near Gadsden, SC	Gage height

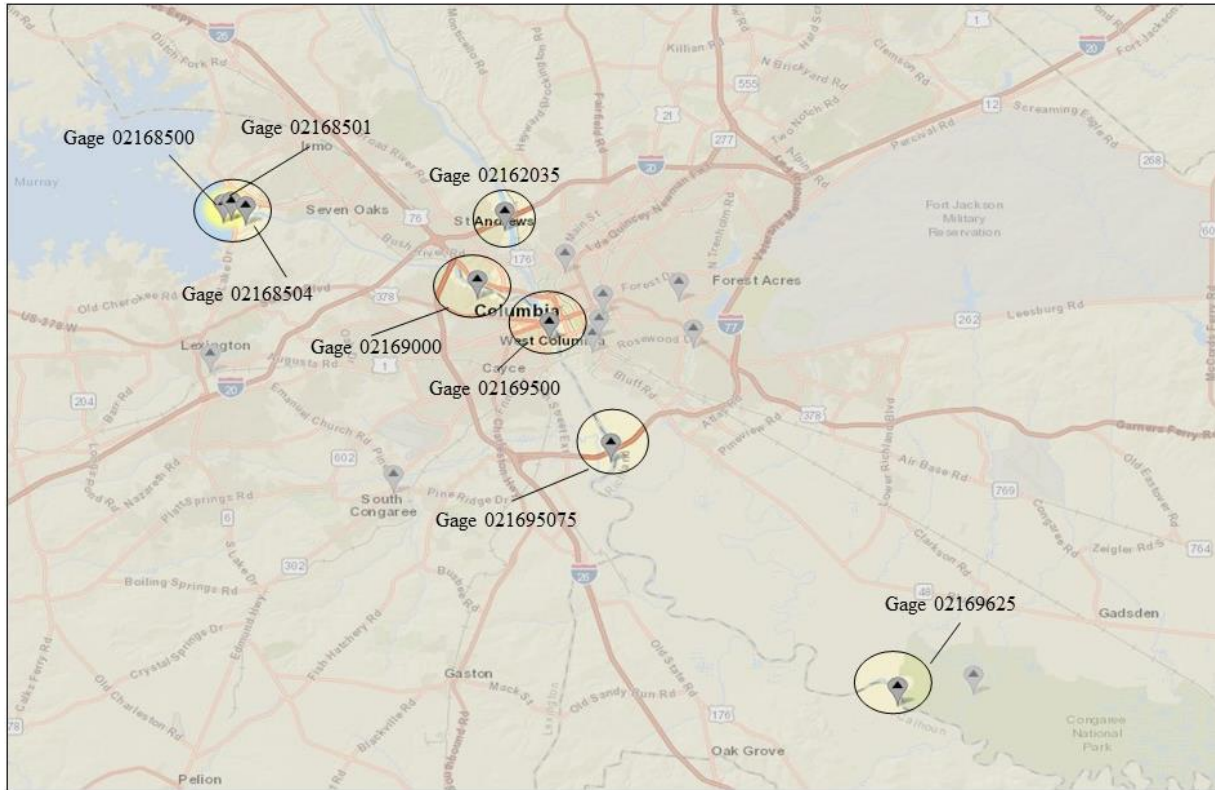


Figure 6. Map showing location of river gages described in Table 5.

5.1.1 Flows/Water Quantity

Hydropower dams directly affect the volume and rate of water discharged and SHP may affect water depths and the extent of available habitat downstream of the SHP. The Saluda project has been historically operated to manage the reservoir elevation of Lake Murray on a seasonal basis. Under the new license, the licensee will continue to operate on a seasonal basis to maintain reservoir elevation while releasing minimum flows of 700 cfs (January 1 – March 31); 1,000 cfs (April 1 – May 31); and 700 cfs (June 1 – December 31) from the Saluda Dam. These minimum flows under the new license are above the 180 cfs provided under the previous license. The existence and operation of the Saluda dam results in impacts to flows that adversely affect shortnose sturgeon, by restricting flows available for shortnose migration and other life history functions, such as foraging and spawning. However, the proposed increased flows from the previous license are expected to increase the amount of habitat available to sturgeon for important life history functions, such as foraging and spawning, when those flows are available, over previous operating conditions.

Increased flows are known to act as environmental cues to sturgeon, triggering them to migrate further upstream in search of historically available spawning habitat (Auer 1996a). For example, Vine et al. (2019) report that, along with water temperature, river discharge (i.e., flow) appeared to be a significant predictor of when shortnose sturgeon would begin their spawning migrations in the Savannah River. Similarly, a study of Lake sturgeon (*Acipenser fulvescens*) found they had a greater spawning density, higher percentage of females, increased reproductive readiness, and shorter residence time at spawning sites when hydropower operations consistently mimicked natural flows (Auer 1996b). Another study focusing on the recovery of pallid sturgeon

(*Scaphirhynchus albus*) in Yellowstone National Park determined that the restoration of flow was considered to be a historical ecological condition and would be required for recovery (Bramblett and White 2001).

We anticipate adult shortnose sturgeon may be upstream, near spawning habitat and spawning from, February 1 – May 1 (see discussion in Section 4.1). Additionally, on average, sturgeon eggs and yolk-sac larvae may be concentrated near the spawning area for up to four weeks post-spawning (NMFS 2010). We therefore anticipate that adults, eggs/larvae, and fry may be upstream near the spawning grounds from February 1 – May 31. While the Saluda Dam will continue to restrict flows available below the dam, an increase in minimum flow over the previous license conditions would be an improvement to migrating sturgeon. Releasing the proposed minimum flows, particularly in the sturgeon-spawning period of February 1 – May 1, may cue sturgeon-spawning migrations. Increased minimum flows are also likely to increase water depth at the spawning sites, leading to improved conditions for spawning as compared to conditions under the previous license. Greater minimum flow is also likely to provide greater habitat availability for eggs/fry and improve overall water conditions (i.e., water temperature, DO) for these life stages.

While minimum flows are identified, the LIP reducing flow into the lower Saluda River would supersede the minimum standards when lake elevation falls below the guide curve. The LIP trigger will be based on keeping the elevation of Lake Murray between 356.5 and 352.5 ft. and will be determined in the final license; the licensee proposes a 1-ft below proposed guide curve elevation while FERC staff identified a 2 ft. drop. Based on modeling of 28 years of data, the LIP with a 1-foot drop in the reservoir would occur in 61% of the years compared to 36% with a 2-ft trigger (FERC 2010). Flow under the LIP may be reduced to 400 cfs as described in Section 2.2.4.

Available information does not provide further indication of frequency, duration, or at what times of year an LIP is most likely to be triggered. Triggering the LIP is largely dependent on inflow. Information on future precipitation levels in the Southeast suggests more rain is expected on average going forward (see Section 3.1). However, precipitation projections for South Carolina specifically, suggest less precipitation may occur on average during the winter, spring and fall (Easterling et al. 2017). Less precipitation during those times of year could trigger the LIP. However, future precipitation projections also suggest more rain may fall during the summer than has occurred previously (Easterling et al. 2017). Increased precipitation during the summer may allow excess water to be stored, potentially offsetting diminished rainfall during other parts of the year, ultimately triggering the LIP less frequently.

A reduction in minimum flow would be particularly impactful during dry periods, when water levels in the Congaree River are already low, and when the water released by the SHP accounts for a larger percentage of flow in the Congaree River. During periods of drought, these discharges could be the main flows through the system that carry the cues for migration and ensure enough suitable habitat is available for spawning. The Instream Flow Incremental Methodology (IFIM) study indicated that shortnose sturgeon spawning habitat would be reduced by up to 25%, under LIP during the spring spawning season (FERC 2010). Additional water

release exceptions to “ensure accessibility of public and private docks for recreational activities” (FERC 2010) for Lake Murray may further reduce the availability of consistent increased flows.

In general, the water surface of Lake Murray will be maintained at an elevation of about 4 ft. higher than under the existing rule curve during the majority of the year. However, from March 15 to September 1 the lake elevation is expected to increase by less than the 4 ft. observed during other times of the year. The minimum flows released to the lower Saluda River are also anticipated to be greater than under previous license conditions, under this new guide curve (FERC 2010).

Relative to the flows released under the previous license, the proposed flows under the new license are expected to be greater and to increase the amount of habitat available to sturgeon for important life history functions, such as foraging and spawning, when those flows are available. An IFIM study was conducted to examine flows to achieve 80% of weighted usable area (WUA), or the wetted area of a stream weighted by its suitability for use by aquatic organisms or recreational activity, from the SHP tailrace downstream to the confluence with the Broad River. The study did not extend into the Congaree River; however, we expect some, unquantified, increase to the WUA in the Congaree from previous conditions due to the increased of flows. However, the existence and operation of the Saluda Dam will continue to result in restriction of flows that adversely affect shortnose sturgeon, by restricting flows available for their migration and other life history functions, such as foraging and spawning.

