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F/SER31: KBD

NOV 04 2011

Colonel Jeffrey M. Hall
Commander, Savannah District
U.S. Army Corps of Engineers
Department of the Army
100 W. Oglethorpe Avenue
Savannah, Georgia 31402-0889

Dear Colonel Hall:

NOAA's National Marine Fisheries Service (NMFS) provides the attached final biological opinion (opinion) on species listed under the Endangered Species Act (ESA) of 1973. NMFS is providing the U.S. Army Corps of Engineers (COE) this opinion pursuant to 50 CFR 402.14(h). This document is based on our review of impacts associated with the proposed federal navigational channel dredging activities for the Savannah Harbor Expansion Project (SHEP) to be conducted by the Savannah District COE.

Information concerning the proposed action was obtained by our review of the Biological Assessment (BA), Draft Environmental Impact Statement (DEIS), and Draft General Re-evaluation Report (DGRR) for the SHEP in Chatham County, Georgia, and Jasper County, South Carolina. Supplemental reports were also provided by the Savannah District. This opinion concludes that the proposed action is not likely to jeopardize species listed or proposed for listing under the ESA under NMFS purview and provides reasonable and prudent measures, along with their implementing terms and conditions.

The findings presented in the opinion are not intended to act as the Secretary of Commerce's (the Secretary) final approval of this project as required by the Water Resources and Development Act of 1999 (WRDA) Section 101(b)(9), Public Law 106-53. The Secretary's final decision will depend on a determination that the proposed mitigation measures will adequately address the potential environmental impacts of the project. The mitigative measures include the following actions that must be fulfilled in the agreed upon time frames included in the opinion:

1) Finalization of the off-channel rock ramp fish passage design in coordination with NMFS and the other federal and state resource agencies.

2) Construction of the fish passage facility at the New Savannah Bluff Lock and Dam to provide access to historical spawning habitat for sturgeon as a mitigation measure.

3) Completion of the development and implementation of a comprehensive monitoring and adaptive management plan in coordination with NMFS and the other federal and state resource agencies to help insure the success of all mitigative measures including the fish passage facility.

The no jeopardy conclusion of the opinion is contingent on agreement to implement and maintain all of the mitigative measures.

We appreciate the COE's efforts in working together with NMFS to identify methods and measures to address complex conservation issues that, when implemented, will provide protection for endangered species under NMFS' authority.

We will continue to provide interagency coordination on this project under all our authorities and to work with the COE to finalize the agreed upon protective measures associated with this project. Our primary contact for endangered species issues is Kay Davy. She may be reached by phone at (954) 356-6791 or by e-mail at Kay.Davy@noaa.gov.

Sincerely,

Roy E. Crabtree, Ph.D.
Regional Administrator

Enclosure

Endangered Species Act – Section 7 Consultation
Final Biological Opinion

Action Agency:	U.S. Army Corps of Engineers (COE), Savannah District
Activity:	Deepening of the Savannah Harbor Federal Navigational Channel in association with the Savannah Harbor Expansion Project (NMFS Consultation No. F/SER/2010/05579)
Consulting Agency:	National Oceanic and Atmospheric Administration, National Marine Fisheries Service (NMFS), Southeast Regional Office, Protected Resources Division, St. Petersburg, Florida
Approved By:	Roy E. Crabtree, Ph.D., Regional Administrator NMFS, Southeast Regional Office St. Petersburg, Florida
Date Issued:	NOV 04 2011

TABLE OF CONTENTS

Introduction

Section 7(a)(2) of the Endangered Species Act (ESA) of 1973, as amended (16 U.S.C. § 1531 *et seq*.), requires that each federal agency shall 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 to result in the destruction or adverse modification of any designated critical habitat of such species. The National Marine Fisheries Service and the U.S. Fish and Wildlife Service (USFWS) share responsibilities for administering the ESA. When the action of a federal agency may affect a species or designated critical habitat protected under the ESA, that agency is required to consult with either NMFS or USFWS, depending on the species and/or critical habitat that may be affected.

Consultations on most listed species and critical habitat in the marine environment are conducted between the action agency and NMFS. Consultation is concluded after NMFS determines that an action is not likely to adversely affect listed species or critical habitat or issues a biological opinion (opinion) that identifies whether a proposed action is likely to jeopardize the continued existence of a listed species, or destroy or adversely modify critical habitat. The opinion states the amount or extent of incidental take of the listed species that may occur, develops reasonable and prudent alternatives (RPAs) if the action is expected to jeopardize the continued existence of the species, and recommends conservation measures to further conserve the species. Notably, no incidental destruction or adverse modification of critical habitat can be authorized, and thus, there are no reasonable and prudent measures, only reasonable and prudent alternatives that must avoid destruction or adverse modification.

This document represents NMFS' opinion based on our review of impacts associated with the proposed federal navigational channel dredging activities for the Savannah Harbor Expansion Project to be conducted by the Savannah District COE. The opinion analyzes project effects on sea turtles (Northwest Atlantic loggerhead distinct population segment [DPS], Kemp's ridley, leatherback, hawksbill, and green), North Atlantic right whales, humpback whales, and shortnose sturgeon. It also represents our conference opinion for the South Atlantic DPS of Atlantic sturgeon, which is proposed for listing under the ESA. Conference is only required where the proposed action "is likely to jeopardize" the proposed species; if the listing is finalized without changes from the proposed rule, the conference opinion can quickly be adopted and made operative and avoid potential delays associated with reinitiation of consultation.

Information for this opinion was provided by the COE, or was obtained from a variety of sources including published and unpublished literature cited herein and other sources of information including the COE Sea Turtle Data Warehouse (http://el.erdc.usace.army.mil/seaturtles/index.cfm; COE 2011).

NMFS serves as a cooperating agency for this project pursuant to the National Environmental Policy Act (NEPA), along with the Environmental Protection Agency

(Region IV), the Department of the Interior (acting through the U.S. Fish and Wildlife Service), and the Georgia Ports Authority. NMFS has responsibilities as a consulting agency under the ESA, the Marine Mammal Protection Act (MMPA), and the Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act) (16 U.S.C. §1801 *et seq*.).

BIOLOGICAL OPINION

1 CONSULTATION HISTORY

This section includes information associated with NMFS' current and past involvement with dredging of the lower Savannah River and entrance channel as it relates to the proposed Savannah Harbor Expansion Project (SHEP).

July 1991: COE publishes Savannah Harbor Deepening Feasibility Report. The project would deepen the inner harbor and entrance channel from -38 feet Mean Low Water (MLW) to -42 feet MLW. The outer entrance channel would be deepened from -40 feet MLW to -44 feet MLW. NMFS concurred with the COE's determination that the proposed 4-foot deepening was not likely to adversely affect threatened and endangered species since the COE would abide by the soon-to-be-issued NMFS 1991 Regional Biological Opinion on South Atlantic hopper dredging for the deepening.

November 25, 1991: NMFS issues a regional biological opinion (RBO), "Dredging of channels in the southeastern United States from North Carolina through Cape Canaveral, Florida, to the COE South Atlantic Division (SAD), which includes the Savannah District."

August 25, 1995: NMFS issues a RBO, "Hopper dredging of channels and beach nourishment activities in the Southeastern United States from North Carolina through Florida East Coast," which supersedes the 1991 RBO.

September 1995: COE prepares a Biological Assessment of Threatened and Endangered Species (BATES) and EIS for the Savannah Harbor Long Term Management Strategy (LTMS), Chatham County, Georgia, and Jasper County, South Carolina, that addresses maintenance dredging of the navigation channel and deposition of dredged sediment material.

September 25, 1997: NMFS issues a RBO, "The continued hopper dredging of channels and borrow areas in the southeastern United States," which supersedes the 1995 RBO. It set an annual documented incidental take for the region of 7 Kemp's ridley, 7 green, 2 hawksbill, and 35 loggerhead sea turtles. It also set an annual documented incidental take of 5 shortnose sturgeon and clarified monitoring requirements for beach nourishment projects. The hopper dredge windows, as established in the 1995 RBO, were incorporated into this RBO, provided the COE: (1) continued to minimize sea turtle takes by refining the turtle deflecting dragheads, (2) tried to schedule hopper dredging work in the highest risk areas (Canaveral, Brunswick, Savannah, and Kings Bay) during periods when nearshore waters are coolest (after December 15 but well before March), (3) attempted to complete all projects during the cold-water months when possible, and (4) shut down operations when high numbers of turtle takes occur before approaching the incidental take limit for a given species. This is the current opinion authorizing threatened and endangered species take pursuant to COE dredging activities in the SAD.

October 1997: COE assists Georgia Ports Authority (GPA) in development of a Sampling and Analysis Plan for sampling sediments that would be extracted during harbor deepening. The plan was coordinated with all state and federal agencies, including NMFS.

July 28, 1998: A Feasibility Report and Tier I Environmental Impact Statement (EIS) for deepening the Savannah Harbor is generated in accordance with the NEPA. The Tier I EIS was initially drafted and prepared by the GPA, under the authority of Section 203 of the Water Resources Development Act of 1986 (WRDA 86). The proposed harbor improvement would deepen the existing -42 feet MLW deep-draft navigation channel to -48 feet MLW (preferred alternative). The maximum impact alternative analyzed in the EIS was -50 feet MLW. The DEIS concluded that formal consultation with NMFS Protected Resources Division (PRD) would not be necessary for any species as long as the avoidance and habitat measures proposed in the BATES were implemented.

August 17, 1999: Section 101(b)(9) of WRDA 99, Public Law 106-53 specifies a number of conditions that must be met before SHEP can be constructed. The conditions include the successful completion of the NEPA process, including any necessary consultation under the ESA, the Fish and Wildlife Coordination Act, and the Magnuson-Stevens Act, and the demonstration of compliance with these and other relevant environmental laws. In addition, the Secretaries of the Army, Interior, and Commerce, and the Administrator of the Environmental Protection Agency, must all approve the selected plan and determine that the associated mitigation plan adequately addresses the environmental impacts of the project before it can be approved for construction.

December 22, 1999: COE issues a Record of Decision (ROD) on the Tier I EIS that states the COE Washington-level review determined that the proposed project was not formulated in accordance with applicable COE planning procedures and regulations and that an acceptable mitigation plan had not been determined. Analyses provided in the Tier I EIS only evaluated the potential impacts for a -50 foot MLW channel depth. Additional analyses must be performed in a Tier II EIS to more completely identify and evaluate the potential impacts of alternative depths, develop an acceptable mitigation plan, and conclusively determine the National Economic Development (NED) plan and the cost sharing for the mitigation features.

January 21, 2000: COE hosts an Interagency Fisheries Committee meeting to discuss potential species which could be impacted by SHEP and to review the results of EPA's research on effects of low dissolved oxygen on juvenile shortnose sturgeon. NMFS Habitat Conservation Division (HCD) staff attend.

September 7, 2001: COE requests participation of NMFS as a Federal Cooperating Agency with the development of SHEP pursuant to NEPA. NMFS agrees to participate but states that participation will be limited to matters involving nationally important fishery resources that may be affected by the project, and to matters pertaining to mitigation where trust resources are involved.

September 10, 2002: COE hosts Interagency Fisheries Committee meeting and discusses inclusion of shortnose sturgeon in fisheries models for SHEP. The group identified the lower end of Middle River as a possible habitat for juvenile shortnose sturgeon during the winter. NMFS HCD staff attend.

November 13, 2002: COE hosts SHEP Interagency Fisheries Committee meeting to discuss review of habitat suitability models for various fisheries. Shortnose sturgeon is chosen as a key species for analysis while other species are deleted from analysis. NMFS HCD staff attend.

December 19, 2002: COE hosts SHEP Interagency Fisheries Committee meeting. NMFS HCD and SCDNR identify habitat "areas of concern" for shortnose sturgeon in the lower Middle River. Clarification of the use of the "Hydro model" to determine minimum levels of dissolved oxygen as it relates to fisheries species is discussed. The group decided that 5 percent occurrence values (95% exceedance) should be identified as a measure of the minimum dissolved oxygen levels in the estuary and should be reported every 0.2 miles. The information would not be part of the habitat suitability criteria, but would be additional information to assess the general fishery habitat conditions in the estuary under different flow conditions.

January 28, 2003: COE hosts SHEP Interagency Fisheries Committee meeting and discusses using a pass/fail approach in determining suitable habitat for key species (e.g., shortnose sturgeon). ATM, consulting for the COE, takes on responsibility for describing rationale for habitat criteria to be used to identify suitable habitat for shortnose sturgeon in the Savannah River estuary. NMFS HCD staff attend.

April 21, 2003: COE hosts SHEP Interagency Fisheries Committee meeting and discusses the habitat areas of concern for shortnose sturgeon: juveniles in winter in the lower Middle River; adults in winter in the Savannah River, and juveniles in summer further upstream in the Savannah River. The group agreed it wanted dissolved oxygen data from only a portion of the channel cross-section that would include the deepest cell(s). NMFS PRD staff attend.

July 1, 2003: COE hosts SHEP interagency coordination meeting on wetlands and discusses the effects of salinity increase on marshes and fisheries. NMFS HCD staff attend.

June 16, 2005: COE hosts SHEP Lead and Cooperating Agency meeting. The cooperating agencies (including NMFS) state that the Stakeholders Evaluation Group

(SEG) provides enhanced public input, but cannot make decisions for the federal agencies. The Lead and Cooperating agencies agree that the SEG is advisory to the GPA.

May 31, 2006: COE hosts SHEP Wetlands Interagency Coordination Team Meeting. The group decided to use two levels of sea level rise (25 and 50 cm) over the 50-year project life. Impact analysis parameters were chosen using average historical flows based on 1997 water data and drought flows based on 2001 water data. NMFS HCD staff attend.

June 1, 2006: COE hosts SHEP Interagency Fisheries Committee meeting and discusses the measures developed to define acceptable habitat for key species. The intent is to use the hydraulic and water quality models to identify the amount and location of suitable and unsuitable habitat so that potential impacts of the harbor expansion project could be identified and evaluated. During the meeting there was surprise expressed that the analysis identified areas as unsuitable shortnose sturgeon habitat because of failure to meet salinity criteria. The committee had expected some areas to be unsuitable because of low dissolved oxygen conditions. The COE stated they would re-check how the model determined a cell was unsuitable for sturgeon. NMFS HCD staff attend.

December 15, 2006: COE hosts SHEP Wetlands Interagency Coordination Team meeting. NMFS HCD staff attend and provide comments on FWS' proposal to reroute flow of the Middle River through Rifle Cut, stating that this could drastically increase salinity in the lower Middle River, which could affect the suitability of that habitat for shortnose sturgeon.

January 19, 2007: COE hosts Interagency Water Quality Coordination Team meeting. NMFS-HCD states that the dissolved oxygen injection systems should be designed with an intake velocity of ≤ 0.5 feet per second across the screens to minimize potential impacts to fish and that the system operation should include the ability and a procedure to cease operation if a fish entrainment event occurs.

June 20-21, 2007: COE hosts Interagency Coordination Meeting to review mitigation alternatives and to select appropriate mitigation for SHEP. The group decides to use the existing sea level in basic impact evaluation. The group felt that fish passage at the New Savannah Bluff Lock and Dam would be one method of mitigation for impacts to shortnose sturgeon habitat. The COE explained that although Congress has not funded rehabilitation of the lock and dam, local governments continue to position themselves for the continued existence of the dam. The COE states it would not consider proposing removal as part of this project unless the concept is first discussed with the local governments and an indication that they would not oppose such a proposal is received. NMFS HCD staff recommends that the COE initiate EFH consultation and begin ESA consultation with NOAA.

August 26-28, 2008: COE hosts Alternative Formulation Briefing. NMFS HCD and PRD attend and present a list of potential issues associated with SHEP regarding potential effects to species protected by the ESA and EFH resources protected under the Magnuson-Stevens Act.

September 12, 2008: SAD submits the South Atlantic Regional Biological Assessment for reinitiation of the RBO. SAD also states that additional information regarding modifications to seasonal hopper dredging activities will be forthcoming.

November 19, 2008: NMFS and SAD hold a conference to discuss modifications to hopper dredging windows and relocation trawling activities during which time SAD presents information and analyses supporting its request to modify the conditions of the existing RBO.

July 16, 2009: NMFS and COE meet to discuss suggested changes to SHEP Monitoring and Adaptive Management Plan.

July 31, 2009: NMFS provides recommendations for inclusion in the SHEP Monitoring and Adaptive Management Plan (Appendix D of the DEIS)

August 12, 2009: NMFS requests the COE use the 50-percentile of maximum bottom salinity parameter and 14.9 ppt salinity as the upper threshold for modeling acceptable juvenile shortnose sturgeon habitat in the winter. The new criteria will be proposed to the Fisheries Interagency Coordination Team for agency-wide approval.

November 12, 2009: NMFS PRD provides comments on proposed SHEP entrance channel extension and alignment and requests additional information on the dredging activities associated with the channel extension.

December 9, 2009: COE responds to NMFS PRD request for additional information and analysis of proposed SHEP entrance channel extension/alignment.

February 4, 2010: NMFS PRD submits additional questions and comments on proposed entrance channel extension/alignment to be addressed in Biological Assessment and DEIS being prepared for SHEP.

April 9, 2010: COE provides a Biological Assessment of Threatened and Endangered Species (BATES) for SHEP to NMFS.

April 28, 2010: NMFS submits e-mail request to COE to review dissolved oxygen data showing current conditions, conditions with the proposed deepening, conditions with deepening and hydrologic modification, and conditions with deepening plus hydrologic modification and dissolved oxygen injection.

May 5, 2010: NMFS provides comments on the need to include removal of the New Savannah Bluff Lock and Dam as a mitigation alternative.

August 10, 2010: Preliminary versions of DEIS and DGRR are provided to cooperating agencies for review.

September 10, 2010: NMFS provides comments on the preliminary DEIS and GRR.

September 30, 2010: NMFS meets with COE to discuss outstanding data requests including the need to see the effects of adding the high 2004 point source loads to the sturgeon habitat models. NMFS questions the suitability of habitat in the Back River due to anecdotal reports of the Back River having areas that may be too shallow to provide habitat to sturgeon.

October 18, 2010: NMFS provides comments to COE after re-initiation of agency review of proposed fish passage at the New Savannah Bluff Lock and Dam as partial mitigation for SHEP. NMFS notifies COE about proposed listing of Atlantic sturgeon in the comments.

November 8, 2010: NMFS provides initial comments on language used in preliminary DEIS for protection of whales. COE partially modifies text before issuance of DEIS.

November 15, 2010: The DEIS and DGRR are released for public/agency review.

November 24, 2010: NMFS notifies the COE of intent to conduct joint ESA and EFH consultation. NMFS also identifies the need for habitat modeling for juvenile shortnose sturgeon to include the revised salinity criteria and provides a list of ten outstanding issues not thoroughly addressed in the DEIS.

November 30, 2010: COE provides a response to NMFS' list of ten outstanding issues.

December 1, 2010: NMFS provides comments on the supplemental information provided in "Evaluation of Juvenile Shortnose Sturgeon Habitat Impacts with Proposed Mitigation Plan," noting that the COE ran the model using August conditions instead of the requested January conditions.

December 6, 2010: COE provides the corrected model runs for January conditions for juvenile shortnose sturgeon.

December 20, 2010: COE provides final agreement to NMFS to implement vessel speed restrictions for the protection of North Atlantic and humpback whales, in vessels associated with dredging.

December 29, 2010: COE provides reports with 2004 point source loading included in the habitat suitability models.

January 13, 2011: NMFS provides comments on the previous sturgeon habitat modeling reports and requests additional modeling runs with corrected information (Middle River sill in place, average dissolved oxygen loading, acreage with deepening only, etc.).

January 25, 2011: NMFS provides joint ESA/EFH comments to COE.

January 26, 2011: COE provides comments on NMFS' request for additional modeling runs.

March 11, 2011: COE provides updated evaluations of habitat impacts to shortnose sturgeon juveniles and adults during winter and summer. Formal consultation between NMFS and the COE begins with the receipt of this information.

April 25-27, 2011: COE hosts a workshop to discuss fish passage designs at the New Savannah Bluff Lock and Dam. NMFS provides comments on dam removal and performance criteria for fish passage.

May 11, 2011: COE provides a proposal to construct an off-channel rock ramp for fish passage at the New Savannah Bluff Lock and Dam, citing that the fish passage design (full-channel rock ramp) recommended by the April 25-27 workshop would not be cost effective.

May 27, 2011: COE provides responses to NMFS questions regarding information on the three proposed designs for fish passage at the New Savannah Bluff Lock and Dam presented in the COE "information paper" of May 11, 2011.

July 1, 2011: NMFS provides draft biological opinion on the Savannah Harbor Expansion Project to the COE.

August 25, 2011: NMFS hosts interagency meeting on-site at New Savannah Bluff Lock and Dam with Dr. Luther Aadland, a noted sturgeon fish passage expert. Dr. Aadland is provided with the COE's design plans for an off-channel rock ramp fish passage at the site.

September 6, 2011: COE meets with NMFS to discuss the draft Reasonable and Prudent Measures and Terms and Conditions provided in the draft biological opinion.

September 12, 2011: Dr. Aadland provides a written report summarizing his review of the COE's design plans for fish passage at the New Savannah Bluff Lock and Dam.

October 7, 2011: COE provides final written comments on the draft biological opinion.

October 21, 2011: COE meets with NMFS to negotiate the Reasonable and Prudent Measures and Terms and Conditions to be included in the final version of the biological opinion.

2 DESCRIPTION OF THE PROPOSED ACTION AND ACTION AREA

2.1 Proposed Action

The Savannah District has proposed deepening the federal navigational channel of the Savannah Harbor from the existing depth of -42 feet mean lower low water (MLLW), which has been maintained since 1994 using a 2-foot allowable overdepth and up to 6-feet advance maintenance dredging, as deep as -48 feet. Five incremental deepening alternatives and a "No Action" alternative are evaluated. The No Action alternative is the existing project depth of -42 feet. The U.S. Congress conditionally authorized deepening of the Savannah Harbor up to an additional 6 feet in the Water Resources Development Act of 1999 (Section 101(b)(9)). Authorization is dependent upon the completion of a Tier II EIS, approval of the project by the Secretary of Commerce, Administrator of the Environmental Protection Agency (EPA), Secretary of Interior, Secretary of Army, and a determination by the Secretaries and the Administrator of the EPA that the associated mitigation plan adequately addresses the potential environmental impacts of the project.

According to the DGRR, the Garden City Terminal, located in the Savannah Harbor and operated by the GPA, is the second largest container port on the East Coast and the fourth largest in the Nation. The harbor and deep-draft navigation channel comprise the lower 19.5 miles of the Savannah River and 16.1 miles of channel across the ocean bar to the Atlantic Ocean. The Savannah Harbor currently has the shallowest controlling depth of any major U.S. port. Its depth constraints are similar to the current constraints of the Panama Canal; however, the Panama Canal Expansion Project will be completed by 2014 and will allow passage for vessels up to 50 feet in draft. Information in the DGRR states that since the last authorized deepening to -42 feet MLLW performed in 1994, container ship design and traffic has exceeded projections and in excess of 70 percent of vessels enter the Savannah Harbor are carrying less than their maximum capacity due to draft restrictions, which has resulted in increased shipping costs. Other problems are associated with existing ships experiencing problems with turning capabilities and impaired maneuverability in certain reaches of the inner harbor. It is expected that the severity of problems associated with turning capabilities and overall maneuverability in certain reaches of the inner harbor will increase as vessel size increases.

The COE's development of a NED plan determined that net economic benefits are maximized with the 47-foot depth alternative. Initially, the GPA (as the non-federal sponsor) supported the Maximum Authorized Plan of the 48-foot depth alternative, which was later retracted. The final selected plan will be included in the final EIS and GRR. This opinion will address the 47-foot depth alternative as the maximum depth alternative.

2.1.1 Construction Activities

Brief History of Dredging within the Savannah Harbor

Congress authorized construction of the federal navigation project at Savannah Harbor, which was initially constructed in 1874. In 1896, two jetties were constructed at the mouth of the Savannah River entrance. A submerged offshore breakwater was completed in 1897 to stabilize the inlet and provide a shelter for shipping entering Tybee Roads. Tybee Island is located on the south side of the entrance channel to the Savannah River. The navigation channel of the Savannah River was deepened from 21.5-feet Mean Low Water (MLW) to a depth of 26-feet MLW in 1912 to accommodate larger ships. Depth increases were later made in 1936 to 30-feet MLW and in 1945 to 36-feet MLW. The channel was widened and deepened in 1972 to a depth of 40-feet MLW. In 1994, the authorized depth of the channel was increased to 42-feet MLW. At present, approximately 32.5 miles of navigation channel exist, extending from Savannah Harbor into the Atlantic Ocean.

Proposed Dredging within the Savannah Harbor

All of the project deepening alternatives, -44 feet, -45 feet, -46 feet, -47 feet, and -48 feet, would include dredging from Stations -98+600B ranging to -95+680B (the length of the Entrance Channel Extension varies with each deepening alternative) to 103+000 (Garden City Terminal - River Mile 19.5). The deepening would include the Kings Island Turning Basin and eight berths (Berths 2, 3, 4, 5, 6, 7, 8, and 9) at the Garden City Terminal. Project work would also include widening of three bend wideners and construction of two passing lanes along with extension of the Entrance Channel. By maintaining the existing side slopes of the channel, the proposed deepening alternatives would have a narrower channel at the project depth than currently exists. According to the DEIS, decreasing the channel width by maintaining the existing side slopes at different depths will not adversely impact adjacent marine and estuarine habitat. However, removal of the bottom substrate within the dredging areas would eliminate all benthic resources in those locations. To maintain slope stability, a ratio of 3H:1V would be used in the inner harbor and 5H:1V in the ocean bar channel. Congress authorizes federal navigation channels by specific depth and width. The inherent imprecision in dredging processes varies with the physical conditions, the dredged material characteristics, the channel design (i.e., depths being dredged, side slopes), and the type of dredging equipment (e.g., mechanical, hydraulic, hopper). Due to these variables and the resulting imprecision associated with the dredging activity, COE design, cost estimating, and construction contracting documents recognize that dredging below the Congressionally authorized project dimensions will occur and is necessary to assure the required depth and width as well as cost effective operability. In order to balance project construction requirements against the need to limit dredging and disposal to the minimum required to achieve the designed dimensions, a paid or allowable overdepth of up to 2 feet is incorporated into the project-dredging prism. Material removed from this allowable overdepth is paid under the terms of the dredging contract. Material removed beyond the limits of the allowable overdepth is not paid. Each alternative would include overdepth and advance maintenance dredging (Table 1). Advance maintenance dredging extends the length of time during which authorized channel depths are available. The purpose of advance maintenance dredging is to reduce the frequency of dredging and reduce overall maintenance costs.

Begin Station	End Station	Authorized Advance Maintenance (feet)	Required Contract Depth (feet MLLW)
Inner Harbor			
112+500	105+500	2.0	32.0
105+500	103+000	2.0	38.0
103+000	102+000	0.0	42.0
102+000	100+000	2.0	44.0
100+000	79+600	2.0	44.0
79+600	70+000	2.0	44.0
70+000	50+000	4.0	46.0
50+000	37+000	4.0	46.0
37+000	35+000	6.0	48.0
35+000	24+000	4.0	46.0
24+000	0+000	2.0	44.0
Port Wentworth TB		0.0	30.0
Argyle Island TB		0.0	30.0
Kings Island TB		8.0	50.0
Marsh Island TB		0	34.0
Fig Island TB		4.0	38.0

Table 1. Present Advance Maintenance Sections.

With the 47-foot alternative, approximately 23.6 million cubic yards (mcy) of sediment removed from Stations 103+000 to 4+000 and the Entrance Channel would be placed in the existing upland confined disposal facilities (CDFs) or placed in the EPA-approved Ocean Dredged Material Disposal Site (ODMDS). The ODMDS was designated by EPA under Section 103 of the Marine Protection, Research and Sanctuaries Act of 1972 (MPRSA), as amended (40 CFR Parts 220 to 228). The COE had originally planned to place a portion of the dredged material in nearshore feeder berms, but the decision was made to instead place all material removed from the Entrance Channel into the ODMDS. Total amount of dredged material that would be removed with the other depth alternatives would be: approximately 10.3 mcy of material with the 44-foot alternative, 14.6 mcy with the 45-foot alternative, 19.0 mcy with the 46-foot alternative, and 28.0 mcy with the 48-foot alternative. The estimated annual volume for operation and maintenance is 7.1 mcy for each of the alternatives. The estimated construction period of the entire project would be approximately three to four years.

The proposed methods of dredging include hydraulic pipeline dredge, hopper dredge, mechanical dredge, or similar equipment. Hopper dredges would predominantly be used within the ocean bar channel (Stations 0+000 to 98+600) of the harbor (Figure 1). The proposed project includes operating under the Terms and Conditions set forth in the 1991 and 1995 RBOs, and the current (1997) South Atlantic Regional Biological Opinion (SARBO), and the CESAD Hopper Dredging Protocol (Appendix E). The COE proposes that hopper dredge operations would be conducted from December 1 to March 31. Bed-levelers are currently permitted for certain reaches of the upper harbor, with conditions required to minimize turbidity impacts. The project proposes to authorize their use only in the Bar Channel. Furthermore, their use would be restricted to the leveling of high spots in the channel or placement area, where use of a hopper dredge for such work would be expected to result in equal or greater take of endangered species.

The COE has a specific set of specifications for the Savannah District that deal with large whale protection measures. These specifications apply to Savannah Harbor and require a NMFS-approved endangered species observer approved for whale monitoring be onboard each hopper dredge during the time that right whales may be in the area. Savannah District's specifications included:

No incidental take of right whales is authorized. Vessel speeds of no more than 10 knots as set forth in the proposed action shall be used. However, the Contractor shall restrict dredge and attendant vessel speeds to 5 knots or less (or minimum safe speed) during night (sunset to sunrise) operations unless there is no information from the right whale early warning system (RWEWS) or any other observations/information that reveals any right whales within 15 nautical miles of the project area. (NMFS notes that RWEWS flights are not conducted on a regular basis off of Savannah.) If aerial surveys for right whales show no sightings on a particular day, the vessel speeds of no more than 10 knots as set forth in the proposed action shall be used during the following nighttime operations. If a right whale is determined through any means to be in the project area on a particular day, negative results from any other type of survey on that same day shall not serve to cancel that night's restriction of dredge and attendant vessel speeds. For Savannah Harbor, the project area is defined as the Savannah Harbor Entrance Channel (Stations 0+000 to -60+000B), the designated offshore disposal areas shown on the Contract drawings, and transit routes. If right whale occurrence/ distribution information is not available from the RWEWS due to severe weather restrictions, then vessel speeds will be restricted to 5 knots (or minimum safe speed) during night operations. It is currently expected that the RWEWS will be in effect from December through March for Savannah. No aerial survey is required when the RWEWS is not in effect. Nighttime speeds will still be restricted to 5 knots or less (or minimum safe speed) when the RWEWS is not in effect if other information indicates right whales are in the project area. The requirement for nighttime speed restrictions are available from the COR (OP-NN) or the RWEWS on a daily basis. Previous right whale monitoring along the Georgia coast indicates that for Savannah Harbor the Contractor might expect up to 8 nights of reduced speed operations between 1 December and 31 March. For Brunswick Harbor, the Contractor might expect up to 13 nights of reduced speed operations between 1 December and 31 March. Contractor should also expect at least 22 days of additional reduced speed operations between the period of 1 December and 31 March due to weather restricting RWES aerial surveys. During daylight hours, the dredge operator shall take necessary precautions to avoid whales. If whales have been spotted within 15 nautical miles of the project area in the previous 24 hours, then the dredge shall slow down to 5 knots or less (or minimum safe speed) when transiting to and from the dump site during evening hours or during daylight hours when there is limited visibility due to fog or sea states of greater than Beaufort 3. The hopper dredge shall not get closer than 500 yards to right whales. The speed limits for hopper dredges as set forth in the proposed action would only apply until a new Regional Biological Opinion for hopper dredging is signed, at which time the project would abide by the conditions in the Regional Opinion.

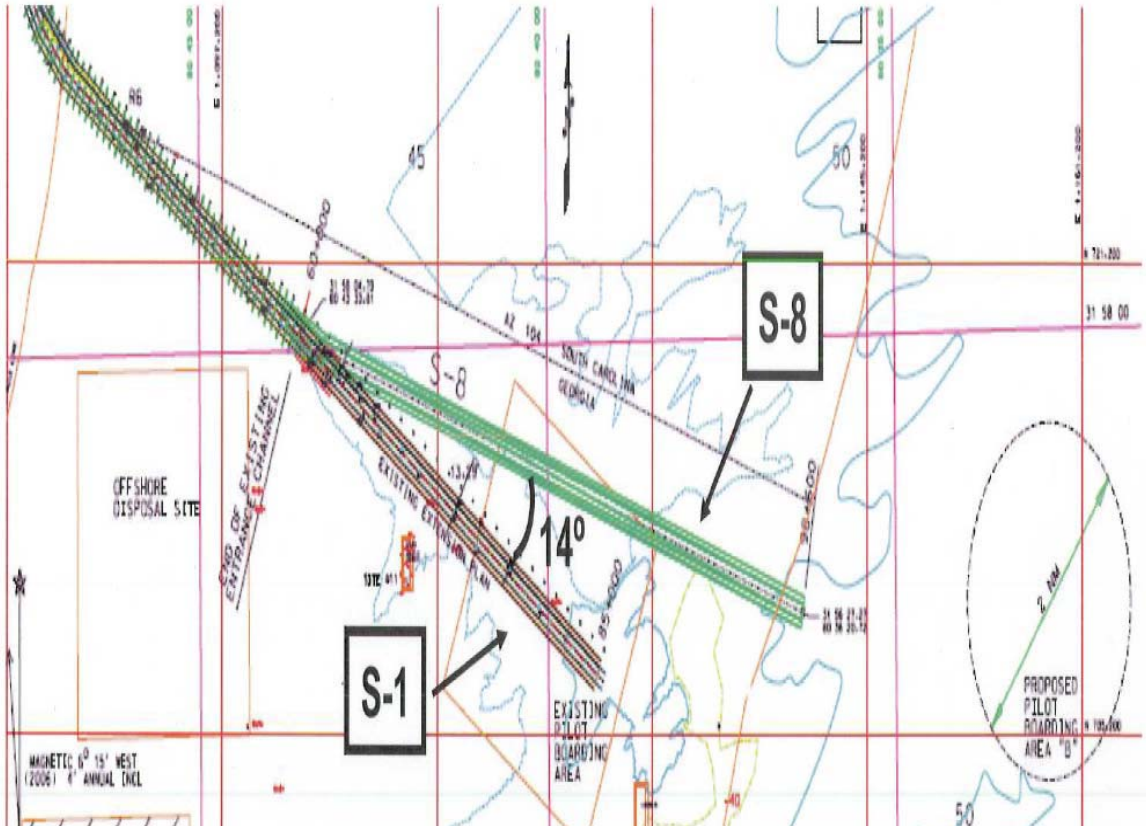

Figure 1. Reconfigured Ocean Bar Channel Alignment. (S-1) Existing Extension Plan, (S-8) Proposed Extension Plan

2.1.2 Flow Re-routing Modification

The deepening of the navigational channel would permit higher salinity water to travel further up the river. The salt water would affect freshwater habitats found within the Savannah National Wildlife Refuge adjacent to the project area along the middle and back river. To address this project effect, the COE developed flow re-routing modification plans that would re-direct freshwater to areas adjacent to (and found within) the refuge with the intent of minimizing the loss of the freshwater tidal marsh. The intent was to identify alterations that could be made in the braided rivers and tidal creeks to reduce salinity levels in critical areas of the estuary. Over 160 different flow re-routing models were conducted to evaluate the effects of each plan. An interagency team comprised of natural resource agency representatives evaluated the models and the COE determined the design that would be most effective at each of the flow re-routing locations. After further evaluation of the options presented by the COE, the interagency team concurred with the COE's approach in August 2006. Ultimately, two plans were selected for the different deepening scenarios. Plan 6A (Figure 2) was selected for deepening to 45, 46, 47, and 48 feet, while Plan 6B (Figure 3) was selected for the 44-foot deepening alternative.

Both of the plans developed for the different deepening alternatives include construction of a diversion feature and closing of the lower arm at McCoy Cut, filling the Sediment Basin to -3.85 m NGVD (National Geodetic Vertical Datum of 1929), removing the Tide gate and its associated abutments and piers, and closing Rifle Cut. Plan 6a also includes deepening within the upper reaches of the Middle and Back Rivers to -3 m NGVD and -4 m NGVD within McCoy Cut.

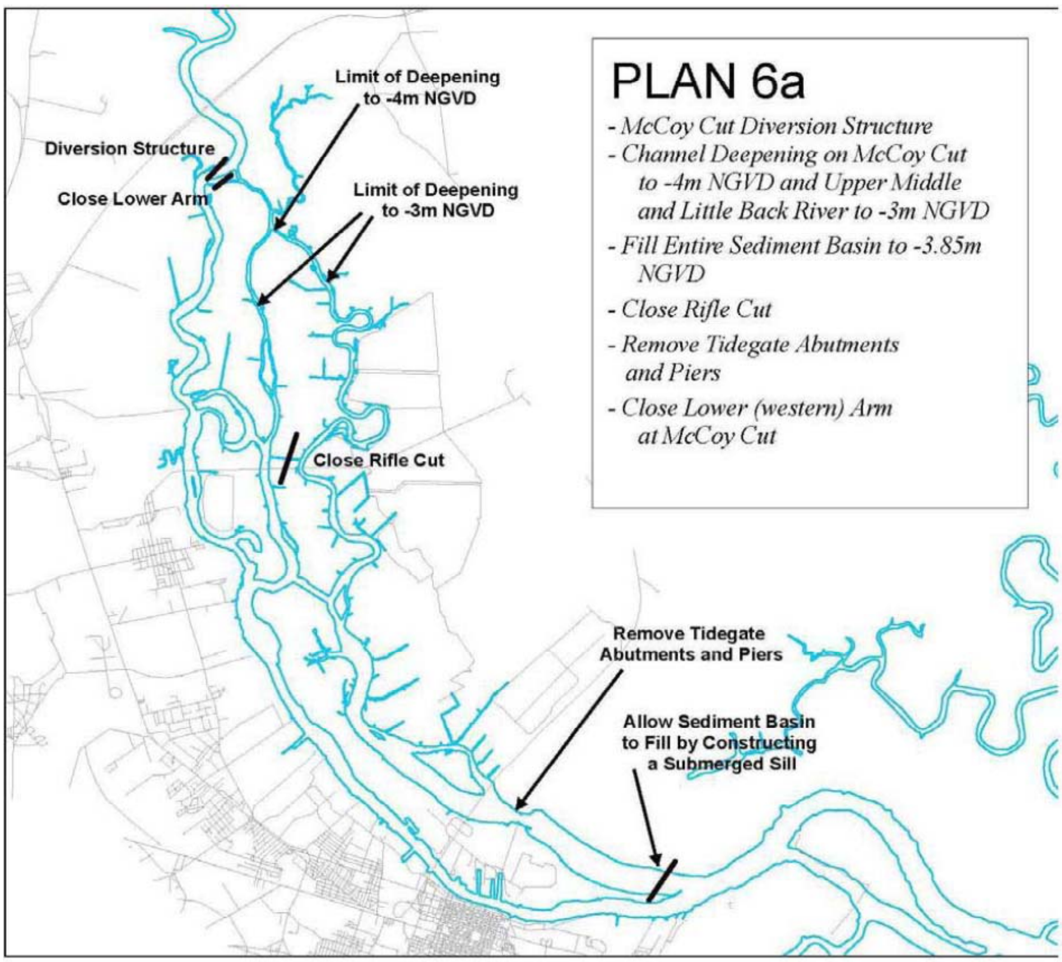

Figure 2. Flow Re-routing Plan 6A for 45-, 46-, 47-, and 48-foot Deepening

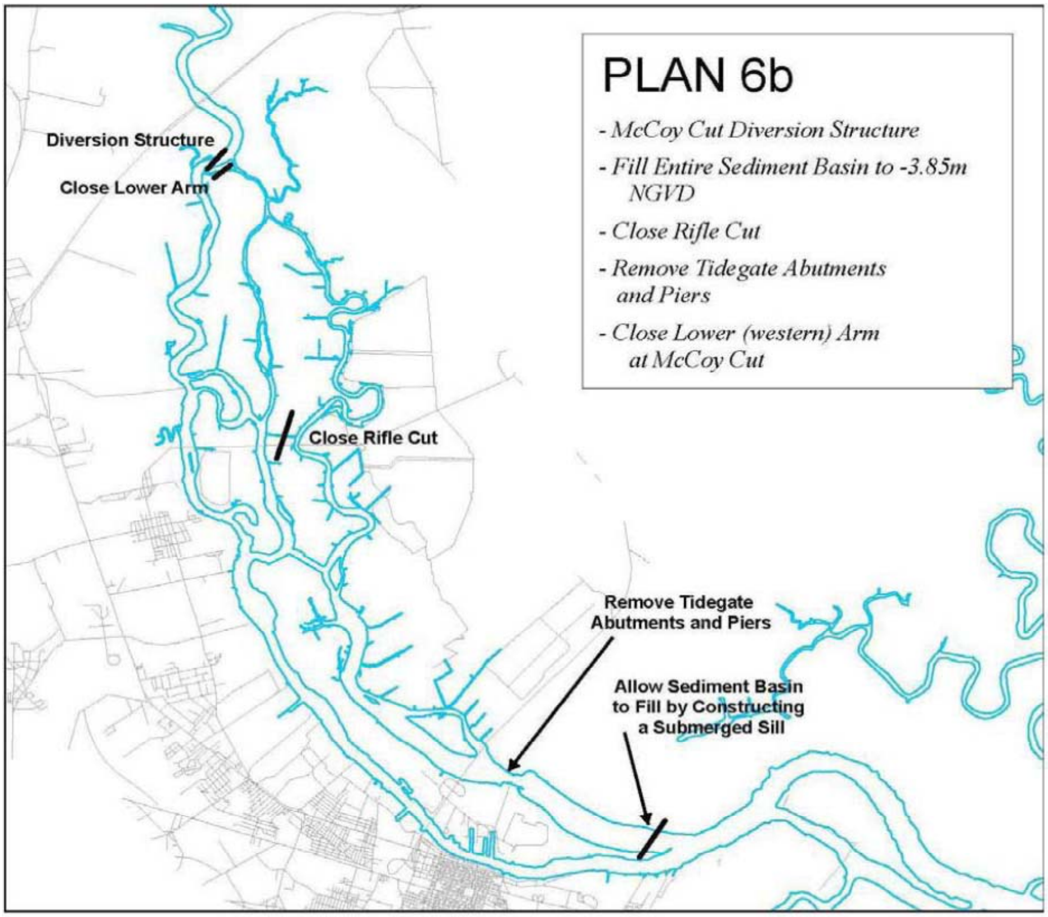

Figure 3. Flow Re-routing Plan for 44-foot Deepening

2.1.3 Dissolved Oxygen Injection

Deepening the navigation channel would adversely impact dissolved oxygen levels in the harbor and can be divided into three issues: (1) as the channel depth increases, the ability of oxygen to reach the river bottom decreases, causing lower average levels of dissolved oxygen at the bottom; (2) as the channel prism enlarges, additional saltwater is moved to the upper portions of the harbor and into the estuary, decreasing the ability of those waters to accept oxygen from the air; and (3) as the channel prism enlarges, the average tidal velocity decreases, reducing the mixing of oxygen throughout the water column. A drop in dissolved oxygen levels typically occurs during summer months at the upper end of tidal rivers in Georgia and South Carolina. This results from the combined effect of the reduced diffusion of oxygen into warm waters and the higher rate of uptake of oxygen from biologic organisms. To address the project impacts the COE has included a feature in the mitigation plan for each depth alternative to minimize that adverse effect.

The COE conducted a demonstration project to investigate whether injection of dissolved oxygen could be a viable method of improving dissolved oxygen levels in the harbor. The COE found that, due to site-specific requirements, a land-based injection system would be the most effective solution and that the use of Speece cones (Figure 4) would be the most efficient technique to inject oxygen into the water. The systems would be deployed to remove the incremental effects of the channel deepening. Eight to ten Speece cones would be needed to increase dissolved oxygen and would be located at three sites (Figure 5). Cones placed at all three locations—one near Georgia Pacific, and two on the east and west side of Hutchinson Island—would be needed for each channel depth alternative. The systems would be land-based, with water being withdrawn from the river through pipes, then super-saturated with oxygen and returned to the river. The water intake structures would be located at mid-water depths and would include screens to reduce the intake of trash and other suspended solids. The screens would be sized to keep flow velocities from exceeding 0.5 feet per second to minimize entrainment of fish larvae. The intake and discharge would be located along the side of the river and not extend into the authorized navigation channel. Tidal flows and currents would mix the dissolved oxygen in the water column.

Figure 4. Speece Cones set up as Demonstration Project on the Savannah River

Figure 5. Modeled Locations for Dissolved Oxygen Injection Systems

Modeling of Dissolved Oxygen Injection
Two models were used to evaluate the impacts of the deepening alternatives on the dissolved oxygen regime in Savannah Harbor. The Environmental Fluid Dynamics Code (EFDC) model was used to develop the hydrodynamic data and then linked to the Water Quality Analysis Simulation Program Version 7.0 (WASP7) to obtain the dissolved oxygen data predictions. The study evaluated 26 spatial zones (Figure 6) that extend from Clyo, Georgia (61 miles above Fort Pulaski), to the Atlantic Ocean (17 miles offshore from Fort Pulaski). The 26 zones included 11 zones for Front River (FR), 6 zones for Middle River (MR), 3 zones for Back River (BR), 3 zones for Little Back River (LBR), 2 zones for South Channel (SC), and 1 zone for the Savannah River (SR) above the I-95 Bridge. The South Carolina standards for dissolved oxygen were used to evaluate severity of impacts, because they were the most restrictive at the time of the study (daily average of 5 mg/Liter, with an instantaneous minimum of 4.0 mg/Liter, applied throughout the water column).

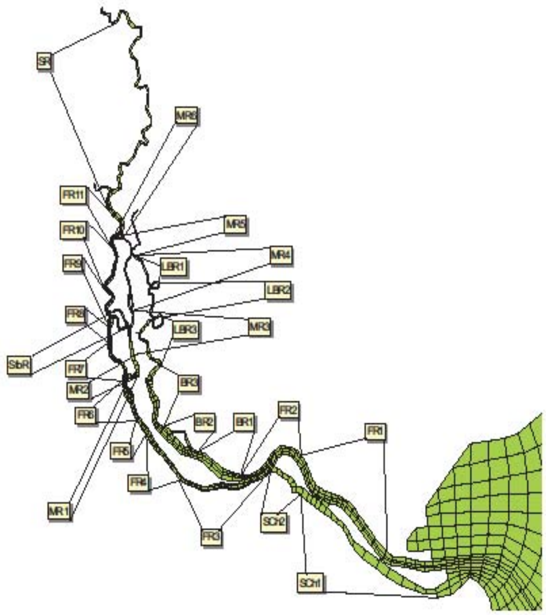

Figure 6. Zones used for Dissolved Oxygen Modeling.

As specified by the Water Quality Interagency Coordination Team, the COE conducted its basic dissolved oxygen impact analyses using average summer drought river flow conditions (August 1999). The interagency team also requested the COE evaluate the project’s potential effects under other conditions, as sensitivity tests for the input conditions. These additional analyses included average flows in the river (August 1997), natural conditions (i.e., river depths prior to any harbor deepening), 2004 point source loads, and full permitted point source loads. Project impacts to dissolved oxygen were found to be higher under droughts than during average flow conditions.

In general, the models showed that there would be significant upstream shifts of lower dissolved oxygen zones in bottom and surface layers of the estuary as the channel deepening increased in magnitude. The studies also indicated that deteriorations of the lowest dissolved oxygen values along critical cells (the cell with the lowest dissolved oxygen concentration during specified simulation period) of major parts of the estuary increase proportionately to the amount of deepening. The COE’s data reflected conditions in the bottom half of the water column (i.e., bottom 3 layers of the 6-layer model), where dissolved oxygen levels are lower.

For the 47-foot channel alternative, a substantial decrease in dissolved oxygen would occur in the critical cells of Front River Zone FR6, FR7, FR8, FR9, FR11, and Middle River Zones MR1 and MR6 as well as Back River Zones BR1, BR2, and BR3. Dissolved oxygen would increase in Lower Back River Zones LBR1 and LBR2.

To mitigate for the low dissolved oxygen, the Speece cones would add dissolved oxygen directly into the estuary. These systems would be operated during conditions of low dissolved oxygen (below 5.0 mg/L average or 4.0 mg/L instantaneous reading) occurring during the summer when dissolved oxygen monitoring indicates the minimum accepted levels had been exceeded (State of South Carolina dissolved oxygen standards of 5.0 mg/L average, but allow 4.0 mg/L instantaneous reading). The number of Speece cones that would be used varies with the deepening alternative selected. The dissolved oxygen levels are higher near the injection site and taper off to lower levels as distance from the site increases. Removing the incremental adverse project effect at a great distance from the injection site would require large amounts of oxygen. A tradeoff results between the amount of oxygen required and the distance from the injection site. The dissolved oxygen system configuration is designed to remove the incremental effect of a deeper channel in 97 percent of the cells in the hydrodynamic model.

2.1.4 Monitoring and Adaptive Management Plan

The COE has proposed development of a comprehensive monitoring and adaptive management plan that would ensure that impacts are not exceeded and that the mitigation plans would function as intended. The multi-phase monitoring program would be conducted during pre-construction, construction, and post-construction, and would include the following features:

1. Continuous hydrodynamic and water quality monitoring
2. Intense 30-day periods of hydrodynamic and water quality monitoring
3. Bathymetric monitoring
4. Recalibration of the hydrodynamic and water quality models, if necessary
5. Monitoring wetland vegetation
6. Monitoring salinity levels in the marshes
7. Monitoring shortnose sturgeon and Atlantic sturgeon distribution
8. Monitoring fish passage at New Savannah Bluff Lock and Dam
9. Monitoring chloride levels at the City of Savannah’s water intakes on Abercorn Creek
10. Long Term monitoring of hydrodynamic and water quality parameters at select locations

The adaptive management approach would assess the monitoring results and make modifications, if necessary. Multi-agency approval of the adaptive management decisions would be needed before actions would be initiated.

The monitoring plan would be used to evaluate the accuracy of the predicted environmental impacts with the correlative goal of improving the predictive capability of the models used to identify and quantify project-induced impacts. The second component consists of assessing the effectiveness of the mitigation features with the goal of determining the efficacy of the constructed mitigation feature at reducing impacts. Physical parameters would be monitored within the estuary that describe how the system is functioning with the mitigation in place. Biota would also be monitored to determine the system's biological responses to those parameters. After post-construction monitoring data is available, the updated models would be re-run using the observed river flow conditions. This would provide the basis for the model's predictions for conditions under the observed conditions. Those predictions would be compared to the observed physical parameters to determine the accuracy of the models and the effectiveness of the mitigation features. The third component concerns modification of the project to ensure the levels of environmental effects predicted in the EIS are not exceeded. The goal is to implement whatever modification is needed to the mitigation plan to keep the levels of observed environmental effects within the values predicted in the EIS. Monitoring would continue beyond the length of the full post-construction monitoring program to evaluate the effectiveness of the mitigation feature that was changed. The additional monitoring would ensure that the modification was effective and that the observed environmental effects are then within the values predicted in the EIS. The COE has stated they will coordinate with the resource agencies in further development of the comprehensive and detailed monitoring and adaptive management plan.

2.1.5 Proposed Fish Passage at the New Savannah Bluff Lock and Dam

When the COE's fish habitat models indicated that all of the deepening scenarios would involve the loss of sturgeon habitat and that the loss of sturgeon habitat within the lower Savannah River cannot be replaced, the COE suggested an action that would increase the extent of sturgeon habitat in the Savannah River at the upper range of habitat used by sturgeon. They referred to a previous study, which proposed adding a fish bypass at the lowest dam on the river, the New Savannah Bluff Lock and Dam near Augusta, Georgia.[1] The construction of a fish passageway would open up an additional 20 miles of habitat upstream of the dam to provide access to historical spawning habitat. Fish passage would also benefit American shad and other anadromous fish species, thereby helping those populations. The first design proposed by the COE was a horseshoe-shaped rock ramp. In October 2010, the COE, at NMFS' request, asked for comments on the design and its potential for successful passage of sturgeon. NMFS responded that dam removal was the preferred choice because there would be no risk of it failing to pass sturgeon, and that the proposed fish bypass design was probably not likely to successfully pass sturgeon. The remarks were based on new knowledge of fish passage design and the behavior of sturgeon in regards to fish bypasses. Other resource agencies also voiced their concern with the proposed design. To address these concerns, the COE hosted a fish passage workshop, held April 25-27, 2011, which brought in sturgeon experts to discuss fish

[1] After the fish passage design was developed in 2002, no funds were available for its construction or for the required rehabilitation of the lock and dam. This study followed a previous study in 2000 (Section 216 Disposition Study) where the COE had proposed to recommend to Congress that the New Savannah Bluff Lock and Dam Project be deauthorized and completely removed.

passage design criteria. During the workshop, a matrix was developed that explored design alternatives and provided performance criteria for each alternative. The results indicated that dam removal would be the best option as it had the highest expected passage effectiveness associated with it, but it would also result in loss of the pool, which had been identified as a concern by local governments upstream. The second best alternative proposed would be a full rock ramp built across the existing sill of the dam. The lock would remain operational and the pool would be maintained. The in-channel, full-river rock ramp would be the most natural pathway, as it would not involve a diversion to a side channel. Using the theory that percent of flow through a fish passage facility is roughly equal to the percentage of fish that would pass through, they felt this option would be 90 percent effective in upstream passage and 100 percent in downstream passage efficiency. A separate floodway would be constructed to assist in flood control. The third choice consisted of a hybrid design that would include partial removal of two of the dam's gates and construction of a rock ramp on the upland side of the dam.

Five other alternatives were also discussed that included different levels of effectiveness and offered design challenges that would need to be overcome to obtain successful upstream and downstream passage. Since most fish passage engineers who were invited were unavailable to attend the workshop, the COE proposed to consult their engineers who worked on the fish passage design for the Cape Fear River Lock and Dam (not yet constructed) to review new design criteria for fish passage at the New Savannah Bluff Lock and Dam. The workshop participants determined that the performance criteria for any passage design should be safe and effective passage with negligible chances for harm to fish as a result of interactions with the passage facility or dam.

Based on the input provided by the resource agencies and sturgeon experts, the COE conducted a reassessment of their proposed fish passage design from the November 2010 DEIS. The COE provided NMFS an "Information Paper" on May 11, 2011, discussing their assessment of alternative designs and informed NMFS they intend to include an off-channel rock ramp in the Final EIS. Although not specifically considered at the interagency workshop, the COE considers the off-channel rock ramp to be a variation of the full rock ramp and hybrid rock ramp designs since they would all transport roughly the same volume of water. They differ by their location across the channel's cross-section. The COE's information paper considered the off-channel rock ramp, the full river rock ramp, and the hybrid rock ramp. The COE selected the off-channel rock ramp because it has significantly lower estimated cost to construct and the predicted passage efficiency would be almost as high as with the more expensive designs.

The Off-Channel Rock Ramp (Figure 7) would consist of a rock ramp constructed around the South Carolina side of the dam. This design takes into account the aspects of the workshop's preferred designs and performance criteria discussed at the workshop and in subsequent responses by COE to resource agency questions on the May 11, 2011, Information Paper.

OFF-CHANNEL ROCK RAMP

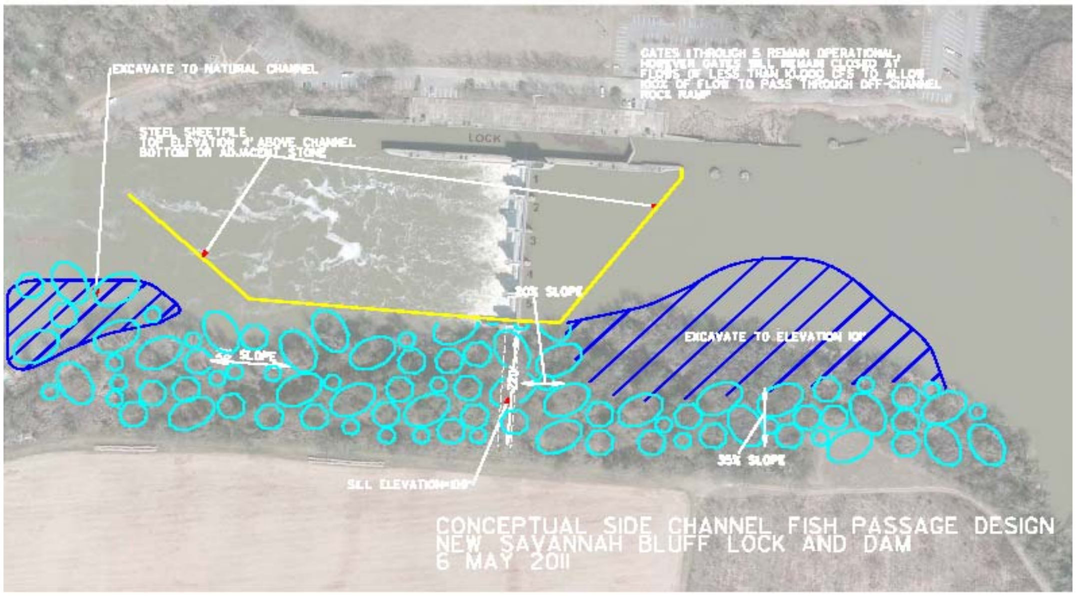

Figure 7. COE-proposed Off-channel Fish By-pass Design at New Savannah Bluff Lock and Dam

The design features consist of:

1. A rock ramp to be constructed in South Carolina within excavated uplands along one side of the dam
2. All five gates of the dam would remain operational
3. Gates 1 and 5 would be structurally modified so they function as lift gates rather than overflow gates
4. Allowance of 100 percent of the flow to pass through the fishway up to 8,000 cfs
5. Ramp would be sloped up to a minimum crest elevation of EL 109 feet at a 2 percent slope (1:50) on the downstream side and a 20 percent slope (1:5) on the upstream side
6. Top crest would be 25 feet wide
7. Ramp would provide water depths of at least 3.5 feet.

This design would allow 100 percent of the river flow to pass through the ramp at flows up to 8,000 cfs. When the upper pool exceeds EL 115 feet, anticipated when river flows exceed 8,000 cfs, the gates would be opened to pass the high flows. Gates 1 and 5 would be modified to operate in the same way as gates 2, 3, and 4. A gate opening schedule would be developed to minimize water velocity through the gates. When the flows are less than 8,000 cfs, the gates would be closed. The water elevation and flow characteristics through the rock ramp under a range of river flows are shown in the following table (Table 2):

Off-Channel Rock Ramp

Flow (cfs)	Upper Pool Elevation (feet)	Depth of Flow Over Rock Ramp (feet)	Percent of Flow	Velocity at Crest (fps)
3,100	112.57	3.57	100%	7.53
3,600	112.87	3.87	100%	7.92
4,300	113.27	4.27	100%	8.39
5,000	113.63	4.63	100%	8.82
6,000	114.13	5.13	100%	9.37
8,000	115.04	6.04	100%	10.29
10,000	115*	6*	80%*	10.29*
12,000	115*	6*	67%*	10.29*
15,000	115*	6*	53%*	10.29*
20,000	115*	6*	40%*	10.29*
25,000	115*	6*	32%*	10.29*
30,000	115*	6*	27%*	10.29*

*estimated values

Table 2. Off-Channel Rock Ramp water elevation and flow characteristics

Based on recent average flow rates at the New Savannah Bluff Lock and Dam, the design would accommodate 100 percent of the river flow (i.e., daily river flows would be less than 8,000 cfs) for up to 64 percent of the days of February through June. The period from February to June is critical to sturgeon as this is when the adults are migrating upriver to spawn, and then return downstream following spawning, and the larval sturgeon will be beginning their migration to the lower reaches of the river. The percent of flow through the passage is considered an important determinant in the effectiveness for fish passage. For upstream passage, the proportion of flow coming out of the passage is an attractant for fish to enter the fish passage. Similarly for downstream passage, the proportion of flow can help determine how fish are led by water velocity or passively carried to the upstream fish passage entrance. As it is currently configured, sturgeon are unable to migrate upriver through the lock and dam. It is thought that high submerged sills at the base of the lock and dam prevent bottom-oriented sturgeon from following the attractant flow to reach habitat above the dam. The off-channel rock ramp would be constructed to provide a suitable bottom topography, slope, and substrate, which would simulate the natural river bottom and attractant flow. To maximize the attractant flow it would have a high percentage of days when all or most of the flow would pass through the rock ramp. Figure 8 shows the by-month proportion of days with flows less than given values. In March, the month with the highest flows, there have been, on average, 14 days when 100% of the river flow would flow through the off-channel rock ramp. There have been 7 days when river flow has been between 8,000 cfs and 15,000 cfs and the proportion of flow through the channel would be between 53 and 100%. During only

10 days in March, less than 53% of the river flow would pass through the passage. In the late spring months of May and June, when downstream passage is more critical, the 100 percent flow capacity of the off-channel rock ramp increases to 78 percent of the time.

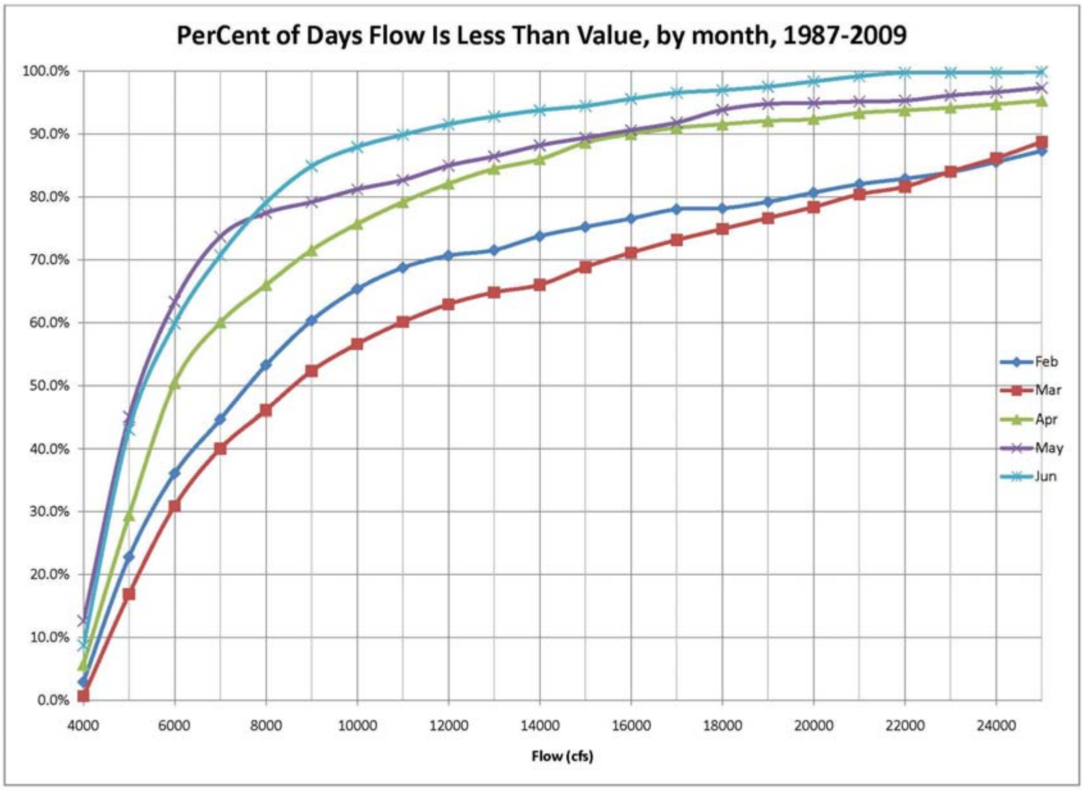

Figure 8. Percentage of monthly flow at New Savannah Bluff Lock and Dam that meets target value from 1987-2009

A submerged sheet pile wall would be placed at a height of 3 to 4 feet above the river bottom or above the rock ramp. This wall would guide the bottom-oriented sturgeon out of the deep river channel and through the ramp in both upstream and downstream directions. Use of the submerged sheet pile guide walls across most of the channel width will increase the passage performance during days when some flow will pass through the spillway gates. Even if flow through the gates attracts upstream migrating fish toward the base of the dam, the guide wall is intended to lead fish to the fish passage entrance. Similarly, downstream migrating fish will be led toward the upstream entrance to the passage, when some water is spilled through the gates. With this guide wall feature, additional sturgeon should use the rock ramp to move past the lock and dam, and the performance of the ramp would be expected to be higher than just the percent of river flow moving through it. A small amount of dredging would be performed to shape the channel bottom so that the thalweg[2] flows to the rock ramp. This thalweg feature would also increase the design's expected upstream and downstream passage performance for sturgeon.

The rock ramp would use a 2 percent upstream slope, well within the 4 percent slope design criteria provided by the agencies during the interagency fish passage workshop. The maximum velocities expected on the ramp would vary depending on river flows. They would range from around 7 feet/second at flows of 3,100 cfs to around 10 feet/second at 10,000 cfs. The velocity down the main slope of the off-channel rock ramp would be 1-3 feet/second slower than that predicted for the full-river rock ramp, due to the longer length of the off-channel rock ramp. Incorporating numerous rock boulders to form pools up the rock slope would reduce the typical velocity the sturgeon would have to navigate. With incorporation of the rock boulders to provide areas of low velocity, this design should readily pass sturgeon. The design also includes a small ramp on the upstream end of the passage. Its 1:5 slope is flatter than one recently designed for the Cape Fear River Lock and Dam to pass sturgeon, so it is believed that it should acceptably pass sturgeon downstream at the New Savannah Bluff Lock and Dam. Since construction at the Cape Fear River fish passage has not been completed yet, we cannot assess its effectiveness. Downstream migrating sturgeon do not need to swim against the current, so the slope does not affect the water velocities they would need to contend with, and it is just needed to provide the bottom-oriented fish with a smooth transition into the passage, rather than an abrupt sill.

This design would require the least modification to the existing dam of the three alternatives that the COE considered. None of the gates would need to be removed from the dam; however, the two end gates would need to be modified from a 12-foot height to 15-feet. The present ability of the lock and dam project to reduce flood levels in upstream areas would be retained. The dam itself would not require modification. The lock and its operation would be unaffected. Upstream infrastructure in Augusta and North Augusta should not be impacted since the pool would not need to be lowered, even during construction. The off-channel rock ramp would reduce the work that would need to be performed if funds become available to rehabilitate the lock and dam. However, the funds for rehabilitation of the lock and dam would not be provided by the SHEP. Construction of the rock ramp as a part of SHEP would address Congress' prior requirement for a fish passage design developed in 2002 to be constructed at the New Savannah Bluff Lock and Dam, since it would provide the same function. It would also reduce the cost of the rehabilitation project. The dam would still need to be rehabilitated, to stabilize its structure and ensure its function continues to be provided in the future. The lock and its control house would still require the same amount of rehabilitation.

Lands presently associated with the lock and dam would be needed to construct and operate the rock ramp around the SC end of the dam. Those lands are presently wooded and not used to operate the existing project. They provide structural stability to the dam and serve a limited security function. Those purposes would not be affected by construction and operation of the off-channel rock ramp. Additional lands would also

[2] A thalweg is defined as a line drawn to join the lowest points along the entire length of a streambed.

need to be acquired to construct the rock ramp and for an access road to the site. Those lands would be acquired as part of the SHEP and not as part of the rehabilitation of the lock and dam. NMFS has included a Reasonable and Prudent Measure with an implementing term and condition as part of the incidental take statement of this opinion requiring that the initiation of COE land acquisition needed for construction of the off-channel rock ramp be completed prior to, or concurrent with, the start of SHEP dredging actions.

The off-channel rock ramp considered in this opinion is a preliminary design and does not include specific design details. The design was intended to meet the criteria set forth by the workshop of safe and effective up-stream and downstream passage with negligible chances for harm to fish as a result of interactions with the passage facility or dam. NMFS sent the COE follow-up questions on details of the off-channel rock ramp and the COEs May 11, 2011 Information Paper. The COE responded on May 27 with considerable additional technical detail but also noted that detailed design work still needs to be done before some specific questions (e.g., 3-d water velocities) can be answered. Some of those answers may affect technical details of the final design (e.g., dimensions of the guide walls, passageway cross-sections). Dr. Luther Aadland, a technical expert on fish passage design for passing sturgeon, was contracted by NMFS to review the COE's design for the off-channel rock ramp. Based on his experience with designing fish passages and successful passage of sturgeon, Dr. Aadland concluded that design modifications to the proposed fish passage would be needed. NMFS has requested that the COE review Dr. Aadland's comments and incorporate the necessary modifications as provided by Dr. Aadland. The COE has stated that they will work with NMFS and other resource agencies (i.e., FWS, SCDNR, and GADNR) to complete the final design of this facility. They have also indicated that they intend to consult with Dr. Aadland and to work with an engineering firm to prepare the final design. The COE will provide a comparison analysis of existing fish passages with similar characteristics to the New Savannah Bluff Lock and Dam fish passage conditions in order to study the effectiveness of the rock ramp design for sturgeon.

The incidental take statement includes terms and conditions that require NMFS' review and validation of the final design and requires timeframes for design completion and construction. The proposed action for this project and incidental take statement of this opinion also include monitoring and adaptive management to help insure the success of all mitigative measures including the fish passage facility.

2.1.6 Sea Turtle Conservation Measures

The COE SAD has a well-established suite of sea turtle conservation measures that are implemented to minimize the incidental take of sea turtles during hopper dredging, under the SARBO. The dredging for SHEP will not be conducted under the SARBO, but rather will be authorized by and subject to the requirements of this biological opinion.

Draghead Deflector

The COE requires the use of sea turtle deflecting dragheads on all hopper-dredging projects where the potential for sea turtle interactions exist. Contractors are required to equip dragheads with rigid sea turtle deflectors which are rigidly attached to the draghead. In order to assure that the turtle deflecting draghead is engineered and installed correctly, the Contractor provides the COE with drawings and calculations for the project depth to be dredged. These submittals are approved by the COE prior to project commencement. The leading edge of the deflector must be designed to have a plowing effect of at least 6-inch depth when the draghead is being operated so that turtles located in front of the draghead are pushed away by the resultant sand wave. The dragtender must have the appropriate instrumentation on board the dredge to assure that the critical "approach angle" is maintained during dredging operations. The design "approach angle" or the angle of lower draghead pipe relative to the average sediment plane is very important to the proper operation of a deflector. Hopper dredge contract specifications require that dredge pumps not be operated when the dragheads are not firmly on the bottom. The pumps must either be shut off or reduced in speed to the point where no suction velocity or vacuum exists while the dredge is turning. Pumping water through the dragheads is not allowed while maneuvering or during travel to/from the disposal area. To assure that these conditions are understood and implemented by the Contractor, the COE requires that the Contractor develop a written operational plan to minimize turtle takes and submit it as part of the Environmental Protection Plan for approval prior to project commencement. In order to assure contractor compliance with all sea turtle protection measures during hopper dredge operations, detailed quality assurance inspections are performed by COE personnel on each hopper dredge contract, as well as after each sea turtle take. Sea turtle deflecting dragheads will be required for this project.

Environmental Windows

To minimize risk of sea turtle incidental takes by dredges, environmental windows were established by NMFS, and further refined by the COE, which restrict dredging to periods when turtles are least abundant or least likely to be affected by dredging. The environmental windows for turtle-safe dredging target the winter months when sea turtle abundance is dramatically reduced. Turtle abundance is greatly reduced at water temperatures below 13°C, and they are typically absent during temperatures below 11°C. The environmental window for the hopper dredging activities within the project area is from December 1 through March 31 of any year.

Inflow/Overflow Screening

In accordance with the Reasonable and Prudent Measures (RPMs) outlined in previous (1995 and 1997) NMFS SARBO's, all SAD hopper dredging contracts require 100 percent inflow screening throughout the duration of each contract. One hundred percent inflow screening is required, and 100 percent overflow screening is recommended, when sea turtle observers are required on hopper dredges in areas and seasons when sea turtles may be present. If conditions disallow 100 percent inflow screening, inflow screening can be reduced, but 100 percent overflow screening is required, and an explanation must be included in the preliminary dredging report.

The water intake ports on the top of the draghead shall be screened with metal elliptical cages, or other suitable means to exclude sea turtles from entering the drag arm. The configuration of inflow and overflow screening is hopper dredge specific, resulting in multiple Contractor configurations to meet COE contract screening requirements. COE hopper dredging contracts require a 4-inch x 4-inch screen mesh size for inflow screening to allow biotic and abiotic debris to be screened and evaluated by endangered species observers before being allowed into the hopper. The same screen mesh size is used for overflow screening. The efficacy of this inflow and overflow screening mechanism depends on the dredge specific configuration. Some configurations are more prone to clogging with debris, thus resulting in reduced monitoring efficiency and coverage. In some cases, clay and debris accumulation in the inflow boxes is so significant that effective observer coverage is not possible and the COE must reduce or replace the inflow screening with 100 percent overflow screening. Depending on the type of debris encountered, overflow screening may become clogged with floating debris and compromise the safety of the vessel. The COE has consulted with the NMFS on a case-by-case basis to address these site specific circumstances. Ample lighting on a hopper dredge is specifically required for the observers on board to provide safe access at night to the inflow boxes and screens.

Observers
During hopper dredging operations, observers approved by NMFS for sea turtles, sturgeon, and whales are required to be aboard the hopper dredge to monitor for the presence of the species. The COE will require 100 percent observer coverage (i.e., 24 hour monitoring requiring two observers each monitoring for 12 hours daily) conducted from December 1 to March 31, the dredging window for hopper dredge operations. During transit to and from offshore borrow or placement areas, the observer monitors from the bridge during daylight hours for the presence of protected species, during the period December 1 through March 31. During dredging operations, while dragheads are submerged, the observer continuously monitors the inflow and/or overflow screening for turtles and/or turtle parts. Upon completion of each load cycle, dragheads are monitored as the draghead is lifted from the sea surface and is placed on the saddle in order to assure that sea turtles or turtle body parts that may be impinged within the dragheads are properly documented. Physical inspections of dragheads and inflow and overflow screening/boxes for threatened and endangered species take are performed to the maximum extent practicable. A trained turtle observer will be placed on the hopper dredges to monitor for sea turtles for 100 percent of the period from December 1 to March 31.

Dredging Quality Management Program (Silent Inspector)
The Dredging Quality Management Program is an automated dredge monitoring system comprised of both hardware and software developed by the COE. The COE developed the program as a low cost, repeatable, impartial system for automated dredge monitoring. Currently, it is required for all COE hopper and scow contracts; however, it is not on all Government-owned dredges yet. NMFS will require the COE to use hopper dredges equipped with the appropriate automated dredge monitoring system for this project. The

system integrates various automated systems to digitally record dredging and disposal activities for both government-owned and contract dredges. The system collects and records measurements from shipboard sensors, calculate the dredging activities, and displays this information using standard reports and graphical displays.

On hopper dredges, the program monitors the operating conditions of the dredge in near real time. Once loaded into the program database, graphical displays can be generated to help assure contractor compliance with the draghead operating requirements in order to minimize sea turtle take risk. Visual graphs can be used to display dredging data variables such as draghead elevation, slurry density, and slurry velocity. If a sea turtle take occurs, these data can be used to generate graphs that may help in developing risk assessments to assess what the conditions of the dragheads were during any given load cycle. If a sea turtle take can be correlated to non-compliance with contract specification requirements through the program, it is possible to let the Contractor know of the action so it can be corrected and the risk of taking another turtle minimized.

Dredging shall be suspended upon the taking of more than two turtles in any 24-hour day, the taking of one hawksbill turtle, or one leatherback turtle, or one green turtle, or once three turtles are taken. Dredging operations will not re-commence until coordination between South Atlantic Division and the NMFS has taken place and any remediation requirements are implemented to ensure compliance with the Endangered Species Act.

Relocation Trawling
Relocation trawling for the project is subject to requirements, terms, and conditions for trawl times, handling during trawling, captured sea turtle holding, scientific measurement, take and release time during trawling, injury, flipper tagging, PIT-Tag scanning, and other sampling procedure conditions. There are also PIT-Tag scanning and data submission requirements and handling fibropapillomatose turtle guidelines that must be followed (See Section 9.4). Relocation trawling involves directed take of sea turtles (capture and handling). However, since it also meets the definition of a reasonable and prudent measure (by capturing and relocating turtles that would otherwise be killed in dredges), it will be authorized through this opinion. Further, since it involves take and some of the take may be lethal, the effects of this RPM are evaluated as effects of the proposed action, and in the jeopardy analysis.

2.1.7 Whale Conservation Measures

The COE will require monitoring by endangered species observers with at-sea large whale identification experience to conduct daytime observations for whales between November 1 and April 30. In addition, the COE will restrict the speeds of vessels during offshore transits to reduce the risk of injury and mortality to North Atlantic Right Whales.

To ensure that dredging operations do not adversely affect the North Atlantic right whale and other marine mammals, the COE has a specific set of specifications for the Savannah District that deal with large whale protection measures. These specifications apply to

Savannah Harbor and require a NMFS-approved endangered species observer approved for whale monitoring be onboard each hopper dredge during the time that right whales may be in the area. Savannah District's specification language is included below:

No incidental take of right whales is authorized. Vessel speeds of no more than 10 knots as set forth in the proposed action shall be used. However, the Contractor shall restrict dredge and attendant vessel speeds to 5 knots or less (or minimum safe speed) during night (sunset to sunrise) operations unless there is no information from the right whale early warning system (RWEWS) or any other observations/information that reveals any right whales within 15 nautical miles of the project area. (NMFS' notes that RWEWS flights are not conducted on a regular basis off of Savannah.) If aerial surveys for right whales show no sightings on a particular day, the vessel speeds of no more than 10 knots as set forth in the proposed action shall be used during the following nighttime operations. If a right whale is determined through any means to be in the project area on a particular day, negative results from any other type of survey on that same day shall not serve to cancel that night's restriction of dredge and attendant vessel speeds. For Savannah Harbor, the project area is defined as the Savannah Harbor Entrance Channel (Stations 0+000 to -60+000B), the designated offshore disposal areas shown on the Contract drawings, and transit routes. If right whale occurrence/distribution information is not available from the RWEWS due to severe weather restrictions, then vessel speeds will be restricted to 5 knots (or minimum safe speed) during night operations. It is currently expected that the RWEWS will be in effect from December through March for Savannah. No aerial survey is required when the RWEWS is not in effect. Nighttime speeds will still be restricted to 5 knots or less (or minimum safe speed) when the RWEWS is not in effect if other information indicates right whales are in the project area. The requirement for nighttime speed restrictions are available from the COR (OP-NN) or the RWEWS on a daily basis. Previous right whale monitoring along the Georgia coast indicates that for Savannah Harbor the Contractor might expect up to 8 nights of reduced speed operations between 1 December and 31 March. For Brunswick Harbor, the Contractor might expect up to 13 nights of reduced speed operations between 1 December and 31 March. Contractor should also expect at least 22 days of additional reduced speed operations between the period of 1 December and 31 March due to weather restricting RWES aerial surveys. During daylight hours, the dredge operator shall take necessary precautions to avoid whales. If whales have been spotted within 15 nautical miles of the project area in the previous 24 hours, then the dredge shall slow down to 5 knots or less (or minimum safe speed) when transiting to and from the dump site during evening hours or during daylight hours when there is limited visibility due to fog or sea states of greater than Beaufort 3. The hopper dredge shall not get closer than 500 yards to right whales. The speed limits for hopper dredges would only apply until a new Regional Biological Opinion for hopper dredging is signed, at which time the project would abide by the conditions in that new opinion.

The COE has established precautionary collision avoidance measures to be implemented during dredging and sediment placement operations that take place during the time North Atlantic right whales are present in waters offshore of the Savannah Harbor project. These include:

Pre-project briefing
Before the initiation of the project, at the pre-construction/partnering meeting, the COE briefs the Contractor on the presence of the species, and reviews the requirements for right whale protection.

Contractor requirements
Each Contractor will be required to instruct all personnel associated with the dredging/construction project about the possible presence of endangered North Atlantic right whales in the area and the need to avoid collisions. Each Contractor will also be required to brief his personnel concerning the civil and criminal penalties for harming, harassing, or killing species that are protected under the ESA and the MMPA. Dredges and all other disposal and attendant vessels are required to stop, alter course, or otherwise maneuver to avoid approaching the known location of a North Atlantic right whale. The contractor will be required to submit an endangered species watch plan that is adequate to protect North Atlantic right whales from the impacts of the proposed work.

Vessel speed
During transport of dredged material through offshore waters to the disposal site and when returning to the dredge site, dredge vessels and all support vessels will use extreme caution and proceed at a safe speed, no greater than 10 knots, from November 1 through April 30 such that the vessel can take proper and effective action to avoid a collision with a North Atlantic Right Whale or other marine mammal, and can be stopped within a distance appropriate to the prevailing circumstances and conditions. During daylight hours, the dredge operator must take necessary precautions to avoid whales. During evening hours or when there is limited visibility due to fog or sea states of greater than Beaufort 3, the dredge must slow down to no greater than 5 knots when transiting between areas if whales have been spotted by observers or RWEWS within 15 nm (nautical miles) of the vessel's path within the previous 24 hours. Slower vessel speeds can reduce the potential for a vessel strike with a listed species by providing more time for animals to react to a vessel and move out of the way. Slower vessel speeds also reduce the likelihood of a strike resulting in serious injury or mortality.

Observers
Monitoring is required by NMFS-approved endangered species observers with at-sea large whale identification experience to conduct daytime observations for whales between November 1 and April 30. Observers would monitor for the presence of marine mammals from the bridge during daylight hours while transiting to and from the disposal area. Floating weeds, algal mats, Sargassum rafts, clusters of seabirds, and jellyfish are good indicators of the potential presence of sea turtles and marine mammals. Therefore, increased vigilance in watching for sea turtles and marine mammals will be taken where these are present. During daylight hours, the dredge operator must take necessary precautions to avoid whales.

The COE will notify the program manager for the whale aerial survey of dredging activities that are likely to take place during calving season, and likely beginning, ending, and duration of the dredging activities.

2.2 Action Area

50 CFR 404.02 defines action area as "all areas to be affected directly or indirectly by the federal action and not merely the immediate area involved in the action." Savannah Harbor is an approximately 32.5-mile federal navigation project located along the Savannah River in southeast Georgia. The Savannah River basin includes portions of North Carolina, South Carolina, and Georgia and flows through the Blue Ridge Mountain, Piedmont, and Coastal Plain provinces. The river constitutes the state boundary between Georgia and South Carolina along its entire length of 313 miles. Freshwater flow is largely controlled by three COE-operated reservoirs (Hartwell, Richard B. Russell, and Clarks Hill – known as J. Strom Thurmond Dam in South Carolina) and the New Savannah Bluff Lock and Dam just south of Augusta, Georgia (Figure 9). Other dams are the Steven's Creek Dam located north of Augusta and the Augusta Diversion Dam. The Augusta Canal is created by the Augusta Diversion Dam and is the nation's only industrial power canal still in use for its original purpose. The Augusta Shoals are located below the Augusta Diversion Dam. The Savannah River begins at the Hartwell Reservoir by the confluence of the Seneca and Tugaloo Rivers. It passes through the port city of Savannah and flows to the Atlantic Ocean. Tidal fluctuations average 6.8 feet at the mouth of the harbor and 7.9 feet at the upper limit of the harbor. Salinity ranges from 0 ppt in the freshwater flow to 35 ppt in the ocean bar channel. Most of the shipping channel is 500 feet wide, with the wider portions of the river ranging from 2,400 feet near the river entrance to 1,000 feet at the Kings Island Turning Basin.

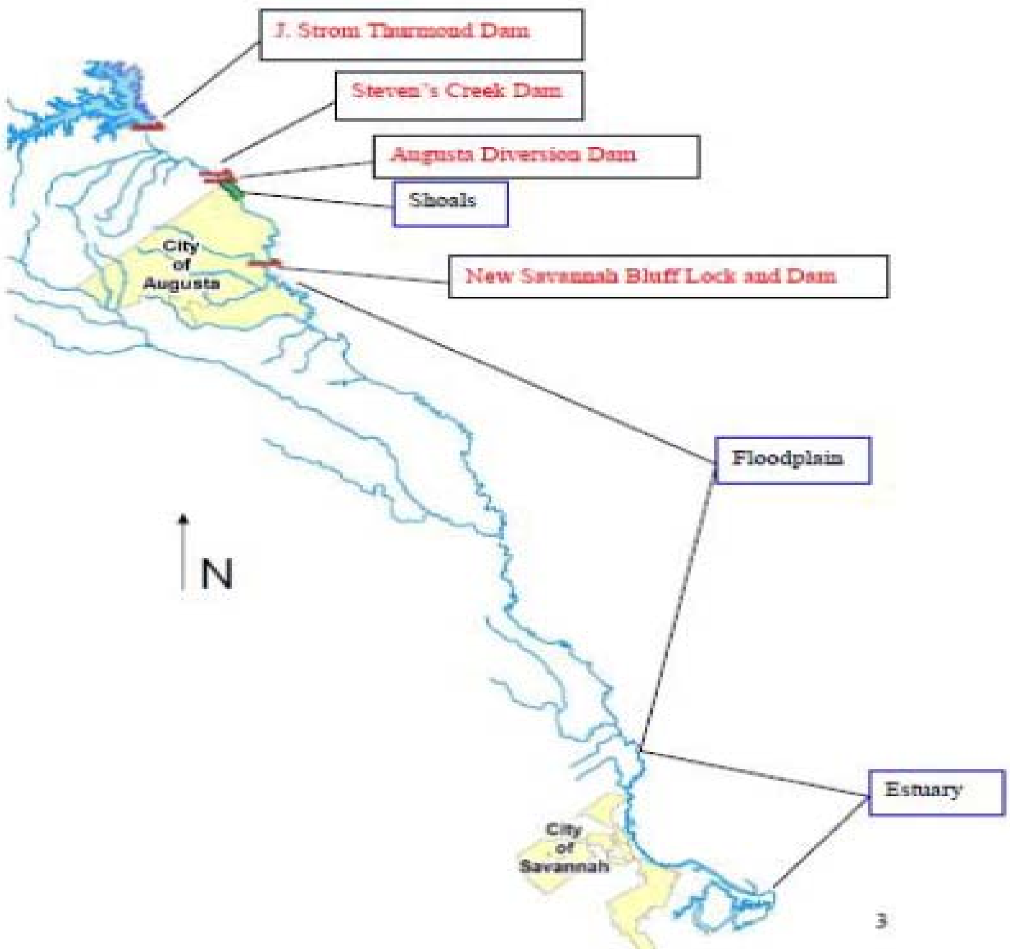

Figure 9. Dams on the Savannah River

The deepening site itself is located within Chatham County, Georgia, and Jasper County, South Carolina. Urban and industrial development extends northwestward along the Georgia side of the river. Lands on the opposite side of the Savannah River in Jasper County, South Carolina are characterized by a system of dikes, canals, and former rice fields constructed in the 18th and 19th centuries. It is dominated by tidal freshwater, brackish, and salt marsh that comprise the Savannah National Wildlife Refuge. A system of eight confined disposal facilities (CDFs), maintained by the COE and provided by the Georgia Department of Transportation (non-federal sponsor), are found along the river bank within South Carolina. Dredged material not suitable for disposal offshore would be placed in the upland CDFs. In the lower Savannah, the river branches into three sections referred to as the Front River, Middle River, and Back River. The Federal Navigational Channel is located within the Front River (Figure 10). A sediment basin is located in the lower portion of the Back River. Small canals (Rifle Cut, McCoy Cut) connect the Front, Middle, and Back Rivers. The mainland areas are separated from the ocean by a line of barrier islands and intervening salt marshes and tidal rivers. The mouth of the Savannah River is located just north of Tybee Island. The action area for the proposed project includes the entrance channel for Savannah and the river channel from Station -60+000B, the oceanward extent of the Entrance Channel (or Ocean Bar Channel), to the Garden City Terminal at Station 103+000. Additionally, the action area includes several disposal sites including an authorized ocean dredged materials disposal site (ODMDS), and submerged berms located near Tybee Island. The action area includes the New Savannah Bluff Lock and Dam, the river downstream to Savannah, and also the upland area adjacent to the New Savannah Bluff Lock and Dam, within South Carolina, where a fish passage bypass would be constructed as a part of the proposed action.

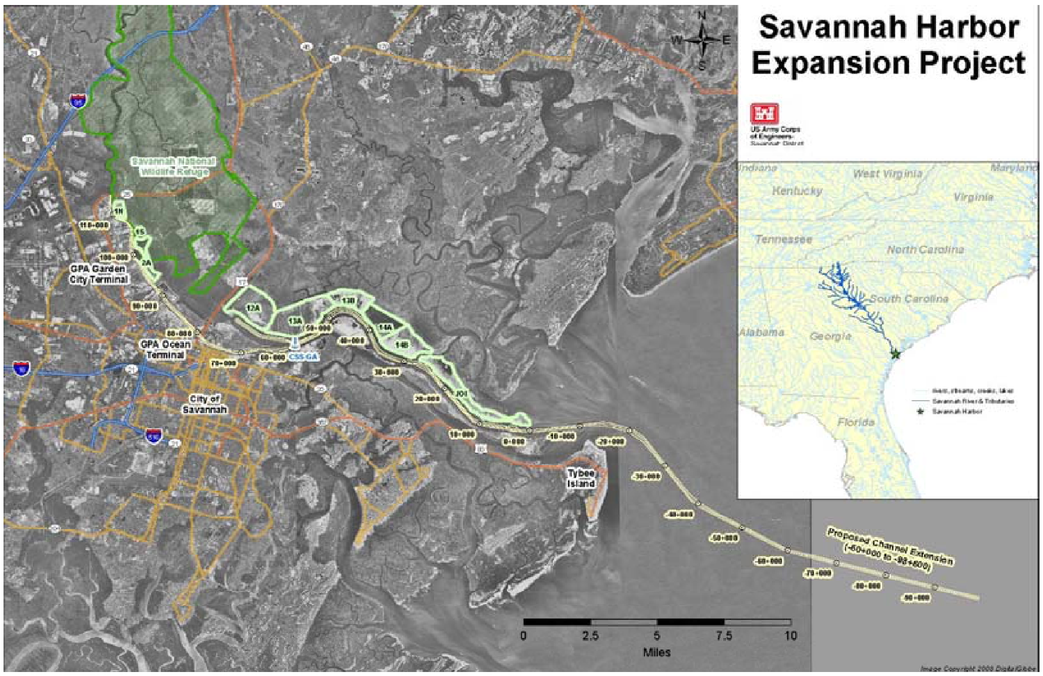

Figure 10. Deepening and Harbor Modification Action Area

3 SPECIES AND CRITICAL HABITAT OCCURRING IN THE ACTION AREA

3.1 SPECIES

The following table lists the endangered (E) and threatened (T) species and DPSs (proposed) under the jurisdiction of NMFS that may occur in the action area:

Common Name	Scientific Name	Status
Sea Turtles		
Hawksbill sea turtle	*Eretmochelys imbricata*	E
Loggerhead sea turtle (Northwest Atlantic Ocean DPS)	*Caretta caretta*	T
Green sea turtle	*Chelonia mydas*	E/T[3]

[3] Green turtles are listed as threatened except for the Florida and Pacific coast of Mexico breeding populations, which are listed as endangered.

Kemp's ridley sea turtle	*Lepidochelys kempii*	E
Leatherback sea turtle	*Dermochelys coriacea*	E
Fish		
Shortnose sturgeon	*Acipenser brevirostrum*	E
Atlantic sturgeon (South Atlantic DPS)	*Acipenser oxyrinchus oxyrinchus*	E (proposed)
Whales		
North Atlantic right whale	*Eubalaena glacialis*	E
Humpback whale	*Megaptera novaeangliae*	E

NMFS and USFWS issued a final rule designating nine DPS' for loggerhead sea turtles (76 FR 58,868, September 22, 2011; effective October 24, 2011). The Northwest Atlantic DPS (NWA DPS) is the only loggerhead DPS that occurs in the action area. Additionally, On October 16, 2010, NMFS proposed ESA listing for the Atlantic sturgeon (*A. oxyrinchus oxyrinchus*); five DPSs were identified. The Atlantic sturgeon South Atlantic DPS inhabits the Savannah River and is proposed for listing as endangered (75 FR 61904).

3.2 Critical Habitat

There is currently no designated critical habitat in the action area. NMFS is required to designate critical habitat for Atlantic sturgeon at the time of final listing unless not determinable, in which case NMFS must designate critical habitat within one additional year. NMFS intends to propose critical habitat for the loggerhead NWA DPS in future rulemaking as critical habitat was deemed not determinable at the time of the listing.

3.3 Species Not Likely to be Adversely Affected

We have determined that the proposed action being considered in this opinion is not likely to adversely affect leatherback sea turtles, green sea turtles, hawksbill sea turtles, North Atlantic right whales, and humpback whales, and these species are excluded from further analysis and consideration in this opinion. The following discussion summarizes our rationale for this determination.

Leatherback Sea Turtle
Leatherback sea turtles (Figure 11) may be found in the action area, particularly when onshore winds and/or currents push jellyfish, their preferred prey, close to inshore.

Figure 11. Leatherback sea turtle

However, leatherbacks are primarily a pelagic species, preferring deeper waters than those of the action area (the deepest portions of the offshore action area are less than 60-feet-deep). Furthermore, in over 30 years of NMFS consultations with the COE on hopper dredging projects carried out in the Savannah Harbor, there has never been a documented take of a leatherback sea turtle by a hopper dredge. Because of this and their very large size (compared to hopper dredge dragheads), pelagic nature (surface and mid-water), preference for deeper waters located beyond the project area further offshore, and feeding habits (which make it unlikely they would ever encounter a bottom-hugging hopper dredge draghead), NMFS believes the possibility that they would be adversely affected by a hopper dredge is discountable.

Green Sea Turtle

Green sea turtles (Figure 12) are distributed circumglobally and can be found in the Pacific, Indian, and Atlantic Oceans as well as the Mediterranean Sea (NMFS and USFWS 1991, NMFS and USFWS 2007a). Green sea turtles are primarily herbivorous, feeding on algae and sea grasses, but also occasionally consume jellyfish and sponges. The post-hatchling, pelagic-stage individuals are assumed to be omnivorous, but little data are available.

Figure 12. Green sea turtle

Green sea turtle foraging areas in the southeastern United States include any coastal shallow waters having macroalgae or seagrasses. This includes areas near mainland coastlines, islands, reefs, or shelves, as well as open-ocean surface waters, especially where advection from wind and currents concentrates pelagic organisms (Hirth 1997, NMFS and USFWS 1991). Principal benthic foraging areas in the southeastern United States include Aransas Bay, Matagorda Bay, Laguna Madre, and the Gulf inlets of Texas (Doughty 1984, Hildebrand 1982, Shaver 1994), the Gulf of Mexico off Florida from Yankeetown to Tarpon Springs (Caldwell and Carr 1957, Carr 1984), Florida Bay and the Florida Keys (Schroeder and Foley 1995), the Indian River Lagoon system, Florida (Ehrhart 1983), and the Atlantic Ocean off Florida from Brevard through Broward Counties (Wershoven and Wershoven 1992, Guseman and Ehrhart 1992). Adults of both sexes are presumed to migrate between nesting and foraging habitats along corridors adjacent to coastlines and reefs.

Some of the principal feeding pastures in the western Atlantic Ocean include the upper west coast of Florida and the northwestern coast of the Yucatán Peninsula. Additional important foraging areas in the western Atlantic include the Mosquito Lagoon and Indian

River Lagoon systems and nearshore wormrock reefs between Sebastian and Ft. Pierce Inlets in Florida, Florida Bay, the Culebra archipelago and other Puerto Rico coastal waters, the south coast of Cuba, the Caribbean coast of Panama, the Miskito Coast in Nicaragua, and scattered areas along Colombia and Brazil (Hirth 1997). The summer developmental habitat for green turtles also encompasses estuarine and coastal waters from North Carolina to as far north as Long Island Sound (Musick and Limpus 1997).

The vast majority of green sea turtle nesting within the southeastern United States occurs in Florida (Meylan et al. 1995, Johnson and Ehrhart 1994). Green sea turtle nesting in Florida has been increasing since 1989 (Florida Fish and Wildlife Conservation Commission, Florida Marine Research Institute Index Nesting Beach Survey Database). Certain Florida nesting beaches have been designated index beaches. Index beaches were established to standardize data collection methods and effort on key nesting beaches. Since establishment of the index beaches in 1989, the pattern of green turtle nesting shows biennial peaks in abundance with a generally positive trend during the ten years of regular monitoring. This is perhaps due to increased protective legislation throughout the Caribbean (Meylan et al. 1995). Occasional nesting has been documented along the Gulf coast of Florida, at southwest Florida beaches, as well as the beaches on the Florida Panhandle (Meylan et al. 1995). More recently, green turtle nesting occurred on Bald Head Island, North Carolina; just east of the mouth of the Cape Fear River; on Onslow Island; and on Cape Hatteras National Seashore. Increased nesting has also been observed along the Atlantic coast of Florida, on beaches where only loggerhead nesting was observed in the past (Pritchard 1997). Recent modeling by Chaloupka et al. (2007) using data sets of 25 years or more has resulted in an estimate of the Florida nesting stock at the Archie Carr National Wildlife Refuge growing at an annual rate of 13.9 percent, and the Tortuguero, Costa Rica, population growing at 4.9 percent annually.

During the past 30 years of maintenance dredging in the Savannah Harbor Entrance Channel, green sea turtles have not been encountered and no take of green sea turtles has occurred. It is doubtful they would be found in the area due to the lack of preferred habitat (i.e., shallow well-vegetated bottom) and absence of preferred food items (e.g., seagrass, macroalgae). Considering these factors, it is not expected that interactions would occur in the action area; therefore, NMFS believes the possibility that they would be adversely affected is discountable.

Hawksbill Sea Turtle
In the western Atlantic, the largest hawksbill (Figure 13) nesting population occurs on the Yucatán Peninsula of Mexico (Garduño-Andrade et al. 1999). With respect to the United

Figure 13. Hawksbill sea turtle

States, nesting occurs in Puerto Rico, the U.S. Virgin Islands, and along the southeast coast of Florida. Nesting also occurs outside of the United States and its territories, in Antigua, Barbados, Costa Rica, Cuba, and Jamaica (Meylan 1999a). Outside of the nesting areas, hawksbills have been seen off the U.S. Gulf of Mexico states and along the Eastern Seaboard as far north as Massachusetts, although sightings north of Florida are rare (NMFS and USFWS 1993). Hawksbill sea turtles could occasionally be found in the action area. Hawksbills are the most tropical sea turtle species, ranging from approximately 30°N latitude to 30°S latitude. They are closely associated with coral reefs and other hardbottom habitats, but they are also found in other habitats including inlets, bays, and coastal lagoons (NMFS and USFWS 1993). Adult foraging habitat, which may or may not overlap with developmental habitat, is typically coral reefs, although other hardbottom communities and occasionally mangrove-fringed bays may be occupied. Hawksbills show fidelity to their foraging areas over several years (van Dam and Díez 1998). The hawksbill's diet is highly specialized and consists primarily of sponges (Meylan 1999). Other food items, notably corallimorphs and zooanthids, have been documented to be important in some areas of the Caribbean (van Dam and Díez 1997, Mayor et al. 1998, León and Díez 2000). With the frequent trawling of the project area associated with the shrimp fishery, there is no abundance of sponges or other food items available to hawksbill sea turtles.

During the past 30 years of NMFS consultations with the COE on hopper dredging projects carried out in the Savannah Harbor there has never been a documented take of a hawksbill sea turtle by a hopper dredge. Due to hawksbill sea turtles' preferred habitat and diet, it is not expected that interactions would occur in the action area; therefore, NMFS believes the possibility that they would be adversely affected is discountable.

North Atlantic Right Whale

The nearshore waters of northeast Florida and southern Georgia were first identified as a likely calving and nursery area for right whales (Figure 14) in 1984. While sightings off Georgia and Florida include primarily adult females and calves, juveniles and adult males are also commonly observed. Annual right whale migration to and from, and use of, calving grounds off the southeastern U.S. coast, occur from November 1 through April 30. Systematic surveys conducted off the coast of North Carolina during the winters of 2001 and 2002 sighted 8 calves, suggesting that the calving grounds may extend through South Carolina as far north as Cape Fear, North Carolina (Waring et al. 2009).

Figure 14. North Atlantic right whale

Twenty percent of all right whale mortalities observed between 1970 and 1989 were caused by vessel collisions/interactions with right whales. Seven percent of the population exhibit scars indicative of additional, non-lethal vessel interactions (Kraus 1990). So far in 2011, of four deceased right whales encountered, half were associated with rope entanglement, one had multiple skull and vertebral fractures that are consistent with ship strike, and a fourth was found floating offshore with no evidence of entanglement. In January 2011, a live right whale was observed with approximately 14 propeller cuts across its body; it had been observed five days earlier with no injuries. On January 24, 2011, a right whale entered the St. John's River in Florida and proceeded upstream. Its presence for nine hours in the navigational channel resulted in the closure of commercial marine traffic, Navy operations, and COE dredging activities.

The COE has proposed to create a new bar channel extension-alignment would result in a 14 degree offset from the extension's original orientation and/or approach. With respect to the already-established vessel travel corridors in the area, the 14 degree offset for the extension constitutes a negligible correction factor for the Bar Channel, and the new alignment would not introduce any additional variability to the existing approach and departure vectors (i.e., vessel tracks) currently used by ship traffic. The configuration of the new alignment for the entrance channel is roughly oriented perpendicular to the coastline, which is intended to ensure that ships approaching the entrance channel from seaward direction will take the shortest path through coastal waters and lessen the chance of encountering a migrating whale.

NMFS review of the project indicates that the proposed action will not result in increased level of container vessel visits to the area, however due to the nature of the project NMFS is expecting a significant increase in vessel traffic related to dredge activities transiting between the navigational channel and the disposal sites.

As a result of the potential for interactions between hopper dredges and right whales, the 1991 biological opinion for the dredging of channels in the southeastern United States from North Carolina through Cape Canaveral, Florida (NMFS 1991) required observers on board dredges operating from December through March off Georgia and northern Florida to maintain surveys for the occurrence of right whales during transit between channels and disposal areas. Continuation of aerial surveys which had been instituted in Kings Bay, Georgia, was also required. Since January 1994, aerial surveys funded by the COE in association with dredging activities in the Southeast have been amplified through the implementation of the right whale early warning surveys (EWS). These surveys, jointly funded by the COE, NMFS, the Navy, and the Coast Guard, are conducted to identify the occurrence and distribution of right whales in the vicinity of ship channels in the winter breeding area, and to notify nearby vessel operators of whales in their path. However, the aerial surveys conducted off of Savannah are very sporadic, due to a lack of funding to cover the area off Savannah. The regularly-conducted EWS flights off Georgia cover the area from Sapelo Island, which is approximately 35 miles south of Savannah, to Brunswick.

Records of right whale ship strikes (Knowlton and Kraus 2001) and large whale ship strike records (Laist et al. 2001, Jensen and Silber 2003) have been compiled, and all indicate vessel speed is a principal factor in ship strikes. In assessing records in which vessel speed was known, Laist et al. (2001) found "a direct relationship between the occurrence of a whale strike and the speed of the vessel involved in the collision." The authors concluded that most deaths occurred when a vessel was traveling in excess of 14 knots.

NMFS considered whether it is better for a vessel to travel faster through a sensitive area (and thus get through it more quickly), or go slower, increasing the amount of time spent in the sensitive areas (exposure). Vanderlaan and Taggart (2007) attempted to briefly address this question by approximating the probability of a vessel-whale encounter as a function of vessel speed and length of exposure (in time) using a very simplistic random walk model. Their simple model demonstrates that the encounter probability increases slowly with decreasing speed and begins to increase rapidly only at speeds below 3-4 knots (Vanderlaan and Taggart 2007); at these speeds the approximated encounter probability is increasingly more a function of whale movement and decreasingly less a function of vessel movement (i.e. a modeled, randomly-moving whale overtaking or encountering a near-stationary ship). Therefore, a vessel reducing its speed from 24 knots (or any other speed between 24 and 10 knots) to 10 knots would not increase the encounter probability. The encounter probability changes with the number of vessels, and would show different results if this model used multiple whales and various sizes or speeds for the whale and vessel. To ensure that these variables would not increase encounter probability at 10 knots, NMFS independently conducted a sensitivity analysis using a random walk model, and tested the additional variables mentioned above. The outputs of this sensitivity analysis agreed with the findings of the Vanderlaan and Taggart (2007) random walk model. In conclusion, slower vessels do not increase the risk of ship strike simply by transiting through an area for a longer time, unless they were to go 4 knots or less.

Jensen and Silber (2003) identified 292 records of known or probable ship strikes of all large whale species from 1975 to 2002. In 58 of the records, ship speed at the time of collision was known: it ranged from 2 to 51 knots, with an average of 18.1 knots. A majority (79 percent) of ship strikes occurred at speeds of 13 knots or greater. Of the 58 cases where speed was known, 19 (32.8 percent) resulted in serious injury to the whale. The mean vessel speed that resulted in serious injury or death to the whale was 18.6 knots (Jensen and Silber 2003).

Using a total of 64 records of ship strikes in which vessel speed was known, Pace and Silber (2005) tested speed as a predictor of the probability of death or serious injury. The authors concluded that there was strong evidence that the probability of death or serious injury increased rapidly with increasing speed. Specifically, the predicted probability of serious injury or death increased from 45 percent to 75 percent as vessel speed increased from 10 to 14 knots, and exceeded 90 percent at 17 knots. Interpretation of the logistic regression curve used to obtain these probabilities indicates that there is a 100 percent probability of serious injury or death around 25 knots and faster. In a related study, Vanderlaan and Taggart (2007) analyzed all published historical data on vessels striking large whales. The authors found that the probability of a lethal injury resulting from a strike ranged from 20 percent at 9 knots to 80 percent at 15 knots and 100 percent at 21 knots or more.

Related studies of the occurrence and severity of strikes relative to vessel speed have been conducted for other species and locations. Panigada et al. (2006) concluded that vessel speed restrictions and the relocation of vessel routes in high cetacean density areas would reduce the likelihood of ship strikes of fin whales in the Mediterranean Sea. Speed zones were adopted in Florida in the early 2000s to reduce the numbers of collisions and manatee injuries resulting from collisions with boats. Laist and Shaw (2006) assessed the effectiveness of these speed zones at reducing watercraft-related manatee deaths. Watercraft-related manatee deaths did decline in the areas assessed in the paper, and the authors reported that this decline reflected the fact that well-designed speed restrictions could be effective if properly enforced. They further stated that "reduced speed allows time for animals to detect and avoid oncoming boats, and that similar measures may be useful for other marine mammal species vulnerable to collision impacts with vessels (e.g., North Atlantic right whales)" (Laist and Shaw 2006).

The behavior of whales in the path of approaching ships is uncertain, but in some cases, last-second flight responses may occur. If a whale attempts to avoid an oncoming vessel at the last minute, a burst of speed coupled with a push from the bow wave could mean that mere seconds might determine whether the whale is struck (Laist et al. 2001). A reduction in speed from 18 knots to 10 knots would give whales an additional 8.6 seconds (at a distance of 100 m) to avoid the vessel in this flight response (Laist 2005, unpublished data). In a separate study involving whale behavior, Kite-Powell et al. (2007) developed a model that analyzed ship strike risk with respect to vessel speed and whale avoidance behavior. The authors of the ship strike analysis assert that ship strike risk decreases as speed decreases and the distance that the whale detects the vessel increases. Assuming certain whale behavior, the model suggests that the ship strike risk posed by a conventional ship (e.g., container ship) traveling at 20 to 25 knots can be reduced by 30 percent at a speed of 12 or 14 knots, and by 40 percent at 10 knots, due to the whales' increased ability to detect and avoid approaching vessels. If a whale detects and reacts to an oncoming vessel at a distance of 820 ft (250 m) or greater, it will likely avoid a ship strike, whereas at detection distances less than 328 ft (100 m), the probability of ship strike is almost one hundred percent at speeds of 15 knots or faster. However, research on vessel-whale collisions indicates that of three speeds considered — 10, 12, and 14 knots — adopting a speed limit of 10 knots would be the most beneficial to the recovery of the right whale population. Historically, only a small percentage of ship strikes occurred at 10 knots, and those that did usually resulted in injury rather than death (Laist et al. 2001). Although, it is important to note of the three speeds considered above, while a 10-knot speed restriction is most effective at reducing the risk of ship strikes, it will not eliminate the risk; there is still a 45 percent predicted probability of serious injury or mortality at 10 knots (Pace and Silber 2005).

In summary, NMFS believes that the mandatory dredge-related-vessel speed limit during the right whale migration/calving season of no greater than 10 knots (no greater than 5 knots at night and during periods of limited visibility), will reduce the chance of an inadvertent collision with a right whale by (1) significantly increasing the watch stander(s) reaction time (i.e., the time between when s/he detects the whale and takes action to avoid it), (2) significantly increasing the likelihood of detection of a right whale that may be in, near, or approaching the path of the vessel, and (3) significantly increasing the likelihood that the whale will detect the oncoming vessel and avoid it.

NMFS-approved endangered species observers will be required to be present to watch for marine mammals during all daytime hopper dredging and vessel transits that occur during the right whale migration/calving season. This will further reduce the chances of an inadvertent collision with a right whale by increasing vessel reaction time, whale reaction time, and likelihood of detection of a right whale. Depending on the size of the vessel used, it is estimated there could be 769 to 2,307 hopper dredge trips during the project. During the previous ten years of entrance channel dredging, there were 263 days of dredging. If it is assumed that there were 3 trips per day, as is normally conducted, this would have resulted in 789 trips. Based on the estimated total dredged material to be removed (13,325,513 cubic yards) during this project, there would be approximately 1,439 trips.