5.1.2 Water Quality

The controlled water releases from Lake Murray have depressed seasonal ambient DO levels and temperatures in the lower Saluda River for decades. Under the proposed relicensing terms, these controlled water releases, and therefore depressed seasonal ambient DO concentrations and temperatures, will continue.

The lower Saluda River has occasionally suffered from short periods of low DO concentrations because of water released from Lake Murray, and these events are expected to occur under the proposed action. The depth of Lake Murray (the SHP reservoir), coupled with the relatively high water-retention, results in seasonal thermal stratification of the lake and an associated decrease in DO concentrations in the lower water column. Reduced DO concentrations are further exacerbated by watershed factors such as high nutrient loading, particularly from point discharges of phosphorus in the inflow. High nutrient inputs into Lake Murray leads to an increase in the biological oxygen demand, especially during periods of high runoff (high flow), and consequent depletion of DO concentrations from the water column (Kleinschmidt 2009).

We first evaluated DO under the previous license conditions. FERC (2010) reports that between 1989-1998, the *median* DO concentrations released from Lake Murray into the project area during the late summer and early fall months was 2.7 mg/L. FERC (2010) reports the DO concentrations in the Saluda Dam tailwaters were below 5 mg/l approximately 82% of the time and below 4 mg/l approximately 70% of the time. In 1999, the licensee installed turbine vents and modified its operations to increase the DO concentrations in the water being released from Lake Murray. These changes increased the *median* DO concentrations from 2.7 mg/l before 1999 to 7.2 mg/l after 1999. In 1999, the occurrence of concentrations below 5.0 mg/l was

approximately 12% of the time and was below 3.0 mg/l approximately 3% of the time. Water quality monitoring data from 2000 to 2008 (since aeration) indicate that DO levels have been above the *daily* DO standard of 5.0 mg/l 96% of the time, with a *daily median* of 7.2 mg/l.

Because even short periods of low DO concentrations can be detrimental to young sturgeon, we reviewed the available data on average and minimum daily DO concentrations recorded at USGS gage 02168504 and gage 02169000. USGS gage 02168504 reports the maximum, minimum, and average DO concentrations of water being released from Lake Murray and USGS gage 02169000 reports maximum, minimum, and average DO concentrations of water in the lower Saluda entering the Congaree River.

We were particularly interested in the DO concentrations reported during the times of year when we anticipate at least one life stage of sturgeon may be present upstream (February 1 – May 31). From 2000-2022, USGS gage 02168504 (base of the Saluda Dam) recorded daily DO concentrations 7,862 times.¹⁰ During that period the daily *minimum* DO concentration at the base of the Saluda Dam fell below 5.0 mg/l only 20 times in the February 1 – May 31 timeframe and the daily *average* DO concentration was below 5.0 mg/l only 9 times. All instances of DO concentrations falling below 5.0 mg/l (whether daily average or daily minimum) occurred in May; no instances of DO concentrations below 5.0 mg/l have been recorded in February-April. DO concentrations below 5.0 mg/l were reported more frequently in late fall and winter. For example, minimum DO concentrations below 5.0 mg/l were recorded 140 times in month of October between 2000-2022.

In the limited number of instances where DO concentrations in water released from Lake Murray were less than 5.0 mg/l during the February 1 – May 31 period, DO concentration increased to over 5.0 mg/l by the time it reached the lower Saluda River (i.e., USGS gage 02169000). From 2000-2022, the lower Saluda gage (gage 02169000) recorded daily DO concentrations 7,768 times. The gage recorded no instances (0 observations) of the daily minimum or daily average DO concentrations falling below 5.0 mg/l¹¹ during the times of year (February 1 – May 31) when we anticipate at least one life stage of sturgeon may be present in the upper Congaree River.

We additionally considered any adverse effects to shortnose sturgeon from implementation of the LIP between February 1 – May 31. We evaluated the potential future impacts of the LIP by considering water quality conditions during previous releases from the SHP that matched or were less than the 400 cfs threshold proposed under the LIP. Using flow data filed with FERC by Dominion (Dominion Energy 2021), we determined when releases of 400 cfs or less occurred from 2000-2020,¹² during the period of time we believe shortnose sturgeon may be up river (February 1 – May 31). We cross-referenced those low flow days with the available DO concentration information reported by USGS gage 02169000 (lower Saluda River). That effort revealed 258 instances of flow releases at or below 400 cfs, from 2000-2020, during the period

¹⁰ Data queried from https://waterdata.usgs.gov/nwis/inventory?agency_code=USGS&site_no=02168504, on December 14, 2022.

¹¹ Data queried from https://waterdata.usgs.gov/nwis/dv?referred_module=sw&site_no=02169000, on December 14, 2022.

¹² Flow data going back to 1941 was provided by Dominion Energy. To allow for direct comparison to stream gauge data provided by USGS, those data were truncated to 2000-2020.

of time we believe shortnose sturgeon may be up river (February 1 – May 31); no instances of flow releases at or below 400 cfs were reported since 2012 (Dominion Energy 2021). USGS gage 02169000 did not record any instance of the mean DO concentrations falling below 6.0 mg/L during those 258 instances of low flow in the February 1 – May 31 timeframe.¹³

Due to improvements in the proposed action, we expect water quality effects to be improved under the proposed action, as compared to conditions observed under the previous license. Therefore, dissolved oxygen effects are expected to be ameliorated prior to USGS gage 02169000, the confluence of the Saluda and Broad Rivers, during the times of year (February 1 – May 31) when we anticipate at least one life stage of sturgeon may be present upstream. Based on this information, we anticipate low DO concentrations are extremely unlikely to occur in areas and during times of year when we anticipate at least one life stage of sturgeon may be present. Low DO conditions have occurred in the past and implementation of the LIP, and the Maintenance and Emergency Protocol may cause such condition again over the course of the 50-year license. However, our review of past flow releases similar to those anticipated under the LIP suggest low DO conditions are unlikely to occur between February 1 – May 31, when shortnose sturgeon may be present. As a result, we anticipate any adverse effects to shortnose sturgeon related to low DO concentrations caused by releases from Lake Murray are extremely unlikely to occur.

Water Temperature of Flows Released from Lake Murray

Hypolimnetic water releases from Lake Murray will affect water temperature in both the lower Saluda River and the Congaree River, based on historic data.

We examined spatial and temporal thermal regimes because water temperature is another known cue for sturgeon to initiate upstream migration for spawning. The licensee conducted a study using paired temperature probes to characterize the effects of water releases from the SHP on the temperature regime of the lower Saluda River and Congaree River. This included determining the downstream extent of temperature alteration, timing and duration of temperature alteration, and mixing characteristics (Kleinschmidt 2008). Water temperature was measured on the left and right banks between March 2006 and November 2007 and compared to investigate SHP flow in the Congaree River via Lake Murray from the lower Saluda River (right bank; when facing downstream) and the Broad River (left bank; when facing downstream). Temperature sensors were placed in the lower Saluda River at the Riverbanks Zoo just upstream of the confluence with the Broad River. Additional sensors were placed at six locations in the Congaree River from the city of Columbia through Congaree National Park (Figure 7); site numbers increase with downstream location.

¹³ Data queried from https://waterdata.usgs.gov/nwis/dv?referred_module=sw&site_no=02168504, on January, 3 2023.