Another factor to be considered is the probability of a right whale encounter by vessels associated with dredging activities for this action. During the fiscal year 2011 right whale EWS aerial survey for the Southeast calving grounds and the additional aerial surveys off the coast of Georgia and South Carolina, a total of 164 unique right whales were sighted, including 20 right whale calves. It is believed that about two-thirds of all right whales transiting the area are detected by the EWS (the rest go unseen because they are submerged and not detected). Given the density and numbers of these animals and their irregular distribution within the area designated as critical habitat, it is unlikely that right whales will be adversely impacted by dredge-related vessel transits, given the precautions stipulated for vessel avoidance. Additionally, the configuration of the new alignment for the entrance channel is roughly oriented perpendicular to the coastline, which should help ensure that ships approaching the entrance channel from seaward will take the shortest path through coastal waters and lessen the chance of encountering a whale.

Thus, NMFS concludes that the project's vessel related effects on North Atlantic right whales are discountable based on the rarity of the species and on the implementation of the suite of Whale Conservation measures discussed above.

Humpback Whale

Humpback whales (Figure 15) occur in waters under U.S. jurisdiction throughout the year. Migrations occur annually between their summer and winter ranges. The summer

Figure 15. Humpback whale

range for the Western North Atlantic stock includes the Gulf of Maine, Canadian Maritimes, western Greenland, and the Denmark Strait. All humpback whales feed while on the summer range. The primary winter range includes the Lesser Antilles, the Virgin Islands, Puerto Rico, and the Dominican Republic (NMFS 1991). In general, it is believed that calving and copulation take place on the winter range. Calves are born from December through March and are about 4 meters at birth. Sexually mature females give birth approximately every two to three years. Sexual maturity is reached between 4 and 6 years of age for females and between 7 and 15 years of age for males. Size at maturity is about 12 meters.

Until recently, humpback whales in the Mid- and South Atlantic were considered transients. Few were seen during aerial surveys conducted over a decade ago (Shoop et al. 1982). However, since 1989, sightings of feeding juvenile humpbacks have increased along the coast of Virginia and North Carolina, peaking during the months of January through March in 1991 and 1992 (Swingle et al. 1993). Studies conducted by the Virginia Marine Science Museum (VMSM) indicate that these whales are feeding on, among other things, bay anchovies and menhaden. Researchers theorize that juvenile humpback whales, which are unconstrained by breeding requirements that result in the migration of adults to relatively barren Caribbean waters, may be establishing a winter foraging area in the mid-Atlantic (Mayo, pers. comm., 1993). The lack of sightings south of the VMSM study area is a function of shipboard sighting effort, which was restricted to waters surrounding Virginia Beach, Virginia.

In concert with the increase in whale sightings, strandings of humpback whales have increased between New Jersey and Florida since 1985. The increase in sightings is attributed to population increase and shift in feeding areas to the mid-Atlantic during this season. Strandings were most frequent during the months of September through April in North Carolina and Virginia waters, and were composed primarily of juvenile humpback whales of no more than 11 meters in length (Wiley et al. 1995). Of the 18 humpbacks for which the cause of mortality was determined, six (33 percent) were killed by vessel strikes. An additional humpback had scars and bone fractures indicative of a previous vessel strike that may have contributed to its mortality.

As mentioned in the right whale species status, using a total of 64 records of ship strikes in which vessel speed was known, Pace and Silber (2005) tested speed as a predictor of the probability of death or serious injury. The authors concluded that there was strong evidence that the probability of death or serious injury increased rapidly with increasing speed. Specifically, the predicted probability of serious injury or death increased from 45 percent to 75 percent as vessel speed increased from 10 to 14 knots, and exceeded 90 percent at 17 knots. Interpretation of the logistic regression curve used to obtain these probabilities indicates that there is a 100 percent probability of serious injury or death around 25 knots and faster.

Panigada et al. (2006) concluded that vessel speed restrictions and the relocation of vessel routes in high cetacean density areas would reduce the likelihood of ship strikes of fin whales in the Mediterranean Sea. The behavior of whales in the path of approaching ships is uncertain, but in some cases, last-second flight responses may occur. If a whale attempts to avoid an oncoming vessel at the last minute, a burst of speed coupled with a push from the bow wave could mean that mere seconds might determine whether the whale is struck (Laist et al. 2001). A reduction in speed from 18 knots to 10 knots would give whales an additional 8.6 seconds (at a distance of 100 m) to avoid the vessel in this flight response (Laist 2005, unpublished data). In a separate study involving whale behavior, Kite-Powell et al. (2007) developed a model that analyzed ship strike risk with respect to vessel speed and whale avoidance behavior.

The authors assert that ship strike risk decreases as speed decreases and the distance that the whale detects the vessel increases. Assuming certain whale behavior, the model suggests that the ship strike risk posed by a conventional ship (e.g., container ship) traveling at 20 to 25 knots can be reduced by 30 percent at a speed of 12 or 14 knots, and by 40 percent at 10 knots, due to the whales' increased ability to detect and avoid approaching vessels. If a whale detects and reacts to an oncoming vessel at a distance of 820 ft (250 m) or greater, it will likely avoid a ship strike, whereas at detection distances less than 328 ft (100 m), the probability of ship strike is almost one hundred percent at speeds of 15 knots or faster.

NMFS believes that Humpback whales transiting the area during the right whale migration will benefit from the mandatory dredge-related-vessel speed limit during the right whale migration/calving season of no greater than 10 knots (no greater than 5 knots at night and during periods of limited visibility), will reduce the chance of an inadvertent collision with a humpback whale by (1) significantly increasing the watch stander(s) reaction time (i.e., the time between when s/he detects the whale and takes action to avoid it), (2) significantly increasing the likelihood of detection of a humpback whale that may be in, near, or approaching the path of the vessel, and (3) significantly increasing the likelihood that the whale will detect the oncoming vessel and avoid it.

As noted above, the COE proposes that hopper dredge operations would only be conducted in the ocean bar channel from December 1 to March 31. Monitoring to avoid vessel strikes after the right whale migration/calving season will be done by the dredge operator and the sea turtle observer between 1 April and 30 November.

NMFS concludes that the project's dredge vessel related effects on humpback whales are discountable or insignificant based on implementation of the Whale Conservation Measures discussed above, and for the same reasons they are expected to prevent harm to the North Atlantic right whale.

Summary
For the reasons discussed above, NMFS has determined that hawksbill sea turtles, green sea turtles, leatherback sea turtles, North Atlantic right whales, and humpback whales are not likely to be adversely affected by the proposed action; therefore, these species will not be considered further in this opinion.

3.4 Species Likely to be Adversely Affected

Sea Turtles

The following sea turtle subsections focus primarily on the Atlantic Ocean populations of these species since these are the populations that may be directly affected by the proposed action; as sea turtles are highly migratory, potentially affected species in the action area may make migrations in other areas of the Gulf of Mexico, Atlantic Ocean, and Caribbean Sea. The global status and trends of the loggerhead sea turtle are included in order to provide a basis for our final determination of the effects of the proposed action on the species as listed under the ESA. The following subsections are synopses of the best available information on the life history, distribution, population trends, and current status of the two species of sea turtles that are likely to be adversely affected by one or more components of the proposed action. Additional background information on the status of sea turtle species can be found in a number of published documents, including: Kemp's ridley sea turtle (USFWS and NMFS 1992) and loggerhead sea turtle (NMFS and USFWS 2008) status reviews, stock assessments, and biological reports (NMFS and USFWS 1995, NMFS and USFWS 2007a-e, Marine Turtle Expert Working Group (TEWG) 1998, 2000, 2007, and 2009; NMFS SEFSC 2001 and 2009d, and Conant et al. 2009).

3.4.1 Status of Kemp's Ridley Sea Turtles

The Kemp's ridley (Figure 16) was listed as endangered on December 2, 1970. Internationally, the Kemp's ridley is considered the most endangered sea turtle (Zwinenberg 1977, Groombridge 1982, TEWG 2000). Kemp's ridleys nest primarily at Rancho Nuevo, a stretch of beach in Mexico's Tamaulipas State. This species occurs mainly in coastal areas of the Gulf of Mexico and the northwestern Atlantic Ocean. Occasional individuals reach European waters (Brongersma 1972). Adults of this species are usually confined to the Gulf of Mexico, although adult-sized individuals sometimes are found on the east coast of the United States.

Figure 16. Kemp’s ridley sea turtle

Life History and Distribution

The TEWG (1998) estimates age at maturity from 7-15 years. Females return to their nesting beach about every 2 years (TEWG 1998). Nesting occurs from April into July and is essentially limited to the beaches of the western Gulf of Mexico, near Rancho Nuevo in southern Tamaulipas, Mexico. The mean clutch size for Kemp’s ridleys is 100 eggs/nest, with an average of 2.5 nests/female/season.

Little is known of the movements of the post-hatchling stage (pelagic stage) within the Gulf of Mexico. Studies have shown the post-hatchling pelagic stage varies from 1-4 or more years, and the benthic immature stage lasts 7-9 years (Schmid and Witzell 1997). Benthic immature Kemp’s ridleys have been found along the Eastern Seaboard of the United States and in the Gulf of Mexico. Atlantic benthic immature sea turtles travel northward as the water warms to feed in the productive, coastal waters off Georgia through New England, returning southward with the onset of winter (Lutcavage and Musick 1985, Henwood and Ogren 1987, Ogren 1989). Studies suggest that benthic immature Kemp's ridleys stay in shallow, warm, nearshore waters in the northern Gulf of Mexico until cooling waters force them offshore or south along the Florida coast (Renaud 1995).

Stomach contents of Kemp's ridleys along the lower Texas coast consisted of nearshore crabs and mollusks, as well as fish, shrimp, and other foods considered to be shrimp fishery discards (Shaver 1991). A 2005 dietary study of immature Kemp’s ridleys off southwest Florida documented predation on benthic tunicates, a previously undocumented food source for this species (Witzell and Schmid 2005). These pelagic stage Kemp’s ridleys presumably feed on the available *Sargassum* and associated infauna or other epipelagic species found in the Gulf of Mexico.

Population Dynamics and Status

Of the seven extant species of sea turtles in the world, the Kemp's ridley has declined to the lowest population level (Pritchard 1969). Most of the population of adult females nest on the Rancho Nuevo beaches (Pritchard 1969). When nesting aggregations at Rancho Nuevo were discovered in 1947, adult female populations were estimated to be in excess of 40,000 individuals (Hildebrand 1963). By the mid-1980s, nesting numbers were below 1,000 (with a low of 702 nests in 1985). However, observations of increased nesting (with 6,277 nests recorded in 2000) suggest that the decline in the ridley population has stopped and the population is now increasing (USFWS 2000). The number of nests observed at Rancho Nuevo and nearby beaches increased at a mean rate of 11.3 percent per year from 1985 to 1999 (TEWG 2000). These trends are further supported by 2004-2007 nesting data from Mexico. The number of nests over that period has increased from 7,147 in 2004, to 10,099 in 2005, to 12,143 in 2006, and 15,032 during the 2007 nesting season (Gladys Porter Zoo nesting database 2007). In 2008, there were 17,882 nests in Mexico (Gladys Porter Zoo 2008), and nesting in 2009 reached 21,144 (Gladys Porter Zoo 2010). In 2010, nesting declined significantly, to 13,302 (Gladys Porter Zoo 2010) but it is too early to determine if this is a one-time decline or if it is indicative of a change in the trend. Final numbers for 2011were not available at the time of this opinion. However, preliminary information for Kemp's ridley nesting in Mexico indicates there were fewer nests than in 2009, but nesting numbers did rebound from 2010's reduced nesting to over 20,000 (pers. comm. Jaime Peña, Gladys Porter Zoo). A small nesting population is also emerging in the United States, primarily in Texas, rising from 6 nests in 1996 to 128 in 2007, 195 in 2008, and 197 in 2009. Texas nesting then experienced a decline similar to that seen in Mexico for 2010, with 140 nests (National Park Service data, http://www.nps.gov/pais/naturescience/strp.htm), but nesting rebounded in 2011 with a record 199 nests (National Park Service data, http://www.nps.gov/pais/naturescience/current-season.htm).

A period of steady increase in benthic immature ridleys has been occurring since 1990 and appears to be due to increased hatchling production and an apparent increase in survival rates of immature sea turtles beginning in 1990. The increased survivorship of immature sea turtles is attributable, in part, to the introduction of TEDs in the United States' and Mexico's shrimping fleets. As demonstrated by nesting increases at the main nesting sites in Mexico, adult ridley numbers have increased over the last decade. The population model used by TEWG (2000) projected that Kemp's ridleys could reach the recovery plan's intermediate recovery goal of 10,000 nesters by the year 2015. Recent calculations of nesting females determined from nest counts show that the population trend is increasing towards that recovery goal, with an estimate of 4,047 nesters in 2006 and 5,500 in 2007 (NMFS 2007f, Gladys Porter Zoo 2007).

Next to loggerheads, Kemp's ridleys are the second most abundant sea turtle in Virginia and Maryland waters, arriving in these areas during May and June (Keinath et al. 1987, Musick and Limpus 1997). The juvenile population of Kemp's ridley sea turtles in Chesapeake Bay is estimated to be 211 to 1,083 sea turtles (Musick and Limpus 1997). These juveniles frequently forage in submerged aquatic grass beds for crabs (Musick and Limpus 1997). Kemp's ridleys consume a variety of crab species, including *Callinectes* spp., *Ovalipes* spp., *Libinia* spp., and *Cancer* spp. Mollusks, shrimp, and fish are consumed less frequently (Bjorndal 1997). Upon leaving Chesapeake Bay in autumn, juvenile Kemp's ridleys migrate down the coast, passing Cape Hatteras in December and January (Musick and Limpus 1997). These larger juveniles are joined there by juveniles of the same size from North Carolina sounds and smaller juveniles from New York and New England to form one of the densest concentrations of Kemp's ridleys outside of the Gulf of Mexico (Musick and Limpus 1997, Epperly et al. 1995a, Epperly et al. 1995b).

Threats

Kemp's ridleys face many of the same threats as other sea turtle species, including destruction of nesting habitat from storm events, natural predators at sea, and oceanic events such as cold-stunning. Although cold-stunning can occur throughout the range of the species, it may be a greater risk for sea turtles that utilize the more northern habitats of Cape Cod Bay and Long Island Sound. For example, in the winter of 1999-2000, there was a major cold-stunning event where 218 Kemp's ridleys, 54 loggerheads, and 5 green sea turtles were found on Cape Cod beaches (R. Prescott, NMFS, pers. comm. 2001). Annual cold-stunning events do not always occur at this magnitude; the extent of episodic major cold-stun events may be associated with numbers of sea turtles utilizing Northeast waters in a given year, oceanographic conditions, and the occurrence of storm events in the late fall. Many cold-stunned sea turtles can survive if found early enough, but cold-stunning events can still represent a significant cause of natural mortality. A complete list of other indirect factors can be found in NMFS SEFSC (2001).

Although changes in the use of shrimp trawls and other trawl gear have helped to reduce mortality of Kemp's ridleys, this species is also affected by other sources of anthropogenic impacts similar to those discussed in previous sections. For example, in the spring of 2000, a total of 5 Kemp's ridley carcasses were recovered from the same North Carolina beaches where 275 loggerhead carcasses were found. Cause of death for most of the sea turtles recovered was unknown, but the mass mortality event was suspected to have been from a large-mesh gillnet fishery operating offshore in the preceding weeks. The 5 Kemp's ridley carcasses that were found are likely to have been only a minimum count of the number of Kemp's ridleys that were killed or seriously injured as a result of the fishery interaction because it is unlikely that all of the carcasses washed ashore.

The impacts of pollution on Kemp's ridley sea turtles, as with all sea turtles, are still poorly understood. There is little data to provide an understanding of how water quality impacts sea turtles. In 2010, there was a massive oil well release in the Gulf of Mexico at British Petroleum's Deepwater Horizon well. Official estimates are that 4.9 million barrels of oil were released into the Gulf, with some experts estimating even higher volumes. At this time the assessment of total direct impact to sea turtles has not been determined. Additionally, the long-term impacts to sea turtles as a result of habitat impacts, prey loss, and subsurface oil particles and oil components broken down through physical, chemical, and biological processes are not known.

There is a large and growing body of literature on past, present, and future impacts of global climate change induced by human activities, i.e., global warming. Some of the likely effects commonly mentioned are sea level rise, increased frequency of severe weather events, and change in air and water temperatures. The Environmental Protection Agency's climate change Web page provides basic background information on these and other measured or anticipated effects (see www.epa.gov/climatechange/index.html). However, the impacts on sea turtles currently cannot, for the most part, be predicted with any degree of certainty.

The Intergovernmental Panel on Climate Change has stated that global climate change is unequivocal (IPCC 2007) and its impacts may be significant to the hatchling sex ratios of Kemp's ridley sea turtles (Wibbels 2003, NMFS and USFWS 2007c). In marine turtles, sex is determined by temperature in the middle third of incubation with female offspring produced at higher temperatures and males at lower temperatures within a thermal tolerance range of 25°-35°C (Ackerman 1997). Increases in global temperature could potentially skew future sex ratios toward a higher numbers of females (NMFS and USFWS 2007c).

The effects from increased temperatures may be exacerbated on developed nesting beaches where shoreline armoring and construction has denuded vegetation. Sea level rise from global climate change (IPCC 2007) is also a potential problem, particularly for areas with low-lying beaches where sand depth is a limiting factor, as the sea may inundate nesting sites and decrease available nesting habitat (Daniels et al. 1993, Fish et al. 2005, Baker et al. 2006). The loss of habitat as a result of climate change could be accelerated due to a combination of other environmental and oceanographic changes such as increased frequency of storms and/or changes in prevailing currents, both of which could lead to increased beach loss via erosion (Antonelis et al. 2006, Baker et al. 2006).

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

3.4.2 Summary of Status for Kemp's Ridley Sea Turtles

The only major nesting site for Kemp's ridleys is a single stretch of beach near Rancho Nuevo, Tamaulipas, Mexico (Carr 1963). The number of nests observed at Rancho Nuevo and nearby beaches increased from 1985 to 2009. Nesting has also exceeded 12,000 nests per year from 2004-2009 (Gladys Porter Zoo database). However, in 2010 the nesting declined dramatically compared to the previous few years. Early speculation on the decline may be related to the events of the Deepwater Horizon oil spill. Kemp's ridleys mature at an earlier age (7-15 years) than other chelonids, thus "lag effects" as a result of unknown impacts to the non-breeding life stages would likely have been seen in the increasing nest trend beginning in 1985 (USFWS and NMFS 1992).

The largest contributors to the decline of Kemp's ridleys in the past were commercial and local exploitation, especially poaching of nests at the Rancho Nuevo site, as well as the Gulf of Mexico trawl fisheries. The advent of TED regulations for trawlers and protections for the nesting beaches has allowed the species to begin to recover. Many threats to the future of the species remain, including interactions with fishery gear, marine pollution, foraging habitat destruction, illegal poaching of nests and potential threats to the nesting beaches from such sources as global climate change, development, and tourism pressures.

3.4.3 Status of Northwest Atlantic Ocean DPS of Loggerhead Sea Turtles

The loggerhead sea turtle (Figure 17) was listed as a threatened species throughout its global range on July 28, 1978. It was listed because of direct take, incidental capture in various fisheries, and the alteration and destruction of its habitat. Loggerhead sea turtles inhabit the continental shelves and estuarine environments along the margins of the Atlantic, Pacific, and Indian Oceans. The majority of loggerhead nesting occurs in the Western Atlantic Ocean (south Florida, United States), and the western Indian Ocean (Masirah, Oman); in both locations nesting assemblages have more than 10,000 females nesting each year (NMFS and USFWS 2008). Loggerhead sea turtles are the most abundant species of sea turtle in U.S. waters.

Figure 17. Loggerhead sea turtle

NMFS and USFWS published a final rule designating nine DPSs for loggerhead sea turtles (76 FR 58,868, September 22, 2011; effective October 24, 2011). The DPSs established by this rule include: (1) Northwest Atlantic Ocean (threatened); (2) Northeast Atlantic Ocean (endangered); (3) South Atlantic Ocean (threatened); (4) Mediterranean Sea (endangered); (5) North Pacific Ocean (endangered); (6) South Pacific Ocean (endangered); (7) North Indian Ocean (endangered); (8) Southeast Indo-Pacific Ocean (endangered); and (9) Southwest Indian Ocean (threatened). The NWA DPS is the only one that occurs within the action area and therefore is the only one to be considered in this opinion.

Atlantic Ocean

Within the NWA DPS, most loggerhead sea turtles nest from North Carolina to Florida and along the Gulf coast of Florida. Previous Section 7 analyses have recognized at least five Western Atlantic subpopulations, divided geographically as follows: (1) a northern nesting subpopulation, occurring from North Carolina to Northeast Florida at about 29ºN; (2) a South Florida nesting subpopulation, occurring from 29°N on the east coast to Sarasota on the west coast; (3) a Florida Panhandle nesting subpopulation, occurring at Eglin Air Force Base and the beaches near Panama City, Florida; (4) a Yucatán nesting subpopulation, occurring on the Eastern Yucatán Peninsula, Mexico (Márquez 1990 and TEWG 2000); and (5) a Dry Tortugas nesting subpopulation, occurring in the islands of the Dry Tortugas, near Key West, Florida (NMFS 2001b). The recovery plan for the Northwest Atlantic population of loggerhead sea turtles concluded, based on recent advances in genetic analyses, that there is no genetic distinction between loggerheads nesting on adjacent beaches along the Florida Peninsula and that specific boundaries for subpopulations could not be designated based on genetic differences alone. Thus, the plan uses a combination of geographic distribution of nesting densities, geographic separation, and geopolitical boundaries, in addition to genetic differences, to identify recovery units. The recovery units are: (1) the Northern Recovery Unit (Florida/Georgia border north through southern Virginia); (2) the Peninsular Florida Recovery Unit (Florida/Georgia border through Pinellas County, Florida); (3) the Dry Tortugas Recovery Unit (islands located west of Key West, Florida); (4) the Northern Gulf of Mexico Recovery Unit (Franklin County, Florida, through Texas); and (5) the Greater Caribbean Recovery Unit (Mexico through French Guiana, the Bahamas, Lesser Antilles, and Greater Antilles) (NMFS and USFWS 2008). The recovery plan concluded that all recovery units are essential to the recovery of the species. Although the recovery plan was written prior to the listing of the NWA DPS, the recovery units for what was then termed the Northwest Atlantic population apply to the NWA DPS.

Life History and Distribution

Past literature gave an estimated age at maturity of 21-35 years (Frazer and Ehrhart 1985, Frazer et al. 1994) with the benthic immature stage lasting at least 10-25 years. However, based on new data from tag returns, strandings, and nesting surveys, NMFS SEFSC (2001) estimated ages of maturity ranging from 20-38 years and benthic immature stage (sea turtles that have come back to inshore and nearshore waters)—the life stage following the pelagic immature stage—lasting from 14-32 years.

Mating takes place in late March-early June, and eggs are laid throughout the summer, with a mean clutch size of 100-126 eggs in the southeastern United States. Individual females nest multiple times during a nesting season, with a mean of 4.1 nests per individual (Murphy and Hopkins 1984). Nesting migrations for an individual female loggerhead are usually on an interval of 2-3 years, but can vary from 1-7 years (Dodd 1988). Generally, loggerhead sea turtles originating from the Western Atlantic nesting aggregations are believed to lead a pelagic existence in the North Atlantic Gyre for as long as 7-12 years or more. Stranding records indicate that when pelagic immature loggerheads reach 40-60 cm straight-line carapace length they begin to live in coastal inshore and nearshore waters of the continental shelf throughout the U.S. Atlantic and Gulf of Mexico, although some loggerheads may move back and forth between the pelagic and benthic environment (Witzell 2002). Benthic immature loggerheads have been found from Cape Cod, Massachusetts, to southern Texas, and occasionally strand on beaches in northeastern Mexico.

Tagging studies have shown loggerheads that have entered the benthic environment undertake routine migrations along the coast that are limited by seasonal water temperatures. Loggerhead sea turtles occur year-round in offshore waters off North Carolina where water temperature is influenced by the Gulf Stream. As coastal water temperatures warm in the spring, loggerheads begin to immigrate to North Carolina inshore waters (e.g., Pamlico and Core Sounds) and also move up the coast (Epperly et al. 1995a-c), occurring in Virginia foraging areas as early as April and on the most northern foraging grounds in the Gulf of Maine in June. The trend is reversed in the fall as water temperatures cool. The large majority of loggerheads leave the Gulf of Maine by mid-September but some may remain in mid-Atlantic and Northeast areas until late fall. By December loggerheads have emigrated from inshore North Carolina waters and coastal waters to the north to waters offshore of North Carolina, particularly off Cape Hatteras, and waters further south where the influence of the Gulf Stream provides temperatures favorable to sea turtles (≥ 11°C) (Epperly et al. 1995a-c). Loggerhead sea turtles are year-round residents of central and south Florida.

Pelagic and benthic juveniles are omnivorous and forage on crabs, mollusks, jellyfish, and vegetation at or near the surface (Dodd 1988). Sub-adult and adult loggerheads are primarily coastal dwelling and typically prey on benthic invertebrates such as mollusks and decapod crustaceans in a variety of habitats.

More recent studies are revealing that the loggerhead's life history is more complex than previously believed. Rather than making discrete developmental shifts from oceanic to neritic environments, research is showing that both adults and (presumed) neritic stage juveniles continue to use the oceanic environment and will move back and forth between the two habitats (Witzell 2002, Blumenthal et al. 2006, Hawkes et al. 2006, McClellan and Read 2007). One of the studies tracked the movements of adult females post-nesting and found a difference in habitat use was related to body size with larger turtles staying in coastal waters and smaller turtles traveling to oceanic waters (Hawkes et al. 2006). A tracking study of large juveniles found that the habitat preferences of this life stage were also diverse with some remaining in neritic waters while others moved off into oceanic waters (McClellan and Read 2007). However, unlike the Hawkes et al. study (2006), there was no significant difference in the body size of turtles that remained in neritic waters versus oceanic waters (McClellan and Read 2007). In either case, the research not only supports the need to revise the life history model for loggerheads but also demonstrates that threats to loggerheads in both the neritic and oceanic environments are likely impacting multiple life stages of this species.

Population Dynamics and Status

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

Numbers of nests and nesting females can vary widely from year to year. However, nesting beach surveys can provide a reliable assessment of trends in the adult female population, due to the strong nest site fidelity of females turtles, as long as such studies are sufficiently long and effort and methods are standardized (see, e.g., NMFS and USFWS 2008). NMFS and USFWS (2008) concluded that the lack of change in two important demographic parameters of loggerheads, remigration interval and clutch frequency, indicate that time series on numbers of nests can provide reliable information on trends in the female population. Recent analysis of available data for the Peninsular Florida Recovery Unit has led to the conclusion that the observed decline in nesting for that unit over the last several years can best be explained by an actual decline in the number of adult female loggerheads in the population (Witherington et al. 2009).

Annual nest totals from beaches within what NMFS and USFWS have defined as the Northern Recovery Unit (NRU) averaged 5,215 nests from 1989-2008, a period of near-complete surveys of NRU nesting beaches (GDNR unpublished data, NCWRC unpublished data, SCDNR unpublished data), and represent approximately 1,272 nesting females per year (4.1 nests per female, Murphy and Hopkins 1984). The loggerhead nesting trend from daily beach surveys showed a significant decline of 1.3 percent annually. Nest totals from aerial surveys conducted by SCDNR showed a 1.9 percent annual decline in nesting in South Carolina since 1980. Overall, there is strong statistical data to suggest the NRU has experienced a long-term decline. Data in 2008 has shown improved nesting numbers, but future nesting years will need to be analyzed to determine if a change in trend is occurring. In 2008, 841 loggerhead nests were observed compared to the 10-year average of 715 nests in North Carolina. The number dropped to 276 in 2009, but rose again to 846 in 2010. In South Carolina, 2008 was the seventh highest nesting year on record since 1980, with 4,500 nests, but this did not change the long-term trend line indicating a decline on South Carolina beaches. Then in 2009 nesting dropped to 2183, with an increase to 3,141 in 2010. Georgia beach surveys located a total of 1,648 nests in 2008. This number surpassed the previous statewide record of 1,504 nests in 2003. In 2009, the number of nests declined to 998, and in 2010, a new statewide record was established with 1,760 loggerhead nests. According to analyses by Georgia DNR, the 40-year time-series trend data show an overall decline in nesting, but the shorter comprehensive survey data (20 years) indicate a stable population (SCDNR 2008; GDNR, NCWRC, and SCDNR nesting data located at www.seaturtle.org).

Another consideration that may add to the importance and vulnerability of the NRU is the sex ratio of this subpopulation. NMFS scientists have estimated that the Northern subpopulation produces 65 percent males (NMFS SEFSC 2001). However, research conducted over a limited time frame has found opposing sex ratios (Wyneken et al. 2004), so further information is needed to clarify the issue. Since nesting female loggerhead sea turtles exhibit nest fidelity, the continued existence of the Northern subpopulation is related to the number of female hatchlings that are produced. Producing fewer females will limit the number of subsequent offspring produced by the subpopulation.

The Peninsular Florida Recovery Unit (PFRU) is the largest loggerhead nesting assemblage in the Northwest Atlantic. A near-complete nest census (all beaches including index nesting beaches) undertaken from 1989 to 2007 showed a mean of 64,513 loggerhead nests per year, representing approximately 15,735 nesting females per year (from NMFS and USFWS 2008). The statewide estimated total for 2010, was 73,702 (FWRI nesting database). An analysis of index nesting beach data shows a 26 percent decline in nesting by the PFRU between 1989 and 2008, and a mean annual rate of decline of 1.6 percent despite a large increase in nesting for 2008, to 38,643 nests (Witherington et al. 2009, NMFS and USFWS 2008, FWRI nesting database). In 2009, nesting levels, while still higher than the lows of 2004, 2006, and 2007, dropped below 2008 levels to approximately 32,717 nests, but in 2010 a large increase was seen, with 47,880 nests on the index nesting beaches (FWRI nesting database). The 2010 Florida index nesting number is the largest since 2000. With the addition of data through 2010, the nesting trend for the proposed NWA DPS of loggerheads became only slightly negative and not statistically different from zero (no trend) (NMFS and USFWS 2010). Nesting at the index nesting beaches in 2011 declined from 2010, but was still the second highest since 2001, at 43,595 nests (FWRI nesting database).

The remaining three recovery units—Dry Tortugas (DTRU), Northern Gulf of Mexico (NGMRU), and Greater Caribbean (GCRU)—are much smaller nesting assemblages but still considered essential to the continued existence of the species. Nesting surveys for the DTRU are conducted as part of Florida's statewide survey program. Survey effort has been relatively stable during the 9-year period from 1995-2004 (although the 2002 year was missed). Nest counts ranged from 168-270, with a mean of 246, but with no detectable trend during this period (Florida Fish and Wildlife Conservation Commission, Florida Marine Research Institute, Statewide Nesting Beach Survey Data, NMFS and USFWS 2008). Nest counts for the NGMRU are focused on index beaches rather than all beaches where nesting occurs. The 12-year dataset (1997-2008) of index nesting beaches in the area shows a significant declining trend of 4.7 percent annually (NMFS and USFWS 2008). Similarly, nesting survey effort has been inconsistent among the GCRU nesting beaches and no trend can be determined for this subpopulation. Zurita et al. (2003) found a statistically significant increase in the number of nests on seven of the beaches on Quintana Roo, Mexico, from 1987-2001, where survey effort was consistent during the period. However, nesting has declined since 2001, and the previously reported increasing trend appears to not have been sustained (NMFS and USFWS 2008).

Determining the meaning of the nesting decline data is confounded by various in-water research that suggests the abundance of neritic juvenile loggerheads is steady or increasing (Ehrhart et al. 2007, M. Bresette, pers. comm. regarding captures at the St. Lucie Power Plant, SCDNR unpublished SEAMAP-SA data, Epperly et al. 2007). Ehrhart et al. (2007) found no significant regression-line trend in the long-term dataset. However, notable increases in recent years and a statistically significant increase in CPUE of 102.4 percent from the 4-year period of 1982-1985 to the 2002-2005 periods were found. Epperly et al. (2007) determined the trends of increasing loggerhead catch rates from all the aforementioned studies in combination provide evidence there has been an increase in neritic juvenile loggerhead abundance in the southeastern United States in the recent past. A study led by the South Carolina Department of Natural Resources found that standardized trawl survey CPUEs for loggerheads from South Carolina to North Florida was 1.5 times higher in summer 2008 than summer 2000. However, even though there were persistent inter-annual increases from 2000-2008, the difference was not statistically significant, likely due to the relatively short time series. Comparison to other datasets from the 1950s through 1990s showed much higher CPUEs in recent years regionally and in the South Atlantic Bight, leading SCDNR to conclude that it is highly improbable that CPUE increases of such magnitude could occur without a real and substantial increase in actual abundance (Arendt et al. 2009). Whether this increase in abundance represents a true population increase among juveniles or merely a shift in spatial occurrence is not clear. NMFS and USFWS (2008), citing Bjorndal et al. 2005, caution about extrapolating localized in-water trends to the broader population and relating localized trends in neritic sites to population trends at nesting beaches. The apparent overall increase in the abundance of neritic loggerheads in the southeastern United States may be due to increased abundance of the largest Stage III individuals (oceanic/neritic juveniles, historically referred to as small benthic juveniles), which could indicate a relatively large cohort that will recruit to maturity in the near future (TEWG 2009). However, in-water studies throughout the eastern United States also indicate a substantial decrease in the abundance of the smallest Stage III loggerheads, a pattern also corroborated by stranding data (TEWG 2009).

The NMFS Southeast Fishery Science Center has developed a preliminary stage/age demographic model to help determine the estimated impacts of mortality reductions on loggerhead sea turtle population dynamics (NMFS SEFSC 2009). This model does not incorporate existing trends in the data (such as nesting trends) but instead relies on utilizing the available information on the relevant life-history parameters for sea turtles and then predicts future population trajectories based upon model runs using those parameters. Therefore, the model results do not build upon, but instead are complementary to, the trend data obtained through nest counts and other observations. The model uses the range of published information for the various parameters including mortality by stage, stage duration (years in a stage), and fecundity parameters such as eggs per nest, nests per nesting female, hatchling emergence success, sex ratio, and remigration interval. Model runs were done for each individual recovery unit as well as the western North Atlantic population as a whole, and the resulting trajectories were found to be very similar. One of the most robust results from the model was an estimate of the adult female population size for the western North Atlantic in the 2004-2008 time frame. The distribution resulting from the model runs suggest the adult female population size to be likely between approximately 20,000 to 40,000 individuals, with a low likelihood of being up to 70,000 (NMFS SEFSC 2009). A much less robust estimate for total benthic females in the western North Atlantic was also obtained, with a likely range of approximately 30,000-300,000 individuals, up to less than 1 million (NMFS SEFSC 2009).

The results of one set of model runs suggest that the western North Atlantic population is most likely declining, but this result was very sensitive to the choice of the position of the parameters within their range and hypothesized distributions. This example was run to predict the distribution of projected population trajectories for benthic females using a range of starting population numbers from the 30,000 estimated minimum to the greater than the 300,000 likely upper end of the range and declining trajectories were estimated for all of the population estimates. After 10,000 simulation runs of the models using the parameter ranges, 14 percent of the runs resulted in growing populations, while 86 percent resulted in declining populations. While this does not translate to an equivalent statement that there is an 86 percent chance of a declining population, it does illustrate that given the life history parameter information currently thought to comprise the likely range of possibilities, it appears most likely that with no changes to those parameters the population is projected to decline. Additional model runs using the range of values for each life history parameter, the assumption of non-uniform distribution for those parameters, and a 5 percent natural (non-anthropogenic) mortality for the benthic stages resulted in a determination that a 60-70 percent reduction in anthropogenic mortality in the benthic stages would be needed to bring 50 percent of the model runs to a static (zero growth or decline) or increasing trajectory.

As a result of the large uncertainty in our knowledge of loggerhead life history, at this point predicting the future populations or population trajectories of loggerhead sea turtles with precision is very uncertain. The model results, however, are useful in guiding future research needs to better understand the life history parameters that have the most significant impact in the model. Additionally, the model results provide valuable insights into the likely overall declining status of the species and in the impacts of large-scale changes to various life history parameters (such as mortality rates for given stages) and how they may change the trajectories. The results of the model, in conjunction with analyses conducted on nest count trends (such as Witherington et al. 2009) which have suggested that the population decline is real, provides a strong basis for the conclusion that the western North Atlantic loggerhead population is in decline. NMFS also recently convened a new Turtle Expert Working Group (TEWG) for loggerhead sea turtles that gathered available data and examined the potential causes of the nesting decline and what the decline means in terms of population status. The TEWG ultimately could not determine whether or not decreasing annual numbers of nests among the Western North Atlantic loggerhead subpopulations were due to stochastic processes resulting in fewer nests, a decreasing average reproductive output of the adult females, decreasing numbers of adult females, or a combination of those factors. Past and present mortality factors that could impact current loggerhead nest numbers are many, and it is likely that several factors compound to create the current decline. Regardless of the source of the decline, it is clear that the reduced nesting will result in depressed recruitment to subsequent life stages over the coming decades (TEWG 2009).

Threats

The 5-year status review of loggerhead sea turtles recently completed by NMFS and the USFWS provides a summary of natural as well as anthropogenic threats to loggerhead sea turtles (NMFS and USFWS 2007c). The Loggerhead Recovery Team also undertook a comprehensive evaluation of threats to the species, and described them separately for the terrestrial, neritic, and oceanic zones (NMFS and USFWS 2008). The diversity of sea turtles' life history leaves them susceptible to many natural and human impacts, including impacts while they are on land, in the benthic environment, and in the pelagic environment. Hurricanes are particularly destructive to sea turtle nests. Sand accretion and rainfall that result from these storms, as well as wave action, can appreciably reduce hatchling success. For example, in 1992 all of the eggs over a 90-mile length of coastal Florida were destroyed by storm surges on beaches that were closest to the eye of Hurricane Andrew (Milton et al. 1994). Also, many nests were destroyed during the 2004 and 2005 hurricane seasons. In August 2011, Hurricane Irene side-swiped the U.S. Atlantic sea turtle nesting beaches prior to making landfall farther to the north. Impacts to sea turtle nests and nesting beaches varied from minor to hundreds of nests and the loss of extensive nesting habitat on the various beaches. The damage to turtle nesting was somewhat mitigated by the storm's occurrence late in the nesting season, as many nests had already hatched and the hatchlings had already left the beach. Although no specific information is available to determine the long-term population impacts of Hurricane Irene, the impact is not expected to be significant.

Other sources of natural mortality include cold-stunning and biotoxin exposure. Cold-stunning is not considered a major source of mortality, but cold-stunning of loggerhead turtles has been reported at several locations in the northeast and southeast United States, including the Indian River Lagoon in Florida (Mendonca and Ehrhart 1982, Witherington and Ehrhart 1989) and Texas inshore waters (Hildebrand 1982). Cold-stunning is a phenomenon during which turtles become incapacitated as a result of rapidly dropping water temperatures (Witherington and Ehrhart 1989, Morreale et al. 1992). As temperatures fall below 8°-10°C, turtles may lose their ability to swim and dive, often floating to the surface. The rate of cooling that precipitates cold-stunning appears to be the primary threat, rather than the water temperature itself (Milton and Lutz 2003). Sea turtles that overwinter in inshore waters are most susceptible to cold-stunning because temperature changes are most rapid in shallow water (Witherington and Ehrhart 1989). In January 2010, an unusually large cold-stunning event occurred throughout the southeast United States, with well over 3,000 sea turtles (mostly greens but also hundreds of loggerheads) found cold-stunned. Most were able to be saved, but a few hundred were found dead or died after being discovered in a cold-stunned state.

Anthropogenic factors that impact hatchlings and adult female sea turtles on land or the success of nesting and hatching include: beach erosion, beach armoring and nourishment, artificial lighting, beach cleaning, increased human presence, recreational beach equipment, beach driving, coastal construction and fishing piers, exotic dune and beach vegetation, and poaching. An increase in human presence at some nesting beaches or close to nesting beaches has led to secondary threats such as the introduction of exotic fire ants, feral hogs, dogs, and an increased presence of native species (e.g., raccoons, armadillos, and opossums), which raid and feed on turtle eggs. Although sea turtle nesting beaches are protected along large expanses of the Northwest Atlantic coast (in areas like Merritt Island, Archie Carr, and Hobe Sound National Wildlife Refuges), other areas along these coasts have limited or no protection. Sea turtle nesting and hatching success on unprotected East Florida nesting beaches from Indian River to Broward County, including some high density beaches, are affected by all of the above threats.

Loggerhead sea turtles are affected by a completely different set of anthropogenic threats in the marine environment. These threats include oil and gas exploration, coastal development, marine transportation, marine pollution (which may have a direct impact, or an indirect impact by causing harmful algal blooms), underwater explosions, hopper dredging, offshore artificial lighting, power plant entrainment and/or impingement, entanglement in debris, ingestion of marine debris, marina and dock construction and operation, boat collisions, poaching, and fishery interactions. In 2010, there was a massive oil well release in the Gulf of Mexico at British Petroleum's Deepwater Horizon well. Official estimates are that 4.9 million barrels of oil were released into the Gulf, with some experts estimating much higher volumes. At this time the assessment of total direct impact to sea turtles has not been determined. Additionally, the long-term impacts to sea turtles as a result of habitat impacts, prey loss, and subsurface oil particles and oil components broken down through physical, chemical, and biological processes are not known. Loggerheads in the pelagic environment are exposed to a series of longline fisheries, which include the highly migratory species' Atlantic pelagic longline fisheries, an Azorean longline fleet, a Spanish longline fleet, and various longline fleets in the Mediterranean Sea (Aguilar et al. 1995, Bolten et al. 1994). Loggerheads in the benthic environment in waters off the coastal United States are exposed to a suite of fisheries in federal and state waters including trawl, purse seine, hook-and-line, gillnet, pound net, longline, and trap fisheries. The sizes and reproductive values of sea turtles taken by fisheries vary significantly, depending on the location and season of the fishery, and size-selectivity resulting from gear characteristics. Therefore, it is possible for fisheries that interact with fewer, more reproductively valuable turtles to have a greater detrimental effect on the population than one that takes greater numbers of less reproductively valuable turtles if the fishery removes a higher overall reproductive value from the population (Wallace et al. 2008). The Loggerhead Biological Review Team determined that the greatest threats to the Northwest Atlantic DPS of loggerheads result from cumulative fishery bycatch in neritic and oceanic habitats (Conant, et al. 2009). Attaining a more thorough understanding of the characteristics, as well as the quantity, of sea turtle bycatch across all fisheries is of great importance.

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

Impacts on sea turtles currently cannot, for the most part, be predicted with any degree of certainty; however significant impacts to the hatchling sex ratios of loggerhead turtles may result (NMFS and USFWS 2007c). In marine turtles, sex is determined by temperature in the middle third of incubation with female offspring produced at higher temperatures and males at lower temperatures within a thermal tolerance range of 25°-35°C (Ackerman 1997). Increases in global temperature could potentially skew future sex ratios toward higher numbers of females (NMFS and USFWS 2007c). Modeling suggests an increase of 2°C in air temperature would result in a sex ratio of over 80 percent female offspring for loggerheads nesting near Southport, North Carolina. The same increase in air temperatures at nesting beaches in Cape Canaveral, Florida, would result in close to 100 percent female offspring. More ominously, an air temperature increase of 3°C is likely to exceed the thermal threshold of most clutches, leading to death (Hawkes et al. 2007).

Warmer sea surface temperatures have been correlated with an earlier onset of loggerhead nesting in the spring (Weishampel et al. 2004, Hawkes et al. 2007), as well as short inter-nesting intervals (Hays et al. 2002) and shorter nesting season (Pike et al. 2006).

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

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

Actions have been taken to reduce anthropogenic impacts to loggerhead sea turtles from various sources, particularly since the early 1990s. These include lighting ordinances, predation control, and nest relocations to help increase hatchling survival, as well as measures to reduce the mortality of pelagic immatures, benthic immatures, and sexually mature age classes in various fisheries and other marine activities. Recent actions have taken significant steps towards reducing the recurring sources of mortality of sea turtles in the environmental baseline and improving the status of all loggerhead subpopulations. For example, the Turtle Excluder Device (TED) regulation published on February 21, 2003 (68 FR 8456), represents a significant improvement in the baseline effects of trawl fisheries on loggerhead sea turtles, though shrimp trawling is still considered to be one of the largest source of anthropogenic mortality on loggerheads (NMFS SEFSC 2009).

3.4.4 Summary of Status for Loggerhead Sea Turtles

NMFS recognizes five recovery units of loggerhead sea turtles in the western North Atlantic based on genetic studies and management regimes. Cohorts from all of these are known to occur within the action area of this consultation, and together comprise the NWA DPS. Using data up through 2007-2008, no long-term data suggest any of the loggerhead subpopulations throughout the entire North Atlantic were increasing in annual numbers of nests (TEWG 2009). Additionally, using both computation of susceptibility to quasi-extinction and stage-based deterministic modeling to determine the effects of known threats to Northwest Atlantic loggerheads, the Loggerhead Biological Review Team determined that this population is likely to decline in the foreseeable future, driven primarily by the mortality of juvenile and adult loggerheads from fishery bycatch throughout the North Atlantic Ocean. These computations were done for each of the recovery units, and all of them resulted in an expected decline (Conant et al. 2009). However, with the recent increase in nesting, data through 2010 changes the trend for the

PFRU from negative to no trend (slightly negative but not statistically significant) (NMFS and USFWS 2010). Nesting at the index nesting beaches for the PFRU in 2011 declined from 2010, but was still the second highest since 2001, at 43,595 nests (FWRI nesting database). Because of its size, the PFRU may be critical to the survival of the species in the Atlantic Ocean.

All loggerhead subpopulations are faced with a multitude of natural and anthropogenic effects that negatively influence the status of the species. Many anthropogenic effects occur as a result of activities outside of U.S. jurisdiction (i.e., fisheries in international waters).

Sturgeon

3.4.5 Status of Shortnose Sturgeon

Shortnose sturgeon (*Acipenser brevirostrum)* (Figure 18) inhabit large coastal rivers of eastern North America. Although it is considered an anadromous species, shortnose sturgeon distributed in the southern areas of the United States 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. Historically, shortnose

Figure 18. Shortnose sturgeon

sturgeon were found in the coastal rivers along the east coast of North America from the Saint John River in Canada, to perhaps as far south as the Indian River in Florida (Gilbert 1989, Evermann and Bean 1898). In the southern portion of the range, they are currently found in the Altamaha, Ogeechee, and Savannah Rivers in Georgia. They are thought to be extremely rare or possibly extirpated from the St. Johns River in Florida as only a single specimen was found by the Florida Fish and Wildlife Conservation Commission during extensive sampling of the river in 2002/2003. Shortnose sturgeon prefer nearshore marine, estuarine, and riverine habitat of these large river systems. The species is significantly more abundant in some rivers in northern portions of its range than it is in the south. Bycatch in commercial fisheries and increased industrial uses of the nation’s large coastal rivers during the 20th century (e.g., hydropower, nuclear power, port dredging) have contributed to the further decline and slow recovery of shortnose sturgeon.

While adult shortnose sturgeon may occasionally be found in marine waters during the summer, they typically are found in more estuarine waters, and in rivers near the saltwater-freshwater interface. There are spawning populations in the Savannah River and Hall et al. (1991) and Collins et al. (1993), using telemetry techniques, identified two distinct spawning locations. However, the status of stocks is poorly understood and survival of juveniles and recruitment to the adult population has been identified as a potential limiting factor in population growth (Smith et al. 1992). According to historical distribution records much of the spawning and nursery habitat formerly available to sturgeon in the Savannah River is inaccessible (USFWS 2001).

In addition to the distribution of wild (native) shortnose sturgeon in the Savannah River, broodstock are currently held at the University of Florida, Gainesville, and the USFWS Warm Springs Fish Technology Center (Georgia and South Carolina), USGS Conte Research Center (Massachusetts), and Alden Research Lab (Massachusetts). These research facilities conduct a variety of research to investigate sturgeon culture, tagging technology, fish passage, embryonic development, and other biological studies. Shortnose sturgeon of Savannah River origin are also currently being held at several educational facilities for public display including North Carolina Aquarium, Wilmington, North Carolina; North Carolina Zoo Asheboro, North Carolina; and Riverbanks Zoo Columbia, South Carolina. Although, captive shortnose sturgeon may not typically be released into the wild and measures are taken to ensure escapement does not occur. Because wild and cultured shortnose sturgeon share similar genetic, physical, physiological, ecological, and behavioral characteristics, all individuals and components of shortnose sturgeon derived from or by those initially removed from the Savannah River, including populations of natural individuals and hatchery stocks derived from similar populations, are included in the ESA listing of the species.

Listing

Shortnose sturgeon were originally listed as an endangered species by the 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 the 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.

Although the original listing notice did not cite reasons for listing the species, a 1973 Resource Publication issued by the U.S. Department of Interior stated that shortnose sturgeon were “in peril ... gone in most of the rivers of its former range [but] probably not as yet extinct” (USDOI 1973). Pollution and overfishing, including bycatch in the shad fishery, were listed as principal reasons for the species’ decline. Anthropogenic factors are likely responsible for the persistently depressed abundance of shortnose sturgeon in southern rivers. Shortnose sturgeon in the southeastern United States are exposed to three or more of the following impacts: harvest (bycatch and poaching), dams, river flow regulation, pollution (e.g., paper mill effluent), or dredging of fresh/saltwater interface reaches.

Range

Geographic distribution of the shortnose sturgeon extends from the Saint John River, New Brunswick, Canada, to the St. Johns River, Florida (Vladykopy and Greeley 1963);

the historic extent may have extended as far south as Indian River, Florida (Evermann and Bean 1898, Gilbert 1989). Currently, the distribution of shortnose sturgeon across their range is disjunct, with northern populations separated from southern populations by a distance of about 400 km near their geographic center in Virginia.

Life History

The scientific name for the shortnose sturgeon is *Acipenser brevirostrum: Acipenser* is Latin for sturgeon and *brevirostrum* means short snout. LeSueur originally described the species from a specimen taken from the Delaware River (Dadswell et al. 1984).

The shortnose sturgeon is the smallest of the three sturgeon species that occur in eastern North America: they attain a maximum length of about 120 cm, and a weight of 24 kg (Dadswell et al. 1984). Adults resemble similar-sized juvenile Atlantic sturgeon (*A. oxyrinchus oxyrinchus*) that historically co-occurred in the lower mainstem rivers of major basins along the Atlantic coast. The shortnose sturgeon is distinguished from other North American sturgeons by a wide mouth, absence of a fontanelle, nearly complete absence of postdorsal scutes, and preanal scutes often arranged in a single row (Scott and Crossman 1973, Dadswell et al. 1984). Morphological differences between shortnose and Atlantic sturgeon have been discussed (Bath et al. 1981, Gilbert 1989, Kynard and Horgan 2002, Vecsei and Peterson 2004); most researchers in the field use mouth width versus interorbital width to separate species. Coloration varies but adult shortnose sturgeons are generally dark dorsally and are lighter ventrally, usually white to yellow in color beginning at the row of lateral scutes. All of the fins are pigmented, and the paired fins are outlined in white. There is no external sexual dimorphism in morphology.

Shortnose sturgeon migrate seasonally between upstream freshwater spawning habitat and downstream foraging mesohaline areas within the river based on water temperature, flow and salinity cues. Shortnose sturgeon have generally been described as being anadromous[4] but freshwater amphidromous[5] may be a better description for the fish occurring in the southern rivers because they rarely leave their natal rivers or associated estuaries (Kieffer and Kynard 1993).

Spawning migration and cues

Initiation of the upstream movement of shortnose sturgeon to spawn is likely triggered partially by water temperatures above 8°C (Dadswell 1979, Kynard 1997) during late winter/early spring (southern rivers) to mid-to-late spring (northern rivers); specifically occurring in the southern range (North Carolina and south) between late December and March. Southern populations of shortnose sturgeon usually spawn at least 200 km upriver (Kynard 1997) or throughout the fall zone, if they are able to reach it. Spawning areas are usually associated with areas where the substrate is composed of gravel, rubble, cobble, or large rocks (Dadswell 1979, Taubert 1980, Buckley and Kynard 1985a, Kynard 1997), or timber, scoured clay, and gravel (Hall et al. 1991). Water depth and flow are also important parameters for spawning site (Kieffer and Kynard 1996).

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[4] An anadromous fish is defined as a species that lives in the ocean mostly, and breeds in fresh water.
[5] A freshwater amphidromous species is defined as a species that spawns and remains in freshwater for most of its life cycle but spends some time in saline water.

Spawning sites are characterized by moderate river flows with average bottom velocities between 0.4 and 0.8 m/s (Hall et al. 1991, Kieffer and Kynard 1996, NMFS 1998). Spawning in the southern rivers has been reported at water temperatures of 10.5°C in the Altamaha River (Heidt and Gilbert 1978) and 9°-12°C in the Savannah River (Hall et al. 1991. In the southern portion of the range, adults typically spawn well upriver in the late winter to early spring and spend the rest of the year in the vicinity of the fresh/brackish water interface (Collins and Smith 1993).

Shortnose sturgeon vary in pre-spawning migration patterns that may reflect energetic adaptations to migration distance, river discharge and temperature, and physiological condition of fish (Kieffer and Kynard 1993). The three patterns of migrations are: (1) a rapid, 1-step migration in spring only a few weeks before spawning, (2) a longer, 1-step migration many weeks in late winter and spring before spawning, and (3) a 2-step migration composed of a long fall migration, which places fish near the spawning site for overwintering, then a short migration in spring to spawn.

Following the spring spawning period, adult shortnose sturgeon move rapidly and directly downstream to freshwater reaches of rivers or river reaches that are influenced by tides; as a result, they often inhabit only a few short reaches of a river’s entire length (Buckley and Kynard 1985a). Adult shortnose sturgeon are usually located in deeper downstream areas with soft substrate and vegetated bottom areas where their prey are present. Juvenile (non-spawning, sexually immature) shortnose sturgeon generally move lesser distances upstream for the spring and summer seasons and downstream for fall and winter; however, these movements usually occur above the salt/freshwater interface of the rivers they inhabit (Dadswell et al. 1984, Hall et al. 1991).

Age and Growth

Dadswell et al. (1984) reviewed shortnose sturgeon growth throughout the latitudinal range. Growth of all juveniles is rapid, attaining lengths of 14-30 cm during the first year. Fish in the southern portion of the range grow the fastest, but do not reach the larger size of fish in the northern part of the range that continue to grow throughout life. This phenomenon may be related to different bioenergetic styles of southern and northern shortnose sturgeon, but sufficient data are not available for conclusions. The land-locked shortnose sturgeon population located upstream of Holyoke Dam at river km 140 of the Connecticut River has the slowest growth rate of any surveyed (Taubert 1980); growth rates of the other land-locked population in Lakes Marion and Moultrie are not available for comparison. The slower growth rate of this land-locked population suggests bioenergetic consequences to foraging in freshwater habitat and advantages associated with foraging in the lower river or fresh/saltwater interface.

Length at maturity (45-55 cm FL) is similar throughout the latitudinal range of shortnose sturgeon, but growth rate, maximum age, and maximum size vary with latitude. Fish in the southern areas grow more rapidly and mature at younger ages but attain smaller maximum sizes than those in the north (Dadswell et al. 1984). Maximum age of shortnose sturgeon in the northern portion of the species’ range is greater than the southern portion of the species’ range (Gilbert 1989). The maximum age reported for a shortnose sturgeon in the Saint John River in New Brunswick is 67 years (for a female), 40 years for the Kennebec River, 37 years for the Hudson River, 34 years in the Connecticut River, 20 years in the Pee Dee River, and 10 years in the Altamaha River (Gilbert 1989 using data presented in Dadswell et al. 1984).

Shortnose sturgeon also exhibit sexually dimorphic growth patterns across latitude: males mature at 2-3 years in Georgia, 3-5 years in South Carolina, and 10-11 years in the Saint John River, Canada; females mature at 4-5 years in Georgia, 7-10 years in the Hudson River, and 12-18 years in the Saint John River. Males begin to spawn 1-2 years after reaching sexual maturity and spawn every other year and perhaps annually in some rivers (Dadswell 1979, Kieffer and Kynard 1996, NMFS 1998). Age at first spawning for females is about approximately 5 years post-maturation (Dadswell 1979) with spawning occurring about every three years although spawning intervals may be as infrequent as every 5 years for some females (Dadswell 1979). Female shortnose sturgeon apparently grow larger than and outlive males (Dadswell et al. 1984, Gilbert 1989, COSEWIC 2005). Fecundity of shortnose sturgeon ranges between approximately 30,000-200,000 eggs per female (Gilbert 1989).

Shortnose sturgeon eggs are darkly colored, usually dark brown, black, or olive gray (Dadswell 1979, Hoff et al. 1988, Kynard 1997). Dadswell (1979) reported egg size from 3.00-3.20 mm in diameter. Eggs are negatively buoyant and not adhesive when first spawned; special protuberances on the egg membrane that maximize surface area available for attachment develop within a few minutes after water exposure (Dadswell et al. 1984). Once attached, the highly adhesive and demersal eggs adhere to the river substrate (Dadswell et al. 1984, Kynard 1997). Substrates commonly used by spawning shortnose sturgeon include gravel, rubble, large rock, sand, logs, and cobble (Dadswell 1979, Taubert 1980, Kieffer and Kynard 1996, Kynard 1997). Development of fertilized eggs is directly related to water temperature (Wang et al. 1985, Hardy and Litvak 2004).

At hatching, shortnose sturgeon are blackish-colored, 7-11 mm long, and resemble tadpoles (Buckley and Kynard 1981, Dadswell et al. 1984). Hatchlings have a large yolk-sac, poorly developed eyes, mouth, and fins, and are capable of only "swim-up and drift" swimming behavior (Richmond and Kynard 1995). They are ill-equipped to survive as free-swimming fish in the open river. In the laboratory, 1- to 8-day old shortnose sturgeon were photonegative, actively sought cover under any available material, often forming dense aggregations with other larvae, and swam along the bottom until cover was found (Richmond and Kynard 1995). Sheltering in dark substrate (i.e., in the crevasse of rocks/cobble at the spawning site) may enhance survival at this vulnerable life stage by allowing for some protection from predators (Richmond and Kynard 1995). Litvak observed that from a few days after hatching, they exhibit shoaling behavior, forming tight, well-spaced schools, and swim against the current; this shoaling behavior only exists when there is a flow (COSEWIC 2005).

Within 9-12 days, shortnose sturgeon absorb the yolk-sac and develop into larvae with a length of about 15 mm TL (Buckley and Kynard 1981). They experience a rapid change in sensory, feeding and locomotor systems (Bemis and Grande 1992). At this stage, the larvae have well-developed eyes. Fins begin to develop allowing for swimming behavior that is more typical of juvenile and adult sturgeon, and larvae begin to feed exogenously. In the wild, these larvae are often found in the deepest water, usually within the channel (Taubert and Dadswell 1980, Bath et al. 1981, Kieffer and Kynard 1993). They also have a mouth with teeth which may aid in specialized larval feeding (Taubert and Dadswell 1980); the teeth are later absorbed during the juvenile phase. At about 15mm TL, larval coloration begins to resemble that of an adult with darker dorsal pigmentation and lighter lateral and ventral coloration (Taubert and Dadswell 1980). In the lab, larvae could become lighter or darker, corresponding with changes in light intensity (Buckley and Kynard 1981, Richmond and Kynard 1995, Kynard and Horgan 2002).

Research indicates that yearlings are the primary migratory stage (Kynard 1997), while juveniles (3-10 year olds) reside near the saltwater/freshwater interface in most rivers (Dadswell 1979, Pottle and Dadswell 1979, Dovel et al. 1992, Hall et al. 1991, Flournoy et al. 1992, Weber 1996). Juveniles regularly move throughout the saline portions (0-16 ppt) of the salt wedge during summer (Pottle and Dadswell 1979, Weber 1996) and are more active when water temperatures are cooler (<16°C) (Weber 1996). Juveniles have been found congregating in deeper sand/mud substrate in depths of 10-14 m (Hall et al. 1991). Due to their low tolerance for high temperatures, warm summer temperatures (above 28°C) may severely limit available juvenile rearing habitat in some rivers in the southeastern United States. Juveniles in the Altamaha and Ogeechee Rivers have been found in a single area with cool and deep water (Flournoy et al. 1992, Rogers and Weber 1994, Rogers and Weber 1995, Weber 1996). Telemetry studies have identified nursery habitats for juveniles, a primary example being just inside the mouth of the Middle River branch of the lower Savannah River, and near the Kings Island Turning Basin.

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 salt wedge for about one year (Dadswell et al. 1984, Kynard 1997). Residence of YOY in freshwater is supported by several studies on cultured shortnose sturgeon. Jenkins et al. (1993) found that salinity tolerances of young shortnose sturgeon improve with age; individuals 76 days old suffered 100 percent mortality in a 96-hour test at salinities ≥15 ppt while those 330 days old tolerated salinities as high as 20 ppt for 18 hours but experienced 100 percent mortality at 30 ppt. Jarvis et al. (2001) demonstrated that 16-month old juveniles grew best at 0 percent salinity and poorest at 20 percent salinity. Lastly, Ziegeweid et al. (2008b) demonstrated that salinity and temperature interact, affecting survival of YOY shortnose sturgeon. As salinity and temperature increased, survival decreased; however, as body size increased, individuals were better able to tolerate higher temperatures and salinities (Ziegeweid et al. 2008b).

Juveniles in the Saint John, Hudson, and Savannah Rivers use deep channels over sand and mud substrate for foraging and resting (Pottle and Dadswell 1979, Hall et al. 1991, Dovel et al. 1992). In most rivers, juveniles age one and older join adults and show similar spatio-temporal patterns of habitat use (Kynard 1997). In the upper segment of the Connecticut River, where some juveniles and adults are always in freshwater, there was no macrohabitat segregation by age as both adults and juveniles used the same river reaches (Savoy 1991, Seibel 1993). In the Southeast, juveniles age one and older make seasonal migrations like adults, moving upriver during warmer months where they shelter in deep holes, before returning to the fresh/salt water interface when temperatures cool (Flournoy et al. 1992, Collins et al. 2002). Conversely, juveniles of this age in the Saint John River, Canada, preferred different habitat than adults. Dadswell (1979) reported these juveniles prefer freshwater habitats until they reach about 45 cm TL or age eight.

Researchers have noted that some shortnose sturgeon appear to aggregate with the same individuals within season and from year to year. Dadswell (1979) first observed these groupings in gillnet capture data on the Saint John River, Canada. Individuals that were recaptured were caught with the same group as in the original capture effort and often in the same order. The probability that pairs of fish would be recaptured together and removed from the gillnet in the same order by chance is extremely low (Dadswell, 1979). Decades later, students from Litvak's lab working on the Saint John River observed the same phenomenon (COSEWIC 2005).

Foraging

Adult shortnose sturgeon typically leave the spawning grounds soon after spawning and move rapidly to downstream feeding areas in the spring (Dadswell et al. 1984, Buckley and Kynard 1985a, Kieffer and Kynard 1993, O'Herron et al. 1993, Collins and Smith 1993). Kieffer and Kynard (1993) reported that post-spawning migrations were correlated with increasing spring water temperature and river discharge. Shortnose sturgeon are benthic carnivores throughout their life who locate prey by using their barbels as tactile receptors and vacuuming either the substrate or plant surfaces with their protuberant mouth (Dadswell et al. 1984, Gilbert 1989). Shortnose sturgeon feed opportunistically on benthic insects, crustaceans, mollusks, and polychaetes (Dadswell et al. 1984). Studies of gut contents show that the diet of adult shortnose sturgeon typically consists of small bivalves, gastropods, polychaetes, and even small benthic fish (McCleave et al. 1977, Dadswell 1979, Marchette and Smiley 1982, Dadswell et al. 1984, Gilbert 1989, Moser and Ross 1995, Kynard et al. 2000, Collins et al. 2002), and they have also been observed feeding off plant surfaces and may take fish bait (Collins et al. 2002). Some reports indicate that female adult shortnose sturgeon have been found to feed throughout the year; however, Dadswell (1979) found that females ceased feeding nearly eight months before spawning. Conversely, males continue to feed throughout the fall and winter as long as they are located in saline waters (Dadswell et al. 1984). Dadswell (1979) documented individuals of both sexes actively feeding immediately after spawning. Limited observations indicate that feeding occurs primarily at night (Dadswell et al. 1984, Gilbert 1989). Juveniles feed indiscriminately, often ingesting large amounts of mud, stone, and plant material along with prey items (Dadswell 1979, Carlson and Simpson 1987). Because substrate type strongly affects composition of benthic prey, both juvenile and adult shortnose sturgeon primarily forage over sandy-mud bottoms, which support benthic invertebrates (Carlson and Simpson 1987, Kynard 1997).

In the southern part of their range, shortnose sturgeon are known to forage widely throughout the estuary during the winter, fall, and spring (Collins and Smith 1993, Weber et al. 1998). During the hotter months of summer, foraging may taper off or cease as shortnose sturgeon take refuge from high water temperatures by congregating in cool, deep areas of rivers (Flournoy et al. 1992, Rogers and Weber 1994, Rogers and Weber 1995, Weber 1996). During winter months, adults in southern rivers spend much of their time in the slower moving waters downstream near the salt-wedge and forage widely throughout the estuary (Collins and Smith 1993, Weber et al. 1999). Older juveniles likely inhabit the same areas as adults, but younger juveniles primarily remain in freshwater habitats perhaps due to low salinity tolerances (Jenkins et al. 1993, Jarvis et al. 2001).

Hatchery fish
Approximately 97,483 hatchery-reared shortnose sturgeon were stocked into the Savannah River between 1985-1992. Few of the shortnose sturgeon released were tagged and fewer retained their tags. Tagged shortnose sturgeon stocked and released into the Savannah River have been captured in rivers adjacent to the Savannah in both South Carolina and Georgia. Beginning in 1995, shortnose stocked in the Savannah River were found in the Ogeechee River and were found to comprise 7.4 percent of the entire adult population between 1997 and 2000 (Smith et al. 2002). Likewise, 10.6 percent of the adults captured in the Edisto River between 1995 and 2000 were identifiable as fish stocked into the Savannah River (Smith et al. 2002). Given that only about 19 percent of the shortnose sturgeon stocked into the Savannah River were tagged coupled with low tag retention, it is likely that the stocked fish comprised a much larger part of these riverine populations. Shortnose sturgeon bearing tags indicating they were stocked into the Savannah River have also been detected in the Cooper River (M. Collins, SCDNR, pers. comm. 2008) and the Winyah Bay System (about 300 km to the north) in South Carolina. The emigration from the Savannah River may suggest the fish were released at an age too late to imprint on the Savannah River.

3.4.6 Population Structure and Characteristics: Riverine Populations and Metapopulations

Riverine Populations
The majority of shortnose sturgeon remain in their natal river or estuary throughout their lives, compared to other sturgeon species that migrate into marine waters to forage. The lack of marine movements by most adult shortnose sturgeon suggests that the recolonization rate of rivers from where they have been extirpated would be slow (Kynard 1997). Individuals that are infrequently captured in coastal waters could represent emigrants that colonize new rivers and maintain gene flow among populations. Previously most available information on marine captures indicated a greater incidence of marine emigrants in the north compared to the south (Kynard 1997); however, recent information indicates that coastal migrations also occur in the southeast. Because shortnose sturgeon populations in the northeast United States are generally larger than southern populations, there may be a relationship between population size and number of marine emigrants (Kynard 1997). Within natal rivers and estuaries, shortnose sturgeon populations have limited movements and show a high degree of site fidelity.

Sturgeon have been known to recolonize rivers, albeit slowly or after stocking of hatchery-reared fish. A period of greater than 100 years has been hypothesized for Atlantic sturgeon to recolonize a neighboring river (Secor and Waldman 1999).

Fragmentation of habitat via man-made barriers (i.e., dams) results in artificially isolated and range-constricted populations. Fragmentation is relatively easy to accomplish in rivers; a single damming event can isolate adjacent river segments and obstruct avenues of fish dispersal (Schlosser and Angermeier 1995). Fragmentation of rivers by dams further biases colonization rates by blocking upstream movement. Small isolated populations are more susceptible to extinction (both absolute and functional), and amphidromous species, such as sturgeon, are the first fish to subside (Poddubny and Galat 1995, Welcomme 1995).

Population Sizes

While historical population estimates for shortnose sturgeon are not available, fishery accounts indicate sturgeon were previously abundant in many river systems along the U.S. Atlantic coast.

North American sturgeon populations existed in enormous abundance prior to the 1880s based on both anecdotal observations (e.g., Catesby 1734) and historical catch data (e.g., McDonald 1887, Smith and Clugston 1997). In many Atlantic coast river basins, intensive exploitation of diadromous fish spawning migrations began to occur in the late 18th century: sturgeon caviar fisheries in mid-Atlantic states emerged rapidly in the 1870s (Cobb 1900) as processing and transportation improved. Because caviar was the principal marketable product, large females were targeted primarily using large mesh leaded gillnets that were drifted ahead of skiffs (Secor 2002).

Because all sturgeon along the Atlantic coast were called "common sturgeon" in the commercial catch statistics, it is difficult to estimate historic abundance of shortnose sturgeon as these records included both Atlantic and shortnose sturgeon until 1973 when the shortnose sturgeon was listed under the ESA (Murawski and Pacheco 1977). Consequently, the relative importance of the two species cannot be accurately ascertained from fisheries statistics. The Atlantic sturgeon, being of considerably greater maximum size, likely comprised the greatest percentage of the total weight of the overall catch. Statistical information on quantities of sturgeon harvested commercially first appeared in 1880; landings quickly peaked in 1890.

The current status of the shortnose sturgeon is mixed. Trends in abundance and population demographics vary by riverine populations. It is difficult to ascertain trends in abundance of shortnose sturgeon at a riverine scale, as few long-term data sets exist. Many historical records indicate only sporadic sightings, not abundance estimates. Direct comparison of available data sets to investigate abundance trends at a riverine scale can be misleading due to differences in survey methodologies and data analysis.

Although comprehensive population estimates are available for only a few rivers, most major river systems in the southeast United States are known to be inhabited by shortnose sturgeon, as depicted in Table 2. It is difficult to obtain a population estimate as it requires expensive multi-year survey of netting in order to appropriately assess population size within statistical parameters.

River/Estuary		Source
Albemarle Sound, NC	Anecdotal	Moser et al. 1998
Chowan, NC	Juvenile specimen collected	1881
Roanoke, NC	Adult collected	1998
Pamlico Sound, NC	Anecdotal	Moser et al. 1998
Neuse. NC	Anecdotal	Moser et al. 1998
Black, NC	Adult at river mouth	1991
Cape Fear, NC	Adults	Moser and Ross, 1989, 1993, 1995
Waccamaw, SC	Adults	SCDNR
Pee Dee, SC	Adults	SCDNR
Black, SC	Adults	SCDNR
Sampit, SC	Adults	SCDNR
Winyah Bay, SC	Adults	SCDNR
Wateree, SC	Adults	SCDNR
Congaree, SC	Adults	SCDNR
Ashley, SC	Unknown	
Edisto, SC	Adults and Juveniles	SCDNR
Ashepoo, SC	Adults	SCDNR
Combahee, SC	Unknown	
Savannah, GA	Adults, Juveniles	SCDNR
Ogeechee, GA	Adults	GADNR/UGS
Altamaha, GA	Adults, Juvenile, Eggs	UGS
Satilla, GA	Adults	GADNR
St. Mary's, GA	Adults	GADNR
St. Johns, FL	Adult collected	FFWC

Table 2. List of rivers in the southeast United States known to support shortnose sturgeon. These rivers collectively comprise the Southern metapopulation of shortnose sturgeon.

Differentiation of Riverine Populations and Metapopulations

Since the 1998 shortnose sturgeon recovery plan identified 19 distinct shortnose sturgeon populations based on natal rivers, significantly more field data on straying rates to adjacent rivers has been collected, and several genetic studies (nDNA and mtDNA) have determined that coastal migrations and effective movement (i.e., movement with spawning) are occurring between adjacent rivers in some areas, particularly in the Gulf of Maine and the southeast United States. Despite sometimes extensive coastal movements, both field (tagging) and laboratory studies [indirect gene flow estimates from mtDNA (i.e., < 2 individuals per generation), genetic distance, and assignment results from nDNA] conclude that greater mixing of riverine populations occur in areas where the distance between rivers mouths is relatively close (Wirgin et al. 2000, King et al. 2001, Waldman et al. 2002, Wirgin et al. 2005, Wirgin et al. 2009), such as between the Ogeechee and Altamaha Rivers, Georgia.

To determine if inter-riverine movement was effective, King et al. examined gene flow estimates between individual riverine populations of shortnose sturgeon to determine variation. Gene flow estimates are effective metric of reproductive effectiveness as they are based on the legacy of many generations (Wirgin et al. 2009). Greater than 30 reports indicate that most, if not all, shortnose sturgeon riverine populations are statistically different ($P < 0.05$) based on allelic/haplotype frequencies, and AMOVA and F_{ST} (and mtDNA equivalent) statistical tests using both mtDNA and nDNA genetic markers. That is, while shortnose sturgeon tagged in one river may later be recaptured in another, it is likely that the individuals are not spawning in those non-natal rivers, as gene flow is known to be low between riverine populations. Adult shortnose sturgeon are known to return to their natal rivers to spawn. Gene diversity estimates for shortnose sturgeon have been shown to be moderately high in both mtDNA (Quattro et al. 2002, Wirgin et al. 2000, Wirgin et al. 2005) and nDNA (King et al. in prep.) genomes, suggesting that dispersal is a very important factor in maintaining high levels of genetic diversity in populations within a metapopulation. Thus, although some shortnose sturgeon move between rivers, genetic analyses indicate that much of this movement is not effective.

Ample evidence exists indicating significant levels of genetic diversity are present in the shortnose sturgeon genome. Characterization of genetic differentiation (haplotype frequency) and estimates of gene flow (genetic distance) provide a quantitative measure to investigate population structure across the range of the shortnose sturgeon and reproductive connectiveness. By identifying zones of genetic discontinuity across the range, researchers have identified great genetic differentiation that indicates high degrees of reproductive isolation into at least three groupings (i.e., metapopulations). Both haplotype frequencies and the genetic distances between populations indicate population structure for shortnose sturgeon within their geographic range (Grunwald et al. 2002 and 2007, King et al. 2001, Wirgin et al. 2002, Waldman et al. 2002, Walsh et al. 2001, Wirgin et al. 2009). Notably, sturgeons are polyploid (the nucleus has 4 to 6 times the haploid number of chromosome sets), and so determining their evolutionary relatedness is challenging as the degree to which the nuclear genome exhibits disomic (having one or more chromosomes present in two copies) inheritance is unknown.

Three zones of genetic discontinuity translate into discrete functional groupings known as metapopulations (Wirgin et al. 2009; Figure. 19). Although some additional shallower patterns of discontinuity in the nDNA phenotypic variation were also identified in one grouping (labeled as the "Virginian Providence" in Figure. 19), data are lacking to conclude if this grouping is a single metapopulation or three distinct evolutionary lineages (King et al. in prep.). The presence of these demographically distinct zones of genetic discontinuity is consistent with the findings of researchers assessing behavioral patterns of shortnose sturgeon.

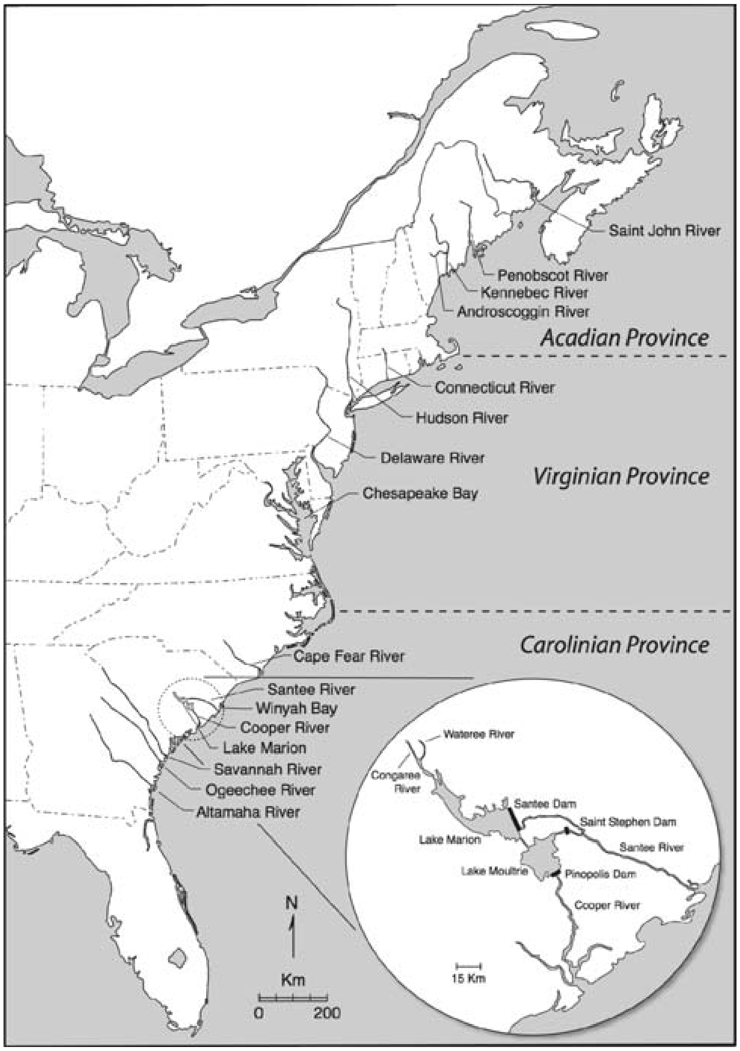


Figure 19. The North American Atlantic coast depicting three shortnose sturgeon metapopulations based on mtDNA control region sequence analysis. Figure from Wirgin et al. 2009.

Similar patterns of differentiation in the genomes among three metapopulations were found when 11 microsatellite DNA loci in 561 shortnose sturgeon from 17 geographic collections/rivers were surveyed to identify populations and phylogeographic structuring; notably the data were limited to include only YOY and spawning adults to reduce classification error by excluding migrating sub-adults (T. King, USGS, pers. comm.). Not only is the degree of congruence between the genetic variation qualitatively detectable, a strong quantitative relationship ($r = 0.83$, $P<0.00012$) exists between populations within a metapopulation, as supported by a Mandel analysis comparing the mtDNA F_{ST} values and nDNA φ_{PT} pair-wise distance for the 14 shortnose sturgeon collections used by Wirgin et al. (2009). Wirgin et al. (2009) proposed that the relatively shallow genetic differences among rivers within the Southern metapopulation, as compared to the Northern metapopulation(s), may result from one of a combination of two scenarios: (1) the movement of hatchery-reared individuals of Savannah River origin into non-natal rivers and their natural reproduction there led to significant alteration and homogenization of haplotype patterns and frequencies; or (2) shortnose sturgeon within the southern metapopulation may naturally migrate to adjoining rivers more than northern.

Comparing results from the most recent and best available genetics data from 14 collections surveyed for patterns in both mtDNA (Wirgin et al. 2009) and nDNA (King et al. in prep.) variation, all indications are that the variation detected in the mtDNA control regions and at 11 polysomic DNA markers is highly phylographically congruent. Pair-wise distance matrices also supported structure into three major metapopulations. Network mapping of genetic sequences reveal that each metapopulation exists very much in reproductive isolation with the most similarity among adjacent populations located within a larger metapopulation.

The Savannah River population of shortnose sturgeon, together with the other populations inhabiting rivers in the southeast United States, constitute the Southern metapopulation of shortnose sturgeon. Of the four known spawning populations present in the Southern metapopulation of shortnose sturgeon, only the Pee Dee, Savannah, and Altamaha populations are viable and self-sustaining, having sufficient numbers and successful reproduction to maintain the population without immigration or human interaction. The Santee-Cooper population is not self-sustaining. The Altamaha and Savannah Rivers support the only populations numbering in the hundreds within the Southern metapopulation. If any of these populations become extirpated, recolonization would likely require a long period of time (cf. Atlantic sturgeon estimated to take 100 years) and be further hindered by the lack of local recruits.

3.4.7 Ecology of Metapopulations

A metapopulation is a population of populations (Levins 1969) in which distinct populations occupy separate patches of habitat separated by unoccupied areas. All patchy populations are not necessarily metapopulations (Hanski and Simberloff 1997). The amount and effectiveness of movement separates a metapopulation from a single large, patch population. Low rates of connectivity through dispersal, with little to no effective movement, allow individual populations to remain distinct as the rate of migration between local populations is low enough not to have an impact on local dynamics or evolutionary lineages and distinguishes a metapopulation from a patchy population (Harrison 1991). On the other hand, high rates of connectivity via dispersal lead to the unification of the population and genetic lineages and results in a patchy population. Each metapopulation cycles in relative independence of other metapopulations. A metapopulation can go extinct as a consequence of demographic stochasticity (fluctuations in population size due to random demographic events); the smaller the metapopulation (or population), the more prone it is to extinction. Anthropogenic impacts acting on top of demographic stochasticity further increase the risk of extinction.

Not all species form metapopulations and metapopulation structure varies among species. A metapopulation may have many small satellite populations surrounding a large source population: the satellite populations rely on the source for recruits as they are too small and fluctuate too much to maintain themselves indefinitely. Elimination of the source population from this metapopulation usually results in the eventual extinction of the smaller satellite populations. Collectively metapopulations, or populations, constitute a species.

It is not unusual for lotic fishes to form metapopulations within coastal habitats. Separation into metapopulations is expected from sturgeon, and other anadromous fishes, given their likely stepping-stone sequential model of recolonization of northern rivers following post-Pleistocene deglaciation (Waldman et al. 2002).

3.4.8 (Meta)Population Stability, Viability, and Persistence

Populations of long-lived species tend to decline more rapidly and take much longer to recover than more productive species (Musick 1999). Because sturgeon are long-lived and slow-growing, stock productivity is relatively low. Although sturgeon employ the teleostean strategy of profligate spawning, with shortnose fecundity ranging between 27 and 208 thousand eggs per female, spawners within the action area are blocked from accessing appropriate spawning habitat above the dams.

Despite the longevity of sturgeon, the viability of sturgeon populations is highly sensitive to increases in juvenile mortality that result in chronic reductions in the number of sub-adults that recruit into the adult, breeding population (Anders et al. 2002, Gross et al. 2002, Secor et al. 2002). This relationship caused Secor et al. (2002) to conclude that sturgeon populations can be grouped into two demographic categories: populations that have reliable (albeit periodic) natural recruitment, and those that do not. The shortnose sturgeon populations without reliable natural recruitment are at risk of becoming critically endangered, extinct in the wild, or completely extinct.

Several authors have also demonstrated that sturgeon populations generally, and shortnose sturgeon populations in particular, are much more sensitive to adult mortality than other species of fish (Boreman 1997, Gross et al. 2002, Secor et al. 2002). These authors concluded that sturgeon populations cannot survive fishing-related mortalities that exceed five percent of an adult spawning run and they are vulnerable to declines and local extinction if juveniles die from fishing-related mortalities.

Using elasticity analysis, Gross et al. (2002) found that population growth in sturgeon is: (1) most sensitive to YOY and juvenile survival [on an age-specific basis]; (2) about equally sensitive to survival in the entire juvenile state and the entire adult stage; and (3) least sensitive to annual adult fecundity. The elasticity analysis by Gross et al. (2002) indicated that habitat improvements to increase survival of YOY, or any age-class within the juvenile life stage will make strong contributions to population growth. Conversely, habitat improvements that increase only fecundity or survival of a specific age-class, such as increased feeding opportunities for certain adults, will provide less of an increase in population growth (Gross et al. 2002).

Because a metapopulation is a population of populations, the stability, viability and persistence of individual populations affects the persistence and viability of the greater metapopulation. The loss of any population will result in: (1) a long-term gap in the range of the species; (2) loss of reproducing individuals; (3) loss of genetic biodiversity; (4) potential loss of unique haplotypes; (5) potential loss of adaptive traits; (6) reduction in total number; and (7) potential for loss of population source of recruits. In turn, the loss of populations will negatively impact the persistence and viability of both the metapopulation and the species as a whole.

Metapopulation persistence depends on the balance of extinction and colonization in a static environment (Hanski 1999). Models and empirical observations suggest that very small populations are relatively likely to become extinct (Soule 1986, Lande 1988, Simberloff 1988, Thomas 1990, Kindvall and Alhlen 1992), and many local populations in remnant habitat fragments will remain small. Under the assumption that the environment does not change greatly, many empirical studies have shown that the expected lifetime of a population increases with its current size (Williamson 1981, Diamond 1984). However, for rare and declining species, Thomas (1994) argues that: (1) extinction is usually the deterministic consequence of the local environment becoming unsuitable (through habitat loss or modification, introduction of a predator, etc.); (2) that the local environment usually remains unsuitable following local extinction, so extinctions only rarely generate empty patches of suitable habitat; and (3) that colonization usually follows improvement of the local environment for a particular species. Therefore, if habitat remains suitable following local extirpation, recolonization via immigrants into now-empty habitat may replace at least some of those losses (Thomas 1994). However, if the cause of extinction is a deterministic population response to unsuitable conditions, the local habitat is likely to remain unsuitable after extinction and be unavailable for recolonization (Thomas 1994). Therefore, recolonization is dependent upon both immigration and habitat suitability.

It has been established that the relationship between migration rate and population size strongly affect the dynamics of a metapopulation (Saether et al. 1998). In non-territorial animals, like the sturgeon, emigration of recruits is positively density-dependent. That is, larger populations have more emigration. Density-dependent migration strongly influences both the establishment and rescue effects in the local dynamics of metapopulations (Saether et al. 1998). In contrast, the dispersal rate decreases with increasing density in many territorial mammals (see examples in Diffendorfer1998).

The distribution of populations within a metapopulation is determined by habitat availability. Commonly the habitat within the geographic range of a metapopulation can be divided into suitable and unsuitable parts. In heterogeneous landscapes, persistence of a population is determined by dispersal ability as animals must traverse unsuitable habitat when moving between patches of suitable habitat. Usually, dispersal rates are determined by observed movement of tagged individuals. Generally, more individuals move short distances while a few individuals move longer distances. The probability of recolonization within a metapopulation decreases with increasing distances from existing local populations (Hanski 1999).

Regional persistence of a species is dependent on the existence of a metapopulation. Hence, elimination of much of the metapopulation increases the probability of regional extinction of the species. Persistence of a metapopulation depends on probability of recolonization (Hanski and Simberloff 1997) and dictates the viability of populations and, in turn, the metapopulation. Immigrants must be present, within dispersal distance of available appropriate habitat. If appropriate habitat is not available, immigrants may disperse into the area but will not survive. If local immigrants disperse into the patch and appropriate habitat is available, then inter-population emigration can rescue a population from extinction (called the rescue effect). If nearby recruits are scarce and the linear distance to the nearest reproducing population exceeds normal dispersal rates, immigration will not occur regardless of habitat availability. Regional stability of the metapopulation is strengthened as individuals disperse to recolonize empty patches with appropriate habitat.

The status of the Southern metapopulation of shortnose sturgeon is mixed. The Altamaha River supports the largest known population with successful self-sustaining recruitment. Spawning is also occurring in the Savannah River, the Cooper River, the Congaree River, and the Great Pee Dee River. The Savannah River is facing many environmental stressors and the current spawning is limited to a small area. While active spawning is occurring in South Carolina's Winyah Bay complex (Black, Sampit, Pee Dee and Waccamaw Rivers) the population status is unknown. Status of the other riverine populations supporting the Southern metapopulation is unknown due to limited survey, with capture in some rivers limited to less than five specimens.

The persistence of a species is dependent on the existence of metapopulations. The three metapopulations of shortnose sturgeon should not be considered collectively but as individual units of management. Each of these three shortnose sturgeon metapopulations is reproductively isolated from the other and therefore, constitutes an evolutionary (and likely an adaptively) significant lineage. The loss of any metapopulation would result in the loss of evolutionarily significant biodiversity and would result in a significant gap(s) in the species' range. Loss of the Southern shortnose sturgeon metapopulation would result in the loss of the southern half of the species' range (i.e., no known reproduction south of the Delaware River). Loss of the Mid-Atlantic metapopulation (Virginian Province) would create a conspicuous discontinuity in the range of the species from the Hudson River to the northern extent of the Southern metapopulation. The Northern metapopulation constitutes the northernmost portion of the U.S. range. Loss of this metapopulation would result in a significant gap in the range that would serve to isolate the shortnose sturgeon residing 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. Two metapopulations would be more vulnerable to recover from stochastic events than three; the loss of any metapopulation would increase species' vulnerability to stochastic events.

Threats
As noted in the shortnose sturgeon recovery plan, habitat degradation or loss (resulting from dams, bridge construction, channel dredging, and pollutant discharges), and mortality (from impingement on cooling water intake screens, dredging, and incidental capture in other fisheries) are principal threats to the species' survival.

A shortnose sturgeon population segment will remain listed as long as there is: 1) present or threatened destruction, modification, or curtailment of its habitat or range; 2) overutilization for commercial, recreational, scientific or educational purposes; 3) disease or predation; 4) inadequate existing regulatory mechanisms; or 5) other natural or anthropogenic factors affecting their continued existence (ESA, 1973).

Summary of Status of Shortnose Sturgeon
The shortnose sturgeon is a freshwater amphidromous fish inhabiting large coastal rivers along the eastern seaboard of North America from the Saint John River in New Brunswick, Canada, south to the St. Johns River in Florida. Clinal differences in growth and behavior are obvious for shortnose sturgeon: fish in the north grow slower but reach larger size, timing of spawning migration is earlier in the south, etc. Genetic analysis has indicated that population structure occurs across the range of shortnose sturgeon: at least two or perhaps three metapopulations of shortnose sturgeon exist. Within a metapopulation, individual populations interact at some level via movement, but not effectively (i.e., reproduction). Shortnose sturgeon from North Carolina south through Florida are part of a single metapopulation, the Southern (or, “Carolinian Province”) metapopulation. There are markedly fewer shortnose sturgeon in the southern United States compared to the north. No recent population trend data exist.

3.4.9 Status of the Atlantic Sturgeon

Listing
Five separate distinct population segments (DPS) of the Atlantic sturgeon (*A. oxyrinchus oxyrinchus*) (Figure 20) were proposed for ESA listing by NMFS on October 6, 2010: from north to south these DPS groupings are the Gulf of Maine, New York Bight, Chesapeake Bay, Carolina, and South Atlantic (75 FR 61872 and 61904) (Figure 21). The South Atlantic DPS is estimated to number less than 6 percent of its historical population size (ASSRT 2007), with all river populations except the Altamaha estimated to be less than 1 percent of historical abundance. Prior to 1890, Secor (2002) estimated there were 8,000 adult spawning females in South Carolina and 11,000 adult spawning females in Georgia. Currently, there are an estimated 343 spawning adults in the Altamaha and less than 300 spawning adults (total of both sexes) in each of the other major river systems occupied by the DPS, whose freshwater range occurs in the watersheds of the ACE Basin in South Carolina to the St. Johns River, Florida. The South Atlantic DPS was proposed for listing as endangered under the ESA as a result of a combination of habitat curtailment and alteration, overutilization in commercial fisheries, and inadequacy of regulatory mechanisms in ameliorating these threats and impacts. This represents NMFS’ conference opinion on the South Atlantic DPS of Atlantic sturgeon.

Figure 20. Atlantic sturgeon

Range

The range of the South Atlantic DPS includes fish that spawn in the watersheds from the Ashepoo, Combahee, and Edisto Rivers (ACE Basin) in South Carolina, southward to the Satilla River in Georgia (Table 3). Sturgeon are still found within the St. Johns River in Florida, but this river is now believed to only serve as a nursery. The marine range of Atlantic sturgeon from the South Atlantic DPS extends from the Bay of Fundy, Canada, to the St. Johns River, Florida. While sturgeon are commonly captured 40 miles offshore (D. Fox, DSU, pers. comm.), the offshore range of Atlantic sturgeon is best investigated through fishery bycatch records that record data by depth rather than distance offshore. The vast majority of Atlantic sturgeon bycatch via gillnets is observed in waters shoal of 50 fathoms, but Atlantic sturgeon are recorded as bycatch out to 500 fathoms.

River/Estuary	Reproduction	Source
Ashepoo River, SC	Uncertain,	NMFS 2010
Combahee River, SC	Spawning, YOY	NMFS 2010
Edisto River, SC	Spawning, YOY	NMFS 2010
Savannah River, GA/SC	Spawning, YOY	NMFS 2010
Ogeechee River, GA	Spawning, YOY	NMFS 2010
Altamaha River, GA	Spawning, YOY	NMFS 2010
Satilla River, GA	Spawning, YOY	NMFS 2010
St. Johns River, FL	Uncertain	NMFS 2010

Table 3. List of rivers in the southeast United States known to support Atlantic sturgeon that comprise the South Atlantic Distinct Population Segment.

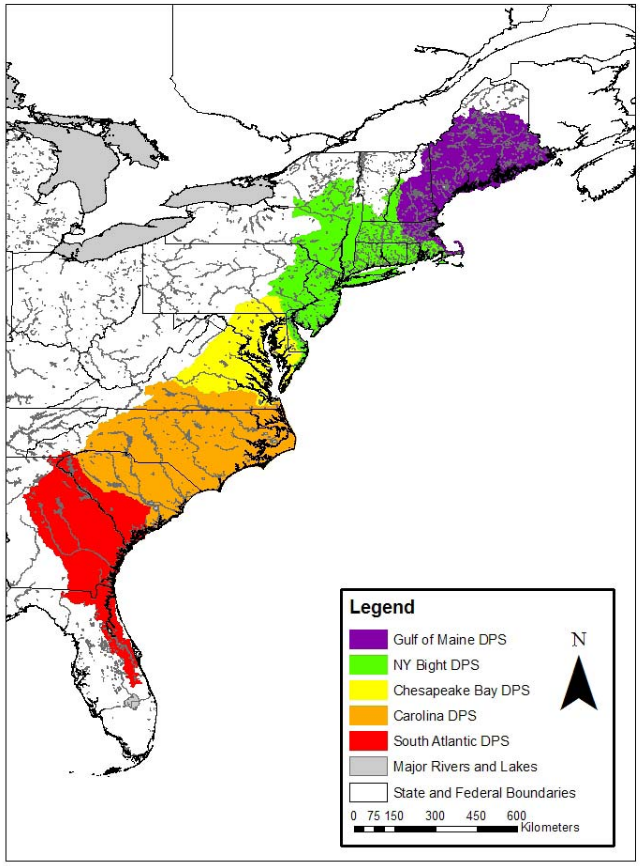


Figure 21. Map depicting the five Distinct Population Segments (DPSs) of Atlantic sturgeon: Gulf of Maine, New York Bight, Chesapeake Bay, Carolina, and South Atlantic.

Life History

The scientific name for Atlantic sturgeon is *Acipenser oxyrinchus oxyrinchus*: *Acipenser* is Latin for sturgeon and *oxyrinchus* means sharp nose. Mitchell originally described the species from a New York specimen in 1815.

Although specifics vary across latitude, the general life history pattern of Atlantic sturgeon is that of a long-lived, late maturing, estuarine dependent, anadromous species. Atlantic sturgeon reach lengths up to 4.3 m and weigh over 363 kg. Atlantic sturgeon have been aged to 60 years (Mangin 1964); however, this should be taken as an approximation, as the only age validation study conducted to date shows variations of ±5 years (Stevenson and Secor 1999). Scott and Crossman (1973) report maximum age for the species as 30. Juvenile Atlantic sturgeon often resemble adult shortnose sturgeon; the species are sympatric. Atlantic sturgeon are distinguished by armor-like plates (scutes) and the presence of two sets of barbels below their long, sharply V-shaped snout, located in a transverse line midway between the end of the snout and the anterior edge of the protruding mouth. Coloration varies but adult Atlantic sturgeon are generally dark bluish-black in color dorsally and lighter ventrally (white or yellow in color below lateral scutes).

Sturgeon are omnivorous benthic feeders (feed off the bottom) and filter quantities of mud along with their food. Adult sturgeon diets include mollusks, gastropods, amphipods, isopods, and fish. Juvenile sturgeon feed on aquatic insects and other invertebrates (ASSRT 2007). A recent investigation by Collins et al. (2006) indicated that sub-adult Atlantic sturgeon in both the Edisto and Savannah Rivers foraged mostly on invertebrates with a high percentage of amphipods and polychaetes. Although prey and foraging habitat overlap, Atlantic and shortnose sturgeon are not thought to compete for the same food items, as Atlantic sturgeon diet is more generalized comprised of invertebrates, and shortnose sturgeon having a more specialized diet of amphipods (Collins et al. 2006). In marine waters, Atlantic sturgeon feed on mollusks, polychaete worms, gastropods, shrimps, amphipods, isopods, and small fish (Scott and Crossman 1973). The presence of food in the stomachs of large (>1.25 m FL) Atlantic sturgeon captured in the Edisto and Savannah Rivers demonstrates that these fish do not fast while in freshwater as previously believed (Collins et al. 2006).

Atlantic sturgeon migrate seasonally between upstream freshwater spawning habitat, estuarine nursery habitat, and marine foraging habitat. Atlantic sturgeon likely do not spawn every year. Multiple studies have shown that spawning intervals range from 1–5 years for males (Smith 1985, Collins et al. 2000a, Caron et al. 2002) and 2–5 years for females (Vladykov and Greeley 1963, Van Eenennaam et al. 1996, Stevenson and Secor 1999). Sexual maturity varies across latitude, with faster growth and earlier age at maturation in southern rivers compared to northern. Atlantic sturgeon mature in South Carolina at 5–19 years (Smith et al. 1982), in the Hudson River at 11–21 years (Young et al. 1988), and in the Saint Lawrence River at 22–34 years (Scott and Crossman 1973). Thirty-nine adult Atlantic sturgeon were sexed in the Combahee and Edisto Rivers, South Carolina: females ranged between 180-234 cm TL and were aged 15-20 years; males ranged between 139-195 cm TL and were aged 7-15 years (Collins et al. 2000b).

To spawn, adult Atlantic sturgeon move from the sea to the estuary as the river water temperatures warm. This occurs earlier in southern rivers than in northern rivers. Atlantic sturgeon are known to return to their natal river to spawn as indicated from both tagging records (Collins et al. 2000b, K. Hattala, NYSDEC, pers. comm.) and the relatively low rates of gene flow indicated by population genetics studies (King et al. 2001, Waldman et al. 2002). During non-spawning years, adults use marine waters either year-round or seasonally (Bain 1997) and do not migrate upstream to the spawning areas.

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

Atlantic sturgeon spawning behavior is also gender specific. Spawning females do not migrate upstream together as a group; rather, individual females make rapid spawning migrations upstream and quickly depart the area following spawning (Bain 1997). Spawning males appear to move upstream on incoming tides and then remain stationary for several hours (Dovel and Berggren 1983), meander back and forth across the channel remaining in water depth greater than 7.6 m, and usually arrive on the spawning grounds before any of the females have arrived and leave after the last female has spawned (Bain 1997). Presumably, this provides an opportunity for a single male to fertilize eggs of multiple females.

Spawning is believed to occur in flowing water between the salt front of estuaries and the fall line of large rivers, upstream to at least rkm 100, where optimal flows are 46–76 cm/s and depths are 11–27 m (Scott and Crossman 1973, Bain et al. 2000). Sturgeon eggs are highly adhesive and are deposited on the benthos, usually on hard substrates such as cobble (Gilbert 1989, Smith and Clugston 1997). Fecundity of female Atlantic sturgeon has been correlated with age and body size, with observed egg production ranging from 400,000 to 4 million eggs per spawning year (Smith et al. 1982, Van Eenennaam et al. 1996). The average age at which 50 percent of the maximum lifetime egg production is achieved is estimated to be 29 years (Boreman 1997).

Atlantic sturgeon eggs must be spawned upstream of the salt front due to their low tolerance for saline environments (Van Eenennaam et al. 1996). Atlantic sturgeon eggs have a low salt tolerance, with mortality documented at salinities as low as 5 to 10 ppt (McEnroe and Check 1985, Jenkins et al. 1993). After spawning, most studies indicate adult Atlantic sturgeon migrate to salt water (Vladykov and Greeley 1963), with down-estuary migrations occurring up to several months (Bain 1997), likely initiated by a combination of increased flow and temperature (Kieffer and Kynard 1993).

Eggs hatch approximately 94-140 hrs after fertilization and, once hatched, larvae assume a demersal existence (Smith et al. 1980). The yolksac larval stage is completed in about 8–12 days. Newly hatched larvae are active swimmers and, once the yolk sac is absorbed, the larvae exhibit benthic behavior (Smith et al. 1980) and initiate downstream movement (Kynard and Horgan 2002). Downstream larval migration is diel; larvae move only at night and use benthic structure (e.g., gravel matrix) as refuge during the day (Kynard and Horgan 2002). As the larvae mature, downstream movement occurs during both day and night. Larvae transition into the juvenile phase as they continue to move downstream into brackish waters, developing salinity tolerance with maturity. Juveniles eventually become residents in estuarine waters for months to years before migrating to open ocean as subadults (Dovel and Berggren 1983, ASSRT 2007, Schueller and Peterson 2010).

Juvenile Atlantic sturgeon eventually join adults in the upper estuarine habitat where they frequently congregate around the saltwater interface. Both of these life stages may travel short distances upstream and downstream throughout the summer and fall, and during late winter and spring spawning periods (Greene et al. 2009), between fresh and brackish waters, influenced by changes in water temperature (Van Den Avyle 1984) as they seek the cooler waters and avoid shallow areas with the highest water temperature (Bain 1997). These estuarine habitats are important for juveniles as they serve as a nursery area by providing abundant foraging opportunities, and thermal and salinity refuges while undergoing rapid growth. Some juveniles will take up residency in non-natal rivers that lack active spawning sites (Bain 1997). Residency time of these young Atlantic sturgeon in the estuarine areas varies between one (Secor et al. 2000b), three (Schueller and Peterson 2010), and six (Smith 1985) years before commencing outmigration to sea. Outmigration of adults from the estuaries out to the sea is cued by water temperature and velocity. Adult Atlantic sturgeon will then reside in the marine habitat during the non-spawning season and forage extensively. Coastal migrations by adult Atlantic sturgeon are extensive and are known to occur over sand and gravel substrate (Greene et al. 2009). Atlantic sturgeon remain in the marine habitat until the waters begin to warm, at which time developing adults migrate back to their rivers.

Few diet studies have been conducted on the Atlantic sturgeon. A recent investigation by Collins et al. (2006) indicated that sub-adult Atlantic sturgeon in both the Edisto and Savannah Rivers foraged mostly on invertebrates, with a high percentage of amphipods and polychaetes. In marine waters, Atlantic sturgeon feed on mollusks, polychaete worms, gastropods, shrimps, amphipods, isopods, and small fish (Scott and Crossman 1973). The presence of food in the stomachs of large Atlantic sturgeon sampled in freshwater river systems demonstrates that fish do not fast while in freshwater, as previously believed (Collins et al. 2006).

Distinct Population Segment Viability

The viability of sturgeon population growth is particularly sensitive to mortality, given their long lived, slow growing, and relatively low stock productivity. Because a DPS is a group of populations, the stability, viability, and persistence of individual populations affects the persistence and viability of the larger DPS. The loss of any population within a DPS will result in: (1) a long-term gap in the range of the DPS that is unlikely to be recolonized; (2) loss of reproducing individuals; (3) loss of genetic biodiversity; (4) potential loss of unique haplotypes; (5) potential loss of adaptive traits; and (6) reduction in total number. The loss of a population will negatively impact the persistence and viability of the DPS as a whole, as fewer than two individuals per generation spawn outside their natal rivers (Secor and Waldman 1999). The persistence of individual populations, and in turn the DPS, depends on successful spawning and rearing within the freshwater habitat, the immigration into marine habitats to grow, and then the return of adults to natal rivers to spawn.

The riverine spawning habitat of the South Atlantic population segment occurs within the South Atlantic Coastal Plain eco-region. TNC describes the South Atlantic Coastal Plain eco-region as fall-line sandhills to rolling longleaf pine uplands to wet pine flatwoods;

from small streams to large river systems to rich estuaries; from isolated depression wetlands to Carolina bays to the Okefenokee Swamp. Other ecological systems in the eco-region include maritime forests on barrier islands, pitcher plant seepage bogs and Altamaha grit (sandstone) outcrops. The primary threats to biological diversity in the South Atlantic Coastal Plain listed by TNC are intensive silvicultural practices, including conversion of natural forests to highly managed pine monocultures and the clear-cutting of bottomland hardwood forests. Changes in water quality and quantity, caused by hydrologic alterations (impoundments, groundwater withdrawal, and ditching), and point and nonpoint pollution, are threatening the aquatic systems. Development is a growing threat, especially in coastal areas. Agricultural conversion, fire regime alteration, and the introduction of nonnative species are additional threats to the eco-region's diversity. The South Atlantic DPS' spawning rivers, located in the South Atlantic Coastal Plain, are primarily of two types: brownwater (with headwaters north of the Fall Line, silt-laden) and blackwater (with headwaters in the coastal plain, stained by tannic acids). Therefore, the eco-region delineations support that the physical and chemical properties of the Atlantic sturgeon spawning rivers utilized by the South Atlantic DPSs are unique to the population segment. Since reproductive isolation accounts for the discreteness of each population segment, the South Atlantic population segment of Atlantic sturgeon are ''significant'' as defined in the DPS policy given that the spawning rivers for each population segment occur in a unique ecological setting. The loss of the South Atlantic population segment of Atlantic sturgeon would create a significant gap in the range of the taxon.

The concept of a viable population able to adapt to changing environmental conditions is critical to Atlantic sturgeon, and the low population numbers of every river population in the South Atlantic DPS puts them in danger of extinction throughout their range; none of the populations are large or stable enough to provide with any level of certainty for continued existence of Atlantic sturgeon in this part of its range. The South Atlantic DPS is estimated to number less than 6 percent of its historical population size (ASSRT, 2007), with all river populations except the Altamaha estimated to be less than 1 percent of historical abundance. Prior to 1890, Secor (2002) estimated there were 8,000 adult spawning females in South Carolina and 11,000 adult spawning females in Georgia. Currently, there are an estimated 343 spawning adults in the Altamaha and less than 300 spawning adults (total of both sexes) in each of the other major river systems occupied by the DPS, whose freshwater range occurs in the watersheds of the ACE Basin in South Carolina to the St. Johns River, Florida.

Their late age at maturity provides more opportunities for individual Atlantic sturgeon to be removed from the population before reproducing. While a long life-span allows multiple opportunities to contribute to future generations, it also increases the timeframe over which exposure to the multitude of threats facing the South Atlantic DPS can occur. These threats include the loss, reduction, and degradation of habitat resulting from dams, dredging, and changes in water quality parameters (such as depth, temperature, velocity, and dissolved oxygen).

Threats

Atlantic sturgeon throughout the South Atlantic DPS are exposed to a variety of habitat threats including: restricted access to riverine habitat; large portions of degraded habitat, which may result in high levels of tissue contamination and water quality standards that are below fish health standards; and/or poor quality of some benthic habitat. Without substantial mitigation and management to improve the habitat and water quality of these systems, Atlantic sturgeon subpopulations will likely continue to be depressed until suitable habitat and water quality conditions are achieved. This is evident in southern streams that are suspected to no longer support reproducing Atlantic sturgeon subpopulations, such as the St. Mary's and St. Johns rivers. Although these rivers are at the southern range of the species, the degradation of habitat via dredging and water pollution likely prohibit Atlantic sturgeon from recolonizing these systems. The recovery of Atlantic sturgeon along the Atlantic Coast, especially in areas where habitat and water quality is severely degraded, will require improvements in the following areas: 1) elimination of barriers to spawning habitat either through dam removal, breaching, or installation of successful fish passage facilities; 2) operation of water control structures to provide flows compatible with Atlantic sturgeon use in the lower portions of rivers (especially during the spawning season); 3) imposition of restrictions on dredging, including seasonal restrictions and avoidance of spawning/nursery habitat; and 4) mitigation of water quality parameters that are restricting sturgeon use of a river (i.e., dissolved oxygen). Additional data regarding sturgeon use of riverine and estuarine environments is needed.

The Atlantic sturgeon recovery team (SRT) evaluated the status of Atlantic sturgeon using the five-factor analysis described in section 4(a)(1) of the ESA. The SRT identified 15 stressors within these five factors and summarized their impacts on Atlantic sturgeon using a semi-quantitative extinction risk analysis (ERA), similar to that used by other status review reports (e.g. *Acropora*). Of the stressors evaluated, bycatch mortality, water quality, lack of adequate state and/or Federal regulatory mechanisms, and dredging activities were identified as the most significant threats to the viability of Atlantic sturgeon populations.

A review of the literature and potential threats to South Atlantic DPS revealed that dredging, water quality, and commercial bycatch were ranked as the greatest threats to the South Atlantic DPS - receiving ERA scores of 3 or moderate risk (<50% chance of becoming endangered over the next 20 years). While the median value associated with the risk for the DPS was moderate and did not meet the threshold of >50% chance of becoming endangered, the team recognized that three of the eight historic subpopulations are likely extirpated and data is lacking for many of the other subpopulations. As a result, the SRT determined that available science was insufficient to allow a full assessment of these subpopulations within the South Atlantic DPS.

Summary of the Status of Atlantic Sturgeon

The Atlantic sturgeon is an anadromous species inhabiting large coastal rivers along the Eastern seaboard of North America from the Saint John River in New Brunswick, Canada south to the St. Johns River in Florida. Clinal differences in growth and behavior are obvious for Atlantic sturgeon: fish in the north grow slower, but reach larger size; timing of spawning migration is earlier in the south; etc. Genetic analysis has indicated that population structure occurs across the range of Atlantic sturgeon. Atlantic sturgeon between the Ashepoo, Combahee, and Edisto Rivers (ACE Basin) in South Carolina, southward to the Satilla River in Georgia, constitute the South Atlantic DPS that was proposed for ESA listing as endangered (75 FR 61904). The marine range of the Atlantic sturgeon South Atlantic DPS extends from the Bay of Fundy, Canada, to the St. Johns River, Florida.

3.4.10 Sturgeon Habitat Use and Requirements

Shortnose and Atlantic sturgeon habitat requirements are ontogenetic and clinal: water temperature, dissolved oxygen concentration, and water depth requirements change as they mature and vary across latitudes. Shortnose and Atlantic sturgeon require appropriate habitat throughout their life cycle. Atlantic sturgeon are anadromous and shortnose sturgeon are freshwater amphidromous, which means they differ mostly in their use of salt water habitat: while both shortnose and Atlantic sturgeon utilize freshwater systems extensively, only adult Atlantic sturgeon extensively utilize saltwater habitat, compared to shortnose sturgeon who rarely leave natal rivers/estuaries. Adult Atlantic sturgeon are generally present in southern rivers between February and October; they outmigrate and reside in the ocean during winter months and later return to spawn in their natal rivers. In contrast, shortnose sturgeon remain in the river system throughout their lives, only periodically utilizing saline water in the river's estuary (Buckley and Kynard 1985b, Kieffer and Kynard 1993); a few have been known to occasionally migrate short distances to a nearby river.