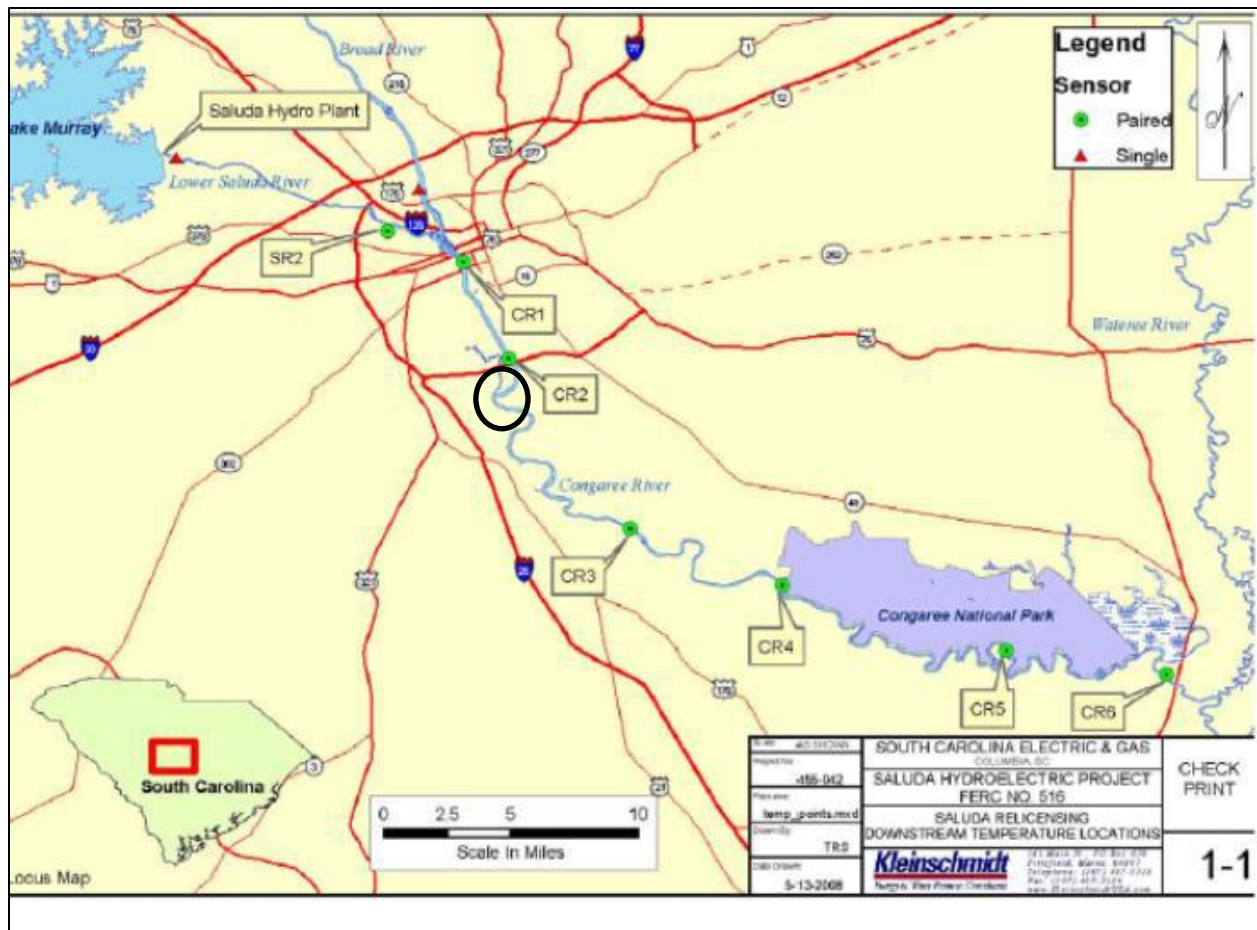


Figure 7. Map of lower Saluda River and Congaree River showing locations of Saluda Hydro Power Temperature Sensor Deployment sites in South Carolina. Site location number is indicated in the boxes. Figure from Kleinschmidt 2008. The inserted circle indicates the known shortnose sturgeon spawning location just below study location CR2.

Results of the thermal stratification study found little difference in water temperature between the right and left bank in the lower Saluda River at the site adjacent to the Riverbanks Zoo (SR2) upstream from the confluence with the Broad River, about 10 miles downstream of the Saluda Dam. This was expected as flow in this reach is primarily influenced by release from the SHP powerhouse, although there are some additional contributions from small tributaries (Kleinschmidt 2008). A distinct water temperature signature from the SHP was expected downstream of this location as the lower Saluda and the Broad merge to form the Congaree; downstream water from the lower Saluda River flows into the right side of the Congaree while the water from the Broad flows into the left side.

Temperature differences between the right bank (Saluda River water) and left bank (Broad River water) were detectable at all of the Congaree River sites (Figure 7); some differences were significant (CR1, CR2 and CR5) indicating that waters in these locations are not well-mixed, while temperature differences were not significant at sites CR3, CR4, and CR6 (indicating better-mixed water). The channel characteristics in the vicinity of CR1 are dominated by an extensive submerged bedrock outcropping along the right bank that extends greater than half-

way across the river resulting in shallower water depths compared to the left bank (Kleinschmidt 2008). As a result, the majority of the volume of the lower Saluda River is shifted toward the center and left bank of the river (Kleinschmidt 2008). SHP flow releases were often detected along the left bank in this area (i.e., CR1) presumably due to channel characteristics and during periods of drought (Kleinschmidt 2008).

Downstream of CR1, about 0.5 mile upstream of CR2, is the abandoned Granby Lock and Dam where the majority of flow is through the open lock chamber located on the right (Saluda) bank of the Congaree River. While the Granby Lock would seem to facilitate mixing, it does not. Water from the lower Saluda and the Broad remain relatively unmixed, with statistically significant differences in water temperature between the right and left bank still detected below the lock at CR2 (Figure 7).

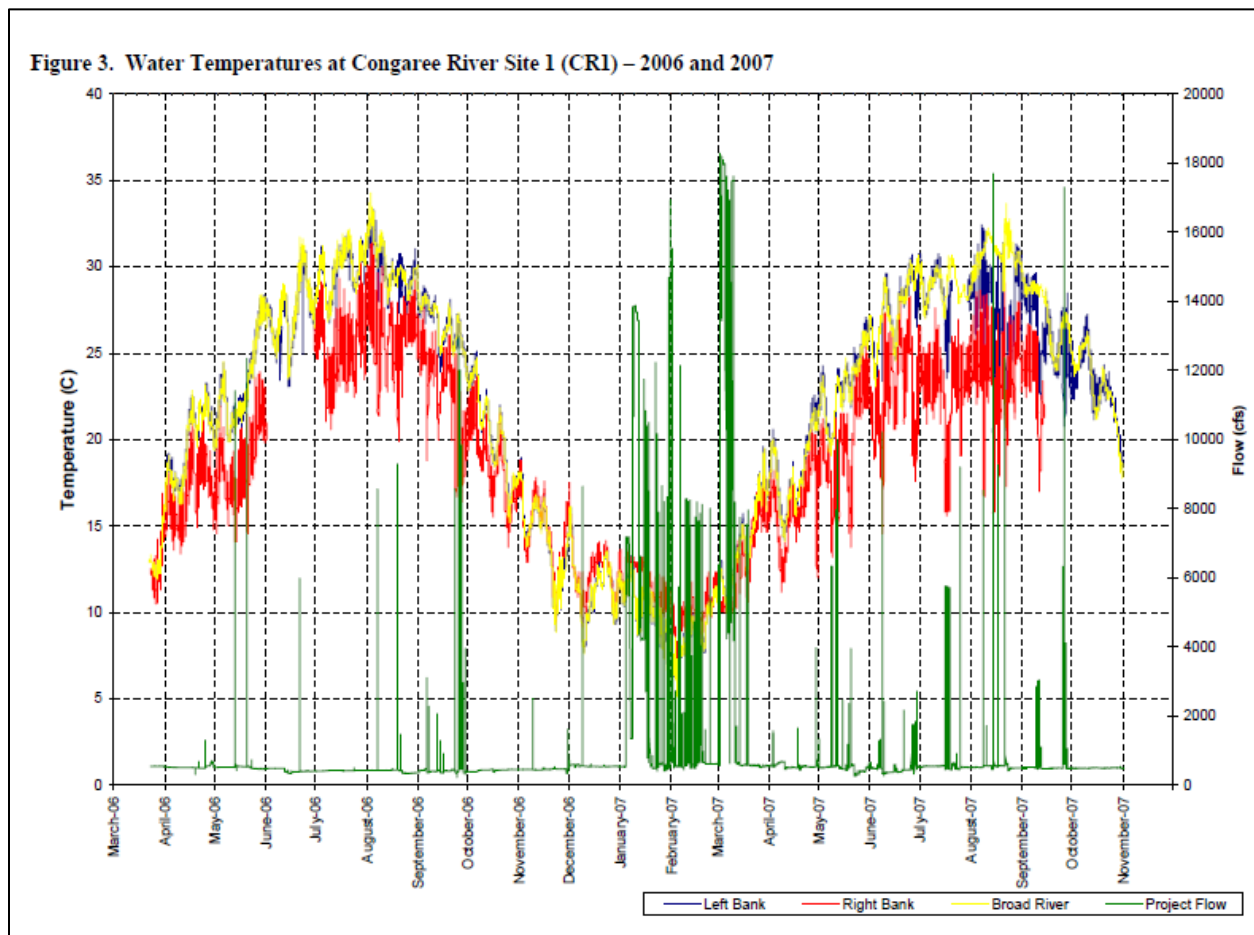


Figure 8. Water temperature differences between right (Saluda River in red) and left (Broad River in blue) banks in the Congaree River as measured at site CR1 located in the city of Columbia upstream of Granby Lock and Dam on the Congaree River. Water temperature in the Broad River, upstream the confluence with the lower Saluda River, is shown in yellow to reflect ambient water temperature. Figure from Kleinschmidt (2008).