In free-flowing rivers, adults of both species migrate annually between upstream spawning areas and then downstream to estuarine areas. Within the project area, the New Savannah Bluff Lock and Dam blocks access to the majority of historical sturgeon spawning habitat. Apart from the spawning period, both species spend most of the time moving between fresh and brackish water areas to forage, or avoid high water temperatures.

Winter/Spawning

Water temperature cues sturgeon to initiate upstream movement to spawning sites. Therefore, upstream migration to spawning sites is earlier for sturgeon in southern rivers compared to the north. Both shortnose and Atlantic sturgeon spawning usually occurs during February and March in southern rivers. Because it is energetically expensive to migrate, non-mature and most non-spawning adults do not move upstream to spawn, rather they remain downstream year-round.

Male Atlantic sturgeon generally initiate upstream movement when waters reach about 6°C (Smith et al 1982, Dovel and Berggren 1983, Smith 1985) with females following when water temperatures are closer to 12°C or 13°C (Dovel and Berggren 1983, Smith 1985, Collins et al. 2000b). Atlantic sturgeon spawn in waters where temperatures range between 13°-26°C (Huff 1975, Smith 1985, Bain et al. 2000, Caron et al. 2002). Water depth at spawning sites varies greatly and is dependent upon available depth range. Atlantic sturgeon have been reported to spawn in water depths from 3 to 27 m (Scott and Crossman 1973, Bain et al. 2000, Collins et al. 2000b, Caron et al. 2002). Benthic substrate at spawning sites must be hard bottom for successful egg attachment and incubation: these materials include silt-free boulder, bedrock, and cobble-gravel. These hard substrates often occur in the rapids complex with flowing water at velocities between 0.46 to 0.76 m/s. Ripe Atlantic sturgeon and shortnose sturgeon have also been found in the fall, indicating they may have a fall spawning run as indicated by histological examination of gonadal biopsies and directed upriver movements (Collins et al. 2000a).

Shortnose sturgeon have been documented to spawn when water temperatures range from 9°-15°C (Dadswell 1979, Taubert 1980, Kynard 1997, Collins et al. 2000a). Spawning sites have been found to consist of moderate river flows with average bottom velocities between 0.3 – 1.2 m/s (Buckley and Kynard 1985b, Hall et al. 1991, Kieffer and Kynard 1996, NMFS 1998). Water velocity is critical for sturgeon spawning; slow flow allows eggs to clump together while higher velocities may prevent eggs from adhering to the substrate (Taubert and Dadswell 1980, Buckley and Kynard 1985a, Kynard 1997). In populations that have free access to the total length of a river, shortnose sturgeon spawning areas are often located at the farthest accessible upstream reach of the river (Kynard 1997).

Shortnose and Atlantic sturgeon spawning usually occurs over gravel, rubble, and/or cobble or large rocks (Dadswell 1979, Taubert 1980, Buckley and Kynard 1985a, Kynard 1997), or timber, scoured clay and gravel (Hall et al. 1991). Shortnose sturgeon spawning sites have also been characterized as deep, scoured channels with hard substrates for eggs to adhere (Collins et al. 2000a). These sturgeon spawning areas are seemingly discrete, as fish return to specific areas over consecutive years (Kieffer and Kynard 1993).

Following spawning, downstream migration is quicker for spent shortnose sturgeon than spent Atlantic sturgeon. Shortnose move rapidly to downstream feeding areas (Dadswell et al. 1984, Buckley and Kynard 1985a, Kieffer and Kynard 1993, O'Herron et al. 1993, Collins and Smith 1993), while Atlantic sturgeon migration may occur over several months (Bain 1997). Kieffer and Kynard (1993) reported that post-spawning migrations of shortnose sturgeon were correlated with increasing spring water temperature and river discharge.

Few data are available describing the migratory pathways of shortnose and Atlantic sturgeon, as most data describe periodicity of sturgeon movement upstream or downstream but fail to describe habitat parameters such as depth or water temperature. Dovel and Berggren (1983) report migrating Atlantic sturgeon in depths greater than 7.6 meters. Migratory pathways of white sturgeon (*A. transmontanus*) are better described. Phylogenetically, shortnose sturgeon are very similar to white sturgeon (Birstein and Bemis 1997). Water depth is known to be a major factor to determine white sturgeon migratory pathways.

It has been noted that shortnose sturgeon will labor to migrate upstream during spawning season but will eventually abandon the migration and resorb eggs. Kynard (1998) noted the condition of shortnose sturgeon in shallow rapids as having severely worn and bleeding ventral scutes. Water depth is so important for spawning white sturgeon that it was identified as a primary constituent element of the Kootenai white sturgeon critical habitat (73 FR 39506, July 9, 2008).

Spring
Newly hatched sturgeon continue to migrate downstream in the spring to riverine rearing/nursery habitats where they join older juveniles. These young sturgeon require nursery habitats to grow and escape predation. Concentration areas of shortnose sturgeon are occupied year-round by mixed age individuals (Kynard et al. 2000). In both freshwater and estuarine environments, juvenile Atlantic sturgeon are widely dispersed (Schueller and Peterson 2010). Shortnose sturgeon larvae and juveniles have been reported from, and may prefer, deep river channels (Richmond and Kynard 1995) above the salt wedge. Bath et al. (1981) reported larvae occurring at depths of 9.1 – 9.8 m (29.9 - 32.1 feet) where water temperatures were 15.0 – 24.5 °C (59 - 76.1 °F), in salinities of approximately 0 – 22 parts per thousand (ppt).

Studies on the salinity exposure for shortnose sturgeon juveniles indicated that tolerance to increased salinity improved with age. Fish 76 days old experienced 100 percent mortality in a 96-hour test when exposed to salinities >15 ppt while 330-day-old fish tolerated salinities as high as 20 ppt for a duration of 18 hours but exhibited 100 percent mortality at 30 ppt. There is a large amount of variation in the salinity tolerance of juvenile Atlantic sturgeon, individual studies have observed salinity ranges between 0-16 ppt (Greene et al 2009). Younger fish were also more susceptible to low dissolved oxygen concentrations than older fish. In a 6-hour test, fish 64 days old exhibited 86 percent mortality when exposed to dissolved oxygen concentrations of 2.5 mg/liter. However, sturgeon >100 days old were able to tolerate concentrations of 2.5 mg/liter with <20 percent mortality (Jenkins 1993).

Adult shortnose sturgeon prefer lower salinity than pure seawater, typically in the range of 30 - 31 ppt (Holland and Yelverton 1973; Dadswell et al 1984). In areas where shortnose sturgeon occur with the Atlantic sturgeon, the two species apparently segregate the habitat according to salinity preferences, with Atlantic sturgeon preferring more saline areas. Gilbert (1990) suggested that though the shortnose sturgeon is capable of entering the open ocean, it is hesitant to do so. This factor may be the single largest consideration limiting extensive coastal migrations of this species.

Following spawning, both shortnose and Atlantic sturgeon begin foraging. Specific diet items of the shortnose and Atlantic sturgeon were discussed previously (Sections 3.4.3 and 3.4.4, respectively). Both species rely on sandy substrate that supports benthic invertebrates. Foraging occurs over three seasons that vary across latitude, apparently determined by extremes in water temperature and the need to reduce energetic expenditure. Kynard et al. (2000) found distinct seasonal shifts reflected in both foraging activity and habitat change, with change in water temperature. Sturgeon will forage when water temperatures are optimal and find resting habitat when water temperatures become extreme. Therefore, in southern rivers sturgeon are foraging in the fall, winter, and spring and resting in the summer; and in the north they are foraging in spring, summer, and fall.

Shortnose sturgeon in Massachusetts distinctly shifted from summer foraging to fall/wintering resting (Kynard et al. 2000). To minimize energetic expenditure during the extreme cool winter water temperatures, shortnose sturgeon were not actively foraging and selected deep, slow water to minimize swimming while holding position (Kynard et al. 2000). Within southern rivers, that includes the Project area, shortnose sturgeon are known to forage widely throughout the estuary during the fall, winter, and spring (Collins and Smith 1993, Weber et al. 1999), and then significantly reduce or cease foraging completely in the summer as they take refuge from high water temperatures by congregating in cool, deep areas of the river (Flourney et al. 1992, Rogers and Weber 1994, Rogers and Weber 1995, Weber 1996). Both water depth and current velocity have been found to be important in selecting these resting areas, as both Atlantic and shortnose sturgeon have been found to select deeper, slow water during their periods of resting.

Summer

The fresh-brackish water interface area serves as the summer habitat for juvenile Atlantic sturgeon and all ages of shortnose sturgeon in the Southeast (Hall et al. 1991, Flourney et al. 1992, Smith et al. 1992, McCord 1998, Collins et al. 2000b). Juvenile shortnose sturgeon regularly move throughout the saline portions (0-16 ppt) of the salt wedge during summer (Pottle and Dadswell 1979, Weber 1996) and are more active when water temperatures are cooler (<16°C) (Weber 1996). Juveniles have been found congregating in deeper sand/mud substrate in depths of 10-14 m (Hall et al. 1991). As mentioned above, studies on the salinity exposure for shortnose sturgeon juveniles indicated that tolerance to increased salinity improved with age. Fish 76 days old experienced 100 percent mortality in a 96-hour test when exposed to salinities >15 ppt while 330-day-old fish tolerated salinities as high as 20 ppt for a duration of 18 hours but exhibited 100 percent mortality at 30 ppt (Jenkins 1993). Adult shortnose sturgeon prefer lower salinity than pure seawater, typically in the range of 23 - 30 ppt (Collins et al. 2001). Adult Atlantic sturgeon in South Carolina were found to utilize a wide variety of habitats in the summer, with salinities ranging between 0 and 28 ppt, dissolved oxygen between 3.4-8.3 mg/Liter, water temperatures as high as 33.1°C, and in substrates including fine mud, sand, pebbles and shell hash (Collins et al. 2000b). Adult Atlantic sturgeon were located through the summer in depths between 1.5 -13.0 m; however, in nearly all cases fish were in the greatest depth available in the immediate area (Collins et al. 2000b).

Considerable work has been conducted on temperature tolerances of sturgeon (Kynard 1997, Campbell and Goodman 2004, Van Eenennaam et al. 2005, Ziegweid et al. 2008). In recent work on critical thermal maximum, Ziegweid et al. (2008b) demonstrated hatchery–raised YOY shortnose sturgeon can tolerate between 28°-31°C. Kynard (1997) also notes empirical temperatures of 28°-30°C in summer months created unsuitable shortnose sturgeon habitat. Atlantic sturgeon experience lower survival when water temperatures exceed 28°C (Niklitshek and Secor 2005). Summer water temperatures in southern estuaries commonly approach, and sometimes exceed, the maximum tolerable levels identified in the laboratory.

Temperatures in excess of 28°C are considered to have sub-lethal effects on Atlantic sturgeon (Niklitschek and Secor 2005). This low tolerance to temperature and low oxygen is of particular concern during the first two summers when juvenile Atlantic sturgeon are restricted to lower saline waters and are unable to seek out thermal refuge in deeper waters (Secor and Gunderson 1998, Niklitschek 2001, Niklitschek and Secor 2005). Juveniles have been reported in depths between 2-37 m, and water temperatures between 0.5°-27°C (Greene 2009). Summer habitats of Atlantic sturgeon in the Altamaha River were typically in the mid-channel where water temperatures varied between 25.4°-29.5°C (Peterson et al. 2006).

Because warm water holds less dissolved oxygen , high water temperatures coupled with low dissolved oxygen concentrations are known to have synergistic effects and lead to mortality of both shortnose and Atlantic sturgeon; this affects southern populations to a greater extent than those to the north, particularly in the summer months (Collins et al. 2000b). Effects of low dissolved oxygen vary with sturgeon age. Shortnose sturgeon less than 78 days old had 80 percent mortality when exposed to dissolved oxygen at 2.5 mg/Liter and 18-38 percent mortality at 3.0 mg/Liter. Slightly older fish experienced minimal mortality at nominal levels >2.5 mg/Liter; mortality at 2.0 mg/Liter increased to 24-38 percent. Young-of-the-year shortnose sturgeon experienced 96 percent mortality rate within 4 hours after exposure to dissolved oxygen levels ranging from 2.2 mg/Liter to 3.1 mg/Liter (Campbell and Goodman 2004). Bioenergetic and behavioral responses indicate that habitat for YOY (~30 to 200 days old) becomes unavailable with less than 60 percent saturation (Secor and Niklitschek 2001); this occurs at summertime temperatures of 22°-27°C with dissolved oxygen of 4.3-4.7 mg/Liter. Although tolerance for low dissolved oxygen increased with age, Flourney et al. (1992) reported physiological stress to adult sturgeon during periods of high water temperature and low dissolved oxygen levels.

Sensitivity of sturgeon and other fishes to temperature, oxygen, and their interaction has been evaluated experimentally through respirometry. Critical oxygen concentration is determined by melding the metabolic response curve to required dissolved oxygen concentration: oxygen levels below that point will constrain metabolism, growth, and swimming activity. As basal metabolism of fishes increases with water temperature, the critical concentration becomes higher and demand outpaces availability. At very low oxygen concentrations, metabolism decreases rapidly and the fish dies; this is termed threshold concentration. Both critical and threshold concentrations are substantially higher for sturgeons in comparison to freshwater fishes.

In comparison to other fishes, sturgeon are more sensitive to low dissolved oxygen conditions. Sturgeons have limited behavioral and physiological capacity to respond to hypoxia (multiple references reviewed and cited by Secor and Niklitschek 2001 and 2003). Their basal metabolism, growth, consumption, and survival are all very sensitive to changes in oxygen levels, which may indicate their relatively poor ability to oxyregulate (EPA 2003). In summer, the coupling of low dissolved oxygen and water temperatures greater than 20°C amplify the effect of hypoxia on sturgeon and other fishes due to a temperature-oxygen habitat squeeze (Coutant 1987). Sturgeon often seek the temperatures they prefer in deeper waters, but those deeper waters may also occasionally have dissolved oxygen levels below the minimum required. In these instances, sturgeon may avoid the unsuitable areas and may be forced to occupy constricted habitats.

Jenkins et al. (1993) examined environmental tolerance of dissolved oxygen on shortnose sturgeon and found that younger fish were differentially susceptible to low oxygen levels in comparison to older juveniles. Shortnose sturgeon older than 77 days experienced minimal mortality at nominal levels >2.5 mg/Liter; mortality at 2.0 mg/Liter increased to 24-38 percent. Dissolved oxygen at 3.0 mg/Liter resulted in 18-38 percent mortality of fish less than 78 days old, increasing to 80 percent at 2.5 mg/Liter.

More rigorous testing using YOY shortnose sturgeon (77-134 days old) coupling temperature and dissolved oxygen values also found a high degree of sensitivity to low dissolved oxygen in acute tests at low salinities (Campbell and Goodman 2004). YOY shortnose sturgeon exposed to dissolved oxygen levels ranging from 2.2 mg/Liter to 3.1 mg/Liter experienced a mortality rate of 96 percent within 4 hours of exposure. Seventy-seven day old shortnose sturgeon had an estimated median lethal concentration (LC_{50}) at 2.7 mg/Liter at 25°C (Campbell and Goodman 2004); an LC_{50} of 2.2 mg/Liter was found for fish 104 and 134 days old at temperatures of 21.8° to 26.4°C. One-hundred-day-old fish exposed to 29°C were most sensitive to low dissolved oxygen, yielding a LC_{50} of 3.1 mg/Liter (Campbell and Goodman 2004).

Niklitschek (2001) observed poor survival of both shortnose and Atlantic sturgeon at dissolved oxygen concentrations of 40 percent versus 70 percent saturation, with the effects being conditional on temperature. The proportion of energy allocated to growth also decreased as dissolved oxygen concentration varied from normal. Bioenergetic and behavioral responses indicate that habitat for YOY (~30 to 200 days old) becomes unavailable with less than 60 percent saturation (Secor and Niklitschek 2001); this occurs at summertime temperatures of 22°-27°C with dissolved oxygen of 4.3-4.7 mg/Liter.

Laboratory experiments with YOY cultured shortnose sturgeon indicated thermal tolerances were significantly altered by temperature (Ziegeweid et al. 2008b). Fish activity increased with temperature, and at about 5°-6°C prior to lethal endpoint, fish began frantically swimming around the tank, then lost equilibrium as activity level decreased dramatically, and at about 0.3°C before lethal endpoint, most fish were completely incapacitated (Ziegeweid et al. 2008a).

Sub-lethal effects of low dissolved oxygen include impacted growth, metabolism, and foraging; a concurrent increase in water temperature amplifies effects of low dissolved oxygen. Laboratory results indicate that at water temperatures of 20°C and 40 percent saturation (i.e., 3.3 mg/Liter), effects to shortnose sturgeon included a reduction in growth by about 30 percent; a reduction in consumption by about 28 percent, and a reduction in routine metabolism by about 20 percent (Niklitschek 2001). While keeping saturation constant at 40 percent and increasing temperature to 27°C (corresponding to 2.9 mg/Liter), growth was further reduced by 69 percent, consumption by 45 percent, and routine metabolism by 21 percent (Niklitschek 2001). Because the Niklitschek (2001) investigation reported routine rather than basal metabolism, estimates of critical concentrations are not available. In a separate laboratory study using Atlantic sturgeon, Secor and Gunderson (1998) reported about a 3-fold reduction in growth rate due to hypoxia at 26° compared to 19°C.

Beyond metabolic response, sturgeons undertake other physiological and behavioral responses to hypoxia. Signs of stress observed in shortnose sturgeon exposed to low dissolved oxygen included reduced swimming and feeding activity, coupled with increased ventilation frequency (Campbell and Goodman 2004). Niklitschek (2001) observed that egestion levels for Atlantic and shortnose sturgeon juveniles increased significantly under hypoxia, indicating that consumed food was incompletely digested. Behavioral studies indicate that Atlantic and shortnose sturgeon are quite sensitive to ambient conditions of oxygen and temperature. In choice experiments, juvenile sturgeons consistently selected normoxic over hypoxic conditions (Niklitschek 2001). Beyond escape or avoidance, sturgeons respond to hypoxia through increased ventilation, increased surfacing (to ventilate relatively oxygen-rich surficial water), and decreased swimming and routine metabolism (Nonnette et al. 1993, Crocker and Cech 1997, Secor and Gunderson 1998, Niklitschek 2001).

NMFS has identified and established safe environmental limits for capturing and handling sturgeon species (Kahn and Mohead 2010) and recommends that Atlantic and shortnose sturgeon not be captured or handled when dissolved oxygen concentrations are below 4.5mg/Liter or when water temperatures exceed 28°C.

To compensate for these habitat conditions, shortnose sturgeon throughout the Southeast are known to take refuge by congregating in cool, deep areas of rivers as water temperatures increase (i.e., 22°-27°C) through the summer (Flournoy et al. 1992, Rogers and Weber 1994, Rogers and Weber 1995, Weber 1996, DeVries 2006). These warm summer water temperatures severely limit available juvenile rearing habitat; juveniles in the Altamaha and Ogeechee Rivers have been found in a single area with cool and deep water (Flournoy et al. 1992, Rogers and Weber 1994, Rogers and Weber 1995, Weber 1996). Shortnose sturgeon will stay in these refugia areas until water temperatures begin to cool in the fall. All captures of shortnose sturgeon in the Altamaha River when water temperature exceeded 27°C were in areas deeper than the surrounding river stretches, with a maximum depth of 12.8 m (DeVries 2006). Similar behavior has been found in the Savannah River (Collins et al. 2001) and Ogeechee River (Weber 1996). The essential nature of this deep water habitat sought by sturgeon is further illustrated by patterns of capture during summer for shortnose sturgeon in the Altamaha (Flourney et al. 1992), Savannah (Hall et al. 1999), and the Edisto (Collins unpublished data) Rivers where juvenile shortnose sturgeon have been captured only in the vicinity of the salt-freshwater interface and in the deeper water.

Juvenile Atlantic sturgeon in the Cape Fear River have also been found to seek cooler refugia in the summer months (Moser and Ross 1995). McCord (1998) associated drastically reduced growth rates of juvenile Atlantic sturgeon during periods of warm water temperature to severe stress. Absence of such refugia habitat, especially in southern populations, has been attributed to high juvenile mortality and extirpation of some shortnose sturgeon populations (Collins and Smith 1993, Rogers and Weber 1994, Rogers and Weber 1995, Collins et al. 2000a). The early juvenile life stage is often found to be the most sensitive life stage of sturgeon, as it is spatially limited to habitat within estuaries (Munro et al. 2007).

Fall/Winter Foraging
Shortnose sturgeon subadults (3-10 year olds) occur at the saltwater/freshwater interface in most rivers during the winter (Dadswell 1979, Pottle and Dadswell 1979, Dovel et al. 1992, Hall et al. 1991, Flournoy et al. 1992, Weber 1996). Older juveniles likely inhabit the same areas as adults, but younger juveniles primarily remain in freshwater habitat, perhaps due to low salinity tolerance (Jenkins et al. 1993, Jarvis et al. 2001). Juvenile shortnose sturgeon were captured during winter in the Savannah River in water temperatures between 12.8°-21.1°C (Collins et al. 2000a) and in water depths between 6.1-13.4 m (Collins et al. 2000a).

Shortnose sturgeon forage widely throughout the estuary during the winter (Collins and Smith 1993, Weber et al. 1999). In the Altamaha River, just south of the action area, shortnose sturgeon were found year-round in presumed foraging areas comprised of sandy substrate at water depth of 3 to 7.6 m (Devries 2006). Foraging sturgeon (both shortnose and Atlantic) were targeted in the Savannah River at two locations: both locations were downstream of a deep hole (rkm 31.4 and 40.7) that is used for resting by sturgeon. Depth of the sampled sites ranged between 16.7-27.5 ft (Collins et al. 2006). Similarly in the Edisto River, depth in shortnose sturgeon foraging area ranged between 14.7-20.9 ft seasonally (Collins et al. 2006).

During fall, large juveniles and adult Atlantic sturgeon migrate out to sea. Outmigration of river-resident juvenile Atlantic sturgeon older than age 1 may be influenced by density dependence with younger cohorts (Schueller and Peterson 2010). These younger fish are salinity intolerant and are unable to seek alternative foraging habitats; on the other hand, older juveniles have no such constraints but may prefer the relatively predator-free environments of brackish estuaries as long as food resources are not limited (Schueller and Peterson 2010).

All adult Atlantic sturgeon moved out of the Combahee and Edisto Rivers during October through November (Collins et al. 2000b). In the spring, reproductively developing Atlantic sturgeon will return to spawn (mostly March in the Southeast) in their natal rivers and take up residence at the same sites utilized the previous year (Collins et al. 2000b).

4 ENVIRONMENTAL BASELINE

By regulation, environmental baselines for opinions include the past and present impacts of all state, federal, or private actions and other human activities in the action area, the anticipated impacts of all proposed federal projects in the action area that have already undergone formal or early Section 7 consultation, and the impact of state or private actions that are contemporaneous with the consultation in process (50 CFR 402.02).

This section contains a description of the effects of past and ongoing human activities leading to the current status of the species, their habitat, and the ecosystem, within the action area. The environmental baseline is a snapshot of the factors affecting the species and includes federal, state, tribal, local, and private actions already affecting the species, or that will occur contemporaneously with the consultation in progress. Unrelated, future federal actions affecting the same species in the action area that have completed formal or informal consultation are also part of the environmental baseline, as are implemented and ongoing federal and other actions within the action area that may benefit listed species.

The proposed action occurs in the Atlantic Ocean, Savannah Harbor Entrance Channel, and the navigational channel of the Savannah River. The following analysis examines actions that may affect these species' environment specifically within this defined action area. The environmental baseline for this opinion includes the effects of several activities affecting the survival and recovery of ESA-listed sea turtle species, shortnose sturgeon, and Atlantic sturgeon (proposed for listing as endangered) in the action area. The activities that shape the environmental baseline in the action area of this consultation are primarily vessel operations and dredging.

4.1 Status and Distribution of Shortnose Sturgeon in the Action Area

The shortnose sturgeon inhabiting the Savannah River have been studied by, among others, Hall et al. (1991) and Collins et al. (1993). Hall et al. (1991) and Collins et al. (1993) used telemetry techniques to identify maximum upriver positions of shortnose sturgeon during the spawning season. In the Savannah River, these locations were between river kilometer 179 and river kilometer 278. Spawning locations have not been verified by collection of eggs. Historically, shortnose sturgeon likely utilized the entire Savannah River downriver of the fall line where the Clarks Hill Dam is now located upstream of the Augusta Shoals, in Augusta, Georgia, and above the New Savannah Bluff Lock and Dam. New and on-going research by the South Carolina Department of Natural Resources (Bill Post, pers. comm. 2011) and by The Nature Conservancy (Wrona et al. 2011, in prep.) also provide updated information on tracking of shortnose sturgeon in the lower Savannah River project area, which indicates sturgeon are currently using the project area in its existing (pre-project) state.

Shoals located below the New Savannah Bluff Lock and Dam currently serve as spawning habitat for the shortnose sturgeon (Wrona et al. 2011, in prep.). Spawning migrations are likely triggered by water temperatures above 8°C occurring in late winter/early spring, primarily during February and March. Spawning lasts for about three weeks and ends when temperatures reach 12° to 15°C. Subsequent downstream migration post-spawning is rapid and direct, usually occurring from March to May. Females likely do not spawn every year. It is believed that the shortnose sturgeon within the action area do not interbreed with fish from any other population.

It is likely that the total number of shortnose sturgeon within the action area is greatly decreased from historic accounts. The previous abundance estimate for the project area had the population at 1,000 to 3,000 fish in the Savannah River (B. Post, SCDNR, 2003). A low catch rate of juveniles in 1999-2000 sampling indicated that natural recruitment was quite low in the Savannah River. In the southeastern United States low recruitment is often thought to be caused by poor water quality in the nursery habitat located at the fresh water/salt water interface (Collins et al. 2001). The Shortnose Sturgeon Status Review Team, in an ongoing review of the status of the species (to be completed in 2011), estimated the Savannah River population to be between 1,500 to 2,000 adults (S. Bolden, pers. comm.). Males were most abundant (3.5:1) in the available estimates for the Savannah River (Collins and Smith 1997). Sex ratio on the spawning ground may favor males, although spawning females are less mobile making them less susceptible to gillnet gear, which may skew estimates (Kieffer and Kynard in review-B). The size of the Savannah River population puts it at greater risk of extinction than larger populations occurring elsewhere (McElhaney et al. 2000) due to several processes. These processes include: (1) deterministic density effects including depensation (Allee effect) and increased predation; (2) inbreeding resulting in loss of diversity and accumulation of deleterious mutations; and (3) increased susceptibility to catastrophic events.

Within the project area, shortnose sturgeon are present in the lowest reaches of the Savannah River up to the first obstruction (Figure 22) located at the New Savannah Bluff Lock and Dam at river mile 187.5. The entire life cycle of the shortnose sturgeon population occurs within the action area: adults grow, mature, and forage in the area and migrate upstream to spawning habitat, but since passage is not possible they can only go as far as the base of the dam. The COE attempted two fish passage events at New Savannah Bluff Lock and Dam by increasing flows from J. Strom Thurmond to overtop the spill gates during the spawning season. This method of fish passage proved ineffective for shortnose sturgeon. The cold water released from Thurmond Dam may have cooled the water at the dam to the point where fish were no longer induced to spawn. Also, it is doubtful that shortnose sturgeon were able to negotiate the 8-foot-high support walls at the bottom of the dam. The lock and dam was constructed in 1937 to aid commercial navigation and was last used for commercial shipping in 1979. It is currently operated by the City of Augusta. As a requirement of the City of Augusta's lease, the COE requires them to lock fish through the dam twice a week during the spring spawning season. Some limited transmitter studies have been conducted to determine if sturgeon are successfully locked through (like shad and herring), but apparently there is no movement of sturgeon through the lock. The COE made a draft recommendation in the Section 216 Disposition Study of 2000 to remove the structure, but public outcry associated with the potential loss of the impounded pool occurring upriver resulted in Congress declaring in an amendment to the Section 216 Disposition Study that the dam would be repaired and may be turned over to a local government to maintain. The work has not received funding, so the facility has not been rehabilitated. It has been operated to pass some migratory anadromous fish species, but it is thought that sturgeon are not able to pass because they are unable to overcome the vertical obstacles located at the base of the lock and dam.

Figure 22. New Savannah Bluff Lock and Dam

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

Within the project area, the Savannah River is divided into three interconnected sections: the Back River, Middle River, and Front River. The Back River is located adjacent to the boundary with South Carolina and borders much of the Savannah National Wildlife Refuge. The Back River depths are primarily shallow with most less than 10 feet deep; however, the sediment basin area has been reported to be much deeper. The Sediment Basin and the tide gate are located at the lower end of the Back River where it joins the Front River near river mile 11. As a part of the COE's proposed flow re-routing modification, the Sediment Basin would be allowed to fill in. The COE has proposed to place a submerged sill at the lower end of the basin to aid in the process of filling-in.

With the anticipated filling of the Sediment Basin, the depth there could become much shallower and may become too shallow for large sturgeon to pass through. Both upper portions of the Back River and the Middle River join the Front River in an area referenced as McCoy Cut. The lower arm of McCoy cut would be closed with the flow re-routing modifications under Plan 6A. Partial dredging of the upper reaches of the Back River and Middle River would also be conducted with Plan 6A. The lower end of the Middle River empties into the Front River just above the Kings Island Turning Basin. Other than having one area with a deep hole, most of the Middle River is less than 10 feet deep. The Front River depths vary depending on the depths needed to maintain the shipping channel. Throughout the project area up to the Kings Island Turning Basin near river mile 19.5, the depths are 42 feet with the Kings Island Turning Basin having depths up to 50 feet. Upriver from this turning basin, the depths are maintained at 36 feet to river mile 19.9 and then 30 feet to river mile 21.3 at the Port Wentworth Turning Basin. Beyond this point, the authorized channel is 9 feet deep, although it has not been maintained since 1978.

Juvenile and adult shortnose sturgeon use the estuarine areas in the lower Savannah River as a foraging area throughout the year. This unique habitat is only found within the estuary surrounding the freshwater/saltwater interface. Adult sturgeon can tolerate higher salinities than juveniles and have been found in the lowest reaches of the Savannah River in salinities up to 21.5 ppt. Research has indicated that juvenile shortnose sturgeon can be found during the year within the area from river mile 19.3 to 29.5 (river kilometers 31.2 to 47.5), and adult sturgeon from river mile 3.4 to 29.5 (river kilometers 5.5 to 47.5), respectively (Figure 22 and 23). Collins et al. (2001) found juvenile shortnose sturgeon in temperatures of 19.4° to 28.9°C and salinities of 0.1 to 17.6 ppt within depths between 2.1 and 14.9 meters. Adult shortnose sturgeon were found in temperatures of 7.5° to 29.8°C in salinities ranging from 0.1 to 21.5 ppt and depths between 1.5 and 16.7 meters.

Even though tolerance increases with age, juvenile shortnose sturgeon are stressed by reduced dissolved oxygen levels and even moderate salinities (Jenkins et al. 1993). Significant mortality was noted for fish approximately 2.5 months old when held in salinities as low as 11 ppt. Additionally, fish of that age began dying at dissolved oxygen levels of 3.0 mg/Liter and below. In the Savannah Harbor, juveniles were not captured in salinities greater than 14.9 ppt (although a telemetered fish was located very briefly in 17 ppt) or dissolved oxygen levels less than 4.0 mg/Liter. Field observations noted high stress at temperatures greater than 27°C.

Collins et al. (2001) noted that during warm months both adults and juveniles were concentrated in a very small (less than 1.5 kilometer) section of the river and especially seemed to prefer the area within the river kilometer 46.5 to 47.5 segment. During cool months, adults and juveniles used the area just below Houlihan Bridge (at river kilometer 34.3) down to the confluence of Front and Middle rivers (river kilometer 31.3), and during the coldest period they especially used the area at this confluence and up into the Middle River. During 1999 through 2000, shortnose sturgeon consistently utilized a 7.9-meter-deep hole in the Middle River near the confluence with the Front River. Recent and on-going telemetry studies confirm that this area is still being heavily utilized for resting by adult and large juvenile shortnose sturgeon. Water quality data suggest that an existing low sill between this hole and the Front River may minimize salinity fluctuations associated with the tidal cycle. Adults were less concentrated than juveniles during winter. Adults were found in the Front River and appeared to wander extensively in the Middle River but were not found in the Back River. Recent and on-going telemetry studies conducted by the South Carolina Department of Natural Resources and The Nature Conservancy have found adult shortnose sturgeon using the middle part of the Back River near Rifle Cut, which connects the Back River to the Middle River.

In the southern part of their range, shortnose sturgeon are known to take refuge from high water temperatures in the summer by congregating in cool, deep areas of rivers (Flournoy et al. 1992, Rogers and Weber 1994, Rogers and Weber 1995, Weber 1996) and then forage widely throughout the estuary during the winter (Collins and Smith 1993, Weber et al. 1999). Seasonal movements of adults have been documented in the Savannah River. Shortnose sturgeon range widely during cooler winter months, and aggregate and become relatively sedentary during summer. Summer water temperatures in southern estuaries commonly approach, and sometimes exceed, the maximum tolerable levels identified in the laboratory for early juvenile shortnose sturgeon (Jenkins et al., 1993). Observations indicate that sturgeon seek relatively deep, cool holes, possibly to avoid warm temperatures and low dissolved oxygen. A second deep hole occurs upstream of the project area. It is 6.5 meters deep and is located at river mile 29.5 (river kilometer 47.5), just north of the confluence with Abercorn Creek. This location is also frequently used by sturgeon, especially during the summer and early fall, and tracking results have found individuals resting there over several hours to days (Collins et al. 2001). It is characterized as being a deep area located at a sharp bend in the river, adjacent to a large sand bar. It is unknown why this area is preferred, but it may be due to the synergistic effects of salinity, dissolved oxygen, and temperature.

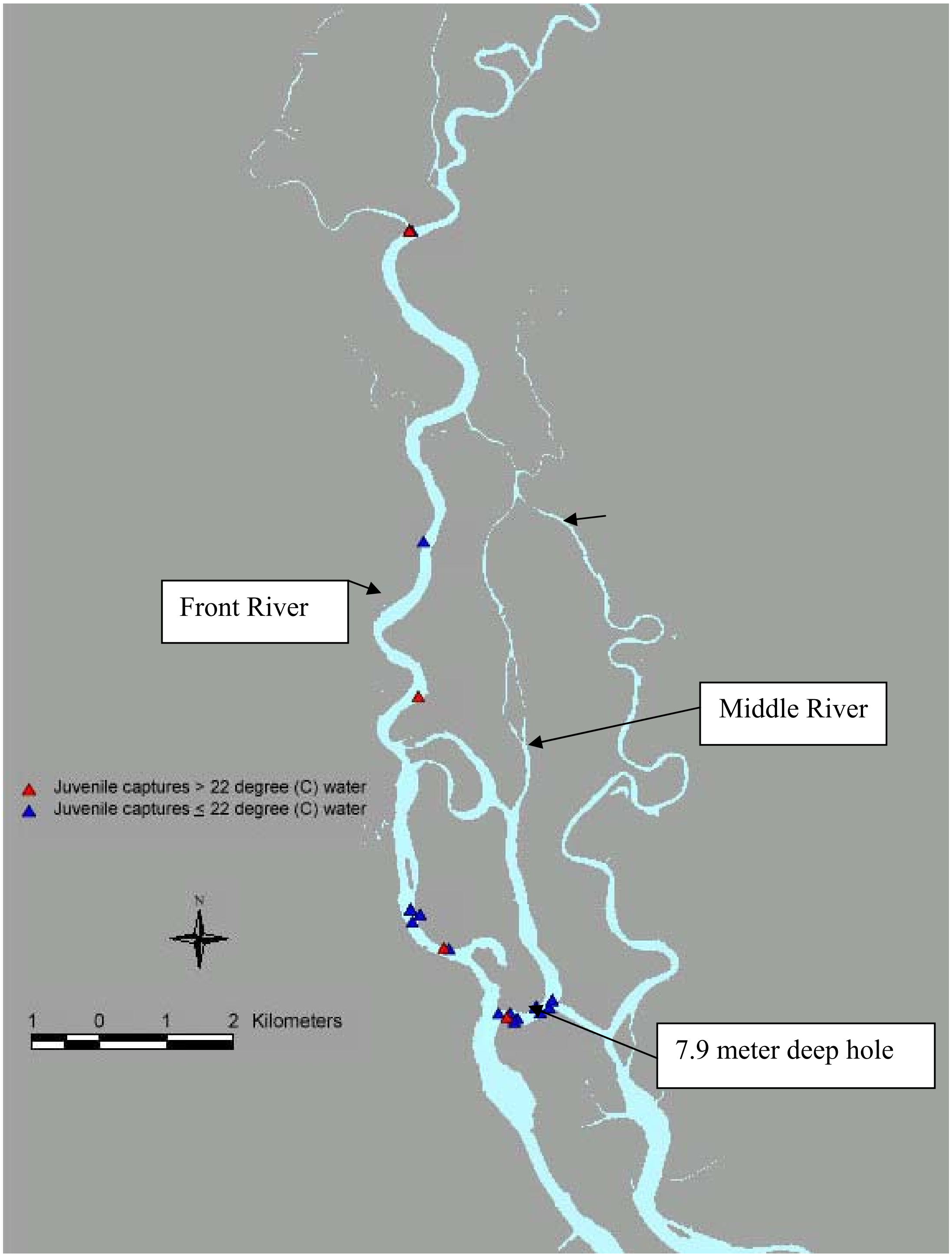


Figure 22. Locations where juvenile shortnose sturgeon have been found in the lower Savannah River.

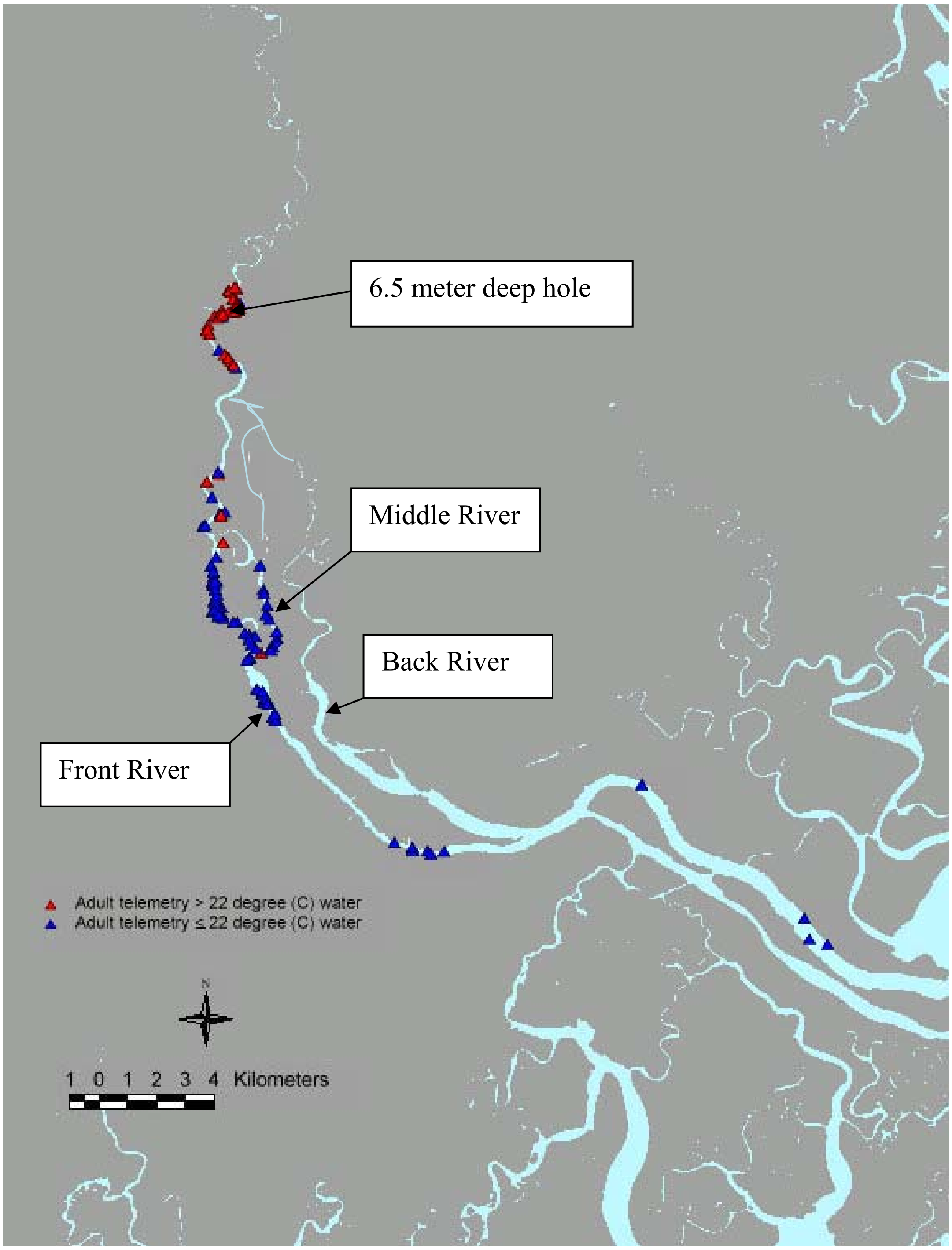


Figure 23. Locations where adult shortnose sturgeon have been found in the lower Savannah River

4.2 Status and Distribution of Atlantic Sturgeon in the Action Area

The Savannah River supports a reproducing subpopulation of Atlantic sturgeon (Collins and Smith 1997). According to NOAA's-National Ocean Service, 70 Atlantic sturgeon have been captured since 1999 (J. Carter, NOS, supplemental data 2006). Twenty-two of these fish have been YOY (< 410 mm TL). A running ripe male was captured at the base of the New Savannah Bluff Lock and Dam during the late summer of 1997, which supports the hypothesis that spawning occurs there in the fall. While spawning has been confirmed in the Savannah River, no spawning sites have been verified (Collins and Smith 1997). The fresh–brackish water interface area serves as the summer nursery habitat for Atlantic sturgeon (Smith et al. 1993, McCord 1998).

It is thought that overharvesting of sturgeon in the 1890s led to the dramatic decline in the population, and poor water quality since then has not been conducive to recovery. Secor and Gunderson (1998) showed that juvenile Atlantic sturgeon are less tolerant of summer-time hypoxia than juveniles of other estuarine species. The recent extirpations and severe population depressions of these species in the South is probably not coincidental; mortalities related to the synergistic effects of low dissolved oxygen levels and high summer temperatures would tend to affect southern populations to a greater extent than those further north.

Prior to the collapse of the fishery in the late 1800s, the sturgeon fishery was the third largest fishery in Georgia. Secor (2002) estimated from U.S. Fish Commission landing reports that approximately 11,000 spawning females were likely present prior to 1890. While fishing occurred in the Savannah River, the sturgeon fishery was mainly centered on the Altamaha River, and in more recent years, peak landings were recorded in 1982 (13,000 lbs). Based on juvenile presence and abundance, the Altamaha seems to currently support one of the healthiest Atlantic sturgeon subpopulations in the Southeast (D. Petersen, UGA, pers. comm. 2006). Atlantic sturgeon are also present in the Ogeechee River, which is interconnected to the Savannah River at its lowest reaches; however, the absence of age-1 fish during some years and the unbalanced age structure suggests that the subpopulation is highly stressed (Rogers and Weber 1995). Spawning adults have been collected in recent years from the Satilla River (Waldman et al. 1996). Recent sampling of the St. Mary's River located sturgeon (D. Petersen, UGA, pers. comm. 2011), which changes previous reports by Rogers et al. (1994) that the subpopulation may be extirpated. In Georgia, Atlantic sturgeon are believed to spawn in the Savannah, Ogeechee, Altamaha, and Satilla rivers.

Previous studies in the nearby Ogeechee River have shown the continued persistence of Atlantic sturgeon in this river, as indicated by the capture of age +1 fish. Sampling efforts (including 1991-1994, 1997, and 1998) to collect age-1 sturgeon as part of the Savannah River genetics study suggest that juvenile abundance is rare, with high inter-annual variability, indicating spawning or recruitment failure. However, the Army's Environmental and Natural Resources Division (AENRD) at Fort Stewart, Georgia, which borders the Ogeechee River, collected 17 sturgeon in 2003 considered to be YOY (less than 30 cm TL) and an additional 137 fish in 2004, using a 30 m x 2 m experimental gillnet (3.8, 7.7, 12.7, 15.2, 17.8 cm stretched mesh). Most of these fish were juveniles; however, nine of these fish measured less than 41 cm TL and were considered YOY. In 2003, 17 sturgeon captured in this survey were also considered YOY (reported as less than 30 cm TL). The AENRD survey provides the most recent captures of YOY in the Ogeechee.

4.3. Factors Affecting Sturgeon in the Action Area

4.3.1 General

In recent years, NMFS has undertaken several ESA Section 7 consultations to address the effects of federal actions on sturgeon in the Savannah River (Table 4). Because Atlantic sturgeon are not listed, there are no consultation records.

Date	Project
4/17/2003	Discharges from J. Strom Thurmond Dam
5/28-2003	FWS grant to GADNR CRD for marine fisheries surveys
7/03/2003	Chatham County dock construction for water ferry
12/07/2004	GPA Berth 8 construction
12/30/2004	COE advance maintenance dredging Savannah Entrance Channel
02/05/2005	Amendment 6 to Shrimp Fishery FMP
08/02/2005	GDOT repair of Back River bridge-Chatham County
03/12/2007	Savannah Economic Development Authority- North Port Project
08/02/2007	Southern LNG & Elba Express Elba III project
12/10/2007	NPS/FHA repair of Fort Pulaski bridge
08/05/2008	Southern Nuclear – Vogtle Electric Plant license renewal
01/12/2009	GDOT replacement of Back River bridge-Chatham County
01/28/2009	Drought Contingency Plan Savannah River
03/16/2009	SAD Non-capture relocation trawling demo project
07/15/2009	Bank stabilization at Cockspur Island Lighthouse
11/06/2009	Fall/Winter Flow Reduction- Savannah River (Thurmond Reservoir)

Table 4. Summary of ESA Section 7 consultations for sturgeon conducted in the Savannah River 2002-2010.

Through an ESA Section 6 cooperative agreement with Georgia and South Carolina, NMFS has supported numerous research projects within the project area to investigate the life history of the shortnose and Atlantic sturgeon.

Through issuance of ESA Section 10(a)(1)(A) permits, scientific and enhancement studies are conducted by researchers on captive shortnose sturgeon maintained at various quarantined research facilities. Researchers employed by USFWS, USGS, the University of Florida, and one private facility, are currently authorized to study captive shortnose sturgeon. These captive individuals are periodically conditioned and spawned and the resulting gametes and progeny are used for scientific studies, such as cryogenics, disease transmission, nutrition, genetics, toxicology, fish passage, and fish culture techniques. Between 1985-1992, 97,483 shortnose sturgeon raised at Bears Bluff National Fish Hatchery were released into the Savannah River. The hatchery-produced individuals were stocked at various ages, locations, and across all seasons. The total estimated number of shortnose sturgeon stocked is great; most were stocked as larvae and early juveniles. Only 18,210 individuals were large enough to be tagged in some fashion. Survival of the very young sturgeon was probably low but unknown. Population estimates of adult shortnose sturgeon pre- and post-stocking suggest that the numbers had increased substantially, but many tags were shed, few fish were marked, and these estimates were never published as statistical assumptions were violated and the estimates were biased (but biased similarly). Some believe the stocking event was successful; however, without information on the survivability and emigration of both the wild and stocked fish, impacts and effects of the stocking event cannot be assessed. A few of the fish that retained their tags have been found in other rivers, suggesting they emigrated and may have been released at an age too late to imprint on the Savannah River. Straying of these hatchery-raised shortnose sturgeon into other rivers was confirmed with the capture of a tagged adult in the Ogeechee River (D. Peterson, University of Georgia, pers. comm.).

There are currently 17 Section 10(a)(1)(A) scientific research permits issued to study shortnose sturgeon in the rivers of the United States. Some of the studies are near, or within, the project area (Table 5). Each permit approves sampling methodology and authorizes incidental take. Two of the ESA Section 10 permits allowing take of shortnose sturgeon include the Savannah River. Ongoing research involves collection of shortnose sturgeon from the Savannah River for ageing, and to attempt to generate an additional population estimate. Tagging and telemetry is occurring to identify upstream spawning location and the effects of reduced flow on spawning habitat. Incidental mortality of a total of twenty-seven shortnose sturgeon is currently permitted through research permits. The specific stressors to fish subject to NMFS-issued ESA permit conditions are capture in nets; handling and restraint during examinations; tagging using PIT, internal, and external tags; tissue sampling; anesthetizing; laparoscopy; blood sampling; and gonad biopsy.

Permit No.	Location	Authorized Take	Objectives and Research Activities
1420 University of Georgia Expires: 9/30/09	Altamaha River, GA	1,000 adult/juv. (2 lethal), 100 ELS	**1) Population Dynamics**; **2) Habitat**; **3) Genetics**; and **4) Contaminants:** Capture, handle, weigh, measure, PIT tag, transmitter tag, tissue sample, anesthetize, conduct laparoscopy, blood collection, fin ray section, collect ELS
10037 University of Georgia Expires: 4/30/2013	Ogeechee River, GA	150 adult/juv (2 lethal), 40 ELS	**1) Population Dynamics**; **2) Habitat**; 3) **Genetics**; & **4) Contaminants:** Capture, handle, measure, weigh, PIT tag, tissue sample, fin-ray section, anesthetize, laparoscopy, blood collection, radio tag, collect ELS
10115 University of Georgia Expires 08/3/2013	Satilla & St. Mary's GA & FL	85 adult/juv 20 ELS	**1) Presence /Absence; 2) Genetics:** Capture, handle, measure, weigh, PIT tag, tissue sample, collect ELS
1447 South Carolina DNR Expires: 2/28/2012	South Carolina Rivers	100 adult/juv. (2 lethal), 100 ELS	**1) River Survey**; **2) Genetics**; and **3) Diet**: Capture, handle, measure, weigh, PIT and DART tag, transmitter tag, anesthetize, tissue sample, gastric lavage, collect ELS
1505 South Carolina DNR Expires: 5/15/2011	South. Carolina Rivers	98 adult/juv. (2 lethal), 200 ELS	**1) River Survey**; **2) Genetics**; and **3) Contaminants; and 4) Diet**: Capture, handle, measure, weigh, PIT and DART tag, transmitter tag, anesthetize, laparoscopy, blood collection, tissue sample, gastric lavage, collect ELS

Table 5. Current shortnose sturgeon research permits authorized for research activities utilizing wild fish under ESA Section 10 (a)(1)(A) permits in, or near, the project area.

NMFS finalized the Recovery Plan for the shortnose sturgeon in 1998 as required by ESA Section 4 with the following recovery objective:

> *"to recover shortnose sturgeon populations to levels of abundance at which they no longer require protection under the ESA, and for each population segment, the minimum population size will be large enough to maintain genetic diversity and avoid extinction."*

The Recovery Plan identified 19 discrete populations of shortnose sturgeon and determined the Savannah River population to be discrete (NMFS 1998). The 1998 shortnose sturgeon Recovery Plan also identified 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 habitat and conditions, and foraging habitat.

In 2007, NMFS initiated a shortnose sturgeon status review pursuant to ESA Section 4; a draft status review report has been peer-reviewed and is expected to be finalized during 2011. Once completed, NMFS will then consider if the current listing is appropriate. NMFS would propose any changes through the federal rule-making process outlined in 50 CFR 424. Once the shortnose sturgeon status review is complete, NMFS intends to designate a new recovery team and initiate a revision of the 1998 shortnose sturgeon recovery plan.

4.3.2 Commercial and Recreational Fisheries

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

State Fisheries
During 1989-1991, the commercial shad gillnet fishery's bycatch included more endangered shortnose sturgeon than juvenile Atlantic sturgeon, which is considered unusual. The incidental capture of sturgeons in the Georgia and South Carolina gillnet fishery for American shad (*Alosa sapidissima*) and the trawl fishery for penaeid shrimp (*Penaeus* spp.) was summarized by Collins et al. (1996): the commercial shad fishery was active from approximately mid-January through mid-April along the South Atlantic coast; sturgeon captured in the shad gillnet fishery were primarily adults and accounted for 52 percent of Atlantic sturgeon bycatch and the shrimp trawl fisheries accounted for 39 percent. Collins et al. (1996) reported that two commercial fishermen collected 14 fish over the period of 1990-1992, averaging seven Atlantic sturgeon/fisher/year. It seems that Atlantic sturgeon abundance within the Savannah River is extremely low, as evident from low bycatch and reported captures over the last 15 years. Thus, bycatch may be an issue if abundance is low and fishing effort is high.

Entanglement of sturgeon in gillnets can result in injury and mortality, reduced fecundity, and delayed or aborted spawning migrations of sturgeon (Moser and Ross 1993 and 1995, Weber 1996, Collins et al. 2000a, Moser et al. 2000). In the Savannah River, adults were common in the bycatch from the lowest point in the river at which gillnet fishing was allowed (about river kilometer 43) up to river kilometer 278 (the uppermost of several sturgeon spawning areas), as reported by Collins and Smith (1993). Bycatch of sturgeon in the river was as high as 102 fish/fisher/yr, and immediate bycatch mortality of sturgeon for this gear type was 16 percent, with another 20 percent of fish being injured (Collins et al. 1996). In addition to such accidental mortality, intentional mortality of shortnose sturgeon captured in the shad fishery has been known to occur (McCord 1998).

Mandatory reporting of sturgeon bycatch was initiated in 2000 by the Atlantic States Marine Fisheries Commission; a summary of self-reported shortnose sturgeon bycatch in the Savannah River via the South Carolina shad gillnet fishery is presented in Table 6. In most cases, shortnose sturgeon captured as bycatch of the shad gillnet fishery are returned to the river unharmed; survival is expected to be greater early in the shad season when waters are cooler. These numbers should be considered a minimum estimate because fishers tend to greatly under-report bycatch, especially of endangered species. The possession of a commercial shad license permits the fishing of 10 nets; however, on average a licensee usually has 4-5 nets (B. Post, SCDNR, pers. comm.). Nets are usually 5 ½-inch stretch mesh and may not exceed 600 feet in length. No net may be set within 600 feet of any gillnet previously set.

Directed fisheries for sturgeon no longer occur, and incidental marine and estuarine hook-and-line fisheries have little impact, but sturgeons (especially juvenile and subadult Atlantics) do occur in the by-catch of trawl fisheries in South Carolina and Georgia, especially the inshore/nearshore segment of the penaeid shrimp trawl fishery during cool months. During the period from 1973 to 1975, commercial shrimp trawlers caught a total of 1,111 sturgeon off North Carolina, South Carolina, and Georgia (Keiser 1976). The report did not identify whether they were shortnose or Atlantic sturgeon. The shrimp trawl fishery produced 39 percent of 97 reported recaptures of Atlantic sturgeon tagged in a Georgia study conducted before use of turtle excluder devices became mandatory (Collins et al. 1996). Use of turtle excluder devices is thought, but not proven, to reduce by-catch of sturgeons.