Alterations in water temperature in the Congaree River from SHP are most pronounced and variable at the location upstream (i.e., CR1) of the Granby Lock and Dam, where water from the

lower Saluda River (right side) side of the Congaree River is significantly cooler than those on the Broad River (left) side (Figure 8). A difference in seasonal water temperatures was also apparent, with the Broad River water (left side in blue) being warmer in the summer and cooler in the winter. This pattern is similar at location CR2 (Figure 9) located just upstream the known shortnose sturgeon spawning location. SHP flow is most variable in both volume (i.e., cfs) and temperature at CR2 during the months of January – April; indicated in green in Figure 8 and Figure 9, corresponding with the shortnose sturgeon-spawning period. Downward temperature excursions during the spring (i.e., shortnose sturgeon spawning period) are apparent on the right bank (in red Figure 8 and Figure 9) and correspond to SHP water releases (Kleinschmidt 2008).

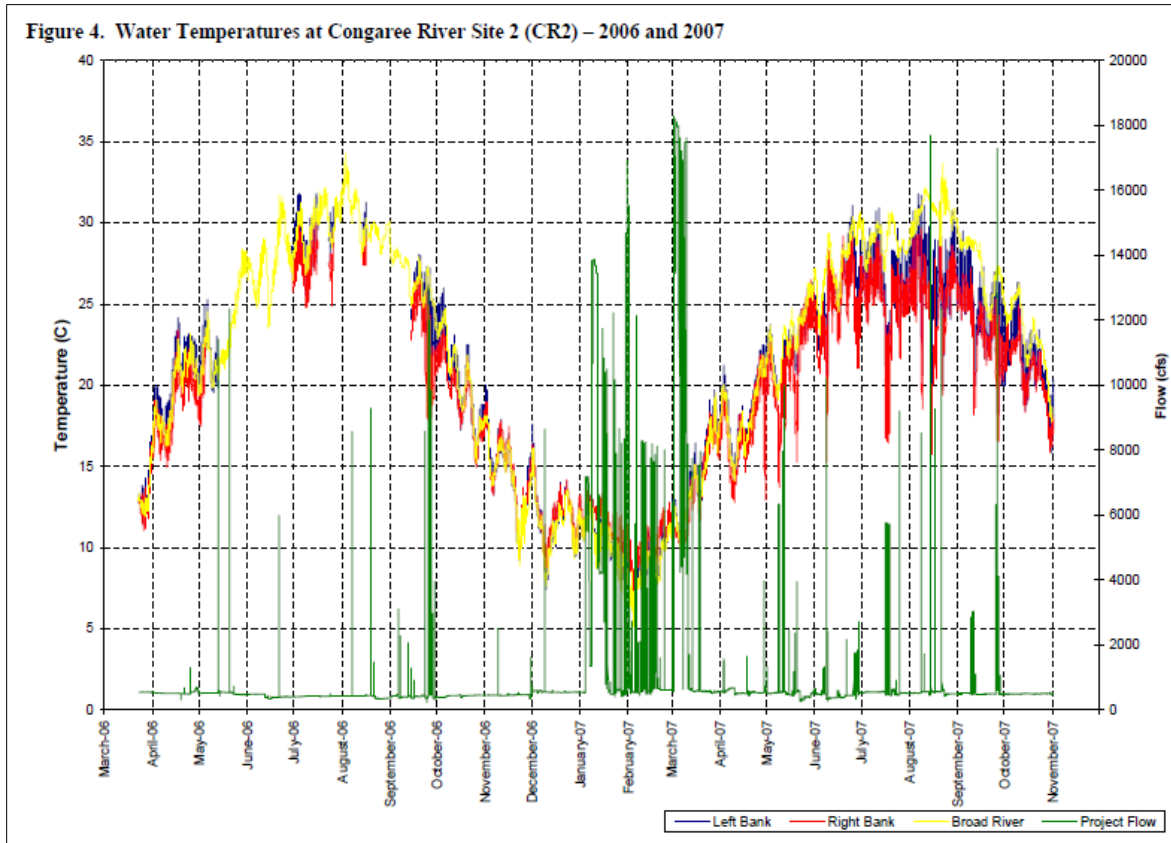


Figure 9. Water temperature differences between right (Saluda River in red) and left (Broad River in blue) banks in the Congaree River as measured at site CR2 located downstream of the Granby Lock and Dam and just upstream of the known shortnose sturgeon spawning area on the Congaree River. Water temperature in the Broad River, upstream the confluence with the lower Saluda River, is shown in yellow to reflect ambient water temperature. Figure from Kleinschmidt (2008).

While not statistically significant, temperature differences were detectable at location CR3 with the right bank (Saluda River) being cooler than the left (Broad River) bank. Temperature alterations in the Congaree River were greater in periods of lower flow as apparent with drought (e.g., 2007) and during the summer and winter months. Since mixing appears complete by station CR3, we anticipate adverse effects from low water temperature would only occur upstream of that location. Given our understanding of how shortnose sturgeon are using the Congaree River,

we anticipate only spawning shortnose sturgeon would be near or upstream of the station CR3. Thus, we anticipate only spawning adults may be adversely affected by low water temperature.

Because the water temperature between the right and left bank differed significantly at location CR2, but not CR3, we believe mixing of water from the Broad River and Saluda River occurs somewhere between these two locations. The known shortnose sturgeon spawning area is located between those locations. Unmixed water on the spawning grounds may adversely affect spawning sturgeon by limiting the spawning area to one side of the river because of the significant temperature differences between the two banks.¹⁴ Aside from the anticipated spawning habitat restriction, once a spawning adult has selected suitable spawning habitat, we do not anticipate any resultant eggs/larvae will be adversely affected.

Aside from the report on water temperatures commissioned by the licensee, we also examined water temperature data available from the USGS gages near the Saluda Dam (USGS gage 02168504), the lower Saluda River (USGS gage 02169000), and the Broad River (USGS gage 02162035). Generally, the mean water temperature increased between Lake Murray (USGS gage 02168504) and the lower Saluda River (USGS gage 02169000). The change in mean water temperature between the Lake Murray and the lower Saluda River was less pronounced during the month of February compared to that during the months of March and April. According to the 2000-2022 USGS water quality monitoring data, average daily water temperature in the lower Saluda River (USGS gage 02169000) from February 1 – May 1 ranged from 6.1 to 19.3°C (2,613 total observations); however, daily average water temperatures between 11-15°C were most commonly recorded during that period.

The water temperature in the Broad River is more variable over the course of the year. During the winter, water from the Broad River is consistently colder than the water released from SHP in the lower Saluda. However, with seasonal warming, Broad River water temperatures increase until they are significantly warmer than those of the lower Saluda River. According to the 2011-2022¹⁵ USGS water quality monitoring data from the Broad River (USGS gage 02162035) from February 1 – May 1, average daily water temperatures ranged from 4.7 to 23.9°C (971 total observations); however, daily average water temperatures between 11-20°C were most commonly recorded during that period.

A comparison of the monthly mean water temperatures recorded in the lower Saluda River (USGS gage 02169000) and the Broad River (USGS gage 02162035) from February 1 – May 1, suggests not much difference (0.8°C) between the two in February. However, the differential

¹⁴ Of note is the presence of the DAK Americas LLC/Columbia Site located at 33.863063°, -81.007212°, approximately equidistant between the temperature sensors CR2 and CR3. This plant is currently permitted, and routinely discharges very warm water into the Congaree River at this location. South Carolina Department of Health and Environmental Control report water discharged from this facility averaged 28 °C and reached temperatures up to 32.8°C during April-May SCDNR. 2018b. SCDNR Comments Regarding DAK Americas LLC, Columbia Site NPDES Permit No. SC0001333. The presence of this warm water discharge may account for why the water temperature difference between CR2 and CR3 is less pronounced. The addition of very warm water to the left bank (Saluda River) from the DAK Americas plant may have raised the temperature of the cold water from the Saluda River.

¹⁵ Unlike the other river gages, water temperature data for the Broad River were only available from 2011 onward.

increases to 2.2°C on average in March and 5.3°C by April.¹⁶ Based on the results of Kleinschmidt 2008, we anticipate water from the lower Saluda River and Broad River would remain largely unmixed by the time those flows reached the spawning grounds. Thus, we expect the magnitude of the temperature differences between at the left and right bank of the Congaree River to be similar to those noted by the USGS gages. Because we expect colder water from the Saluda River will not be mixed with the warmer water from the Broad River before arriving at the spawning grounds, we expect possible adverse effects from the significant temperature differential between the two banks may cause sturgeon to limit the spawning to one side of the river where temperatures are warmer.