Year	Shortnose sturgeon	Atlantic sturgeon
2009	21	15
2008	12	2
2007	16	6
2006	N/A	3
2005	7	0
2004	23	0
2003	1	3
2002	26	4
2001	N/A	N/A
2000	4	5

Table 6. Summary of self-reported effort and incidental bycatch of shortnose and Atlantic sturgeon by commercial shad gillnet fishery in the Savannah River as reported to the Atlantic States Marine Fisheries Commission by South Carolina. Mandatory reporting began in 2000. There are no data to separate total number of sturgeon into unique and recaptured individuals.

4.3.3 Dams

The Savannah River is segmented by several dams (USFWS et al. 2001) that adversely impact fish populations through: (1) the blockage and/or impairment of required migration patterns of anadromous and diadromous species; (2) river ecosystem fragmentation; and (3) instream flow modifications that alter natural, seasonal hydrological conditions and river morphology. Habitat accessibility and location of dams throughout the Southeast river basins are inseparably linked; fish passage at one facility determines the passage potential at other dams. Access to traditional spawning grounds is now blocked by a series of six dams on the Savannah River. The construction of these dams and reservoirs has converted or blocked access to approximately half of 384 miles of historical anadromous fish spawning and nursery habitat. A major portion of high quality anadromous fish spawning habitat (rapids complex: boulder, bedrock, cobble and gravel substrate) that was once available has been blocked or inundated by large reservoirs above the Augusta Diversion Dam, which is located approximately 20 miles above the New Savannah Bluff Lock and Dam. The majority of the habitat that is no longer accessible was the most heavily used. It is estimated that 90 to 95 percent of the quality spawning habitat for rapids-dependent anadromous species has been lost. The New Savannah Bluff Lock and Dam currently impedes shortnose sturgeon from accessing important habitat areas. It is the first impediment encountered by all anadromous fish species migrating between estuarine/marine coastal waters into freshwater habitats of the Savannah River. The New Savannah Bluff Lock and Dam is an inactive navigation dam that precludes sturgeon access to valuable spawning habitat upstream at the Augusta Shoals, which is located just below the Augusta Diversion Dam (Figure 24). The COE has proposed construction of a fish passage bypass facility at the dam as mitigation for the effects of the deepening in the lower Savannah River. Establishing fish passage at the New Savannah Bluff Lock and Dam would enhance spawning potential at sites located upstream of this structure.

Establishing fish passage at the New Savannah Bluff Lock and Dam should also trigger the construction of fish passage at dams located upriver. In 1994, the USFWS, NMFS, SCDNR, and the GADNR completed development of a plan to restore access to a portion of historical anadromous fish spawning habitat in the Savannah River. The plan was filed by the FWS on behalf of the resource agencies in 1994, and was adopted by the Federal Energy Regulatory Commission (FERC) as a Comprehensive Plan pursuant to Section 10(a)(2) of the Federal Power Act. The plan is a guide for resource agency efforts and would restore access to approximately 35 miles of spawning and maturation habitat. The plan includes the following elements: (1) reliable passage of anadromous fish at the New Savannah Bluff Lock and Dam; (2) the design and implementation of an upstream fish passage mechanism and safe downstream (out-migrant) passage at the Augusta Diversion Dam; (3) the design and implementation of an upstream fish passage mechanism and safe downstream (out-migrant) passage at the Stevens Creek Dam; and (4) improvement of poor dissolved oxygen releases from the J. Strom Thurmond Dam during the summer months. Three of the four elements of the plan to restore access to the 35 miles of the Savannah River between the New Savannah Bluff Lock and Dam and the J. Strom Thurmond Dam are in place. In 2004, the NMFS and USFWS sent the FERC a joint prescription for fish passage at the Augusta Diversion Dam as well as minimum flow requirements necessary over the Augusta Shoals in regards to the proposed re-licensing of the Diversion Dam. When FERC issued the license for the Stevens Creek Hydropower Project in 1995, it reserved authority for the USFWS to prescribe a fishway at that project once upstream passage was achieved at the Augusta Diversion Dam. Plans are in place to provide fish passage at the Augusta Diversion Dam and the Stevens Creek Hydroelectric Project when fish passage is achieved at the New Savannah Bluff Lock and Dam. Once fish passage is installed at the Augusta Diversion Dam, sturgeon would be able to pass above the dam and then pass back downstream into the Augusta Canal. If sturgeon entered the canal, they would have to pass through hydroelectric facilities to re-enter the Savannah River. NMFS is working with the Augusta Canal to implement measures that will keep sturgeon out of the canal once fish passage at the dams has been established.

Figure 24. Augusta Diversion Dam and Shoals

Dams and their operations are also the cause of major instream flow alteration in the Southeast (USFWS et al. 2001). Hill (1996) identified the following impacts of altered flow to anadromous fishes by dams: (1) altered dissolved oxygen concentrations and temperature; (2) artificial destratification; (3) water withdrawal; (4) changed sediment load and channel morphology; (5) accelerated eutrophication and change in nutrient cycling; and (6) contamination of water and sediment. Activities associated with dam maintenance, such as dredging and minor excavations along the shore, can release silt and other fine river sediments that can be deposited in nearby spawning habitat. Dams may reduce the viability of sturgeon populations by removing free-flowing river habitat. Seasonal deterioration of water quality can be severe enough to kill fish in deep storage reservoirs that receive high nutrient loadings from the surrounding watershed (Cochnauer 1983). Important secondary effects of altered flow and temperature regimes include decreases in water quality, particularly in the reservoir part of river segments, and changes in physical habitat suitability, particularly in the free-flowing part of river segments. The most commonly reported factor influencing year-class strength of sturgeon species is flow during the spawning and incubation period (Jager et al. 2002). Water temperature is another environmental factor that explains year-to-year variation in recruitment (Counihan et al. in press).

4.3.4 Water Quantity and Quality

Water Quantity

The headwaters for the project area originate in the Blue Ridge Mountains of North Carolina, pass through Georgia, and drain into the Atlantic Ocean through the Savannah River. Water flow is regulated by the COE through dams at Lake Hartwell, Lake Richard B. Russell and Clarks Hill Lake (known as J. Strom Thurmond Lake in South Carolina). Flow in the Savannah River is primarily controlled by releases from J. Strom Thurmond Dam. The gates at the New Savannah Bluff Lock and Dam are controlled remotely at the Thurmond Reservoir. Two nuclear sites—Plant Vogtle in Georgia and the U.S. Department of Energy's Savannah River Site in South Carolina—withdraw water for their facilities. The Vogtle Electric Generating Plant consists of two nuclear reactors and currently uses up to 64 million gallons per day (mgd) of water from the Savannah River to generate power. In March 2008, the Southern Nuclear Operating Company applied to the Nuclear Regulatory Commission for a license to build two additional nuclear reactors at the plant, increasing the potential water usage to 80 mgd. Numerous other large facilities positioned along the river also withdraw water for industrial uses. Up to 100 mgd (379,000 cubic meters per day) of Savannah River water may be withdrawn to support the growth of South Carolina communities located outside of the Savannah River basin, such as Greenville and Beaufort County (Spencer and Muzekari 2002). While Georgia has laws restricting interbasin transfers of water, South Carolina has yet to adopt stream flow protections and does not regulate surface water withdrawals (Rusert and Cummings 2004).

The Savannah National Wildlife Refuge (NWR), located adjacent to the project area in the coastal zone, receives freshwater from the river to seasonally flood wetlands to create, protect, and manage migratory waterfowl and shorebird habitat. Water flow directly affects water level management at the NWR; managed habitats are dependent upon adequate freshwater for maintaining vegetative diversity.

The State of Georgia designates the beneficial uses of the freshwaters within the project area as primary and secondary contact recreation, drinking water supply after conventional treatment in accordance with requirements, fishing, indigenous aquatic community habitat, and industrial and agricultural uses. The city of Savannah has a water intake in Abercorn Creek, located just upstream from the project site, primarily as a water supply for the city’s municipal and industrial water uses. It has a 62.5 million gallon per day (mgd) capacity, but presently operates at around 30 mgd. Several industries located along the lower Savannah River also withdraw water for industrial uses. The Savannah Electric and Power Company is the largest industrial permittee and had a maximum daily withdrawal of 267.0 mgd (reported in year 2000) at its Port Wentworth facility.

Water Quality

In October 2006, the EPA finalized a TMDL for Savannah Harbor and concluded that the Savannah River cannot withstand the introduction of anthropogenic, oxygen-demanding substances and still provide acceptable habitat for critical aquatic life that reside in the reaches of the river (EPA 2006). The finding meant that South Carolina and Georgia would have to revise their permits for point source discharges in those reaches as they expired and came up for renewal. As part of its analysis, EPA evaluated the dissolved oxygen requirements for several fish species and for natural conditions of the river. At that time, the applicable dissolved oxygen site-specific criteria for the Savannah Harbor, as established by Georgia, was a minimum instantaneous dissolved oxygen criteria of no less than 3.0 mg/Liter in June, July, August, September, and October; no less than 3.5 mg/Liter in May and November; and no less than 4.0 mg/Liter in December, January, February, March, and April. However, Georgia revised its dissolved oxygen standard for the Savannah Harbor in 2009 and it now requires a daily average of no less than 5.0 mg/Liter throughout the year, with an instantaneous minimum of 4.0 mg/Liter throughout the water column. The new standard matches the South Carolina standard for waters of the same use classification and applies throughout the water column.

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

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 (von Westernhagen et al. 1981, Hansen 1985, Mac and Edsall 1991), and reduced survival of larval fish (Berlin et al. 1981, Giesy et al. 1986). Several characteristics of shortnose sturgeon (i.e., long lifespan, 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, DDE, DDT, dieldrin, 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 dissolved oxygen, 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 (USFWS 1993, Ruelle and Keenlyne 1993).

To address concerns about the potential for contaminants in the project area, sediment core samples were collected and examined for sediment physical and chemical properties. The sampling area covered the entire area proposed for harbor deepening, extending from deep water in the ocean to the Kings Island Turning Basin (Station 103+000). Parameters investigated included metals, PCBs, PAHs, petroleum hydrocarbons, phenols, pesticides, dioxin congeners, cyanide, organotins, and nutrients. The evaluation found that most of the sediments provided no reason for concern over potential contaminant-related impacts associated with the proposed dredging and dredged sediment placement. However, three potential issues were identified. One issue involved sediments near the old RACON Tower site, which were first sampled in 1997 during a comprehensive survey of the harbor. Subsequent sampling conducted in 2005 revealed that sediments at that location do not pose a potential for contaminant-related environmental impacts. The second issue pertained mostly to whether the sediment chemistry data for pesticides, PAHs and phenols, especially achieved detection limits, were adequate for comparison to screening criteria. That issue was also addressed during the 2005 sampling. The confirmatory sampling within the channel revealed there are no potential sediment contaminant concerns related to pesticides, PAHs, phenols, or metals other than cadmium. The final issue involved the concentration and distribution of cadmium within the new work sediments. Sampling was conducted in 2005 to address this issue. Cadmium was found to occur naturally in unusually high levels within Miocene clays that would be excavated during the SHEP dredging. Evaluation of the laboratory results could not rule out the potential for adverse impacts from sediments with elevated cadmium levels in some reaches of the channel. However, the location of the elevated cadmium levels is down river from known sturgeon habitat and should not present a concern for sturgeon. A more detailed discussion on the cadmium sediments is in Section 5.2.3.

Secor (1995) noted a correlation between low abundances of sturgeon during this century and decreasing water quality caused by increased nutrient loading and increased spatial and temporal frequency of hypoxic conditions. Based on the known effects of dissolved oxygen, temperature, and salinity during the critical summer months, a safe threshold for suitable habitat for shortnose sturgeon appears to be approximately 4.0 mg/Liter in the bottom meter of the water column when temperatures exceed 26°C, and 3.5 mg/Liter when they do not exceed that temperature threshold. The habitat suitability criteria used in modeling shortnose sturgeon habitat in the action area before and after the proposed action are presented in Table 7.

Life Stage	Adults	Adults	Juveniles
Time of Year	Winter	Summer	Winter
Salinity	<= 25 ppt	<= 10 ppt	<= 14.9 ppt
D.O. Exceedance	10 %	Same	Same
Dissolved Oxygen	3.5 mg/Liter	4.0 mg/Liter	3.5 mg/Liter
D.O. Exceedance	5 %	Same	Same
Dissolved Oxygen	3.0 mg/Liter	3.0 mg/Liter	3.0 mg/Liter
D.O. Exceedance	1 %	Same	Same
Dissolved Oxygen	2.0 mg/Liter	2.0 mg/Liter	2.0 mg/Liter
Temperature	Normal January	Normal August	Normal January
River Flow	Normal January	Normal August	Normal January
Location – depth	Bottom layer	Same	Same
Location – width	Where Hydrodynamic Model is 3 cells wide, use deepest cell; where >3 cells wide, use deepest 2 cells	Same	Same

Table 7. Summary of Shortnose sturgeon habitat suitability criteria in the Savannah River Estuary

4.3.5 Dredging

Dredging of navigation channels can adversely affect shortnose and Atlantic sturgeon due to their benthic nature. The Savannah River is home to one of the busiest ports on the Atlantic Coast and is maintenance dredged regularly up to the Garden City Terminal. A seasonal restriction on dredging operations has been imposed from March 16–May 31 to protect striped bass in the Savannah River. This spring closure likely benefits sturgeon as well (M. Collins, SCDNR, pers. comm. 1998).

Seasonal restrictions (hopper dredging “windows”) are also placed on hopper dredging conducted offshore of Savannah Harbor in the shipping channel to protect sea turtles. Hopper dredges can also lethally harm sturgeon directly by entraining sturgeon in dredge drag arms and impeller pumps. Mechanical dredges have also been documented to kill shortnose, Atlantic, and Gulf sturgeon. Environmental impacts of dredging include the direct removal/ burial of organisms; turbidity/siltation effects; contaminant resuspension; noise/disturbance; alterations to hydrodynamic regime and physical habitat; and actual loss of riparian habitat (Chytalo 1996; Winger et al. 2000). According to Smith and Clugston (1997), dredging and filling impact important habitat features of Atlantic sturgeon as they disturb benthic fauna, eliminate deep holes, and alter rock substrates. To reduce the impacts of dredging on anadromous fish species, most of the Atlantic states impose work restrictions during sensitive time periods (spawning, migration, feeding) when anadromous fish are present. Reduced dissolved oxygen levels and upriver movement of the salt wedge may result from channel deepening. Potential impacts from hydraulic dredge operations may be avoided by imposing work restrictions during sensitive time periods (i.e., spawning, migration, feeding) when sturgeon are most vulnerable to mortalities from dredging activity.

Dredging operations may impact sturgeon by destroying benthic feeding areas, disrupting spawning migrations, and re-suspending fine sediments in spawning habitat sediments that cover required substrate. Because shortnose sturgeon are benthic omnivores, the modification of the benthos could affect the quality, quantity, and availability of sturgeon prey species. During the study conducted by Hall et al. in 1985-1992, juvenile shortnose sturgeon were found to be concentrated in the Kings Island Turning Basin (river mile 18.7). No juvenile stages were found in that area during a study conducted later in 1999-2000 (Collins et al. 2001). Collins et al. surmised that the harbor modifications (e.g., harbor deepening from 38 to 42 feet) occurring after 1992 changed the hydrographic conditions and caused the fish to move from the area. The low catch rate of juveniles in the 1999-2000 study indicated that natural recruitment was quite low in the Savannah River. In the southeastern United States, low recruitment is often thought to be caused by poor water quality in the nursery habitat located at the fresh water/salt water interface (Collins et al. 2001).

Dredging Methods and Associated Impacts

Hopper dredges are used within known sturgeon habitat throughout the proposed project area, including the ocean bar channels. In the South Atlantic region, only 9 incidental takes have occurred during hopper dredging operations, all of which were Atlantic sturgeon. Considering that Atlantic sturgeon primarily lead a marine existence, with the exception of their spawning migration, and hopper dredges are often operated in ocean bar channels or offshore borrow areas, it is likely that the risk of entrainment by hopper dredges is higher for Atlantic sturgeon than shortnose sturgeon. It is often less economical to use a hopper dredge in upstream environments, where shortnose sturgeon predominantly spend their time. The unit of dredging effort with respect to hopper dredging in shortnose sturgeon habitat is less than Atlantic sturgeon habitat and; thus, the risk of shortnose sturgeon take with a hopper dredge is likely less than to Atlantic sturgeon in the South Atlantic region. The current best estimate (Collins et al. 2001, Collins et al. 2002) is that adult shortnose sturgeon can be expected throughout the year somewhere within the area from River Mile 3.4 to 29.5 (river kilometers 5.5 to 47.5) and juvenile sturgeon from River Mile 19.3 to 29.5 (river kilometers 31.2 to 47.5), respectively. Therefore, impacts from hopper dredges may occur if hopper dredges were used upstream of River Mile 3 (roughly Station 16+000). There have been no documented takes of shortnose sturgeon in the Savannah Harbor by dredge operations. Shortnose sturgeon are not likely to be present near the river’s mouth (downstream of

Station 16+000) and in the entrance channel (from Station 0+000 to -98+600B); therefore, impacts to shortnose sturgeon from hopper dredges working in that portion of the channel are not anticipated to occur.

The use of the “turtle deflecting draghead” on hopper dredges reduces the potential for take of benthic oriented species (i.e., sea turtles and sturgeon) by creating a sand wave in front of the draghead that pushes animals out of the way that are at risk of entrainment. Though the use of the “turtle deflecting draghead” likely reduces potential risk of sturgeon entrainment based on the understanding of its operating conditions, takes can still occur due to dragtender operator error, uneven bottom contours, or difficult dredging conditions. Few studies exist that evaluate entrainment risk relative to sturgeon behavior, size class, life cycle, etc., though effects of entrainment on adult fish are presumed low (Dickerson et al. 2004).

Although the potential for significant numbers of adult and juvenile sturgeon being hit by a hydraulic cutterhead dredge is fairly low; five shortnose sturgeon takes have been documented. Adult and juvenile sturgeon are believed to be very mobile, even when occupying resting areas during the summer months (deep holes and other deep areas). However, the eggs and larvae of sturgeon are not as mobile, but most of those life stages occur over 100 river miles upstream from where hydraulic dredges are proposed for use in the project area. Therefore, no impacts to sturgeon eggs or larvae are expected with the project work in the harbor.

Though rare, documented incidental take of shortnose and Atlantic sturgeon by mechanical dredges have also been reported. Clamshell dredges operate by dropping an open bucket into the water column which plunges to the bottom where the bucket closes, ascends, and discards the dredged material into a scow or barge. Since 1990, dredging operations throughout the North Atlantic, South Atlantic, and Gulf waters have resulted in a total of three sturgeon (one shortnose and two Atlantic) being reported as captured by clamshell dredge operations. Of the three documented captures by a clamshell, one occurred in the South Atlantic region on December 3, 2000 while performing work for the Wilmington Harbor deepening project in the Cape Fear River, North Carolina. Though this sturgeon was cited in various reports as a lethal incidental take, the endangered species incident report prepared by Coastwise Consulting indicated that the “bucket brought up an Atlantic Sturgeon entangled in a net. The specimen was decomposing.” Assuming that the specimen was killed by entanglement in a net prior to being captured by the bucket, this documented “take” can be discounted. Detailed information is not available for the other two mechanical dredge takes. Given the mobility of sturgeon, the lack of a suction field from mechanical dredging, and the small area of active dredging by a bucket during each load, the likelihood of mechanical dredging to incidentally take sturgeon species is small. Furthermore, compared to other hydraulic dredging techniques, mechanical dredging is often recommended by NMFS as the preferred dredging technique for minimizing incidental take of sea turtles and sturgeon. Though clamshell dredge operations have reported capture of larger sturgeon (adult/juvenile), it is unlikely that clamshell dredging operation would impact small juvenile and larval sturgeon since there is no suction field generated by mechanical dredges.

4.3.6 Ship Strike

Commercial traffic can have an adverse effect on sturgeon through propeller and ship strike damage. Ship strikes pose a particular threat to sturgeon within shipping channels. Sturgeon are benthic feeders and spend most of their time on the bottom. Large vessels that transit shipping channels typically draft close to the bottom of the channel, thereby posing a threat to sturgeon. Multiple suspected ship strikes have been reported in rivers in the Mid-Atlantic States. A large number of the mortalities observed in these rivers from potential ship strikes have been of large adult Atlantic sturgeon. Between 2005 and 2008, a total of 28 Atlantic sturgeon mortalities were reported in the Delaware Estuary. Sixty-one percent of the mortalities reported were of adult size and 50 percent of the mortalities resulted from apparent vessel strikes (Brown and Murphy 2010). Analysis of the location and type of injury indicated that the encounters were most likely due to propeller strikes and not bow strikes. Vessels transit the Delaware Estuary through a shipping channel that extends 121 river miles from the mouth of Delaware Bay to near Bordentown, New Jersey. The relatively long distance vessels need to travel from the sea through the estuary to reach the ports is unusual as most of the other major Atlantic Coast ports, including Savannah Harbor, are located much closer to the sea. It is thought that the long distance that vessels transit through the Delaware Estuary allow for a greater chance of vessel interaction with sturgeon (Brown and Murphy 2010).

The James River, Virginia is similar to the Delaware River in that commercial vessels transit long distances (over 80 river miles) through a narrow channel to reach the ports. During 2005, five sturgeon were reported to have been struck by commercial vessels within the James River. Additionally, an average of one strike per five years has been reported in the Cape Fear River, North Carolina. No vessel strikes to sturgeon have ever been reported occurring in the Savannah River, which has a shipping channel that is shorter and wider than the aforementioned channels. The chance of a ship strike within the Savannah River is low as the populations of sturgeon are small, the distance from the mouth of the harbor to the port is short (less than 19 miles), and the channel is also wide, ranging from 500 to 2400 feet. In addition, according to the COE, there will be fewer (but larger) vessels entering the Savannah Harbor, which should decrease the chance of encounters with sturgeon. Therefore, NMFS believes that the chances of ship strikes to sturgeon that may result from the project is discountable because of the short shipping channel distance through the estuary combined with there being a small population of sturgeon, and a lower number of vessel transits. Also, while ships are transiting the estuary, the wide channel will allow highly mobile sturgeon to safely avoid ship traffic.

4.3.7 Climate Change/Sea Level Rise

Long-term observations confirm that climate is changing at a rapid rate. Over the 20th century, the average annual U.S. air temperature has risen by almost 0.6°C (1°F) and precipitation has increased nationally by 5-10 percent, mostly due to an increase in heavy downpours (NAST 2000). These trends are most apparent over the past few decades.

Climate model projections exhibit a wide range of plausible scenarios for both temperature and precipitation over the next century. Both of the principal climate models used by the National Assessment Synthesis Team (NAST) project warming in the Southeast by the 2090s, but at different rates (NAST 2000): the Canadian model scenario shows the southeast United States experiencing a high degree of warming, which translates into lower soil moisture as higher temperatures increase evaporation; the Hadley model scenario projects less warming and a significant increase in precipitation (about 20 percent). The scenarios examined, which assume no major interventions to reduce continued growth of world greenhouse gases (GHG), indicate that temperatures in the United States will rise by about 3°-5°C (5°°-9°F) on average in the next 100 years which is more than the projected global increase (NAST 2000). A warming of about 0.2°C per decade is projected for the next two decades over a range of emission scenarios (IPCC 2007). This temperature increase will 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.

Sea-level rise (SLR) is one of the more certain consequences 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 Southeast region were prepared, high tidal flood elevations have increased approximately 12 inches. During the 20th century, global sea level has increased between 15 and 20 cm (NAST 2000). Analysts attribute the coastal forest decline in the Southeast to salt water intrusion associated with sea level rise. Coastal forest losses will be even more severe if sea-level rise accelerates as is expected as a result of global warming.

Between 1985 and 1995, more than 32,000 acres of coastal salt marsh were lost in the southeastern United States due to a combination of human development activities, SLR, natural subsidence, and erosion (NAST 2000). Sea level is predicted to increase by 30-100 cm by 2100 (IPCC 2007). The vulnerability of tidal wetlands to accelerated SLR depends on geologic factors, such as tectonic uplift and glacial isostatic adjustment, which buffer shorelines from SLR, and subsidence, which accelerates it. Tide range also effects marsh vulnerability, as macro- (>4 m) and meso-tidal (2-4 m) marshes are less susceptible to SLR than micro-tidal (<2 m) marshes (Stevenson and Kearney in press). In some coastal areas, rising sea level may result in tidal marsh submergence (Moorehead and Brinson 1995) and habitat migration, as salt marshes transgress landward and replace tidal freshwater and brackish marshes (Park et al. 1991). Flood and erosion damage stemming from SLR rise coupled with storm surges are very likely to increase in coastal communities. Simulation modeling predicts that a 52-cm increase in SLR will lead to a decline in tidal marsh area and delivery of ecosystem services along the Georgia coast during this century (Craft et al. 2008): a 20 percent reduction in salt marsh, along with a small increase in tidal freshwater marsh (+2 percent), and a larger increase in brackish marsh (+10 percent). The decline in salt marsh is attributed to submergence and replacement by tidal flats and estuarine open water (Craft et al. 2008). Regionally, the areas most vulnerable to future sea level change are those with low relief that are already experiencing rapid erosion rates, such as the Southeast and Gulf Coast (NAST 2000).

Many ecosystems are highly vulnerable to the projected rate and magnitude of climate change. While it is possible that some species will adapt to changes in climate by shifting their ranges, the degree of adaptation that may occur will likely be limited by human and geographic barriers and the presence of invasive non-native species. Losses in local biodiversity are likely to accelerate towards the end of the 21st century.

It is difficult to assess the potential effects of climate change over the next few decades on coastal and marine resources, especially as climate variability is a dominant factor in shaping coastal and marine systems. The effects of future 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 GHGs, 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. Climate change can cause or exacerbate direct stress on ecosystems through high temperatures, a reduction in water availability, and altered frequency of extreme events and severe storms. Water temperatures in streams and rivers are likely to increase as the climate warms and are very likely to have both direct and indirect effects on aquatic ecosystems. Changes in temperature will be most evident during low flow periods when they are of greatest concern (NAST 2000). In some marine and freshwater systems, shifts in geographic ranges and changes in algal, plankton, and fish abundance are associated with high confidence with rising water temperatures, as well as related changes in ice cover, salinity, oxygen levels, and circulation (IPCC 2007).

A warmer and drier climate will reduce stream flows and increase water temperatures. Expected consequences would be a decrease in the amount of dissolved oxygen 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 will experience greater changes in discharge and water stress than unimpacted, free-flowing rivers (Palmer et al. 2008).

4.3.8 Drought

Large-scale factors impacting riverine water quality and quantity that likely exacerbate habitat threats to shortnose and Atlantic sturgeon include drought, and intra- and inter-state water allocation. Since 2007, the southeastern United States has experienced several years of drought. During this time, Georgia and South Carolina experienced drought conditions that ranged from moderate to extreme. From 2006 until mid-2009, Georgia experienced the worst drought in its history. Between November 2007 and November 2008, 50 to 100 percent of the state of Georgia experienced some level of drought ranging in intensity from "abnormally dry" to "exceptional," based on the drought intensity categories used by the U.S. Drought Monitor (NIDIS 2008). Meanwhile water allocation issues are increasing with population growth; a precedent may also be set by a United States Supreme Court decision in a case between Georgia, Alabama, and Florida and between North Carolina and South Carolina over water transfers out of the river basins found in these states (Chapman 2008, McMaster 2007).

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

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

Maintenance of adequate flow in spawning areas is especially crucial to the survival of sturgeon. Studies on larval dispersal patterns compared behavior of larvae collected from Connecticut River to those spawned from Savannah River stock. All post-yolk-sac larvae made some downstream movement as yolk-sac larvae (observed more often in the Savannah River stock), dispersal downstream was more closely associated with the post yolk-sac larval stage. Dispersal rates differed as fish from the Connecticut River peaked on days 7–12 after hatching while Savannah River individuals had a longer dispersal with multiple, prolonged peaks, and a low level of downstream movement that continued for the entire larval and early juvenile period.

4.3.9 Impingement and Entrainment

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

4.3.10 Conservation and Recovery Actions Benefiting Sturgeon

Many measures have been implemented to protect the sturgeon in the Savannah River estuary. Over-fishing, related to targeted fishing of sturgeon has been eliminated as a causative factor in the decline of the Savannah River sturgeon population. Since its ESA listing in 1967, it has been illegal to kill or possess shortnose sturgeon. In 1998, the Atlantic States Marine Fisheries Commission (ASMFC) instituted a coast-wide moratorium on the harvest of Atlantic sturgeon, which is to remain in effect until there are at least 20 protected age classes in each spawning stock (anticipated to take up to 40 or more years). NMFS followed the ASMFC moratorium with a similar moratorium for federal waters. Sturgeon that are caught incidentally as by-catch in shrimp trawls are to be released alive. The phasing out of the traditional method of catching American shad (gillnets in a coastal intercept fishery) has greatly reduced the number of sturgeon inadvertently caught by shad fisherman. In turn, this has greatly reduced the interruption of sturgeon migrations in the late winter and early fall.

Point source discharges in the Savannah River are regulated under the NPDES program by the Georgia DNR-EPD in coordination with the EPA. Since the NPDES is a federally-mandated program, all permits issued under the program are subject to review per the provisions of the ESA. The EPA established a total maximum daily load (TMDL) for the Savannah River to improve dissolved oxygen conditions in the Savannah Harbor. The TMDL requires a reduction in oxygen demanding substances (over time, as the various NPDES permits come up for renewal) in point source discharges. This impacts NPDES permit holders in the Augusta, Georgia, area as well, since their waste loads contribute to the dissolved oxygen deficiencies in Savannah Harbor.

4.3.11 Summary and Synthesis of Environmental Baseline for Sturgeon

In summary, juvenile and adult shortnose and Atlantic sturgeon occupy habitats likely to be affected by the proposed harbor deepening. Research shows that sturgeon likely move through all areas of a river system but often remain in important resting and feeding aggregations for extended time periods (Kieffer and Kynard 1993). The demersal nature of these fish makes them vulnerable to bottom water quality degradation (i.e., increased salinity and decreased dissolved oxygen) and the adults, because they may be found in the areas undergoing dredging, may be subject to direct mortality from dredging operations and ship strikes. The survival of juveniles and recruitment to the adult population has been identified as a potential limiting factor in population growth (Smith et al. 1992). Deterioration of water quality (especially dissolved oxygen) appears to be degrading the nursery function of these summer refugia, possibly creating a recruitment bottleneck (Collins et al. 2000a). However, spawning failure also contributed to recruitment limitation. The degradation of habitat due to dredging has been indicated as being detrimental to sturgeon in the Savannah River (Collins et al. 2001). The low catch rate of juveniles in the previous and on-going studies suggests that natural recruitment is low. In the Southeast, this is generally attributed to poor water quality in the nursery habitat surrounding the fresh/brackish water interface area (Collins et al. 2001).

4.4 Status and Distribution of Sea Turtles in the Action Area

Sea turtle species occurring in the project area that may be adversely affected by the proposed action are Kemp’s ridley and loggerhead sea turtles. Sea turtles found in the immediate project area may travel widely throughout the Atlantic, Gulf of Mexico, and Caribbean Sea, and individuals found in the action area can potentially be affected by activities anywhere within this wide range. These impacts outside of the action area are discussed and incorporated as part of the overall status of the species as detailed in Section 3 above. The following environmental baseline includes past and ongoing human activities in the action area that relate to the status of the species.

All of these species are highly migratory. The same individuals found in the action area may migrate into offshore waters and thus be impacted by activities occurring there; therefore, the species’ statuses in the action area are considered to be the same as their range-wide statuses and supported by the species accounts in Section 3.

4.4.1 Factors Affecting Sea Turtles in the Action Area

As stated in Section 2.2 (“Action Area”), the proposed project is located off Georgia, within the Savannah Harbor, and within the extension of the Entrance Channel. The following analysis examines actions that may affect these species’ environment specifically within the defined action area.

4.4.1.1 Federal Actions

In recent years, NMFS has undertaken several ESA Section 7 consultations to address the effects of federally-permitted fisheries and other federal actions on threatened and endangered sea turtle species, and when appropriate, has authorized the incidental taking of these species (Appendix A). The term "take" is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct. Each of those consultations sought to develop ways of reducing the probability of adverse effects of the action on sea turtles. Similarly, NMFS has undertaken recovery actions under the ESA that are addressing the problem of take of sea turtles in the fishing and shipping industries and other activities such as COE dredging operations. The summary below of anticipated sources of incidental take of sea turtles includes only those federal actions in or near the action area that have already concluded or are currently undergoing formal Section 7 consultation.

Dredging
The construction and maintenance of federal navigation channels has been identified as a source of sea turtle mortality. Hopper dredges move relatively rapidly (compared to sea turtle swimming speeds) and can entrain and kill sea turtles as the drag arm of the moving dredge overtakes the slower moving sea turtle. The COE has biological opinions from NMFS covering hopper dredging in the Atlantic and Gulf of Mexico. Along the Atlantic coast of the southeastern United States (North Carolina through Florida), NMFS estimates that annual observed injury or mortality of sea turtles from hopper dredging may total 35 loggerheads, 7 greens, 7 Kemp's ridleys, and 2 hawksbills (NMFS 1997a).

ESA Permits
The ESA allows the issuance of permits to take ESA-listed species for the purposes of scientific research (Section 10(a)(1)(a)). In addition, the ESA allows for NMFS and individual states to enter into cooperative agreements developed under Section 6 of the ESA, to assist in recovery actions of listed species. Prior to issuance of these authorizations, the proposal must be reviewed for compliance with Section 7 of the ESA.

Sea turtles are the focus of research activities authorized by a Section 10 permit under the ESA. Authorized activities range from photographing, weighing, and tagging sea turtles incidentally taken in fisheries, blood sampling, tissue sampling (biopsy), and performing laparoscopy on intentionally captured turtles. The number of authorized takes varies widely depending on the research and species involved, but may involve the taking of hundreds of turtles annually. Most takes authorized under these permits are expected to be non-lethal. As of January 2009, there were 10 active scientific research permits directed toward sea turtles. Before any research permit is issued, the proposal must be reviewed under the permit regulations (i.e., must show a benefit to the species). In addition, since issuance of the permit is a federal activity, issuance of the permit by NMFS must also be reviewed for compliance with Section 7 of the ESA to ensure that issuance of the permit does not result in jeopardy to the species.

4.4.1.2 Federally-Managed Fisheries Effects on Sea Turtles

Threatened and endangered sea turtles are adversely affected by several types of fishing gears used throughout the action area. Gillnet, longline, vertical hook-and-line gear, trawl gear, and pot/trap fisheries have all been documented as interacting with sea turtles. Available information suggests sea turtles can be captured in any of these gear types when the operation of the gear overlaps with the distribution of sea turtles. For all fisheries for which there is a fishery management plan (FMP), or for which any federal action is taken to manage that fishery, impacts have been evaluated under Section 7. Formal Section 7 consultation conducted on the following fisheries, occurring at least in part within the action area, were found likely to adversely affect threatened and endangered sea turtles: coastal migratory pelagics, dolphin-wahoo, South Atlantic snapper-grouper, Southeast shrimp, and Atlantic HMS fisheries (i.e., swordfish, tuna, shark, and billfish). An Incidental Take Statement (ITS) has been issued for the take of sea turtles in each of these fisheries.

The FMP for the dolphin/wahoo fishery was approved in December 2003. NMFS conducted a formal Section 7 consultation to consider the effects of implementation of the FMP on sea turtles. The biological opinion concluded that loggerhead, leatherback, hawksbill, green, and Kemp's ridley sea turtles may be adversely affected by operation of the fishery. However, the proposed action was not expected to jeopardize the continued existence of any of these species. An ITS has been provided.

A Section 7 consultation on the South Atlantic snapper-grouper fishery (NMFS 2006) has also been completed by NMFS. The fishery uses spear and powerhead, pots (i.e., traps), longline, and vertical hook-and-line gear. The opinion determined that only longline and vertical hook-and-line gear is likely to adversely affect green, hawksbill, Kemp's ridley, leatherback, and loggerhead sea turtles. The consultation concluded the proposed action was not likely to jeopardize the continued existence of any of these species, and an ITS was provided.

The Southeast shrimp trawl fishery affects more sea turtles than all other activities combined (NRC 1990). On December 2, 2002, NMFS completed the opinion for shrimp trawling in the southeastern United States under proposed revisions to the TED regulations (68 FR 8456, February 21, 2003). This opinion determined that the shrimp trawl fishery under the revised TED regulations would not jeopardize the continued existence of any sea turtle species. This determination was based, in part, on the opinion’s analysis that shows the revised TED regulations are expected to reduce shrimp trawl related mortality by 94 percent for loggerheads and 97 percent for leatherbacks.

Atlantic pelagic longline fisheries targeting swordfish and tuna are also known to incidentally capture large numbers of loggerhead and leatherback sea turtles. The fishery mainly interacts with leatherback sea turtles and pelagic juvenile loggerhead sea turtles, thus, younger, smaller loggerhead sea turtles than the other fisheries described in this environmental baseline.

NMFS reinitiated consultation in 2004 on the pelagic longline component of this fishery as a result of exceeded incidental take levels for loggerheads and leatherbacks (NMFS 2004b). The resulting opinion (i.e., NMFS 2004b) stated the long-term continued operation of this sector of the fishery was likely to jeopardize the continued existence of leatherback sea turtles, but RPAs were implemented allowing for the continued authorization of the pelagic longline fishing that would not jeopardize leatherback sea turtles.

On July 6, 2004, NMFS published a final rule to implement management measures to reduce bycatch and bycatch mortality of Atlantic sea turtles in the Atlantic pelagic longline fishery (69 FR 40734). The management measures include mandatory circle hook and bait requirements, and mandatory possession and use of sea turtle release equipment to reduce bycatch mortality. The rulemaking, based on the results of the 3-year Northeast Distant Closed Area research experiment and other available sea turtle bycatch reduction studies, is expected to have significant benefits to endangered and threatened sea turtles by reducing mortality attributed to this fishery.

NMFS completed a Section 7 consultation on the continued authorization of Migratory Species (HMS) Atlantic shark fisheries. The commercial sector uses bottom longline and gillnet gear, while the recreational sector only uses hook-and-line gear. To protect declining shark stocks, the proposed action seeks to greatly reduce the fishing effort in the commercial component of the fishery. These reductions are likely to greatly reduce the interactions between the commercial component of the fishery and sea turtles. The opinion concluded that green, hawksbill, Kemp's ridley, leatherback, and loggerhead sea turtles may be adversely affected by operation of the fishery; however, the proposed action was not expected to jeopardize the continued existence of any of these species, and an ITS was provided.

NMFS completed a Section 7 consultation on the continued authorization of the coastal migratory pelagic resources fishery in the Gulf of Mexico and South Atlantic (NMFS 2007a). In the Gulf of Mexico and South Atlantic, commercial fishermen target king and Spanish mackerel with hook-and-line (i.e., handline, rod-and-reel, and bandit), gillnet, and cast net gears. Recreational fishermen use only rod-and-reel. Run-around gillnets are still the primary gear used to harvest Spanish mackerel, but the fishery is relatively small because Spanish mackerel are typically more concentrated in state waters where gillnet gear is prohibited. The 2007 opinion concluded that green, hawksbill, Kemp's ridley, leatherback, and loggerhead sea turtles may be adversely affected only by the gillnet component of the fishery. The continued authorization of the fishery was not expected to jeopardize the continued existence of any of these species and an ITS was provided.

4.4.1.3 State or Private Actions

Vessel Traffic
Commercial traffic and recreational pursuits can have an adverse effect on sea turtles through propeller and boat strike damage. Private vessels participate in high-speed marine events concentrated in the southeastern United States and are a particular threat to sea turtles, and occasionally to marine mammals as well. The magnitude of these marine events is not currently known. NMFS and the USCG (which permits these events) have consulted on some of these events in Florida, but a complete analysis has not been completed. Formal consultation is currently undergoing on the USCG Seventh District's marine events permitting program. NMFS has also consulted with other agencies, such as MMS and FERC, on vessel transit interactions with listed species.

The Sea Turtle Stranding and Salvage Network (STSSN) includes many records of vessel interaction with sea turtles. However, it was not possible to determine in many cases whether the vessel strike occurred before or after the turtle's death. Stranding information does not indicate where a potential mortality event (e.g., vessel strike) occurred, as a turtle could have been injured/killed at one location and then drifted with currents (i.e., generally northward with the Gulf Stream on the East Coast) for a considerable distance before coming ashore. The extent of the impact on sea turtles in the action area is not known at this time.

State Fisheries
Commercial state fisheries are located in the nearshore habitat areas that comprise the action area. Recreational fishing from private vessels also occurs in the area. Observations of state recreational fisheries have shown that loggerhead sea turtles are known to bite baited hooks and frequently ingest the hooks. Hooked turtles have been reported by the public fishing from boats, piers, and beach, banks, and jetties and from commercial fishermen fishing for reef fish and for sharks with both single rigs and bottom longlines (NMFS 2001b). Additionally, lost fishing gear such as line cut after snagging on rocks, or discarded hooks and line, can also pose an entanglement threat to sea turtles in the area. A detailed summary of the known impacts of hook-and-line incidental captures to loggerhead sea turtles can be found in the TEWG reports (1998; 2000). In August of 2007, NMFS issued a regulation (72 FR 43176, August 3, 2007) to require any fishing vessels subject to the jurisdiction of the United States to take observers upon NMFS' request. The purpose of this measure is to learn more about sea turtle interactions with fishing operations, to evaluate existing measures to reduce sea turtle takes, and to determine whether additional measures to address prohibited sea turtle takes may be necessary.

4.4.1.4 Other Potential Sources of Impacts in the Environmental Baseline

A number of activities that may indirectly affect listed species in the action area of this consultation include ocean dumping and disposal, aquaculture, anthropogenic marine debris, and acoustic impacts. The impacts from these activities are difficult to measure.

Where possible, conservation actions are being implemented to monitor or study impacts from these sources.

Marine Pollution
Sources of pollutants along the Atlantic coastal regions include atmospheric loading of pollutants such as PCBs, stormwater runoff from coastal towns, cities and villages, runoff into rivers emptying into the bays, groundwater and other discharges, and river input and runoff. Nutrient loading from land-based sources, such as coastal community discharges, is known to stimulate plankton blooms in closed or semi-closed estuarine systems. The effects on larger embayments are unknown. Although pathological effects of oil spills have been documented in laboratory studies of marine mammals and sea turtles (Vargo et al. 1986), the impacts of many other anthropogenic toxins have not been investigated. Issues of marine debris are also a concern for sea turtles as they have been known to ingest or become entangled in various forms of marine debris.

Acoustic Impacts
Acoustic impacts can include temporary or permanent injury, habitat exclusion, habituation, and disruption of other normal behavior patterns. NMFS and the U.S. Navy are working cooperatively to assess military acoustic impacts (e.g., mid-range sonar) along the east coast of the United States (i.e., primarily North Carolina through Florida). Although focused on marine mammals, sea turtles may benefit from increased research on acoustics and reduction in noise levels.

Climate Change
Climate change at normal rates (thousands of years) was not historically a problem for sea turtles species since they have shown unusual persistence over a scale of millions of years. However, there is a 90 percent probability that warming of Earth's atmosphere since 1750 is due to human activities resulting in atmospheric increases in carbon dioxide, methane, and nitrous oxide (IPCC 2007). All reptiles including sea turtles have a tremendous dependence on their thermal environment for regulating physiological processes and for driving behavioral adaptations (Spotila et al. 1996). In the case of sea turtles, where many other habitat modifications are documented (beach development, loss of foraging habitat, etc.), the prospects for accentuated synergistic impacts on survival of the species may be even more important in the long-term. Atmospheric warming creates habitat alteration which may change sex ratios, reproductive periodicity, marine habitats, or prey resources such as crabs and other invertebrates. It may increase hurricane activity leading to an increase in debris in nearshore and offshore waters, resulting in increase in entanglement, ingestion, or drowning. Atmospheric warming may change convergence zones, currents and other oceanographic features that are relevant to various sea turtles' life stages.

4.4.1.5 Conservation and Recovery Actions Benefiting Sea Turtles

Under Section 6 of the ESA, NMFS may enter into cooperative research and conservation agreements with states to assist in recovery actions of listed species. NMFS currently has a Section 6 agreement with the State of North Carolina. Prior to issuance of these agreements, the proposal must be reviewed for compliance with Section 7 of the ESA.

NMFS and cooperating states have established an extensive network of Sea Turtle Stranding and Salvage Network (STSSN) participants along the Atlantic and Gulf of Mexico coasts that not only collect data on dead sea turtles, but also rescue and rehabilitate any live stranded sea turtles.

Other Actions
A revised recovery plan for the loggerhead sea turtle was completed December 8, 2008 (NMFS and USFWS 2008). The recovery plan for the Kemp's ridley sea turtle is in the process of being updated. Recovery teams comprised of sea turtle experts have been convened and are currently working towards revising these plans based upon the latest and best available information. Five-year status reviews have recently been completed for green, hawksbill, Kemp's ridley, leatherback, and loggerhead sea turtles. These reviews were conducted to comply with the ESA mandate for periodic status evaluation of listed species to ensure that their threatened or endangered listing status remains accurate. Each review determined that no delisting or reclassification of a species status (i.e., threatened or endangered) was warranted at this time. However, further review of species data for the green, hawksbill, leatherback, and loggerhead sea turtles was recommended, to evaluate whether distinct population segments (DPS) should be established for these species (NMFS and USFWS 2007a-e). NMFS has also been active in public outreach efforts to educate fishermen regarding sea turtle handling and resuscitation techniques. There is also an extensive network of STSSN participants along the Atlantic and Gulf of Mexico coasts that not only collect data on Dead Sea turtles, but also rescue and rehabilitate any live stranded sea turtles.

4.4.1.6 Summary and Synthesis of Environmental Baseline for Sea Turtles

In summary, several factors adversely affect sea turtles in the action area. These factors are ongoing and are expected to occur contemporaneously with the proposed action. Fisheries in the action area likely had the greatest adverse impacts on sea turtles in the mid to late 80s, when effort in most fisheries was near or at peak levels. With the decline of the health of managed species and economic pressure on the shrimp fishery, effort since that time has generally been declining. Impacts associated with fisheries have been reduced through the Section 7 consultation process and regulations implementing effective bycatch reduction strategies. However, interactions with commercial and recreational fishing gear are still ongoing and are expected to occur contemporaneously with the proposed action. Other environmental impacts including effects of vessel operations, additional military activities, dredging, permits allowing take under the ESA, private vessel traffic, and marine pollution have also had and continue to have adverse effects on sea turtles in the action area in the past, but to a lesser degree of magnitude.

5 EFFECTS OF THE ACTION

In this section of the opinion, we assess the effects of the proposed action on loggerhead sea turtles, Kemp's ridley sea turtles, shortnose sturgeon, and Atlantic sturgeon within the action area. The analysis in this section forms the foundation for our jeopardy analysis in Section 7.0. A jeopardy determination is reached if we would reasonably expect the proposed action to cause reductions in numbers, reproduction, or distribution that would appreciably reduce listed species' likelihood of surviving and recovering in the wild.

The proposed deepening is likely to adversely affect sturgeon and sea turtles. Impacts may include direct, short-term impacts from dredging and disposal operations to more long-term impacts caused by loss of habitat and habitat degradation. Although all dredging and sediment placement activities would be conducted well-below sturgeon spawning areas and downstream of juvenile/adult habitat near the freshwater interface, the effects of the activities will directly impact the habitat of sturgeon and their prey, and reduce the amount of habitat in which sturgeon can perform essential biological functions, such as feeding and maturing. The harbor deepening will impact both adult and juvenile shortnose sturgeon habitat in the upper harbor estuary due to increases in salinity levels and decreases in dissolved oxygen concentrations. Juvenile and adult sturgeon are dependent upon this unique estuarine habitat found near the freshwater/saltwater interface for foraging and resting. Offshore dredging of the Entrance Channel and disposal activities will affect sea turtles and adult Atlantic sturgeon. Restoration of access to spawning habitat at the Augusta Shoals with properly designed fish passage at New Savannah Bluff Lock and Dam would reduce the ongoing adverse effects of the dam's impedance of access to spawning habitat, improving spawning and recruitment success for both sturgeon species.

5.1 Effects of the Action on Sea Turtles

5.1.1 Dredging

The potential for adverse effects of dredging operations on sea turtles has been previously assessed by NMFS (NMFS 1991, 1995, 1997a, 1997b, 2003b) in the various versions of the SARBO and the 2003 (revised in 2005 and 2007) Gulf of Mexico RBO. Additionally, the COE has recently prepared a comprehensive analysis of data from Gulf and Atlantic hopper dredging projects to identify factors affecting sea turtle take rates (Dickerson et al. 2007). Furthermore, the COE maintains an on-line Sea Turtle Data Warehouse (USACE 2010) with historical records of dredging projects and turtle interactions. These are the primary sources, discussed further below, for our analysis of dredging effects on sea turtles.

Mechanical (Clamshell/Bucket Dredges) and/or Cutterhead Dredging
The project may affect sea turtles by injury or death as a result of interactions with equipment or materials used during dredging; however, NMFS believes the chance of injury or death from interactions with clamshell and/or hydraulic dredging equipment is discountable as these species are highly mobile and are likely to avoid the areas during

construction. NMFS has received very few reported sea turtle takes associated with these dredging methods. In the South Atlantic region two sea turtles have been taken by a clamshell dredge over the past 20 years, the most recent of which occurred on May 19, 2011, at Cape Canaveral, Florida, which routinely has very high local turtle abundance. Due to the infrequency of interactions with these gear types, NMFS believes that the likelihood of sea turtles being taken by a hydraulic cutterhead or a clamshell dredge is discountable.

Hopper Dredging
Hopper dredging was implicated in the mortality of South Atlantic endangered and threatened sea turtles as early as the late 1970s and in NMFS' opinions issued in 1979, 1980, and others leading to the RBO issued in 1991. This determination was repeated in the 1995 and 1997 SARBOs (NMFS 1995, 1997a, 1997b). The measures established in consecutive RBOs (NMFS 1991, 1995, 1997a) to avoid and minimize sea turtle interactions during hopper dredging operations permitted by the COE in the southeastern United States are included in this project, with the exception of modifications to dredge timing (i.e., "dredging window") and conditions of/requirements for capture-type relocation trawling.

To date, use of hopper dredges in COE activities in northeast Florida and Georgia has been limited under the 1997 RBO to operating between December 1 through April 15, except in emergency situations, due to the presumption that the potential for lethal and injurious take of sea turtles by hopper dredges would be lower during winter periods of lower seasonal abundance. However, recent data analysis of hopper dredging projects from 1995-2008 by the COE indicates that documented sea turtle take rates in projects from Georgia and the east coast of Florida are lower (on both a turtles-taken-per-project basis and turtles-taken-per-day basis) during May through November (when hopper dredging is discouraged) than during December through April, which is the NMFS-recommended dredging window. Turtles are typically more abundant during the warm summer months but may not spend large amounts of time on or in the bottom sediments and may need to surface more often to breathe due to increased activity. Turtles resting on or in bottom sediments are more vulnerable to dredge entrainment than turtles swimming in the water column above the draghead. Although increased numbers of sea turtles are known to be encountered between June and September (peak nesting season), they may be less vulnerable to entrainment because of their biological requirements (e.g., reproductive activities, reduced feeding, increased metabolism), mandating them to spend more time in the upper water column. Given this evidence and rationale, hopper dredging conducted during December 1 through March 31 may result in more takes than during the summer dredging.

To calculate the expected rates of turtle entrainment in hopper dredging for this project, NMFS consulted the Sea Turtle Data Warehouse (USACE 2011) to find the most applicable historic dredging information for the Savannah Harbor Entrance Channel.

Savannah Harbor Entrance Channel

From 2000 through 2010 (Table 8), maintenance dredging of the Savannah Harbor Entrance Channel generated approximately 7,306,635 cubic yards of material. During the same time period 10 sea turtles were taken in hopper dredges during these maintenance events. This equates to a catch per unit effort (CPUE) of 0.0000013 turtles per cubic yard dredged.

YEAR	QUANTITY OF DREDGED MATERIAL (CUBIC YARDS)	TURTLE TAKES	RELOCATION TRAWLING
2000	1,279,900	2 (1 loggerhead; 1 Kemp's)	N
2001	1,117,900	2 loggerhead	N
2002	446,850	2 loggerhead	N
2003	635,163	0	N
2004	620,642	0	N
2005	888,100	0	N
2006	88,194	4 (3 Kemp's; 1 loggerhead)	N
2007	973,463	0	Y
2008	484,607	0	N
2009	261,780	0	N
2010	510,036	0	N
TOTAL	**7,306,635**	**10**	**-**

Table 8. Dredged material removed and sea turtle takes during dredging of the Savannah Harbor Entrance Channel, 2000-2010 (USACE Sea Turtle Data Warehouse 2011).

Using the CPUE we can calculate the number of sea turtles expected to be adversely affected by hopper dredging activities during the proposed action by multiplying the estimated amount of material to be dredged by the CPUE. The proposed project has an estimated 13,325,513 cubic yards of material that would be dredged from the Ocean Bar Channel (Table 9); therefore, we estimate that 17 turtles (10 loggerhead and 7 Kemp's ridley sea turtles based on species composition reported in previous Savannah Harbor dredging projects) will be observed (and counted) by onboard protected species observers as lethally taken during the course of the proposed hopper dredging in the Savannah Harbor Entrance Channel. This estimate is based on the use of only hopper dredges for the entire project and represents only the sea turtle mortalities *detected* by onboard observers.