We additionally considered how water temperature might be affected by implementation of the LIP. Using the flow data provided by Dominion (Dominion Energy 2021), we identified instances when flows released from SHP were at or below 400 cfs (representative of the conditions expected when the LIP is initiated under the proposed action) between February 1-May 1. We found 236 instances of flows at or below 400cfs that could be cross-referenced with water temperature from the USGS gage in the lower Saluda River (USGS gage 02169000). Then we compared the mean daily water temperature during low flow events with mean daily water temperature for those same days under non-low flow events. This allowed us to evaluate whether flow volume had any discernible effect on water temperature. For example, for April 27 there were 3 years (2002, 2008, 2012) when flows released from SHP were below 400 cfs on that date. The mean daily water temperature during those 3 years was 16.3°C. Conversely, we estimated the mean daily water temperature was 14.3°C on April 27 during the years where flows released from SHP were greater than 400 cfs (2001, 2003-2007, 2009, 2010, 2011), a difference of 2°C. Our evaluation noted a similar pattern of lower flow volumes having higher mean daily water temperatures, relative to normal operations in almost every instance (70 of 73 comparisons).

We saw this in almost every comparison. Assuming this pattern holds during future releases under the LIP, we anticipate LIP releases will be warmer on average when they arrive at the confluence with the Broad River, than flows released under normal operating conditions. This increased water temperature may dampen the temperature differential between the Saluda and Broad River, potentially reducing the adverse effect to sturgeon.

Based on the above analysis, we anticipate similar cold-water releases will continue to adversely affect shortnose sturgeon spawning continue during the 50-year life of the license.

5.1.3 Put Grow and Take Trout Fishery

The hypolimnetic water releases from Lake Murray create a unique environment in the lower Saluda River classified by the state of South Carolina as "Put, Grow and Take" Trout Waters (TPGT). South Carolina characterizes TPGT waters as "freshwater with cooler as normal water temperatures suitable for supporting growth of stocked trout populations and a balanced indigenous aquatic community of fauna and flora."

The coldwater TPGT fishery is possible because of the habitat provided by the licensee and the annual trout stocking by SCDNR. The licensee releases cold water from the four units located at

¹⁶ Data queried from https://waterdata.usgs.gov/nwis/inventory?agency_code=USGS&site_no=02162035, on January, 25 2023.

a depth of 175 ft. in Lake Murray. About 30,000 Rainbow and Brown trout are stocked annually by SCDNR to maintain the trout population, which does not reproduce.

Studies by the U.S. Forest Service have found non-native trout in sub-alpine habitats have caused major changes in abundance and distribution of native amphibians, zooplankton and benthic invertebrates (Welsh et al. 2006). Similarly, removal of introduced trout has led to recovery of a rapidly declining frog (Vredenburg 2004). In addition to the direct impact to these populations, these reductions can have indirect impacts to native fishes through changes in prey availability. Trout are generalist foragers and eat mostly aquatic and terrestrial insects, but have also been found to consume fish, and benthic invertebrates including crustaceans, leeches, and worms. Given trouts are characterized as pelagic and inhabit the water column compared to the demersal nature of shortnose sturgeon coupled with differences in main diet components, it is unlikely that the trouts in the lower Saluda River are out-competing shortnose sturgeon for prey. Overall, the effects to shortnose sturgeon by TPGT include the need to maintain cold water for trout ensuring the utility will not be able to reduce or minimize the effects of cold water releases on shortnose sturgeon spawning as discussed above.

5.1.4 Effects of Obstruction of Upstream Habitat

Historically, sturgeon ascended to the furthest freshwater reaches and riverheads to reach natal spawning grounds (Hightower 1998; Lawson 1709; McDonald 1887). Relative to river reaches where shortnose sturgeon carry out other life history functions (e.g., foraging, resting), spawning sites are the most upstream river reaches used (Kynard and Horgan 2002). The existence of Saluda Dam, and its cold-water releases, serves as an impediment to block migration, forcing shortnose sturgeon to spawn at locations further downriver that may be less favorable of spawning. The existence of the dam and its cold-water releases create suboptimal spawning conditions in the Saluda River. Female shortnose sturgeon do not always release all or a portion of their eggs at the first available habitat encountered containing gravel, cobble, or rocky substrate suitable for egg deposition and will bypass seemingly appropriate habitat in search of spawning areas further upstream. If these sturgeon deposit eggs in habitat that is not suitable for successful adherence, fertilization, and development, then those eggs may not become viable progeny. This affects the survival and recruitment of individuals of that particular year class and, over time, reduces the reproductive success and recruitment of new individuals to the population. By continuing to impede the river with the dam, and creating suboptimal riverine conditions (i.e., low water temperatures), upstream migration to habitat areas in the Saluda River and beyond is prevented. While it is possible that shortnose sturgeon may move further upriver in the Congaree River due to the removal of the Granby Dam, the SHP will continue adversely affecting these individuals and the population by restricting or limiting migration and other life history functions, such as foraging and spawning in the Saluda River, including above the dam.

5.1.5 Summary of Effects to Shortnose Sturgeon Resulting from Water Quality, Water Quantity, Put Grow and Take Trout Fishery, and Obstructing Upstream Habitat

Following the discussion of each route of effect identified above, we consider the combined effects on shortnose sturgeon of all of the routes of effect of the proposed action. Shortnose sturgeon are listed as endangered throughout their range. Their status across their range is considered mixed as some populations are increasing and others are decreasing or unknown. The

population of shortnose sturgeon that inhabit the action area utilize the Santee and Saluda river basins; their abundance has decreased dramatically from historical levels and the current population trend is unknown. The only known successful shortnose sturgeon spawning site within the Santee and Saluda river basins is located within the action area.

The proposed up to 50-year term of the license to be issued by FERC to the licensee for the SHP prescribes water quantity and quality into the Congaree River that will adversely affect shortnose sturgeon. Specifically, we anticipate adverse effects to shortnose sturgeon would occur when:

1. The existence and operation of the Saluda Dam impacts flows that restrict the water available their migration and spawning.
2. The controlled water releases from Lake Murray continue to depress water temperatures, leading to a potential decrease in spawning/reproductive success.
3. Cold-water releases required to support the TPGT fishery “lock in” adverse effects to shortnose sturgeon.
4. Blocked upstream migration restricts or limits migration and other life history functions, such as foraging and spawning.

The proposed action may affect the availability and suitability of submerged areas for shortnose sturgeon to spawn, by affecting water quantity and water temperature. Restriction of flows due to the existence of the dam is expected to adversely affect sturgeon by limiting flows available for migration and life history functions, such as foraging and spawning. Such restrictions are expected to be particularly impactful when water levels may already be low, such as in drought conditions. Water temperature, DO concentrations, day length, and river discharge collectively influence a “spawning suitability window” for shortnose sturgeon (Kynard et al. 2012). Water temperature influences adult spawning migration (Collins et al. 2000; Dovel and Berggren 1983; Smith 1985; Smith et al. 1982) and larval dispersal (Niklitschek 2001). The water released by SHP from Lake Murray into the lower Saluda River joins the Broad River and creates the Congaree River. Significant water temperature differences have been identified between the left and right banks of the Congaree River. The Downstream Temperature Study (Kleinschmidt 2008) indicates the Broad and Saluda rivers waters do not start to mix until somewhere between water temperature station CR2 and CR3, downstream from the shortnose sturgeon spawning site, and are not completely mixed (from a temperature perspective) in the Congaree River until approximately 16 miles below the confluence. The lack of mixing on the spawning grounds may adversely affect spawning sturgeon by causing sturgeon to limit the spawning area to one side of the river because of the significant temperature differences between the two banks. We anticipate adverse effects from cold water will only affect spawning habitat selection by adults. Once a spawning adult has selected suitable spawning habitat, we do not anticipate any resultant eggs/larvae will be adversely affected by cold-water exposure.

We anticipate that restriction of flows and cold-water releases potentially restricting spawning habitat will affect the entire dam-locked population of shortnose sturgeon in the Congaree River. A reduction in spawning area would adversely affect the ability of the shortnose sturgeon population to spawn successfully in numbers that allow the population to increase. The sex ratio of shortnose sturgeon in the Congaree River is unknown. Assuming a 50:50 sex ratio for this population, yields an estimate of 144 females and 143 males. Adult female shortnose sturgeon

tend to spawn every 3-5 years on average. Thus, we anticipate up to 36 adult females attempt to spawn each year.¹⁷ With adult males spawning every 1-2 years, we estimate approximately, 96 males could be affected each year, on average.¹⁸ We expect that all spawning shortnose sturgeon will be impacted by water quantity and quality resulting from SHP releases. In total, we anticipate up to 132 adult shortnose sturgeon (36 females and 96 males) may be affected annually by these releases, with the entire population being adversely affected every 4 years. We anticipate that the sublethal adverse effects to these individuals caused by temperatures will result in reduced reproductive success. Quantifying the exact extent of this impact at a population level is not possible with currently available information; however, we believe the population above Lake Marion is stable based on sampling by SCDNR. We believe this means that the factors affecting the reproductive success of the population have not translated to increases or decreases in the population or have been acting on the population for so long it has reached stasis under these conditions. We believe habitat limitations caused by poor water quality and low flows due to the SHP and the other effects described in the baseline section of this opinion are contributing to the status of the population.

The existence of the TPGT fishery is a consequence of the proposed action and the agreement to ensure it persists effectively “locks in” adverse effects to shortnose sturgeon from the cold-water releases required to support the fishery. The continued introduction of trout may also contribute to some extent to the mortality of shortnose sturgeon eggs/larvae, via predation by the introduced fish. The water released from Lake Murray to support the TPGT fishery occurs with releases through water tower Units 1 – 4. Because the licensee has agreed to continue the existing cold-water releases to support the TPGT, they are unable to reduce or minimize those effects on shortnose sturgeon or spawning habitat.

The Saluda Dam will continue to maintain Lake Murray and obstruct shortnose sturgeon from accessing upstream areas over the course of the license. Lake Murray does not currently provide suitable habitat for shortnose sturgeon given the cold, deep, hypoxic waters. We believe it is possible that shortnose sturgeon will move further upriver than previously recorded under the conditions of the new license, due to improved water quality and removal of the Granby Dam. However, the existence of the Saluda dam creates suboptimal environmental conditions (e.g. low water temperatures) reducing the likelihood shortnose sturgeon will move further upstream. We do not anticipate they will migrate to the Saluda River over the course of the proposed action. However, to not preclude potential movement of shortnose sturgeon around the current Saluda Dam should water conditions change, on September 29, 2009 NMFS filed a reservation of authority to prescribe fishways under Section 18 of the Federal Power Act be included in the license for the project.

We conclude that the entire dam-locked population of shortnose sturgeon will be adversely affected due to harm or injury because of habitat modification, poor water quality conditions, and blocked upstream access. The effects of the proposed action may affect individual adult fish but

¹⁷ 144 adult females in the dam-locked population ÷ females spawning every 4 years, on average = 36 females attempting to spawn each year.

¹⁸ 143 adult males in the dam-locked population ÷ male spawning every 1.5 years, on average = 95.3 male potentially spawning each year.

we expect these effects to adults to be sublethal. We expect these impacts to result in depressed population numbers due to reduced reproduction.

6 CUMULATIVE EFFECTS

ESA Section 7 regulations require NMFS to consider cumulative effects in formulating its Opinions (50 CFR 402.14). Cumulative effects include the effects of future state or private actions, not involving federal activities, that are reasonably certain to occur within the action area considered in this Opinion (50 CFR 402.02).

Within the action area, major future changes are not anticipated in ongoing human activities described in the environmental baseline. The need for surface water withdrawal for both municipal and industrial/agricultural sources within the Saluda River Basin are likely to continue at current rates. The TMDLs developed by SCDHEC and approved by the EPA may lead to reduction in fecal coliform loading.

Reductions in stream flows and increased water temperatures could mean a decrease in the amount of DO in surface waters and an increase in the concentration of nutrients and toxic chemicals due to reduced flushing rate (Murdoch et al. 2000). A warmer-wetter climate could ameliorate poor water quality conditions in places where human-caused concentrations of nutrients and pollutants currently degrade water quality (Murdoch et al. 2000). Increases in water temperature and changes in seasonal patterns of runoff will very likely disturb fish habitat and affect recreational uses of lakes, streams, and wetlands. A global analysis of the potential effects of climate change on river basins indicates that due to changes in discharge and water stress, the area of large river basins in need of reactive or proactive management interventions in response to climate change will be much higher for basins impacted by dams than for basins with free-flowing rivers (Palmer et al. 2008). 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 will likely experience greater changes in discharge and water stress than unimpacted, free-flowing rivers (Palmer et al. 2008).

Beyond the effects noted above, NMFS is not aware of any proposed or anticipated changes in other human-related actions or natural conditions that would substantially change the impacts that each threat has on the sturgeon covered by this opinion.

7 JEOPARDY ANALYSIS

The analyses conducted in the previous sections of this Opinion serve to provide a basis to determine whether the proposed action is likely to jeopardize the continued existence of shortnose sturgeon. In Section 5.0, we outlined how the proposed actions can affect this species. Now we turn to an assessment of the species' response to these impacts, in terms of overall population effects, and whether those effects of the proposed actions, when considered in the context of the status of the species (Section 3.0), the environmental baseline (Section 4.0), and the cumulative effects (Section 6.0), will jeopardize the continued existence of shortnose sturgeon.

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

The NMFS and USFWS’s ESA Section 7 Handbook (USFWS and NMFS 1998) defines survival and recovery, as these terms apply to the ESA’s jeopardy standard. Survival means “the species’ persistence...beyond the conditions leading to its endangerment, with sufficient resilience to allow recovery from endangerment.” The Handbook further explains that survival is the condition in which a species continues to exist into the future while retaining the potential for recovery. This condition is characterized by a sufficiently large population, represented by all necessary age classes, genetic heterogeneity, and number of sexually mature individuals producing viable offspring, which exists in an environment providing all requirements for completion of the species’ entire life cycle, including reproduction, sustenance, and shelter. Per the Handbook and the ESA regulations at 50 CFR 402.02, recovery 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.” Recovery is the process by which species’ ecosystems are restored or threats to the species are removed or both so that self-sustaining and self-regulating populations of listed species can be supported as persistent members of native biotic communities.

Distribution

The Saluda River Basin is known to be within the historic range of the shortnose sturgeon (Newcomb and Fuller 2001; Welch 2000) which, currently extends from Maine to Florida but is interrupted by a large gap separating the northern and southern populations near their geographic center in Virginia (see Figure 3). In the southern portion of the range, they are currently found in North Carolina, South Carolina, and Georgia. The Saluda Dam, along with numerous other dams in this system, has historically combined to impede fish passage and affect water quality for over 75 years in this watershed. During telemetry studies, researchers have documented shortnose sturgeon in Lake Marion, Lake Moultrie, the Congaree River, and, in one instance, the Broad River. While telemetry data indicates shortnose sturgeon have previously ascended upstream of the Granby Lock and Dam to rkm 161 near the confluence of the Broad and Saluda rivers (Finney et al. 2006), more recently, telemetry tagged shortnose sturgeon have not been detected above Granby Dam (SCDNR 2017a; SCDNR 2018a; SCDNR 2019). Historical records regarding shortnose sturgeon in the lower Saluda River are unknown; however, we believe they may have migrated to the headwaters of the Saluda River.

Currently, shortnose sturgeon are not known to occur in the lower Saluda River. Shortnose sturgeon are known to occur in the Congaree River from near the city of Columbia, SC, downstream to the confluence with the Wateree River and into Lake Marion. We believe this is a legacy effect of the Saluda Project’s impacts on water quality. While impacts to DO will be

largely ameliorated under the new license, cold-water releases will still affect water quality. Water released from Lake Murray for the operation of the SHP has depressed seasonal temperatures in the lower Saluda River for decades, and likely played a role in the observed absence of diadromous species including sturgeon (Kleinschmidt 2009). This cold-water release supports the inter-related TPGT recreational fishery in the lower Saluda River.

Over the last 10 years, SCDNR has sampled the sturgeon population above Lake Marion and this population has remained stable. This population still exists after over 75 years of adverse environmental manmade impacts. Because of the proposed action, the Saluda Dam will remain in place and will continue to restrict movement of shortnose sturgeon by not allowing free passage above the dam. The cold-water releases from the dam, and their intermittent periods of low water temperature, in addition to the restrictions of flow caused by the Saluda Dam, will restrict shortnose sturgeon from using the lower Saluda River below the Saluda Dam. However, due to minimum flow release changes in the proposed action, we expect water quality and quantity will improve relative to historical conditions. These improvements are likely to be relatively small compared to the range of environmental conditions shortnose sturgeon experience throughout the action area; therefore, we believe that the effects of the proposed action will largely perpetuate the habitat truncation the population currently experiences. Therefore, while some relatively minor changes to how the shortnose sturgeon used the action area are possible under the proposed action, we do not expect that change would have a meaningful impact on the range of shortnose sturgeon rangewide.