NMFS-approved observers monitor dredged material inflow and overflow screening baskets on many hopper dredging projects, and observers will be required to monitor the proposed action. Dredged material screening, however, is only partially effective, and observed takes likely provide only partial estimates of total sea turtle mortality. NMFS believes that some turtles killed by hopper dredges go undetected because body parts are forced through the sampling screens by water pressure and are buried in the dredged material, or animals are crushed or killed but their bodies or body parts are not entrained by the suction and so the takes may go unnoticed. The only mortalities that are noticed and documented are those where body parts float, are large enough to be caught in the screens, and can be identified as sea turtle parts. Body parts that are forced through the 4-inch (or greater) inflow screens by the suction-pump pressure and that do not float are very unlikely to be observed, since they will sink to the bottom of the hopper and not be detected by the overflow screening. Unobserved takes are not documented, thus, observed takes may under-represent actual lethal takes. It is not known how many turtles are killed but unobserved. Because of this, in the Gulf of Mexico Regional Biological Opinion (NMFS 2003b), in making its jeopardy analysis, NMFS estimated that up to one out of two impacted turtles may go undetected (i.e., that observed take constituted only about 50 percent of total take). That estimate was based on region-wide (overall Gulf of Mexico) hopper dredging projects including navigation channel dredging and sand borrow area dredging for beach renourishment projects, year-round, including seasonal windows when no observers are required, times when 100 percent coverage is required, and times when only 50 percent observer coverage is required (i.e., at sand borrow sites). The proposed December 1 through March 31 dredging of the Savannah Harbor Entrance Channel will include 100 percent observer coverage for the duration of work. Since the 100 percent observer coverage that will be required for the proposed dredging action is twice as intensive (and theoretically, twice as effective) as the 50 percent observer coverage requirement of the 2003 Gulf of Mexico Regional Biological Opinion, NMFS believes that a significantly greater number of turtles will be detected with 100 percent observer coverage than with just 50 percent observer coverage (i.e., one of two turtles), but that a significant number of turtle parts will still pass through the screens undetected. In NMFS' January 7, 2009, Mayport ship channel hopper dredging biological opinion to the U.S. Navy, under similar circumstances to the proposed action (i.e., it also required 100 percent observer coverage year-round), NMFS estimated that approximately 66 percent (two out of three entrained turtles or turtle parts) would be observed/documented by shipboard protected species observers. More recently, NMFS' biological opinion to the COE's Galveston District on the Freeport Harbor navigation channel widening and deepening project (also with 100 percent observer coverage) again anticipated that approximately 66 percent of entrained turtles would be detected. Now, similarly, NMFS estimates that observers on the proposed project will detect approximately two of every three turtles entrained. This estimate is based on the use of 100 percent observer coverage, the best available empirical evidence, years of hopper dredging experience and observer reports, and the commonality of the 100 percent observer requirement with previous dredging consultations under similar conditions. This opinion estimates that observers will detect and record approximately 66.6% of total mortality (i.e., two of every three turtles killed by the dredge will be detected, observed, and tallied by onboard observers), resulting in an additional estimated 6 loggerheads and 4 Kemp's ridleys taken, but not detected, for a total of 27 sea turtles taken.

As with previous NMFS biological opinions on hopper dredging, our subsequent jeopardy analysis is necessarily based on our knowledge (in this case, our best estimate) of the total number of turtles that will be lethally taken, which includes those that are killed but not observed. Our best estimate of turtles lethally taken will be the sum of the observed and unobserved takes, i.e., those observed and documented by onboard protected species observers, plus those unobserved, undocumented lethal takes (because the turtles/turtle parts were either not entrained, or were entrained but were not seen/counted by onboard protected species observers). For example, the 2003 Gulf of Mexico Regional Biological Opinion on hopper dredging estimated that 80 loggerhead sea turtles would be killed by hopper dredges each year, but that only 40 would be detected by onboard observers.

Our ITS, is based on observed takes, not only because observed mortality gives us an estimate of unobserved mortality, but because observed, documented take numbers serve as triggers for some of the reasonable and prudent measures, and for potential reinitiation of consultation if actual observed takes exceed the anticipated/authorized number of observed takes. Furthermore, our ITS level of anticipated/authorized lethal takes is based on the implementation of relocation trawling, since it is an integral and important part of the proposed action. Without the implementation of relocation trawling, mortalities resulting from hopper dredge activities could be higher.

Station	Total by Station in Cubic Yards
-98+600B to -60+000B	4,212,500
-60+000B to -57+000B	401,409
-57+000B to -53+500B	469,252
-53+500B to -40+000B	1,959,186
-40+000B to -30+000B	1,573,800
-30+000B to -20+000B	1,628,379
-20+000B to -10+000B	1,594,871
-10+000B to -0+000B	1,110,713
0+000B to 4+000B	375,403
TOTAL	13,325,513

Table 9. Estimated New Work Sediment by Reach for the Outer Harbor (Ocean Bar Channel)

A very few turtles (over the years, a fraction of a percent) survive entrainment in hopper dredges, usually smaller juveniles that are sucked through the pumps without being dismembered or badly injured. Often they will appear uninjured only to die days later of unknown internal injuries, while in rehabilitation. Experience has shown that the vast majority of hopper-dredge impacted turtles are immediately crushed or dismembered by the violent forces they are subjected to during entrainment. Therefore, we are conservatively predicting that all takes by hopper dredges will be lethal.

In addition to the initial project impacts, an estimated 1,181,000 cubic yards of material would be removed during annual maintenance dredging of the Entrance Channel; annual maintenance dredging events are covered under the 1997 SARBO, which is currently under reinitiation.

5.1.2 Modified Bed-leveling Activities

Bed-leveling is often associated with hopper dredging (and other types of dredging) operations, and may be utilized in this project. Bed-leveling "dredges" do not use suction; they redistribute sediments, rather than removing them. Plows, I-beams, or other seabed-leveling mechanical dredging devices are often used for cleanup operations, i.e., to lower high spots left in channel bottoms and dredged material deposition areas by hopper dredges or other type dredges. Leveling devices typically weigh about 30 to 50 tons, are fixed with cables to a derrick mounted on a barge pushed or pulled by a tugboat at about one to two knots. Some evidence indicates that bed leveling devices may be responsible for occasional sea turtle mortalities (NMFS 2003e). Sea turtles may be crushed as the leveling device passes over a turtle which fails to move or is not pushed out of the way by the sediment "wave" generated by and pushed ahead of the device. Sea turtles in Georgia waters may have been crushed and killed in 2003 by bed-leveling which commenced after the hopper dredge finished its work associated with the Brunswick Harbor Entrance Channel dredging. The local sea turtle stranding network reported documented stranded crushed sea turtles in the area where the bed-leveler dredge was working, within days after the dredge was in the area. Brunswick Harbor is also one of the sites where sea turtles captured by relocation trawlers sometimes show evidence of brumating (over-wintering) in the muddy channel bottom, which could explain why, if sea turtles were in fact crushed by bed-leveler type dredges (there is no proof, but it is the most likely explanation), they failed to react quickly enough to avoid the bed-leveler. Bed-leveler use at other dredging operations has not resulted in observed or documented sea turtle mortalities; therefore, the best available evidence points to occasional potential interactions to brumating sea turtles at Brunswick. All things considered, the use of bed-levelers is probably preferable (less likely to result in sea turtle interactions) to the use of hopper dredges for cleanup operations, since turtles foraging, resting, or brumating on irregular bottoms are probably more likely to be entrained by suction dragheads than crushed by bed-levelers, because: (1) sea turtle deflector dragheads are less effective on uneven bottoms; (2) hopper dredges move considerably faster than bed-leveler "dredges;" and (3) bed-levelers do not use suction.

The project proposes to authorize their use only in the Bar Channel. Furthermore, their use would be restricted to the leveling of high spots in the channel or placement area, where the use of a hopper dredge for such work would be expected to result in equal or greater take of endangered species. Proposed modifications (i.e., integrated deflector configurations) to traditional bed-levelers are expected to reduce their unknown (but thought to be insignificant) potential to impact non-brumating sea turtles. NMFS believes it is unlikely that turtles may be adversely affected by potential bed-leveling activities during "high-spot cleanup" during the proposed action. However, if injurious or lethal bed-leveler interactions appear to have occurred, based on reports of stranded turtles, they shall be immediately reported to NMFS. Any such takes shall not be counted against the total lethal takes allowed by the Incidental Take Statement of this opinion. In addition, unobserved takes have already been accounted for in our total take estimates (see RPMs, Term and Condition No. 6), as discussed in the preceding section (5.1.1).

5.1.3 Relocation Trawling

The function and purpose of capture relocation trawling is to capture sea turtles that may be in the dredge's path. By reducing the sea turtle density immediately in front of the dredge's suction dragheads, the potential for draghead-turtle interactions is reduced. The relocation trawler typically pulls two standard (60-foot headrope) shrimp trawl nets, as close as safely possible in front of the advancing hopper dredge. The trawler also continues sweeping the area to be dredged (channels or borrow areas) even while the hopper dredge is not actively dredging, e.g., when it is enroute to the ODMDS or pumpout station. Relocation trawling has been successful at temporarily displacing Kemp's ridley, loggerhead, leatherback, and green sea turtles from channels in the Atlantic Ocean and Gulf of Mexico during periods when hopper dredging was imminent or ongoing (Dickerson et al. 2007). Historically, relocation trawling has been used to reduce turtle take by capturing the turtle in a modified shrimp net, bringing it onboard the trawler, and transporting it approximately 3-5 miles from the dredging where it is released into the ocean. Dickerson et al. (2007) analyzed historical data for COE dredging projects in the Atlantic Ocean and Gulf of Mexico and concluded that relocation trawling is effective at reducing the rate of sea turtle entrainment by hopper dredges. Dickerson et al. (2007) also found that the effectiveness of relocation trawling was increased: (1) when the trawling was initiated at the beginning or early in the project, and (2) by the intensity of trawling effort (i.e., more time trawling per hour). Dickerson (pers. comm. 2008) noted that when a relocation trawler is used – whether or not turtles are actually captured – the incidence of lethal sea turtle take by hopper dredges decreases. Dickerson concluded that the action of the trawl gear on the bottom results in stimulating turtles off the bottom and into the water column, where they are no longer likely to be impacted by the suction draghead of a hopper dredge. The effects of relocation trawling on sea turtles will be further discussed below.

Effects of Recapturing of Sea Turtles during Relocation Trawling
Some sea turtles captured during relocation trawling operations return to the dredge site and subsequently are recaptured. For example, sea turtle relocation studies by Standora et al. (1993) at Canaveral Channel, Florida, relocated 34 turtles to six release sites of varying distances north and south of the channel. Ten turtles returned from southern release sites, and seven from northern sites, suggesting that there was no significant difference between directions. The observed return times from the southern release sites suggested a direct correlation between relocation distance and likelihood of return or length of return time to the channel. No correlation was observed between the northern release sites and the time or likelihood of return. The study found that relocation of turtles to the site 70 km (43 miles) south of the channel would result in a return time of over 30 days.

Over a 7-day period in February 2002, REMSA, a private company contracted to conduct relocation trawling, captured, tagged, and relocated 69 turtles (55 loggerheads and 14 greens) from Canaveral Channel, Florida, with no recaptures; turtles were relocated a minimum of 3 to 4 miles away (T. Bargo, REMSA, pers. comm. to Eric Hawk, NMFS

SER, June 2, 2003). Twenty-four hour per day relocation trawling conducted by REMSA at Aransas Pass Entrance Channel (Corpus Christi Ship Channel) from April 15, 2003, to July 7, 2003, resulted in the relocation of 71 turtles (56 loggerheads, 15 Kemp's ridleys, and 1 leatherback) between 1.5 and 5 miles from the dredge site, with 3 recaptures, all loggerheads (T. Bargo, REMSA, pers. comm. to Eric Hawk, NMFS SER, July 24, 2003). One turtle released on June 14, 2003, approximately 1.5 miles from the dredge site, was recaptured four days later at the dredge site; another turtle captured June 9, 2003, and released about 3 miles from the dredge site was recaptured nine days later at the dredge site. Subsequent releases occurred five miles away. Of these 68 subsequent capture/releases, one turtle released on June 22, 2003, was recaptured 13 days later (REMSA Final Report, Sea Turtle Relocation Trawling, Aransas Pass, Texas, April-July 2003) at the dredge site. Over 15 days of dredging and associated turtle relocation trawling conducted between July 9 and 23, 2010, for the construction of 35 miles of oil-barrier sand-berms at Hewes Point, Chandeleur Islands, Louisiana, resulted in 194 sea turtle trawl-captures and relocations (185 loggerheads, 8 Kemp's ridleys, and 1 green), with 11 turtles recaptured (all loggerheads) at the sand borrow site after being relocated at least 3 miles away from the dredge site (L. Brown, COE, pers. comm. via e-mail to E. Hawk, NMFS, February 22, 2011). Table 10 below compares the various recapture rates for relocation trawling. More recently, from April 11-June 11, 2011, at the Longboat Key beach nourishment project, 23 sea turtles were captured and relocated (20 loggerheads, two Kemp's, and one green). One, a large, sexually-mature male loggerhead, was captured at the borrow site (and relocated) three times, released each time at least 3-5 miles away from the capture site, each time in a different compass direction from the borrow site. The last time, the turtle was released with a satellite transmitter attached (E. Hawk, NMFS, pers. comm. June 13, 2011).

Number of Turtles Released/Relocated	Relocation Distance from dredge site	Number of Turtles Recaptured	Recapture Timing	Citation
34	43 miles (Southern release site)	10	> 30 days	Standora et al. (1993)
69	Minimum 3-4 miles	0	N/A	T. Bargo, REMSA, pers. comm. to Eric Hawk, NMFS SER, June 2, 2003
71	1.5-5 miles	3	4-13 days	REMSA Final Report, Sea Turtle Relocation Trawling, Aransas Pass, Texas, April-July 2003
194	Minimum 3 miles	11	15 days	L. Brown, COE, pers. comm. via e-mail to E. Hawk, NMFS, February 22, 2011

Table 10. Comparison of Recapture Rates for Relocation Trawling

The capture and handling of sea turtles can result in raised levels of stressor hormones, and can cause some discomfort during tagging procedures; based on past observations obtained during similar research trawls for turtles, these physiological effects are expected to dissipate within a day (Stabenau and Vietti 1999). During the course of 1,600 days of relocation trawling at Wilmington, North Carolina; Kings Bay and Savannah, Georgia; Pensacola, Florida; and Sabine Pass, Galveston, Freeport, Matagorda Pass, and Corpus Christi, Texas, Coastwise Consulting, Inc., successfully captured, tagged, and released over 770 loggerhead, Kemp's ridley, green, and hawksbill, and leatherback sea turtles (C. Slay, Coastwise Consulting, pers. comm. via e-mail to E. Hawk, NMFS, January 25, 2007). Only one leatherback mortality was documented and attributed to illegal artificial reef material deployed within a designated borrow area (the trawl net that captured the leatherback got entangled on the reef material and the trawler was unable to haul its nets timely (within 42 minutes, as required by the GRBO); the turtle drowned before the net was able to be freed and brought to the surface). On the Atlantic coast, REMSA also successfully tagged and relocated over 140 turtles in the last several years, most notably, 69 turtles (55 loggerheads and 14 greens) in a 7-day period at Canaveral Channel in October 2002, with no significant injuries. Other sea turtle relocation contractors (R. Metzger in 2001; C. Oravetz in 2002) have also successfully and non-injuriously trawl-captured and released sea turtles out of the path of oncoming hopper dredges. In the Gulf of Mexico, REMSA captured, tagged, and relocated 71 turtles at Aransas Pass, Texas, with no apparent long-term ill effects to the turtles. Three injured turtles captured were transported to University of Texas Marine Science Institute rehabilitation facilities for treatment (two had old, non-trawl related injuries or wounds; the third turtle may have sustained an injury to its flipper, apparently from the door chain of the trawl, during capture). Three of the 71 captures were recaptures and were released around 1.5, 3, and 5 miles, respectively, from the dredge site; none exhibited any evidence their capture, tag, release, and subsequent recapture, was in any way detrimental (T. Bargo, REMSA, pers. comm. to E. Hawk, NMFS, June 2, 2003. Given that sea turtle recaptures are relatively infrequent, and recaptures that do occur typically happen several days to weeks after initial capture, cumulative adverse effects from recapture are not expected.

Relocation Trawl Tow-Time Effects on Sea Turtles

The Gulf and South Atlantic Fisheries Development Foundation's August 31, 1998, "Alternatives to TEDs: Final Report" study presents data on 641 South Atlantic shallow trawl tows (only one tow was in water over 27.4 m), all conducted under restricted tow times (55 minutes during April through October and 75 minutes from November through March), and 584 Gulf of Mexico nearshore trawl tows conducted under the same tow-time restrictions of 55 and 75 minutes. Offshore effort in the Gulf of Mexico consisted of 581 non-time restricted tows, which averaged 7.8 hours per tow.

All totaled, 323 turtle observations were documented: 293 in the nearshore (time-restricted) South Atlantic efforts, and 30 in the Gulf efforts (24 in nearshore time-restricted tows and 6 in offshore time-unrestricted tows). Of the 293 South Atlantic turtles (219 loggerhead, 68 Kemp's ridley, 5 green, and 1 leatherback), only 274 were used in the analyses (201 loggerhead, 67 Kemp's ridley, 5 green, and 1 leatherback) because 12 escaped from the nets after being seen and 7 were caught in try nets. Of the 274 South Atlantic turtles captured using restricted tow times, only 5 loggerheads and 1 Kemp's ridley died because of the interaction, a 2.2 percent fatality rate (6 divided by 274).

For the Gulf efforts, 30 turtle observations/interactions (24 nearshore and 6 offshore) were recorded but just 26 turtles were included in the study's CPUE analysis (21 in nearshore and 5 in offshore), since some may have been previously dead (i.e., non-trawl-related). These 26 captures (8 loggerhead, 16 Kemp's ridley, and 2 green) resulted in three mortalities (1 loggerhead nearshore, 1 loggerhead, and 1 green offshore). The nearshore restricted tow-time mortality rate was 1 of 21 nearshore captures, or 4.8 percent; the offshore non-restricted tow-time mortality rate was 2 of 5 offshore captures, or 40 percent. The latter figure is unsurprising, given the long, unrestricted tow times.

For purposes of our effects of relocation trawling analysis, we excluded all the offshore tows and mortalities because they occurred under prolonged, non-restricted tow times which are not comparable to time-restricted relocation trawling methods. This leaves 1,225 time-restricted tows (584 in the nearshore Gulf of Mexico + 641 in the nearshore South Atlantic), resulting in 295 trawl-captured turtles (274 [South Atlantic nearshore]+ 21 [Gulf of Mexico nearshore]) resulting in seven mortalities (six in the South Atlantic and one in the Gulf of Mexico), i.e., 2.4 percent of the interactions (295 divided by 7) resulted in death. However, it must be remembered that the COE-authorized relocation trawling tow time limit for conservation trawling in association with hopper dredging is much more conservative (in terms of allowable tow times) than the above study which used 55- and 75-minute allowable tow times. Those trawl tow times greatly exceed currently allowed trawl tow times. The COE hopper dredging/relocation trawling protocol established by the COE's South Atlantic Division limits allowable tow times to 30 minutes or less, which results in significantly lower sea turtle mortalities than 2.4 percent, as discussed below.

Since 1991, the COE has documented more than 65 hopper-dredging projects in the South Atlantic and Gulf of Mexico where a trawler was used as part of the project, consisting of thousands of individual tows of relocation trawling nets. In addition, the COE has also conducted or permitted abundance assessments and/or project-specific relocation trawling of sea turtles in navigation channels and sand borrow areas in the Southeast and Gulf of Mexico using commercial shrimp vessels equipped with otter trawls (Sea Turtle Warehouse Data; D. Dickerson 2007). On eight occasions a turtle has been lethally or injuriously taken by a relocation trawler (six in the Gulf of Mexico and two in the South Atlantic) over the same 20-year period (COE Sea Turtle Warehouse; pers. comm.. T. Jordan, COE, to E. Hawk, NMFS, May 23, 2011). Some of these incidents are described below.

Rarely, properly conducted relocation trawling can result in accidental sea turtle deaths, as the following examples illustrate. Henwood noted that trawl-captured loggerhead sea turtles died on several occasions during handling on deck during winter trawling in Canaveral Channel in the early 1980s, after short (approximately 30 minutes) tow times.

However, Henwood (T. Henwood, pers. comm. to E. Hawk, December 6, 2002) also noted that a significant number of the loggerheads captured at Canaveral during winter months appeared to be physically stressed and in "bad shape" compared to loggerheads captured in the summer months from the same site that appeared much healthier and robust.

In November 2002, during relocation trawling conducted in York Spit, Virginia, a Kemp's ridley sea turtle was likely struck by one of the heavy trawl doors or it may have been struck and killed by another vessel shortly before trawl net capture. The hopper dredge was not working in the area at the time (T. Bargo, pers. comms. and e-mails to E. Hawk, December 6 and 9, 2002). Additionally, during relocation trawling conducted off Destin, Florida, on December 2, 2006, a leatherback turtle was captured and killed. However, this mortality by drowning occurred after the trawler encountered and entangled its trawl net on a large section of uncharted bottom debris, and was unable to retrieve it from the bottom for several hours (C. Slay, pers. comms. and e-mails to E. Hawk, December 4, 2006; see also Dickerson et al. 2007). Over 15 days of dredging and associated turtle relocation trawling conducted between July 9 and 23, 2010, for the construction of 35 miles of oil-barrier sand-berms at Hewes Point, Chandeleur Islands, Louisiana, 194 sea turtles were trawl-captured, with 3 mortalities in 584 thirty-minute tows, or a 1.5 percent mortality rate (R. Crabtree, NMFS, letter to COE, dated January 14, 2011). NMFS considers that this rate is unusually high, given the last two decades of relocation trawling experience. The reason for the unusually high level of relocation trawler turtle mortalities associated with the berm project is unknown. At Mayport Channel dredging in April 2011, a green turtle was drowned when it entangled in an improperly designed non-capture trawl net (non-capture trawl nets have typical tow times of 3-4 hours).

The National Research Council (NRC) report "Decline of the Sea Turtles: Causes and Prevention" (NRC 1990) suggested that limiting tow durations to 40 minutes in summer and 60 minutes in winter would yield sea turtle survival rates that approximate those required for the approval of new TED designs, i.e., 97 percent. The NRC report also concluded that mortality of turtles caught in shrimp trawls increases markedly for tow times greater than 60 minutes. Current NMFS TED regulations allow, under very specific circumstances, for shrimpers with no mechanical-advantage trawl retrieval devices on board, to be exempt from TED requirements if they limit tow times to 55 minutes during April through October and 75 minutes from November through March. The presumption is that these tow time limits will result in turtle survivability comparable to having TEDs installed.

Current NMFS SER opinions typically limit tow times for relocation trawling to 42 minutes or less, measured from the time the trawl doors enter the water when setting the net to the time the trawl doors exit the water during haulback ("doors in – doors out"). This approximates 30 minutes of bottom-trawling time. As previously stated, the COE limits authorized relocation trawling time in association with hopper dredging and its limit is at least as conservative (in terms of allowable tow times) as NMFS'; the COE's current hopper dredging/relocation trawling protocol limits capture-trawling relocation tow times to 30 minutes or less, doors in to doors out. Overall, the significantly reduced tow times used by relocation trawling contractors, compared to those used during the 1998 studies on the effects of unrestricted, 55-minute, and 75-minute tow times leads NMFS to conclude that current relocation trawling mortalities occur (and will continue to occur) at a much lower rate than 2.4 percent. Recent relocation trawling data bears this out strikingly: from October 1, 2006, to June 14, 2011, COE dredging projects relocated 1,216 turtles in the Gulf of Mexico and South Atlantic. There were 5 documented mortalities during those relocation events, or 0.4 percent overall (COE Sea Turtle Data Warehouse, queried June 14, 2011).

Total Impact of Relocation Trawling on Sea Turtles
NMFS believes that properly conducted and supervised relocation trawling (i.e., observing NMFS-recommended trawl speed and tow-time limits, and taking adequate precautions to release captured animals) and tagging is unlikely to result in adverse effects (i.e., injury or death) to sea turtles. As discussed above, NMFS estimates that, overall, sea turtle trawling and relocation efforts will result in considerably less than 0.5 percent mortality of captured turtles, with any mortalities that do occur being primarily due to the turtles being previously stressed or diseased or struck by trawl doors or suffering accidents on deck during codend retrieval and handling. On the other hand, hopper dredge entrainments invariably result in injury, and are almost always fatal.

Even though relocation trawling involves the capture and collection of sea turtles, it has constituted a legitimate RPM in past NMFS biological opinions on hopper dredging because it reduces the level of almost certain injury and mortality of sea turtles by hopper dredges, and it allows the sea turtles captured non-injuriously by trawl to be relocated out of the path of the dredges. Without relocation trawling, the number of sea turtles mortalities resulting from hopper dredging would likely be significantly greater than the estimated number discussed above and specified in the ITS. The Consultation Handbook (for Procedures for Conducting Consultation and Conference Activities under Section 7 of the Endangered Species Act, U.S. Fish and Wildlife Service and National Marine Fisheries Service, March 1998) expressly authorizes such directed take as an RPM at pages 4-54. Therefore, NMFS will in this section evaluate the expected number of sea turtles collected or captured during required relocation trawling, so that these numbers can be included in the evaluation of whether the proposed action will jeopardize the continued existence of the species.

The number of sea turtles collected or captured by trawlers in association with hopper dredging projects varies considerably by project area, amount of effort, and time of year. Additionally, sea turtle distribution can be very patchy, resulting in significant differences in number of turtle captures by relocation trawler, and in some areas, one species may dominate the captures. For example, Canaveral, Florida, is known for its abundance of green turtles; Calcasieu, Louisiana, for its almost exclusive capture of Kemp's ridleys; Brunswick, Georgia, and Mississippi-River Gulf Outlet, Louisiana, captures are predominantly loggerheads (E. Hawk, NMFS, pers. comm., June 13, 2011).

Since October 2011, of the 1,216 turtle captures by relocation trawler, the majority (1,145) occurred in the Gulf of Mexico, while 71 occurred in the South Atlantic (COE Sea Turtle Data Warehouse, June 14, 2011 data). Dickerson et al. (2007) evaluated the effectiveness of relocation trawling for reducing incidental take of sea turtles by analyzing incidental take recorded in endangered species observer reports, relocation trawling reports, and hopper dredging project reports from 1995 through 2006. From 1995 through 2006, 319 hopper dredging projects throughout the Gulf of Mexico (n = 128) and Atlantic Ocean (n = 191) used endangered species monitoring and a total of 358 dredging-related sea turtle takes were reported (Regions: Gulf =147 sea turtles; Atlantic = 211 sea turtles). During the 70 projects with relocation trawling efforts, 1,239 sea turtles were relocated (Regions: Gulf=844; Atlantic=395). Loggerhead is the predominant species for both dredge take and relocation trawling take of sea turtles. Kemp's ridleys rank second. Green turtles have been captured in trawls only during December through March in the Gulf of Mexico. Although 2 hawksbills and 6 leatherbacks were relocated during 1995-2006, neither of these species has ever been killed by a dredge. However, during the Destin-Ft. Walton Beach, Florida, beach nourishment project in December 2006, one leatherback was drowned accidentally when the relocation trawl net in which it was captured got entangled in bottom debris (it took the crew several hours before they were able to free the net and lift it to the surface) (Dickerson et al. 2007).

Based on these data, Dickerson et al. (2007) calculated the average CPUE for dredging projects within the South Atlantic as 1.19 sea turtles per project. This does not account for the volume of sediment dredged during each project. Dickerson et al. (2007) then compared the CPUE of takes per dredge day between dredging periods with and without relocation trawling to evaluate the effectiveness of relocation efforts for reducing incidental take of sea turtles. For projects utilizing relocation trawling, the lowest overall CPUE (0.0222 takes/dredge day) was seen when relocation began at the onset of dredging and continued throughout the entire dredging project. The next lowest take rates were found for projects that either initiated relocation trawling prior to the start of dredging (0.0667 takes/dredge day) or early in the first third of the dredging project (0.0642 takes/dredge day) and continued relocation throughout the remaining dredging project. Smallest reductions in take rates were seen when relocation trawling was initiated either late (during second third) (0.1070 takes/dredge day) or very late (during last third) (0.1808 takes/dredge day) in the dredging project (Dickerson et al. 2007). Table 11 below summarizes the varying CPUE of takes per dredge in relation to when relocation trawling is initiated during a dredge project.

CPUE of takes per dredge day	Initiation of Relocation Trawling
0.0222 takes/dredge day	at onset of dredging and continued throughout the entire dredging project
0.0667 takes/dredge day	Prior to the start of dredging and continued throughout the entire dredging project
0.0642 takes/dredge day	early in the first third of the dredging project and continued throughout the entire dredging project
0.1070 takes/dredge day	during second third of dredging project
0.1808 takes/dredge day	during last third of dredging project

Table 11. CPUE of takes per dredge day in relation to when relocation trawling is initiated during a dredge project.

Dickerson et al. (2007) concluded that relocation trawling is an effective management option for reducing incidental take of sea turtles during hopper dredging in some locations, provided aggressive trawling effort is initiated either at the onset of dredging or early in the project. It is reasonable to assume that, for the proposed action analyzed in this opinion, in the absence of relocation trawling the number of sea turtle mortalities would increase, but predicting a precise number would be problematic due to the fact that the COE has not been consistent in using relocation trawling as a standard practice for the maintenance dredging of the Savannah Harbor Entrance Channel.

The number of sea turtles captured by relocation trawlers does not directly translate into potential mortalities by hopper dredges in the absence of relocation trawling, due to the differences in footprint between the two gear types. The spread of a relocation trawler's net is much greater than the width of a hopper dredge's dragheads; therefore, the trawler will encounter a significantly greater number of sea turtles. Non-injurious takes may be expected with the implementation of relocation trawling. Review of the only relocation data available for the Savannah Harbor where a take occurred, indicates that 159 tows conducted over 7 days (March 28-April 4, 2006) resulted in the take of 1 Kemp's ridley sea turtle. From this, we estimate that during the 121 days of the December 1 to March 31 hopper dredging window (which is the only time period ("window") when hopper dredging is normally allowed by the COE, in accordance with the COE South Atlantic Division's hopper dredging protocol, and is the time frame proposed by the COE for hopper dredging for the currently proposed action), relocation trawling may result in the non-lethal take of up to 17 turtles (of non-specific genera) each year (121 divided by 7 = 17.3). The relocation trawling may result in sea turtle capture, but this type of take is not expected to be injurious or lethal due to the short duration of the tow times (15 to 30 minutes per tow; not more than 42 minutes) and required safe-handling procedures. It cannot be ruled out that injury or mortality could occur, but such events are rare. As previously explained, based on past experience, NMFS estimates that, overall, sea turtle trawling and relocation efforts will result in considerably less than 0.5 percent mortality of captured turtles, primarily due to their being previously stressed or diseased, or if struck by trawl doors, or from accidents occurring during handling in the water and on deck. Over the last 5.5 years, mortality associated with relocation trawling in the Gulf of Mexico and South Atlantic has averaged 0.4 percent.

Flipper Tagging

Flipper tagging of captured turtles is not expected to have any detrimental effects on captured animals. Tagging prior to release will help NMFS learn more about the habits and identity of trawl-captured animals after they are released, and if they are recaptured they will enable improvements in relocation trawling design to further reduce the effect of the hopper dredging activities. External and internal flipper tagging (e.g., with Inconel and PIT tags) is not considered a dangerous procedure by the sea turtle research community, is routinely done by thousands of volunteers in the United States and abroad, and can be safely accomplished with minimal training. NMFS knows of no instance where flipper tagging has resulted in mortality or serious injury to a trawl-captured sea turtle. Such an occurrence would be extremely unlikely because the technique of applying a flipper tag is minimally traumatic and relatively non-invasive; in addition, these tags are attached using sterile techniques. Important growth, life history, and migratory behavior data may be obtained from turtles captured and subsequently relocated. Therefore, these turtles should not be released without tagging (and prior scanning for pre-existing tags).

Genetic Sampling

Analysis of genetic samples may provide information on sea turtle populations such as life history, nesting beach identification, and distribution/stock overlap. This may ultimately lead to enhanced sea turtle protection measures. Tissue sampling is performed to determine the genetic origins of captured sea turtles, and learn more about turtle nesting beach/population origins. This is important information because some populations, e.g., the northern subpopulation of loggerheads nesting in the Southeast Region (i.e., the proposed endangered Northwest Atlantic loggerhead DPS), may be declining. For all tissue sample collections, a sterile 4- to 6-mm punch sampler is used. Researchers who examined turtles caught two to three weeks after sample collection noted that the sample collection site was almost completely healed (Witzell, pers. comm.). NMFS does not expect that the collection of a tissue sample from each captured turtle will cause any additional stress or discomfort to the turtle beyond that experienced during capture, collection of measurements, and tagging. Tissue sampling procedures are specified in the Terms and Conditions of this opinion.

Dredged Material Disposal

NMFS believes the proposed dredged material (approximately 13.3 mcy) disposal activities over the 3-4 year life of the project are not likely to adversely affect sea turtles. Sea turtles may be attracted to ODMDS sites, to forage on the bycatch that may be occasionally found in the dredged material being dumped. As such, turtles could be potentially impacted by the sediments being discharged overhead. However, NMFS has never received a report of an injury to a sea turtle resulting from burial in, or impacts from, hopper-dredge-released sediments, neither from inshore or offshore disposal sites, anywhere the COE conducts dredged material disposal operations. Sea turtles are highly mobile and apparently are able to avoid a descending sediment plume discharged at the surface by a hopper dredge opening its hopper doors, or pumping its sediment load over the side. Even if temporarily enveloped in a sediment plume, NMFS believes the possibility of injury, or burial of normal, healthy sea turtles by dredged material (i.e., sand and silt) disposal, is discountable or its effects insignificant. NMFS believes that foraging habitat for sea turtles is not likely a limiting factor in the action area, and thus the loss of potential sand bottom foraging habitat adjacent to, or on the surface of, the disposal areas (compared to remaining foraging habitat) from burial by dredged material sediments will have insignificant effects on sea turtles. The risk of injury to sea turtles from collisions with dredge-related vessels is also considered discountable, considering the species' mobility and the slow speed of the hopper dredge vessels and associated barges and scows.

5.1.4 Deepening of Harbor Entrance Channel

Hopper dredges can lethally harm sturgeon by entraining them in dredge drag arms and impeller pumps. The use of the "turtle deflecting draghead" on hopper dredges reduces the potential for take of benthic oriented species (i.e., sea turtles and sturgeon) by creating a sand wave in front of the draghead and pushing animals out of the way that are otherwise at risk of entrainment. However, a review of hopper dredging activity since 2000 in the Savannah Harbor Entrance Channel, approximately 7,306,635 cubic yards of material has been dredged with documented incidental takes of Atlantic sturgeon (n=2) occurring during 2007 and 2009. In addition, eleven Atlantic sturgeon were taken during 2006-2007 in relocation trawling and released alive. The amount of material to be dredged (13,325,513 cubic yards) is slightly less than two times greater than that dredged since 2000. Based on this information and the anticipated amount of dredging, NMFS believes that four Atlantic sturgeon will be killed as a result of hopper dredging and up to 20 will be taken in relocation trawls but released alive.

Considering that Atlantic sturgeon primarily lead a marine existence, with the exception of their spawning migration, and hopper dredges are often operated in ocean bar channels or offshore borrow areas, it is likely that the risk of entrainment by hopper dredges is higher for Atlantic sturgeon than shortnose sturgeon. To date, no shortnose sturgeon have been taken by hopper dredges working in the Savannah Harbor Entrance Channel. Shortnose sturgeon have a low tolerance for fully marine water and are not expected to be in locations where hopper dredging will occur; therefore, impacts to shortnose sturgeon from hopper dredges are not anticipated to occur.

The potential for adult and juvenile sturgeon being hit by a hydraulic cutterhead dredge is low. Even when occupying resting areas, adult and juvenile sturgeon are believed to be very mobile and would not be expected to be impacted by cutterhead dredges. There have been rare, documented incidental takes of shortnose and Atlantic sturgeon by mechanical (clamshell) dredges, with one occurring in the South Atlantic region (Wilmington Harbor). However, given the mobility of sturgeon, the lack of a suction field from mechanical dredging, and the small action area when dredging by a bucket, the likelihood that mechanical dredging will incidentally take sturgeon species is small. It is also unlikely that clamshell dredging operation would impact small juvenile and larval sturgeon since there is no suction field generated.

5.2 Project Effects within the Inner Harbor

Development of Sturgeon Habitat Criteria

The COE applied hydrodynamic and water quality models to assess potential impacts associated with the project (primarily within the estuary). Development and approval of the models was initiated in 1999 and completed in 2005. As the models were being developed, the COE consulted with natural resource agencies to determine the type of information to be evaluated. During meetings held in 2001, the Fisheries Interagency Coordination Team provided guidance on fisheries issues and developed a conservative set of parameters for modeling habitat suitability for the endangered shortnose sturgeon. The Fisheries Interagency Coordination Team determined the conditions which the water quality and hydrodynamic models would use to identify acceptable and unacceptable habitat. The Team defined suitable habitat for shortnose sturgeon during January when dissolved oxygen was not less than 3.5 mg/Liter for more than 10 percent of the time, not less than 3.0 mg/Liter for 5 percent of the time, and not less than 2.0 mg/Liter for more than 1 percent of the time. For August conditions, the Team defined suitable habitat for adult shortnose sturgeon when dissolved oxygen was not less than 4.0 mg/Liter for more than 10 percent of the time, not less than 3.0 mg/Liter for 5 percent of the time, and not less than 2.0 mg/Liter for more than 1 percent of the time. River flow rates and time of year were also specified for the modeling. The median (or 50^{th} percentile) river flows of the long-term conditions of the river were used to model the average conditions (Table 12). Drought conditions were also modeled in sensitivity analyses for comparison with average conditions.

While the models were designed with criteria developed primarily for shortnose sturgeon, it is assumed that habitat identified as suitable for shortnose sturgeon will also be suitable for Atlantic sturgeon. Because Atlantic sturgeon have a much higher tolerance of salinity and therefore a wider range of habitat, this assumption would be protective of Atlantic sturgeon. They are routinely found not only in riverine and estuarine habitats, but also offshore in marine waters while migrating along the East Coast.

Life Stage	Simulation Period	Freshwater Flow Conditions	Habitat Criteria
Shortnose sturgeon Adult	January	50%-tile of Long Term	Suitable habitat when DO >= 3.5 mg/Liter at 90% (10th %ile), >=3.0 at 95% (5th %ile), and >=2.0 at 99% (1 %ile) Suitable habitat when max salinity <= 25 ppt
Shortnose sturgeon Adult	August	50%-tile of Long Term	Suitable habitat when DO >= 4.0 mg/Liter at 90% (10th %ile), >=3.0 at 95% (5th %ile), and >=2.0 at 99% (1 %ile) Suitable habitat when max salinity <= 10 ppt
Shortnose sturgeon Juvenile	January	50%-tile of Long Term	Suitable habitat when DO >= 3.5 mg/Liter at 90% (10th %ile), >=3.0 at 95% (5th %ile), and >=2.0 at 99% (1 %ile) Suitable habitat when 50% exceedance of the max salinity <= 14.9 ppt

Table 12. Habitat Suitability Criteria for Adult and Juvenile Shortnose Sturgeon Developed by the Fisheries Interagency Coordination Team.

Once modeling criteria were selected, the tools were applied and the modeling was performed. The models' calibrations were approved by an interagency team including members of EPA Region 4, the USGS, the US Army Corps of Engineers' Engineering Research and Development Center (ERDC), the South Carolina Department of Health and Environmental Control (DHEC), and the Georgia Department of Natural Resources (GADNR) (NMFS was not a member of this team).

Environmental Fluid Dynamic Computer Code (EFDC) model runs were used to predict hydrodynamic model salinity outputs and the Water Quality Analysis Simulation Program (WASP) model was used to predict dissolved oxygen levels. The Post-Processor Habitat Analysis Module combined the output from the EFDC and WASP models to determine habitat suitability based on criteria for each life stage and time of year. The EFDC hydrodynamics model was originally developed at the Virginia Institute of Marine Science and is maintained by TetraTech under contract to the EPA. The model uses a finite difference solution scheme and a sigma-stretched vertical grid. The water quality model (WASP) was originally developed in 1983 and includes the time-varying processes of advection, dispersion, point and diffuse mass loading, and boundary exchange. Both the water column and the underlying benthos can be included. These models are available to the public through the Total Maximum Daily Load (TMDL) Modeling Toolbox maintained by EPA Region 4 and are considered by the EPA to be the best way to model for these parameters. TetraTech applied the models to the Savannah River estuary and developed an enhanced grid which extends 61 miles upriver and 17 miles oceanward of the harbor entrance. Point source loads in the Savannah Harbor were also used in the model simulations for shortnose sturgeon habitat (Table 13).

Facility	May-October 2004 Loads (lbs/day)	May-October 1999 Loads (lbs/day)	January 2004 Loads (lbs/day)
Beaufort-Jasper Water & Sewer Authority	13.0	25.0	19.1
Georgia-Pacific	5,873.0	3,810.5	7599.5
Weyerhaeuser Co., Port Wentworth	6,797.0	809.9	10,142.9
Garden City Water Pollution Control Plant	32.0	122.0	346.5
Savannah Water Pollution Control Plant Travis Field	27.0	129.0	254.1
Savannah Water Pollution Control Plant President Street	1,489.0	4,399.0	3,915.1
International Paper Co.	143,448.0	86,669.8	102,170.9
TOTAL	157,679.0	95,965.2	124,448.1

Table 13. Point source loads in Savannah Harbor (CBODu lbs/day) – January 2004 loads were used in model simulations.

Different life stages of sturgeon have specific requirements for particular dissolved oxygen levels and tolerance for salinity; when these tolerances are exceeded they will not feed or survive. Benthic-dwelling sturgeon occupy the bottom layer of the water column that is most susceptible to low dissolved oxygen and it is also where the higher salinities are found. In addition, sturgeon often find the temperatures they prefer in these deeper waters that consequently may have undesirable dissolved oxygen or salinity levels. The requirements for classifying habitat as suitable for shortnose sturgeon must consider all of these parameters. Habitat suitability maps showing the areas of suitable and unsuitable habitat, based on salinity and dissolved oxygen criteria for adult and juvenile shortnose sturgeon were prepared for each deepening scenario during winter and summer conditions. Figures 25, 26, and 27 show the existing conditions during the winter for juvenile shortnose sturgeon within the estuarine environment located in the lower Savannah River and during the winter and summer for adult shortnose sturgeon. Habitat criteria for juvenile shortnose sturgeon during the summer was not identified by the Team and therefore not modeled. It is thought that the Team believed most juvenile sturgeon would be found well upriver from the project area, beyond the effects of the deepening during the summer.

The COE's original models used all of the habitat criteria first identified by the Team, but NMFS later adjusted the habitat suitability criteria for salinity ranges tolerated by juvenile shortnose sturgeon. This was done to reflect better agreement between the models and field observations of captured juvenile shortnose sturgeon. In general, NMFS accepted the modeled habitats for shortnose sturgeon to be representative of field observations. There were a few small discrepancies, particularly noted for adult shortnose sturgeon during August conditions, and these are noted later in this section.

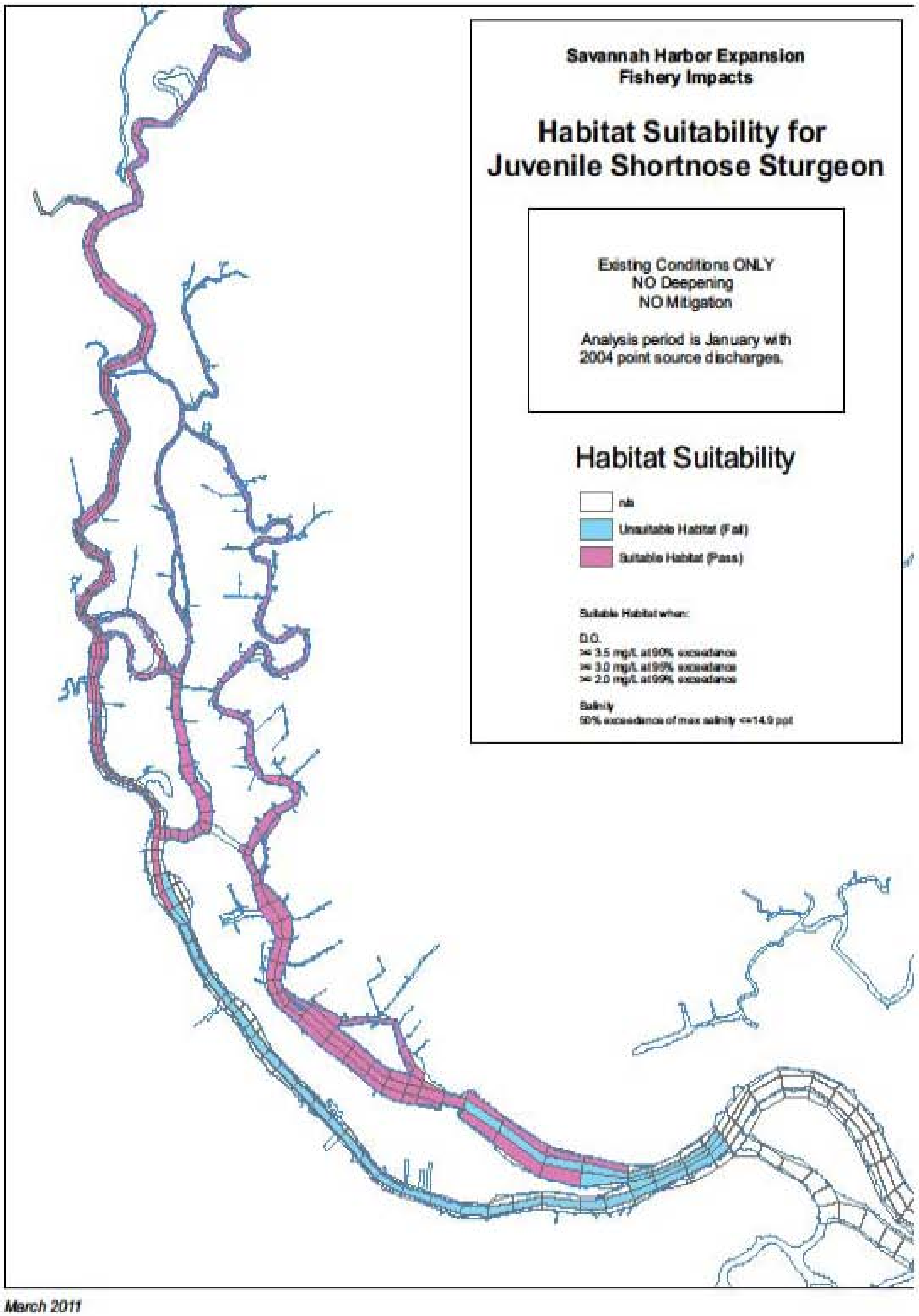


Figure 25. Model of Existing Conditions for Juvenile Shortnose Sturgeon (Winter Conditions).

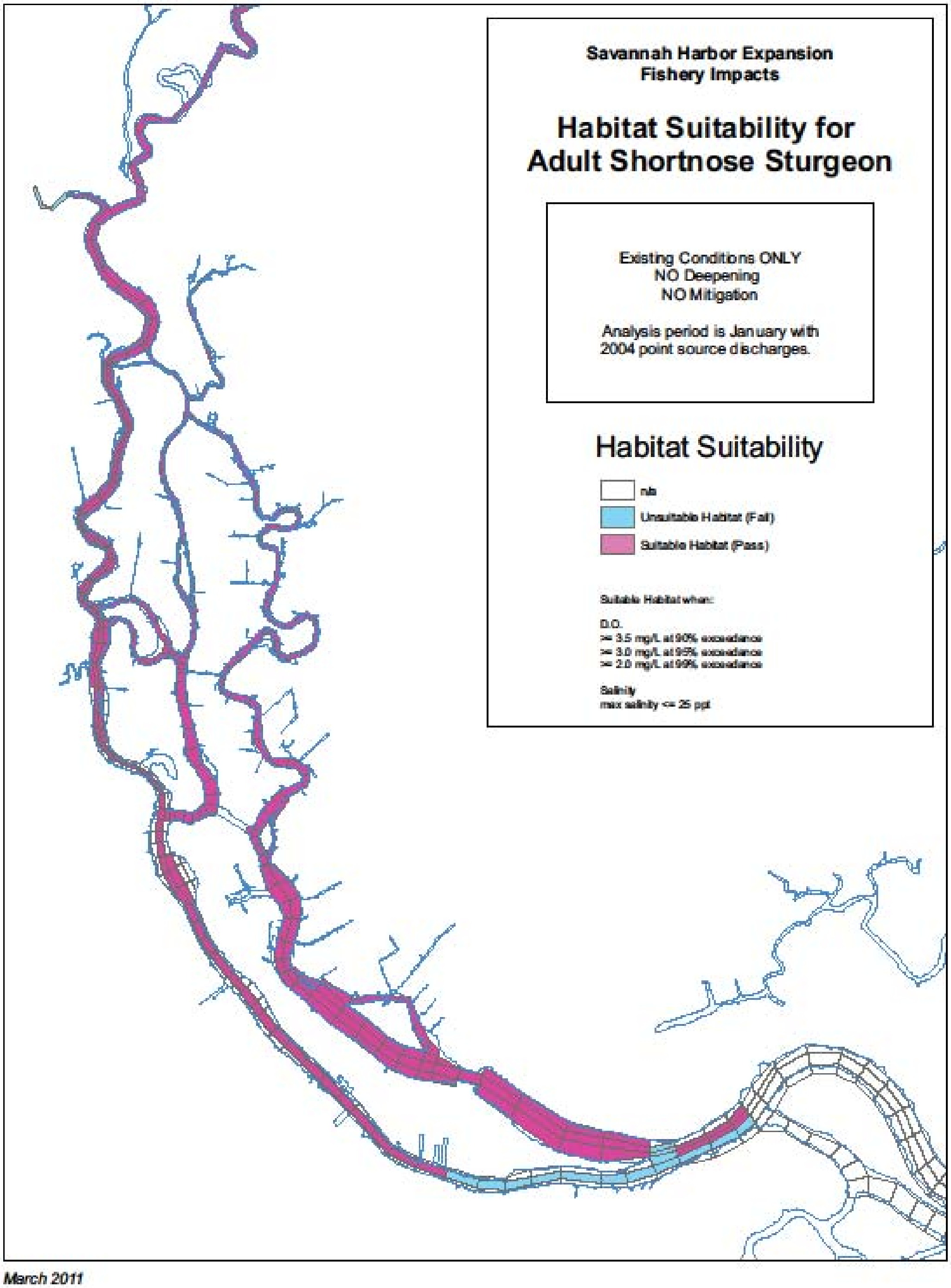


Figure 26. Model of Existing Conditions for Adult Shortnose Sturgeon (Winter Conditions).

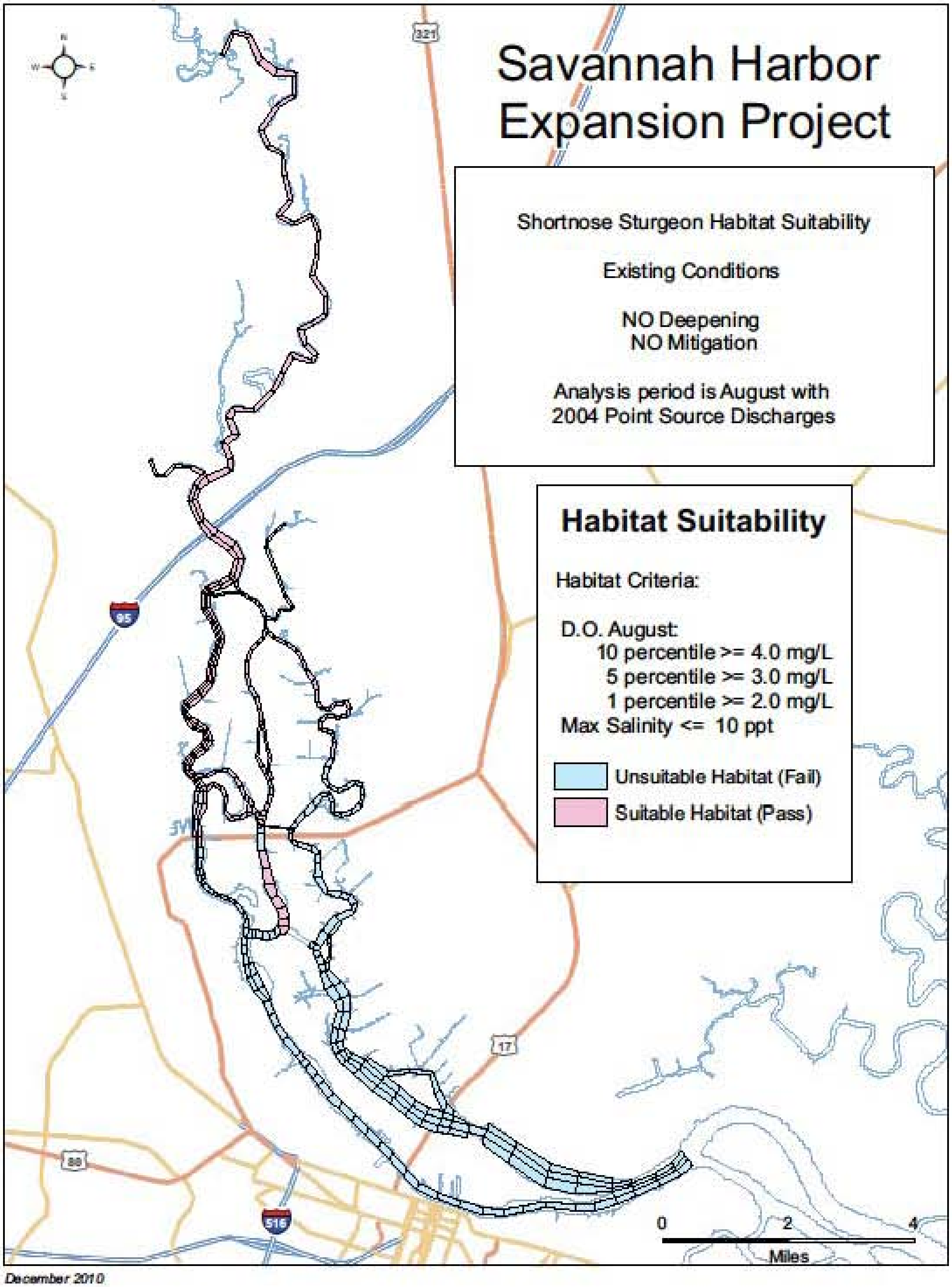


Figure 27. Model of Existing Conditions for Adult Shortnose Sturgeon (Summer Conditions).

Effects of Freshwater Flow Re-routing Modification
The COE used the hydrodynamic and water quality models to evaluate ways to reduce impacts associated with increased salinity and low dissolved oxygen expected to result from the proposed action. A freshwater flow re-rerouting plan (i.e., Plan 6A/6B - described in Section 2.1.2) was developed for each depth alternative that minimized impacts to freshwater tidal wetlands, which the USFWS had identified as being most at risk from this project. The hydrodynamic-related impacts for shortnose sturgeon habitat predicted from the various alternatives are summarized in Table 14. The impacts are related to the diversion of freshwater flow to the Back River to protect freshwater tidal wetlands. The diversion of the freshwater away from the Front River would result in salinity increases in the Front River and lower Middle River, in areas identified as shortnose sturgeon habitat.

Each incremental depth increase would result in larger impacts to sturgeon habitat as more habitat is lost due to salinity increases. There would be a loss of sturgeon habitat with all of the deepening alternatives, except for the 44-foot deepening for adult shortnose sturgeon during August. The losses would be greater during the winter because juvenile sturgeon would be found further down in the estuary foraging and resting in areas of the Front River and lower Middle River directly adjacent to where the deepening would occur. During the winter, adult sturgeon would be found within the areas to be deepened (i.e., lower Front River) or in adjacent areas within the Front River and lower Middle River. During the summer, sturgeon would primarily be located higher in the estuarine environment above the area to be deepened, so there would be less impact to their summer habitat from the deepening and also from the re-routing of freshwater associated with the hydrological modifications. Modeling indicated that without the flow re-routing modifications the salinity increases in the Front River would be less.