Numbers and Reproduction

As discussed in the Effects of the Action (Section 5), the SHP has been restricting the flow and releasing cold water from Lake Murray since the 1930s, and will continue to do so under the proposed action. These releases affect water quality in the Congaree River, including the verified shortnose sturgeon-spawning site. These releases have been affecting shortnose sturgeon in the Congaree River for generations by limiting spawning habitat suitability, and causing potential sublethal affects to adult shortnose sturgeon. Two water quality parameters are particularly influential to the status of sturgeon: water temperature and DO. Water temperature is known to initiate upstream migration of sturgeon to spawn and influences growth rate (Section 3.1). DO is known to influence both habitat availability and the likelihood of survival of shortnose sturgeon (Section 3.1).

Data reported in the Downstream Temperature Study (Kleinschmidt 2008) suggest the cold water released by the Saluda Project has a significant influence on the thermal regimes of both the lower Saluda River and Congaree River. Thermal stratification in the Congaree River between the two riverbanks was detectable at the location closest to the known sturgeon-spawning sites, especially during low flow conditions; water temperatures on the Saluda River side of the river were cooler than those on the Broad River side. The downward temperature excursions corresponding to releases from the Saluda Project were apparent in the spring and summer (Kleinschmidt 2009) when shortnose sturgeon spawning and rearing occur.

Thermal stratification of water in the Congaree River was most pronounced upstream of the Granby Lock and Dam; water from Lake Murray flowing through the Saluda River was much cooler than the waters from the Broad River. Shortnose sturgeon occurrence is uncommon in this

upper section of the Congaree River (See Section 4.1) in part perhaps from Granby Lock currently limiting upstream access, but likely more so a result of water quality influencing habitat availability and the suitability of shortnose sturgeon spawning habitat. Shortnose sturgeon have been found upstream of the Granby Lock and Dam, indicating the possibility for shortnose sturgeon to move upstream of the structure. The Granby Dam is slated for removal in the future. The habitat on the right bank of the Congaree River in this location, where water temperature is cooler due to the influence of the Saluda Project, is known to have extensive submerged bedrock outcropping that extends greater than half-way across the river, with the main river channel located along the left (Broad River) side.

While the Saluda Dam will continue to restrict flows available below the dam, an increase in minimum flow over the previous license conditions would be an improvement to migrating sturgeon. Increased minimum flows are also likely to increase water depth at the spawning sites, leading to improved conditions for spawning as compared to conditions under the previous license. Greater minimum flows is also likely to provide greater habitat availability for eggs and fry and improve overall water conditions (i.e., water temperature, dissolved oxygen) for these life stages. However, the existence and operation of the Saluda Dam will continue to result in restriction of flows that adversely affect shortnose sturgeon, by restricting flows available for their migration and other life history functions, like foraging and spawning.

Restricted flows and poor water quality can have significant impacts on the reproductive success of shortnose sturgeon. Reducing the success of a single shortnose sturgeon reproductive event results in long-term impacts on both the population and the species overall. Male shortnose sturgeon often reproduce every 1-2 years and females typically reproduce every 3-5 years. These relatively frequent spawning intervals; coupled with a shortnose sturgeon's relatively long life, mean some sexually mature individuals have an opportunity to reproduce many times over many years. If individuals are unable to spawn, or if spawning habitat is limited or unsuitable, impacts from decreased fecundity and recruitment accrue geometrically and the impacts to reproductive success can become very large over time.

Gross et al. (2002) reported the elasticity profile for population growth of shortnose sturgeon was most sensitive (i.e., had the highest potential gains in recovery) for YOY and juvenile ages as compared with mature individuals. Smith et al. (1982) determined that within both the Saluda River Basin and the downstream Santee River Basin, the survival of juvenile shortnose sturgeon and their subsequent recruitment to the adult population was a potential limiting factor in population growth. Given the low rate of natural recruitment indicated by the lack of YOY and the low catch rate of juvenile sturgeon in the Santee River Basin located downstream the project, even a slight reduction in survival of these life stages may be particularly deleterious (Collins et al. 2000). While we believe the loss of an entire cohort is uncommon, such a loss eliminates the entire age-class, their reproductive contributions and the reproductive contributions of filial generations.

The current estimated population of dam-locked sturgeon is approximately 287 adults (SCDNR 2017b), and we expect all of those individuals to be adversely affected by the proposed action every 4 years. Male shortnose sturgeon often reproduce every 1-2 years and females typically reproduce every 3-5 years. Thus, we anticipate up to 132 adult shortnose sturgeon (36 females

and 96 males) may experience sublethal adverse effects each year by the continued release of cool waters released from the SHP and potential habitat restriction caused by restricted flows.

Since a single female shortnose sturgeon may produce between 30,000-200,000 eggs annually (Gilbert 1989), impacts to up to 36 female adults annually may be significant. Reducing the success of a single shortnose sturgeon reproductive event results in long-term impacts on both the population and the species overall.

We believe the shortnose sturgeon population above Lake Marion is stable based on sampling by SCDNR. Because the population appears to be relatively stable, we also believe entire cohorts are rarely lost. However, previous reproductive success in the population has not translated to increases in the population. Additionally, there is very little, if any, sustained exchange of individuals from the shortnose sturgeon populations below the dams and the dam-locked population. Thus, the dam-locked population is relatively isolated. Impacts to the reproductive capacity of this population are likely even more significant because of their isolated existence. Without additional adults immigrating into the population, the dam-locked population is more susceptible to stochastic events (e.g., storms, chemical spills) that may significantly reduce reproductive output. Isolation also reduces the potential of genetic mixing during spawning, which may reduce the dam-locked population's overall fitness. We believe potential spawning habitat limitations due to poor water quality and low flows due to the SHP and the other effects described in the baseline section of this opinion are acting to suppress the current population.

However, we anticipate that some improvement in water quality and quantity under the new license relative to historical conditions. We anticipate increased flows will allow this population to continue to reproduce at similar levels as previously observed. Hence, we expect the number of shortnose sturgeon in the dam-locked population will remain stable and may increase over the course of the license due to improved environmental conditions (i.e., water quality and habitat availability) that may result in increased reproductive success. Given that shortnose sturgeon have been documented to spawn in the Congaree River under the previous license conditions, we expect that shortnose sturgeon will remain and spawn in the Congaree River over the term of the new license. Therefore, while the population of shortnose sturgeon within the action area are unlikely to increase dramatically over the course of the license, shortnose sturgeon are expected to persist within the action area and continue to be capable of reproducing. The continued operation of the SHP will continue to obstruct passage upstream and reduce the reproductive potential of shortnose sturgeon in the Congaree River by negatively impacting water quality with water releases; however, we expect that shortnose sturgeon will persist and continue to persist at similar population numbers in the action area. Further, given the isolated nature of this population, we do not expect that the ongoing restriction of this population will affect the reproduction or overall population numbers of shortnose sturgeon rangewide.

In summary, the proposed action would continue to restrict the range of shortnose sturgeon in the Saluda River basin but is not expected to have a measurable effect on current species distribution throughout its range. We anticipate the proposed action's effects on flows and water temperature will impact the dam-locked population of shortnose sturgeon. These impacts will be very similar to what this population has experienced for decades, and will continue to impede reproduction and relatedly suppress the numbers of the dam-locked population. **However, we acknowledge the**

proposed action is expected to increase flow over the previous license conditions, which may improve other environmental conditions. This dam-locked shortnose sturgeon population has been enduring these impacts for generations and there has been no noticeable change in status of the population. This population is also isolated from the rangewide shortnose sturgeon population. Taken together, we believe this suggests the proposed action will not reduce appreciably the likelihood of survival of shortnose sturgeon in the wild

Recovery

We next analyze the impact of the proposed action on the likelihood of shortnose sturgeon recovery in the wild by considering effects resulting from the proposed action relative to accomplishing the conservation goals described in the Shortnose Sturgeon Recovery Plan (NMFS 1998). The long-term recovery goal for shortnose sturgeon focuses on recovering each population independently. An increase in the population to a size that maintains a steady recruitment of individuals representing all life stages would provide population stability and enable the population to sustain itself in the event of unavoidable impacts. Goals listed in the 1998 shortnose sturgeon recovery plan that could be affected by the proposed action include:

1. Restore habitats and their functions in the life histories of each population segment.
2. Restore spawning habitat and conditions.
3. Restore flows in regulated rivers during spawning periods to promote spawning success and rehabilitate degraded spawning substrate.
4. Ensure that all fish passageways permit adequate passage of shortnose sturgeon and do not alter migration or spawning behavior.

Recovery of the shortnose sturgeon will require conservation and threats abatement throughout their range to ensure a high probability of survival into the future. The current conditions, which include fragmented habitat, altered/reduced flow, and decreased water quality, have contributed, in part, to the continued low abundance of the dam-locked shortnose sturgeon population. NMFS believes that there are enough sexually mature individuals and genetic diversity currently in the population to retain the potential for recovery. Project operations at SHP are not expected to further reduce spawning habitat and may improve habitat in the spawning areas over conditions under the previous license, which may in turn increase recruitment success rates. Nursery habitat for early life stages of larval and juvenile sturgeon may also be improved through increased flow. These results may ultimately help restore and rehabilitate degraded spawning habitats, while promoting spawning success and spawning habitat. Improved water quality conditions may also restore or improve habitat functionality for multiple life stages. Together, these improvements may increase survival and help to rebuild the population, thereby aiding in the recovery of the species.

The proposed action does not include safe upstream or downstream passage for shortnose sturgeon, and sturgeon passage has not been prescribed at this time. Quality habitat exists above Lake Murray, but access to these waters is restricted by the presence the SHP. Denying upstream access to sturgeon may continue to have an effect on population growth. However, the habitat below SHP may improve due to enhanced water quality and flows, which will expand available spawning and rearing sites, and aid the recovery of the species despite the continued blockage.

This biological opinion’s assessment of effects is based on studies and modeling that give us some level of understanding of anticipated water flow and stage. With these data, we can make assumptions based on our experience of habitat suitability for sturgeon and other species. However, what ultimately happens in the environment is not as predictable; therefore, monitoring will be required to assess the sturgeon population within the action area.

Based on the best available data, the proposed SHP operations will continue to adversely affect shortnose sturgeon by blocking access to habitat above the Saluda Dam. Downstream, we expect SHP operations’ impact on water temperature will continue to restrict available spawning and rearing habitat, but the proposed action may provide improvements to water quality to some degree. This increase in flow and existing spawning and rearing habitat may in turn support an increase survival and recruitment. We believe that over the up to 50-year period of the proposed action, the population will continue to persist. Thus, it is our opinion that the proposed action will not result in an appreciable reduction in the likelihood of shortnose sturgeon’s recovery in the wild.

8 CONCLUSION

After reviewing the status of the shortnose sturgeon, the environmental baseline, the effects of the proposed action, and cumulative effects, it is NMFS’s Biological Opinion that the proposed action is not likely to jeopardize the continued existence of shortnose sturgeon.

9 INCIDENTAL TAKE STATEMENT

Section 9 of the ESA and federal regulations issued pursuant to Section 4(d) of the ESA prohibit the take of endangered and threatened species, respectively. Section 7(b)(4) and Section 7(o)(2) provide that take that is incidental to an otherwise lawful agency action is not considered prohibited take under the ESA if that action is performed in compliance with the terms and conditions of this Incidental Take Statement.

Section 9 of the ESA makes it illegal to take an endangered species of fish or wildlife. The definition of “take” is to “harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or attempt to engage in any such conduct” (16 U.S.C. 1532(19)). NMFS interprets the term “harm” as an act that actually kills or injures fish or wildlife (64 FR 60727). An “injury” is demonstrated if the habitat modification significantly impairs the listed species’ ability to feed, breed, rear, migrate or any other behavior essential to its biological processes and behavioral patterns (64 FR 60728). Such an act may include significant habitat modification or degradation where it actually kills or injures wildlife by significantly impairing essential behavioral patterns, including breeding, spawning, rearing, migrating, feeding or sheltering (64 FR 60727). “Significant” impairment of essential behavioral patterns constitutes injury. Any habitat modification that significantly impairs spawning, rearing or migrating does constitute harm to the species and is a take pursuant to the provisions of the ESA (64 FR 60728).

Table 6. Anticipated Annual Incidental Take

Anticipated Take	Amount
Adult Shortnose Sturgeon	132 sublethal

Up to 132 spawning shortnose sturgeon are expected to be adversely affected annually by the effects of water being released from the SHP (Table 6). Because we do not have sufficient information to monitor the impact on individual adult animals, take will be monitored and reinitiation will be determined, by population trend monitoring and water quality monitoring. We believe that population trend and water quality monitoring represent the best available scientific information regarding the proposed action's effects to adult shortnose sturgeon.

Population trend monitoring provides an indication regarding the reduction of reproductive success of adults caused by the proposed action. We anticipate that a decreasing population trend or the absence of juvenile and YOY life stages for consecutive three-year periods may indicate effects of this action are more severe than what is described in this opinion and reinitiation may be required. Considering population trends over three-year periods allows us to evaluate trends and accounts for the inherent variability in the population unrelated to the proposed action.

Effect(s) of the Take

This biological opinion found that the proposed action is not likely to jeopardize the continued existence of shortnose sturgeon. The effects of anticipated take will likely be at the population level and likely to influence population growth through delayed or interrupted spawning.

Reasonable and Prudent Measures

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

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

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

Reasonable and Prudent Measures

1. FERC shall require the licensee to monitor water quality via the current water gages and increase monitoring further downstream on the Congaree River especially in shortnose sturgeon spawning sites.
2. FERC shall require the licensee to coordinate with South Carolina Department of Natural Resources (SCDNR) to monitor dam-locked shortnose sturgeon populations.

Terms and Conditions

To be exempt from liability for take prohibited by Section 9 of the ESA, FERC and the licensee (or any subsequent operator or licensee) must comply (or must ensure that any applicant complies) with the following terms and conditions, which implement the RPMs described above. These terms and conditions are nondiscretionary.

FERC must ensure the following terms and conditions (T&Cs) are implemented:

1. USGS water gages to monitor water quality are installed at the I-77 Bridge, or at another nearby location, to ensure water quality effects at known shortnose sturgeon spawning habitats are adequately monitored. Two gauges must be installed, one of the west bank and one on the east bank to monitor water quality.
2. Within 6 months of re-licensing, the licensee will begin working with SCDNR and NMFS to complete a plan to monitor population levels of dam-locked shortnose sturgeon in the Congaree River. Development of this monitoring plan must be completed within 12 months of re-licensing and consider adults, juvenile, YOY, and eggs/larvae life stages. The plan must include installation of an acoustic telemetry receiver array in the Congaree River, the lower Saluda River, and lower Broad River.
3. The shortnose sturgeon-monitoring plan will be implemented and funded by the licensee within 3 months of its completion.
4. Results of the previous year's water quality monitoring and population monitoring will be reported to NMFS by March 31 each year. If the water quality monitoring detects a statistically significant difference in water temperature between the two banks between February 1 to May 31, and the difference persisted for longer than 5 days the licensee must notify NMFS to evaluate if reinitiation is required. All water quality monitoring and population-monitoring reports will be sent to: nmfs.ser.esa.consultations@noaa.gov. The subject line of the email should include the SERO number associated with this Opinion and a description of which report is included. Example: Subject: SER-2010-3874 Saluda Hydroelectric Project Biological Opinion – Annual Report: Water Quality Monitoring Results.

10 CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the ESA directs federal agencies to use their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are designed to minimize or avoid adverse effects of a

proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information.

NMFS believes the following conservation recommendations further the conservation of listed species. NMFS strongly recommends that these measures be considered and implemented by USACE and/or the applicant:

1. Assist SCDNR in their ongoing sturgeon research by providing receivers to record tagged shortnose sturgeon in locations above the Granby Lock and Dam.
2. Explore whether rocks (or something similar) could be placed in the Congaree River, downstream of the confluence of the Saluda and Broad rivers, to facilitate mixing of water.

Please notify NMFS if the federal action agency carries out any of these recommendations so that we will be kept informed of actions that are intended to improve the conservation of listed species or their designated critical habitats.

11 REINITIATION OF CONSULTATION

This concludes NMFS's formal consultation on the proposed actions. As provided in 50 CFR 402.16, reinitiation of formal consultation is required where discretionary federal action agency involvement or control over the action has been retained, or is authorized by law, and if: (1) the amount or extent of incidental take is exceeded, (2) new information reveals effects of the agency action on listed species or designated critical habitat in a manner or to an extent not considered in this Opinion, (3) the agency action is subsequently modified in a manner that causes an effect on the listed species or critical habitat not considered in this Opinion, or (4) a new species is listed or critical habitat designated that may be affected by the action. In instances where the amount or extent of incidental take is exceeded, any operations causing such take must cease pending reinitiation.

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