It is expected that, as the salt wedge moves further upriver due to the deepening, the estuarine habitat will be transformed from a slightly brackish environment to one with higher salinity. With the transition from lower salinities to higher salinities, the estuarine species (vegetation and benthos) currently found in the area will shift further upriver. Plants will die off and be replaced by more salt-tolerant species. Organisms unable to adapt to the higher salinities will relocate upriver to areas with salinity levels similar to those of their former habitat or will die and be replaced by species with higher salinity tolerance. While the actual deepening will only take a few months to complete, the total transformation of the estuarine vegetation and benthic organisms affected by the deepening may take several months to a few years. NMFS expects a very gradual transformation of the new foraging habitat to occur as the prey species of sturgeon colonize the new areas. This transition will temporarily affect the carrying capacity of the river to support sturgeon, as the amount of foraging habitat will be limited during this time. It is thought that once the estuarine environment has stabilized to the new, higher salinity, the carrying capacity of the river to support sturgeon will return to a pre-project state. It is expected that sturgeon will adjust their behavior and use the new areas for foraging once the appropriate prey species have become established. During this transition, sturgeon will become stressed due to lack of sufficient foraging habitat and weak individuals will be harmed.

Habitat Loss (-)	44-Foot (Plan 6B)	45-Foot (Plan 6A)	46-Foot (Plan 6A)	47-Foot (Plan 6A)	48-Foot (Plan 6A)
Shortnose sturgeon adult (January)	-3.9% (-153.0 acres)	- 4.6 % (-179.0 acres)	-6.2 % (-240.0 acres)	-6.9% (-266.0 acres)	-8.4 % (-326.0 acres)
Shortnose sturgeon adult (August)	0.2 % 2.0 acres	- 0.1 % (- 1.0 acres)	- 3.7 % (-50.0 acres)	-5.6 % (-76.0 acres)	- 6.8 % (-93.0 acres)
Shortnose sturgeon juvenile (January)	-6.7 % (-220.0 acres)	-7.0 % (-231.0 acres)	-7.3 % (-238.0 acres)	- 7.6 % (-251.0 acres)	- 11.5 % (-376.0 acres)

Table 14. Summary of Hydrodynamic-related Impacts with Flow Re-routing Plans 6A/6B.

Injection of Dissolved Oxygen as Mitigation

Studies conducted by EPA as part of its 2006 TMDL assessment for Savannah Harbor indicated that construction of the existing project (42-foot channel, turning basins, Sediment Basin, etc.) has impacted the dissolved oxygen regime. The hydrodynamic models estimated that the dissolved oxygen concentration in Savannah Harbor is 1 mg/Liter lower because of deepening that has occurred since the baseline year and condition (i.e., 1854 and a 12-foot controlling depth). The COE's models have shown that water quality will be impacted by higher salinity and lower predicted dissolved oxygen associated with the deepening. In general, the models showed that there would be upstream shifts of lower dissolved oxygen zones in bottom and surface layers of the estuary as the channel deepening increased in magnitude. Analysis of the effects of adding dissolved oxygen to the river shows the most benefit occurs within the Back River. The studies also indicated that deteriorations of the lowest dissolved oxygen values along critical cells[6] (the cell with the lowest dissolved oxygen concentration during specified simulation period) of major parts of the estuary increase proportionately to the amount of deepening. The COE's data reflected conditions in the bottom half of the water column (i.e., bottom 3 layers of the 6-layer model), where dissolved oxygen levels are lower. Using the selected flow re-routing plans (Plan 6A or 6B), the water quality model was evaluated to determine the best placement of the dissolved oxygen injection systems (i.e., Speece cones) described in Section 2.1.3.

Table 15 summarizes the effects of injecting dissolved oxygen into the estuary during the summer. According to the models, new areas, not previously available to sturgeon during the summer because of low dissolved oxygen, would become suitable habitat with the

[6] A thorough description of the COE's use of critical cells is included in Section 5 of the DEIS "Environmental Consequences of the Proposed Action."

injection of dissolved oxygen. These areas are shown as gain in the table below and on the habitat suitability maps. The injection of dissolved oxygen would also be conducted only during the summer when the combination of higher temperatures and low dissolved oxygen can be detrimental to fish.

Habitat Gain	**44-foot <u>(Plan 6B)</u>**	**45-foot (Plan 6A)**	**46-foot (Plan 6A)**	**47-foot (Plan 6A)**	**48-foot (Plan 6A)**
Shortnose sturgeon adult (August)	5.84% 80.0 acres	6.86% 94.0 acres	3.28% 45.0 acres	2.33% 32.0 acres	-0.07% -1.0 acres

Table 15. Summary of Hydrodynamic-related Modifications with Mitigation (Dissolved Oxygen Injection).

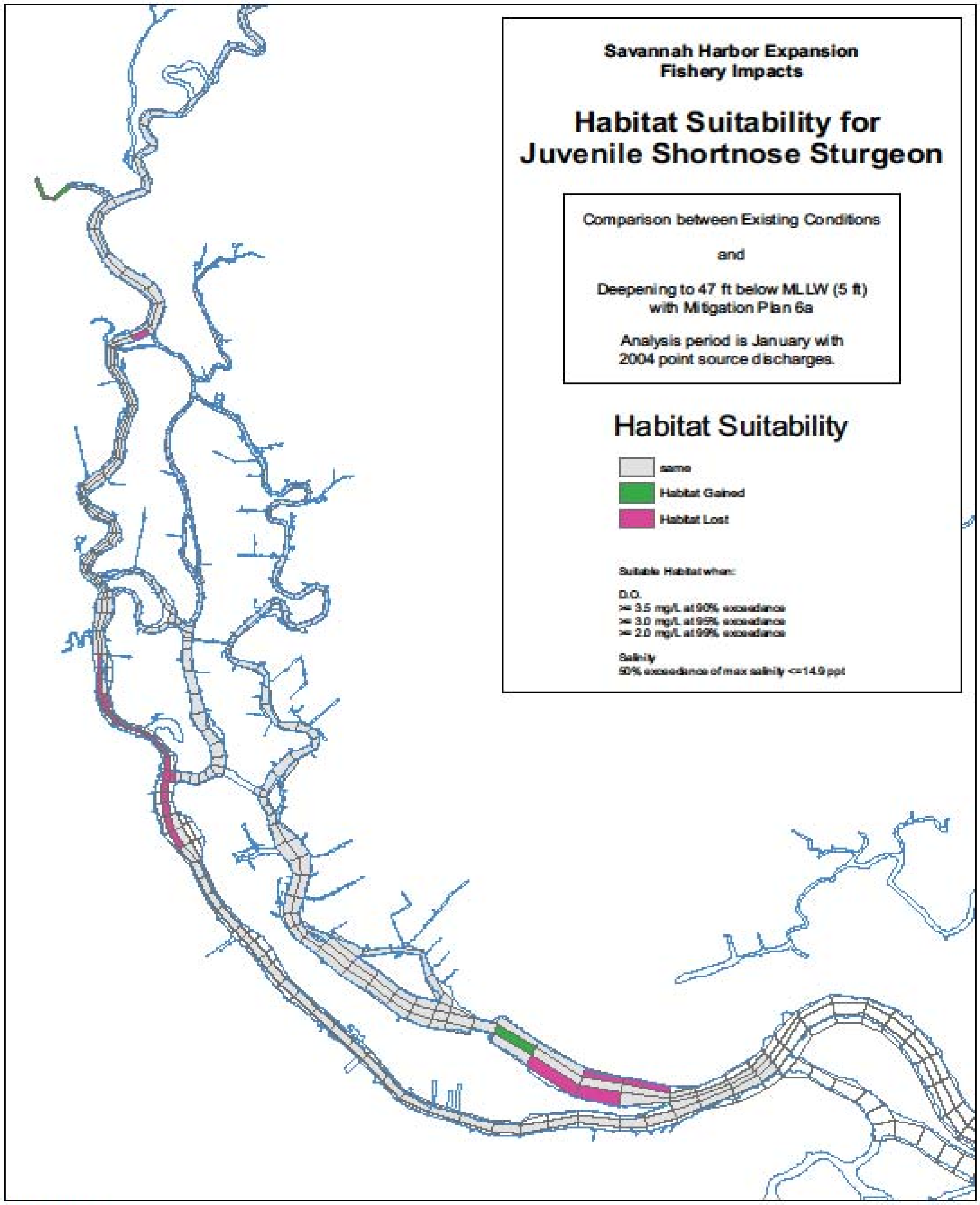
Juvenile shortnose sturgeon habitat

According to the COE's models of project effects on suitable habitat, the juvenile shortnose sturgeon life stage would have the largest proportional amount of habitat lost with all of the deepening scenarios. Acreage loss (as shown in Table 14) would range from 220 to 376 acres, or 6.7 to 11.5 percent of the available habitat as calculated by the COE models for the incremental deepening from 44 to 48 feet. The acreage loss for the COE's preferred deepening alternative (47 feet) would be 251 acres or 7.6 percent of the available habitat as predicted by the COE models (Figure 28). The loss of suitable habitat in the Front River could also affect juvenile sturgeons' ability to access the lower Middle River deep hole via the Front River. Research has not indicated that juvenile sturgeon would use an alternate route through the estuary (i.e., moving down from the upper Middle River) to access the preferred habitat located at the deep hole in the lower Middle River. There has also been no evidence of juvenile sturgeon using the Back River, although it is indicated as suitable habitat in the model of existing habitat. It is also not known whether juvenile shortnose sturgeon would alter their normal activity to travel higher in the water column to avoid the undesirable high salinities in the bottom layer of the salt wedge in the Front River after the deepening. Since the area that would be lost also occurs in a highly industrialized area with heavy vessel traffic, sturgeon may not be inclined to seek the lower salinity in the upper water column in order to travel within the Front River. It is also important to note that with the 47-foot deepening scenario, additional side cells of the model, which would include the entire width of the Front River (including the side slopes) becomes unsuitable habitat, essentially blocking any pathway to downstream habitat that could be utilized by juvenile shortnose sturgeon. There is much uncertainty associated with the sturgeon habitat models due to the numerous factors involved in calculating predicted change in the habitat. However, it is expected that juvenile shortnose sturgeon will probably abandon this area of the Front River, just as they did when the salinity increased in the Kings Island Turning Basin, which is located just downriver of this area and was formerly utilized by juvenile shortnose until it was deepened in 1994. Hall et al. (1991) detected juvenile shortnose in the Kings Island Turning Basin during their research, but they were not detected later by Collins et al. during their 1999-2000 study. The model of existing habitat indicates that there is suitable habitat within the Kings Island Turning Basin, but it is believed that high salinity in the deeper basin may prevent young juvenile sturgeon from using the area.

The juvenile stages of shortnose sturgeon have the most constricted range of habitat in the estuarine areas of the Savannah River due to their low tolerance of high salinities. The deepening would allow salinity to increase upriver to levels which juvenile shortnose sturgeon cannot tolerate causing further constriction of their habitat, particularly affecting foraging habitat in the Front River and preferred resting habitat in the lower Middle River. The COE, working in concert with the resource agencies, was unable to identify any mitigation measures that would compensate for the unavoidable loss of this unique foraging and resting habitat found in the estuarine environment of the Savannah River. As stated above, it is expected that environmental conditions currently found in the estuarine portions of the river that are utilized by juvenile shortnose sturgeon for foraging and resting will shift upriver over a period of several months to years.

Juvenile Atlantic sturgeon habitat

While there was no modeling of Atlantic sturgeon habitat conducted, due to the proposed listing of Atlantic sturgeon occurring after the COE had concluded all of its data analyses prior to the listing, it is generally believed that suitable habitat as determined for juvenile shortnose sturgeon would also be suitable for juvenile Atlantic sturgeon. Information provided by Vladykov and Greeley (1963) indicates that habitat requirements for juvenile Atlantic sturgeon would overlap with those of juvenile shortnose sturgeon when they migrate to the salt water interface. Juvenile Atlantic sturgeon are residents in estuarine waters for months to years before migrating to open ocean as subadults (Holland and Yelverton, 1973; Dovel and Berggen 1983, Waldman et al. 1996a, Dadswell 2006, ASSRT 2007, Schueller and Peterson 2010). Therefore, it expected that juvenile Atlantic sturgeon will likely be affected by the same loss of estuarine habitat in the lower river as juvenile shortnose sturgeon.



March 2011

Figure 28. Model of Juvenile Shortnose Sturgeon Habitat during January with the 47-foot Deepening Alternative. Foraging habitat would be lost in the Front River. Habitat lost in the lower Back River has not been documented as being used by juvenile shortnose. Previous research by SCDNR has documented that the lower Middle River is regularly used by shortnose sturgeon. The peak of use appears to be during the late fall, winter, and spring, but a few fish have also been observed there during the summer.

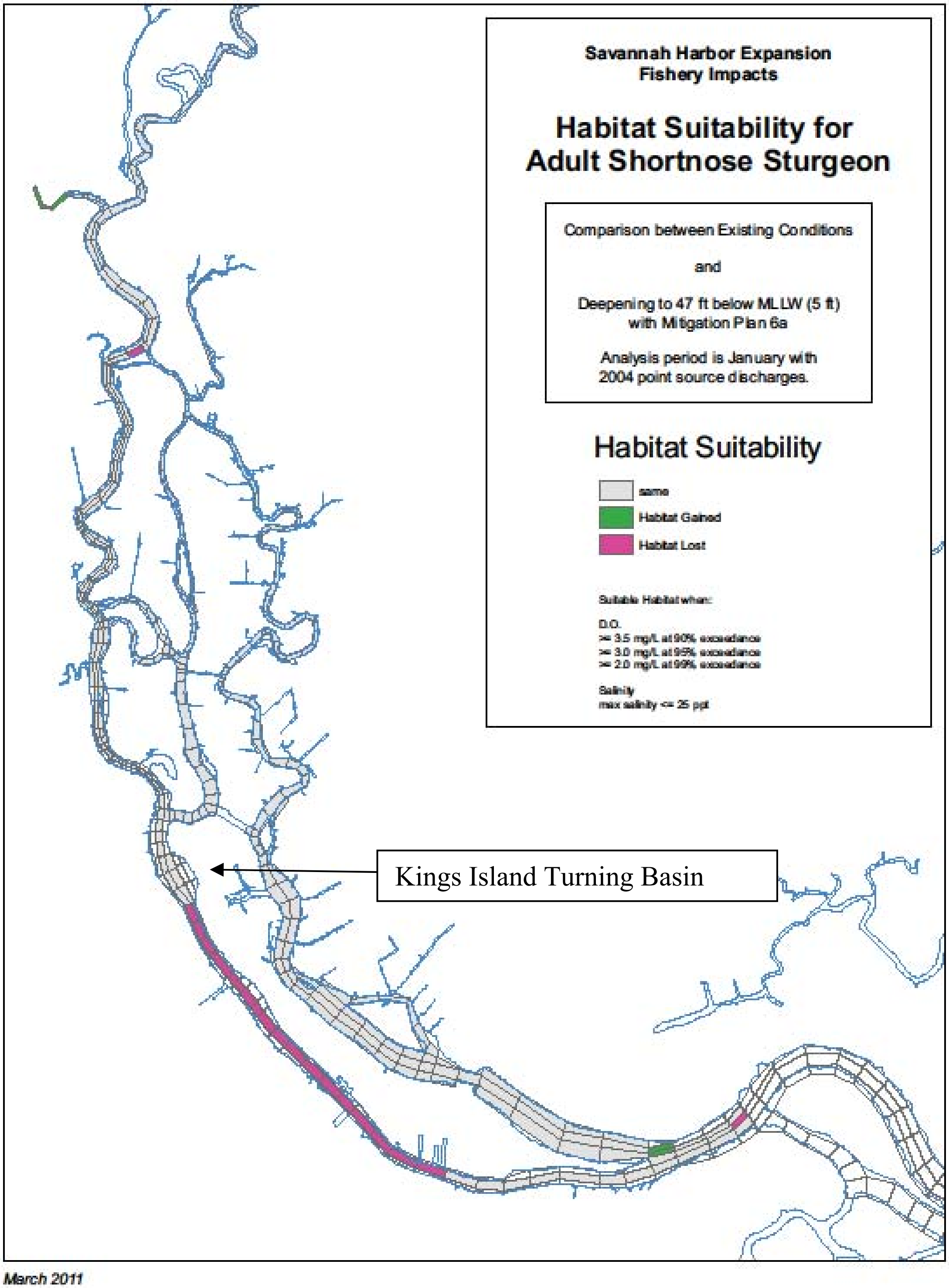


Figure 29. Model of Adult Shortnose Sturgeon Habitat during January with the 47-foot Deepening Alternative.

Adult shortnose sturgeon habitat during winter

Adult shortnose sturgeon would also have a large amount of habitat loss with all of the deepening scenarios. The loss of foraging habitat in the Front River would increase with each depth scenario. Acreage loss, as calculated by the COE models, would range from 160 to 326 acres, or a loss of 4.1 to 8.4 percent of the available habitat, with the incremental deepenings from 44 to 48 feet. The loss of habitat with the COE's preferred deepening alternative (47 feet) would be 266 acres or 6.9 percent loss. The loss of habitat within the Front River would occur up to the location of the Kings Island Turning Basin (Figure 29). The loss of this estuarine habitat would prohibit access to the lower Back River from the Front River, as the area having high salinity would be significantly lengthened. It is thought adult sturgeon may tolerate very brief exposure to high salinities, but not conditions of prolonged exposure such as would be needed to traverse several miles of the lower Front River to reach the lower Back River. Research has not indicated that adult sturgeon would use an alternate route (i.e., traveling down from the upper Back River) to access deep-water habitat at the lower end of Back River. New data indicates that fish have been tracked using Rifle Cut, which connects the Middle River and Back River to access the lower Back River; however, this corridor will no longer be possible after Rifle Cut is closed as a part of the freshwater flow re-routing modifications being implemented to protect freshwater marsh within the Savannah National Wildlife Refuge. As with juvenile shortnose sturgeon, it is also not known whether adult shortnose sturgeon would alter their normal activity to travel higher in the water column to avoid the undesirable high salinities in the bottom layer of the Front River after the deepening. Telemetry tracking has not indicated that sturgeon would travel extensive distances in the upper half of the water column.

While much of the lower Front River estuarine habitat may be lost to sturgeon, research from tracking of shortnose sturgeon performed after the issuance of the DEIS in November 2010 indicates that there is new evidence that adult shortnose sturgeon may use the shallow upper Middle River, which has an average depth of less than 6 feet MLLW, to access the deeper areas in the lower Middle River (Wrona et al. 2011 unpublished data). This is an important discovery, because it could indicate that sturgeon would be able to continue using the deep hole in the lower Middle River as a refuge from high temperature waters. Because of the lack of information documenting sturgeon using the Back River for foraging or resting habitat, NMFS is uncertain whether sturgeon will use these areas even though the areas may possess the appropriate habitat characteristics as defined by the Interagency Fisheries Habitat Committee. According to bathymetry data provided by the COE, the upper Back River contains shallow habitat ranging from 1.8 to 10 feet MLLW. Sturgeon are known to prefer deeper water depths within estuaries, so they may be avoiding use of the area because it does not have the attributes that are preferred by sturgeon. However, during spring tides and upstream flood conditions (due to rain) the Back River may become much deeper. Recent surveys have indicated portions of the upper Back River include depths to 18 feet during these conditions. The irregular or inconsistent nature of the area with its depth (and possibly salinity) extremes may make it unsuitable for sturgeon prey. In the absence of suitable prey, sturgeon would be less likely to use the area for foraging. It is important to note that Atlantic sturgeon, because of their larger body size, may be even more unlikely to use the Back River as habitat when the area is undergoing lower than normal tides or drought conditions. Adult Atlantic sturgeon, which can reach lengths greater than 4 feet, need sufficient water depths for migrating. While the modeling indicates all of the Back River is suitable habitat in all of the deepening scenarios, the fact that there is very little evidence that adult sturgeon actually use the area for foraging or resting suggests that the area should be considered lower priority in evaluating habitat needs of sturgeon. The few new accounts of sturgeon being detected in the Back River are showing limited movement beyond the area immediately adjacent to Rifle Cut. The tracking of these fish is ongoing and SCDNR will be providing data as it is collected (Bill Post, SCDNR, pers. comm.).

Preliminary assessment of new tracking results of shortnose sturgeon obtained by SCDNR in the Middle River are showing that fish reside in preferred locations for extended amounts of time. The new telemetry work, which began in November 2010, has shown that some fish stayed in the vicinity of the Middle River deep hole over a 65-day time period (or until the data was retrieved in January 2011), often moving back and forth within the area over a 1.5-mile radius but always returning to the deep hole. Sturgeon also showed a preference for an area in the Front River located approximately halfway between the confluence with the lower Middle River and Steamboat Creek. Fish remained in the vicinity of the tracking receiver for up to 38 days. This new data provides additional support to the previous data, obtained during 1999-2000, on the importance of the Front River and lower Middle River to both juvenile and adult phases of shortnose sturgeon.

Adult Atlantic sturgeon habitat

While there was no modeling of adult Atlantic sturgeon habitat conducted, due to the proposed listing of Atlantic sturgeon occurring after the COE had concluded all of its data analyses, it is generally believed that suitable habitat as determined for adult shortnose sturgeon would also be suitable for adult Atlantic sturgeon. Adult Atlantic sturgeon are able to tolerate a much wider range of salinity, so habitat that is unsuitable for adult shortnose sturgeon, due to salinity changes, may still be suitable for adult Atlantic sturgeon during the winter and summer. However, they would likely be affected by the lower dissolved oxygen in the same way that adult shortnose sturgeon would be affected. Both adult and juvenile Atlantic sturgeon frequently congregate around the saltwater interface. They may travel short distances upstream and downstream throughout the summer and fall, and during late winter and spring spawning periods (Greene et al. 2009), between fresh and brackish waters influenced by changes in water temperature (Van Den Avyle 1984) as they seek the cooler waters and avoid shallow areas with the highest water temperature (Bain 1997). Outmigration of adults from the estuaries out to the sea is cued by water temperature and velocity. Adult Atlantic sturgeon reside in the marine habitat during the non-spawning season and forage extensively until the waters begin to warm at which time adults migrate back to their rivers to spawn.

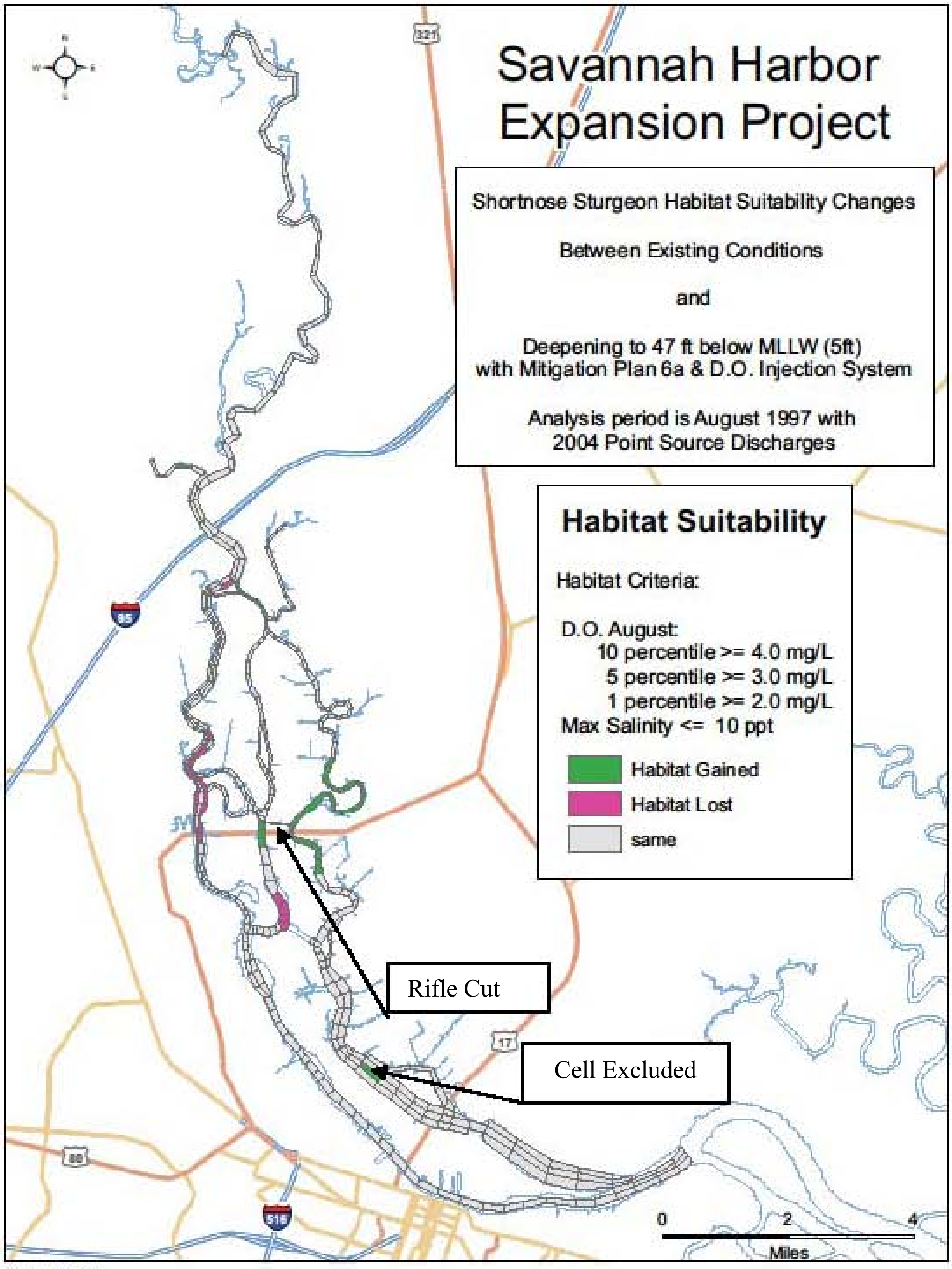


Figure 30. Model of Adult Shortnose Sturgeon Habitat during the Summer with the 47-foot deepening.

Adult shortnose sturgeon habitat during summer conditions
According to the COE's models of summer conditions, there would be a net gain of suitable habitat for adult shortnose sturgeon with all of the deepening scenarios due to the injection of dissolved oxygen. The COE had calculated acreage gain would range from 245 to 24 acres, or a gain of 17.8 to 1.7 percent of habitat, for the incremental deepenings from 44 to 48 feet. However, when NMFS calculated the acreage change, we found there would be a gain of 80 acres, or 5.84 percent with the 44-feet deepening, and a range of 94 to -1 acres, or 6.86 to -0.07 percent of habitat change for the incremental deepenings from 45 to 48 feet. NMFS also found that a single, isolated cell (indicated as gain) within the lower Back River should be excluded from the total acreage gain since it would be completely surrounded by unsuitable habitat.

The cause of the gain (primarily occurring in the Back River) is associated with the placement of dissolved oxygen injection system (Speece cones) within the lower Front River and lower Back River on Hutchinson Island. The gain of suitable habitat would occur in areas not previously identified as suitable for sturgeon. The system is described in Section 2.1.3 and the modeling of the dissolved oxygen injection is described below. The system is designed to mitigate for dissolved oxygen impacts within the harbor. Additional cones are needed for each of the incremental deepenings. The 47-feet deepening would require the use of 10 Speece cones that would add approximately 40,000 pounds of dissolved oxygen per day. The system would operate during the summer months when dissolved oxygen values are usually the lowest. The injection of dissolved oxygen does not affect the loss of habitat in the upper Front River. It does result in a gain within the Back River, (Figure 30) but adult sturgeon have not been documented using this area during the summer. The habitat suitability models show significant gains of suitable habitat in the Back River near Rifle Cut, but with the closure of Rifle Cut, it is unknown whether sturgeon will have access to the area indicated as gained habitat.

5.2.1 Effects of Disturbances during Construction

Turbidity, associated with the disturbance of sediments from construction activities in relation to the flow re-routing modifications (Plan 6A or 6B), would occur within shortnose sturgeon habitat. Dredging activities in the upper Middle and Back River, located less than a kilometer from McCoy Cut, could result in disturbances to sturgeon located within these areas. In addition, the activities associated with the closing of the western arm of McCoy Cut and the construction of a diversion structure (e.g., sheet pile driving, placement of rip rap) in the Front River at McCoy Cut could disturb sturgeon and cause them to avoid these areas. During the summer and early fall, sturgeon appear to be concentrated in the Savannah River above the project area in a deep hole located upstream of the lower entrance to Abercorn Creek and in an area located just below the Abercorn Creek confluence. However, during the late fall through winter, they are found in the area of the proposed diversion structure moving between the deep hole and foraging areas in the Front River and Middle River. In order to minimize impacts to sturgeon, it is important that the construction activities such as those associated with the construction of the diversion structure are conducted while sturgeon are less likely to be found in the area. The impacts to sturgeon would be minimized by conducting construction of the diversion structure while most sturgeon are congregated upstream of the construction area between May 15 and November 1.

Within the lower Front River, the dredging associated with the project deepening will occur up to the Kings Island Turning Basin. In addition, there will be construction activity within Kings Island Turning Basin as it is widened to accommodate larger ships. These areas are located downstream from juvenile shortnose sturgeon foraging habitat, but are within documented habitat used by adult shortnose sturgeon primarily during the winter. The potential for interruption of the movement of sturgeon through the project due to increased turbidity associated with the dredging is an issue of concern. It is important that the construction activities use best management practices.

While sedimentation and turbidity could be elevated during dredging actions, the effects are expected to be localized and temporary. Studies performed by Dr. D.F. Hayes in 1986 on a hydraulic cutterhead dredge operating in Savannah Harbor indicated that average suspended sediment concentrations within 1,600 feet of the dredge were generally raised less than 200 mg/Liter in the lower water column and less than 100 mg/Liter and 50 mg/Liter in the middle and upper water column, respectively. More recent data indicate that present-day dredging operations are conducted in ways that do not increase suspended sediment concentrations to such a degree. The Savannah River has a naturally high suspended sediment load which during storm events increase well beyond the 200 mg/Liter increase created by a hydraulic dredge.

5.2.2 Effects of Dredging on Sturgeon Prey

The deepening within the inner harbor will result in impacts to shortnose sturgeon foraging habitat and the foraging base found there. This directly impacts the entire Savannah River population of shortnose sturgeon that is believed to reside only within the action area. While initial loss of benthic resources within the transitional areas are likely to occur, a quick recovery is expected (Van Dolah et al. 1979, Van Dolah et al. 1984, and Clarke and Miller-Way 1992) within 6 months to two years (Bonsdorff 1980, Ray 1997). Previous benthic studies in Savannah Harbor, conducted just prior to annual maintenance dredging, have shown primarily healthy benthic communities both inside and outside the navigation channel. Average abundance and biomass were found to be higher inside the channel compared to locations outside the channel, with the exception of silt-sand substrates. Areas with soft mud bottoms and oligohaline or mesohaline salinities recovered quickly, likely due to the dominance of opportunistic species assemblages (e.g., *Streblospio benedicti, Capitella capitata, Polydora ligni*) (Ray 1997). Recovery in dredged sites occurs by four basic mechanisms: remnant (undredged) materials in the sites, slumping of materials with their resident fauna into the site, adult immigration, and larval settlement. Remnant materials—sediments missed during the dredging operation—act as sources of "seed" populations to colonize recently defaunated sediments. Adult immigration can occur as organisms burrow laterally throughout the sediments, drift with currents and tides, or actively seek out recently defaunated sediments (Ray 1997). Likewise, materials slumping or falling into the site from channel slopes provide organisms for colonization (Kaplan et al. 1975).

The colonization of prey species into the transitional areas after the deepening has been completed is contingent on there being suitable water quality conditions and bottom substrates for these organisms to survive. However, while prey may be available, it will be of no benefit to shortnose sturgeon if the area has become unsuitable habitat for shortnose sturgeon due to higher salinity, or if access to the foraging habitat is no longer possible due to isolation of the foraging habitat related to the flow re-routing modifications, as may occur with the closing of Rifle Cut.

Dial-Cordy and Associates (2010) conducted a study for the COE to identify the bottom substrates in the Front River between Middle River and Interstate 95. This is the transitional area where the saltwater/freshwater interface will be shifting as a result of the deepening. The study found the bottom substrate to be primarily sand, which they considered to be acceptable habitat capable of supporting benthic populations. The study did not sample for benthic organisms.

Cadmium-laden Sediment Removal

The dredging and subsequent removal of cadmium-laden sediments could negatively influence water quality and affect potential prey species consumed by shortnose sturgeon. Contaminated sediments may be present within the areas where adult shortnose sturgeon forage. Sediment sampling and analysis were performed and the conclusions from that evaluation were that the only sediment contaminant of concern for this project is naturally-occurring cadmium found in Miocene clays.

The sediments containing cadmium would be dredged and/or exposed during construction. The highest concentrations of cadmium (average 21.45 mg/kg) are found between Stations 16+000 and 45+000 (river mile 3.0 to 8.5) and medium concentrations (average 6.67 mg/kg) are found between Stations 45+000 to 94+000 (river mile 8.5 to 17.8). Initially, dredging of the navigation channel may expose sturgeon prey/food species to cadmium. If prey/food species uptake cadmium from Stations 16+000 to 45+000, then it could adversely affect the adult shortnose sturgeon. Several factors could influence the degree to which cadmium might move from channel bottom sediment to benthos to the aquatic food chain. Important related questions that need to be answered are: (1) Do the Miocene clays with elevated cadmium levels support benthic organisms?, and (2) If so, would these benthic organisms growing in the Miocene clays with the elevated cadmium levels bioaccumulate cadmium and pass it through the food chain?

To address these questions, EA Engineering, Science, and Technology (EA 2008) conducted a benthic community assessment of the river bottom both inside and outside of the channel. They found a substantial benthic community within the channel bottom. In addition, they found that the coarse sand/gravel/clay substrate was used by benthic organisms, although they were unable to determine to what extent benthic organisms might burrow into the clay. They found that the substantial presence of benthic organisms within the channel maintenance sediments indicates that the impact of maintenance dredging is temporary. Although EA found that the clay substrate does support benthic organisms, this substrate presently comprises less than 28 percent of the channel bottom between Stations +16+000 and +60+000. This finding indicates that benthic organisms residing in exposed Miocene clays should present a relatively small fraction of the benthic organisms within the channel ecosystem. Potential contaminant impacts associated with exposed high cadmium sediments within a deepened channel would be minimal, primarily because sediment cadmium was found to be unavailable and bioaccumulation tests found cadmium uptake below levels of concern. The essentially anoxic state of the channel sediments should preclude significant movement of cadmium to the environment.

5.2.3 Effects of Proposed Fish Passage at the New Savannah Bluff Lock and Dam

The New Savannah Bluff Lock and Dam at the city of Augusta (rkm 299) is located just a few kilometers below impassible rapids, denying sturgeon access to 7 percent of historically available habitat up to the Augusta Diversion Dam (NMFS and USFWS 1998). The New Savannah Bluff Lock and Dam has five vertical spillway gates that could allow passage for anadromous fish during the normal spawning season flows in the Savannah River. Under normal spring flows when the gates are open, the headpond and tailwater elevations are often at the same level, and fish may pass upstream over the submerged weirs at each gate opening. Limited passage studies at the New Savannah Bluff Lock and Dam have documented significant passage by American shad, river herring, and striped bass for many years, but have not indicated passage by shortnose sturgeon. A study conducted by The Nature Conservancy in 2006 indicated significant numbers of shortnose sturgeon are present at the base of the New Savannah Bluff Lock and Dam during the late winter-spring spawning period. Congressional Acts (Water Resources Development Act of 2000, P.L. 106-541, and the Omnibus Appropriations Act 2001, P.L. 106-554) authorized the Savannah District COE to repair and rehabilitate the New Savannah Bluff Lock and Dam and to transfer the project to the City of North Augusta and Aiken County, South Carolina. The COE commissioned a study to investigate terms for transfer of ownership of the New Savannah Bluff Lock and Dam. The previous study identified and investigated fish passage configurations that would pass many species, including sturgeon.

A recent interagency fish passage workshop held by the COE investigated new alternative fish passage designs and made recommendations for a fish passage design based on performance criteria that would result in safe and effective passage of sturgeon upstream and downstream. NMFS and the workshop participants believed fish passage success criteria should be to provide for safe and effective upstream and downstream passage, where “safe” means negligible chances for harm to fish as a result of interactions with the passage facility or dam, and “effective” refers to the percentage of fish migrating up to and attempting to use the passage facility, that actually succeed in that attempt. Following the workshop, the COE reviewed the designs to determine the engineering specifications that would be needed, along with overall cost for construction, and developed an additional fish passage design alternative that would be less costly; an off-channel rock ramp (described in Section 2.1.5) that they will include in the FEIS.

NMFS has included development of a detailed *Plan for Safe and Effective Fish Passage* as a Term and Condition of this opinion, to ensure the passage facilities will provide the passage benefits upon which this opinion's conclusions are based. The Plan will be developed by the COE in consultation with NMFS, FWS, SCDNR, and GADNR. The Plan will require input of fish passage engineers and sturgeon experts working with COE on the final design and to ensure the effectiveness of the off-channel rock ramp. The Plan will also include a timetable for completion of construction of the off-channel rock ramp. Methodologies included in a separate monitoring and adaptive management plan will help determine if there are problems with the ramp and how they can be corrected. Development of these plans should commence within six months of the COE receiving all environmental approvals to implement the project. NMFS will review the final design to validate that it is anticipated to meet the performance requirements of this opinion.

Passage Effectiveness
Even though the final design details of the proposed off-channel rock ramp are not known, NMFS believes that the conceptual design can be meaningfully analyzed to assess its likely safety and effectiveness for passing sturgeon. The Plan and other terms and conditions included in this opinion will help ensure that the actual design and construction of the fish passage achieve the estimated success criteria. In their May 11, 2011, Information Paper, the COE estimated that the off-channel rock ramp would "provide 75% performance of upstream shortnose sturgeon passage and 85% performance of downstream passage." Those estimates were based on input from the participants in the April 2011 workshop in Augusta stating that fish passage performance generally matches the percent of river flow through the passage structure. This design would accommodate 100 percent of the river flow for 64 percent of the time during the months of February through June. The primary concern for failed upstream passage would be fish that swim past the rock ramp and up to the dam. Until the river nears flood stage, the predominant flow would still be though the rock ramp. Therefore, fish like shortnose sturgeon that follow the bottom contours and the predominant flow should use the off-channel rock ramp. The inclusion of the guide wall and the thalweg dredging in the design should further strengthen that effect. The COE stated that since vertical sills exist at both the downstream and upstream faces of the dam, no shortnose sturgeon are expected to move through the gates on the dam.

NMFS agrees with the COE's assessment of the likely effectiveness of the proposed off-channel rock ramp. NMFS also agrees that no upstream passage through the spill gates is expected. Traditional fish ladder designs are not effective at passing sturgeon. In recent years, there has been an emphasis on development of nature-like fishways, including rock ramp designs like the COE's proposal, particularly at low-head dams like the New Savannah Bluff Lock and Dam and with sturgeon as particular target species (Aadland 2010). The proposed off-channel rock ramp is sized and sloped appropriately for shortnose and Atlantic sturgeon. Inclusion of large boulders reduces overall water velocity through the fishway and also produces localized areas of low velocity where fish may rest between upstream bursts of movement. The rock ramp itself may have appropriate characteristics for some fish to spawn in it, as has been documented with lake sturgeon (Aadland 2010). NMFS agrees that the frequency of days when all or most of the river flow will pass through the fishway is likely a good proxy for the ability of sturgeon that are attempting to pass upstream or downstream to find and successfully pass through the rock ramp. NMFS further agrees that the guide wall and thalweg design features are likely to further improve the likelihood of fish reaching the entrance to the fish passage, rather than be attracted to the base of the dam. Thus, NMFS believes that the COE's estimates of 75% upstream passage effectiveness is reasonable based on the current preliminary design for the off-channel rock ramp.

Failure of downstream passage is of much greater concern. If fish upstream of the dam are subsequently unable to return downstream, either because they are trapped above the dam or because they are injured in passing through the facility or the dam, then the loss of those individual spawners and/or their spawning output (i.e., larval fish) negates any benefit of having passed the fish to better spawning habitat. The inclusion of the guide wall and thalweg features are likely to lead many fish, either passively or behaviorally, to the upstream entrance to the rock ramp, even when water is being spilled through the dam. The majority of the flow will go through the rock ramp, especially later in the spring when downstream migration occurs. However, the COE's downstream passage effectiveness estimate (85%) implies that 15% of fish do not successfully navigate downstream through the rock ramp. For adult sturgeon, NMFS believes that, even if fish initially fail to find the upstream entrance to the rock ramp, they will eventually return downstream. Likewise, adult fish searching for passage downstream will eventually find the rock ramp. The navigation lock, although it has high, downward-leading sills, is another route of exit. Finally, when the spill gates on the dam are opened, sturgeon can be spilled through the gates into the tailrace. Larval fish, if they are carried past the entrance to the rock ramp and over the guide wall, are not likely to navigate back to the ramp or through the navigation lock. Thus, passage through the spill gates is the only way downstream for larval fish that initially fail to find the rock ramp. The frequency of spilling is directly associated with the primary presumed reason for failure to navigate the rock ramp, high overall river flows. Therefore, any larval fish that are carried past the guide wall are likely to pass quickly through the spill gates. Also, NMFS believes that the actual percentage of juvenile sturgeon going over the four foot wall and hence possibly passing through the flood gates may be less than the COE's 15% estimate. Studies with Savannah River shortnose sturgeon embryos and larvae indicate that during downstream movement they stay near the bottom hiding in the rocks and swimming at heights no greater than 117 cm which is slightly less than four feet (Parker and Kynard, 2005). The COE's proposed height for the guide wall is three or four feet. Therefore, NMFS believes the COE's estimate of a minimum of 85% downstream passage effectiveness is a reasonable expectation of performance for the proposed off-channel rock ramp.

Passage Safety

NMFS believes that the proposed off-channel rock ramp will be safe for sturgeon. That is, fish attempting to pass upstream or downstream through the rock ramp are unlikely to experience risk of significant injury. Although artificial, the velocities, grades, and structures in the rock ramp as proposed are designed to accommodate sturgeon and to be similar to conditions in natural spawning areas, such as the Augusta Shoals. Spawning fish may experience minor injuries or abrasions in natural circumstances as they navigate shoals or rapids; NMFS believes fish navigating the off-channel rock ramp would be exposed to no more risk than in navigating a natural, low rapids.

During the April 2011 passage workshop, NMFS and the sturgeon experts in attendance expressed concern about mortality of juvenile and adult sturgeon that do not use the rock ramp on downstream migration and are subsequently passed through the gates of the dam. The COE provided NMFS with additional information in their May 27, 2011, communication on additional details of the off-channel rock ramp design, addressing this issue. The configuration of the dam, spill gates, and tailwater height makes the risk of serious injury or mortality of both juvenile and adult sturgeon to be negligible as a result of passing through the gates during downstream migration. There is a concrete sill extending approximately 70 feet downstream of the gates, 10 feet lower than the gate sill. At the time gates begin to be used (which is the time that would pose the greatest risk of injury or mortality for sturgeon and other fish), water will be approximately 13 feet deep on the apron and 3 feet higher than the bottom of the gate sills. Any fish passing through the gates will therefore not experience any physical drop. Fish would be subjected to brief high velocities and a maximum 12 foot pressure differential (based on the difference in head height upstream and downstream of the dam). Fish would enter a standing pool of water that is roughly 13 feet deep and not be exposed to any significant risk of contact injury, such as a fall onto a hard surface or even the air-water interface. At higher river flow rates and after the gates have been opened, the tailwater will rise, reducing the head and pressure difference between the upstream and downstream sides of the dam, and reducing velocity through the spill gates. Thus, when river flows are highest, and the chances for sturgeon passing through the gates are highest, the potentially injurious hydrodynamic forces are the least.

Mortalities of fish from passing over a spillway have several causes: shearing effects, disorientation, abrasion against spillway surfaces, turbulence in the stilling basin at the base of the dam, sudden variations in velocity and pressure as the fish hits the water, and physical impact against energy dissipaters. Experiments have shown that significant damage occurs (with injuries to gills, eyes, and internal organs) when the impact velocity of the fish on the water surface in the downstream pool exceeds 16 m/s, whatever its size (Bell and Delacy 1972). Passage through a spillway under free-fall conditions is less hazardous for small fish compared to large ones as their terminal velocity is less than the critical velocity (Larinier 2001). A column of water reaches the critical velocity for fish after a drop of 13 m (Larinier 2001); beyond this limit, injuries may become significant and mortality will increase rapidly in proportion to the drop (100% mortality for a drop of 50-60 m). The maximum head differential at the facility would be 12 feet (about 0.36 atmospheres), with the fish being subjected to 17 feet/ sec maximum velocities, both of which are dramatically lower than the injury and mortality thresholds indicated by Bell and Delacy (1972) and Larinier (2001).

Schedule for Construction of Fish Passage

Under the COE's current schedule, any benefits derived from sturgeon passage will not be realized until at least 4 years after the start of project construction, as that is the proposed time frame for construction of the passage facility. The constriction of habitat in the lower Savannah River adds further urgency to fish passage implementation to restore access to habitat upstream that contains high quality spawning habitat and additional foraging habitat. In order to reduce additional adverse impacts associated with delay of construction of the fish passage, NMFS has included a requirement that the land acquisition process for the fish passage will be initiated prior to or concurrently with project dredging of the entrance channel. This would allow fish passage construction to begin prior to or concurrently with project deepening of the inner harbor. NMFS has also added a Term and Condition that contains a minor change in the construction of the diversion structure that will minimize the impacts of that construction.

After construction of the fish passage, monitoring would need to be conducted to assess the effectiveness of the design in passing sturgeon upstream and downstream. Details of the proposed monitoring should be clearly stated within the Monitoring and Adaptive Management Plan to be developed by the COE in coordination with the resource agencies. NMFS has included a requirement that the COE would coordinate with NMFS and the other federal and state resource agencies in the final development of the Plan within 6 months of the COE receiving all environmental approvals to implement the project. NMFS would have final review of the Plan.

Overall Impacts of Fish Passage

Once fish passage is implemented at the New Savannah Bluff Lock and Dam, both shortnose and Atlantic sturgeon will have free upstream passage to the Augusta Diversion Dam. NMFS believes that vitally important spawning habitat is available in the Savannah River upriver from the New Savannah Bluff Lock and Dam to the Augusta Diversion Dam, and that the species will likely expand their geographic range to reoccupy these formerly available habitats. The passage of fish past the New Savannah Bluff Lock and Dam will add 20 miles of additional spawning habitat and may lead to an increase in spawning activity. This could also reduce the adverse effects of loss of juvenile habitat in the lower river because they will be spawned further up the river, thus giving them more time and distance to mature and forage before reaching the lower river and the salt wedge which will be further up river as a result of the deepening.

As indicated in Section 5.2.1, the proposed deepening will result in a loss of juvenile shortnose and Atlantic sturgeon foraging and refuge habitat and will result in a loss of current adult shortnose sturgeon foraging and refuge habitat as a result of upriver movement of the salt wedge. During past dredging activities (Kings Bay turning basin) sturgeon moved further upriver and established new foraging and refuge areas. Based on this, NMFS expects that sturgeon will again find suitable habitat upriver. However, without fish passage this will cause a constriction of their range in the river and cause young fish to encounter higher salinities with less time to mature. The overall effect of the construction of the off-channel rock ramp is expected to add an additional 20 miles of spawning habitat which may lead to an increase in spawning and a possible increase in spawning success. Although fish passage will not replace the lost foraging and refuge habitat in the lower river, it will increase the sturgeons' range within the river and add an additional 20 miles for juvenile sturgeon to forage and mature prior to reaching the salt wedge in the lower river. More mature juvenile sturgeon are better able to tolerate higher salinities.

5.2.4 Summary of Effects to Sturgeon

Atlantic sturgeon will be adversely affected by direct interactions with dredges and relocation trawling in the Savannah Harbor Entrance Channel. Atlantic sturgeon may be encountered by hopper dredges, but relocation trawling should limit these encounters. The relocation trawling would result in nonlethal take as sturgeon are released alive. NMFS expects that 4 Atlantic sturgeon will be killed as a result of interactions with the dredge and 20 will be captured during relocation trawling. Shortnose sturgeon are not expected to be found in the offshore areas where hopper dredges will be operating, so no take should occur. No take is anticipated by dredging within the river channel as hopper dredges will not be used within the river channel.

Water quality will be affected by the changes in water flows through the lower Savannah River related to the freshwater flow re-routing modification and by the deepening. Analysis of the best available information indicates that salinities will increase and dissolved oxygen will decrease, adversely affecting important foraging and resting habitat for sturgeon. It is expected that 251 acres of habitat important to juvenile shortnose and Atlantic sturgeon will be lost, which represents 7.6% of their current estuarine habitat in the lower river. It is also expected that 266 acres of habitat important to adult and sub-adult shortnose sturgeon will be lost, which represents 6.9% of their current estuarine habitat in the lower river. Adult and sub-adult Atlantic sturgeon are more salt tolerant and forage mainly in the Atlantic Ocean so the habitat loss will have insignificant effects on them. Surveys conducted by the COE indicate that substrate suitable for the prey species preferred by shortnose and juvenile Atlantic sturgeon is found in the section of the Front River immediately upriver from the lost estuarine foraging habitat. The COE surveys did not establish whether these areas support sturgeon prey species, but NMFS believes that this upriver habitat may eventually be colonized by prey species as the habitat equalizes to the higher salinities resulting from the upriver movement of the salt wedge. To compensate for the lost foraging habitat, sturgeon will be forced to shift foraging efforts into new areas, once suitable prey become available, or to intensify their foraging in the remaining suitable habitats, if sufficient prey remains there. To the extent that sturgeon and the ecosystem are capable of making these responses, the overall impacts of lost foraging habitat may eventually be reduced.

Analysis of the best available information indicates that all juveniles of both species of sturgeon (no estimates of these populations are available) and all adult shortnose sturgeon (estimated at 2000) in the Savannah River will be affected by the deepening. The loss of foraging area mentioned above will reduce the amount of prey available to juveniles, making successful foraging more difficult. This reduction in prey and reduction in foraging success will result in slower growth rates and reduced fitness of juvenile sturgeon. Reduced fitness can also lead to disease and mortality. Adult shortnose sturgeon will also face a reduction in foraging success which will lead to reduced fitness. Reduced fitness in adult shortnose sturgeon can lead to disease and mortality, lower fecundity in females, and a reduction in the energy required to make spawning runs, thereby, causing a lowering of reproductive success. There is no reliable way to quantify the actual numbers of juvenile shortnose and Atlantic sturgeon or adult shortnose sturgeon that will manifest these effects. Therefore, monitoring of habitat will be used to determine the extent of the effects to these species and to determine the need to reinitiate consultation. The terms and conditions of the incidental take statement issued with this opinion include monitoring of habitat effects.

Monitoring will include ensuring that habitat effects predicted by the COEs modeling are not greater than expected. The monitoring will also be used to determine if prey species do colonize upriver habitats and how long it takes for such colonization to occur. Lastly, monitoring will determine if the sturgeon are using new habitat areas including those that we expect to eventually be newly colonized by prey species. If monitoring indicates that these predictions are not accurate and that the effects of the action are greater than expected, taking action through the adaptive management process will be required.

6 CUMULATIVE EFFECTS

Cumulative effects are the effects of future state, local, or private activities that are reasonably certain to occur within the action area considered in this biological opinion. Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to Section 7 of the ESA.

Within the action area, major future changes are not anticipated in ongoing human activities described in the environmental baseline. The present human uses of the action area, such as commercial shipping, boating, and fishing, are expected to continue at the present levels of intensity in the near future as are their associated risks of injury or mortality to sea turtles and shortnose sturgeon posed by incidental capture by fishermen, vessel collisions, marine debris, chemical discharges, and man-made noises.

Sea Turtles

Beachfront development, lighting, and beach erosion control are all ongoing activities along the southeastern coast of the United States. These activities potentially reduce or degrade sea turtle nesting habitats or interfere with hatchling movement to sea. Human activities and development along nesting beaches may also discourage sea turtles from nesting sites. The extent to which these activities reduce sea turtle nesting and hatchling production is unknown. However, more and more coastal counties have or are adopting more stringent protective measures to protect hatchling sea turtles from the disorienting effects of beach lighting. Some of these measures were drafted in response to lawsuits brought against the counties by concerned citizens who charged the counties with failing to uphold the ESA by allowing unregulated beach lighting which results in takes of hatchlings.

NMFS presumes that any additional increases in recreational vessel activity in inshore and offshore waters of the Atlantic Ocean will likely increase the risk of turtles taken by injury or mortality in vessel collisions. Recreational hook-and-line fisheries have been known to lethally take sea turtles. Future cooperation between NMFS and the states on these issues should help decrease take of sea turtles caused by recreational activities. NMFS will continue to work with states to develop ESA Section 6 agreements and Section 10 permits to enhance programs to quantify and mitigate these takes.

Sturgeon
Human activities that affect riverine water quality and quantity such as non-point and point-source discharges are also expected to continue at current rates. Future cooperation between NMFS and the GADNR and SCDNR should help decrease take of sturgeon caused by recreational activities. NMFS will continue to work with states to develop ESA Section 6 agreements and with researchers in Section 10 permits to enhance programs to quantify and mitigate these takes.

Climatically, sea level is expected to continue to rise, water temperatures are expected to continue to rise, and levels of precipitation are likely to fluctuate more drastically. Drought and inter-and intra-state water allocation and their associated impacts will continue and may intensify. A rise in sea level will likely drive the salt wedge farther upriver, further constricting shortnose sturgeon habitat.

7 JEOPARDY ANALYSIS

The analyses conducted in the previous sections of this opinion serve to provide a basis to determine whether the proposed action would be likely to jeopardize the continued existence of affected ESA-listed sea turtles and sturgeon. In Section 5, we outlined how the proposed action can affect sea turtles and sturgeon and the extent of those effects in terms of estimates of the numbers of each species expected to be killed. Now we turn to an assessment of each species' response to this impact, in terms of overall population effects from the estimated take, and whether those effects of the proposed action, when considered in the context of the status of the species (Section 3), the environmental baseline (Section 4), and the cumulative effects (Section 6), will jeopardize the continued existence of the affected species.

It is the responsibility of the action agency to "insure that any action authorized, funded, or carried out by such agency is not likely to jeopardize the continued existence of any endangered species or threatened species…" (ESA Section 7(a)(2)). Action agencies must consult with and seek assistance from the Services to meet this responsibility. The Services must ultimately determine in a biological opinion whether the action jeopardizes listed species. "To jeopardize the continued existence of" means to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and the recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species (50 CFR 402.02). Thus, in making this determination, NMFS must look at whether the action directly or indirectly reduces the reproduction, numbers, or distribution of a listed species. Then, if there is a reduction in one or more of these elements, we evaluate whether it would be expected to cause an appreciable reduction in the likelihood of both the survival and the recovery of the species.

In the following section we evaluate the responses of loggerhead (NWA DPS) and Kemp's ridley sea turtles, and sturgeon, to the effects of the action. We have previously summarized how the Savannah River population of shortnose sturgeon is a part of the larger, Southern metapopulation. The Southern metapopulation consists of all shortnose sturgeon populations inhabiting the rivers from North Carolina through Florida. The Southern metapopulation is markedly separate from the other two metapopulations of the shortnose sturgeon, both physically and genetically. We will also evaluate in the following section the response of the Atlantic sturgeon South Atlantic DPS to the effects of the action, which is currently proposed for ESA listing as endangered.

7.1 Effects of the Action on Loggerhead Sea Turtles' Likelihood of Survival and Recovery in the Wild

The lethal take of 16 sea turtles by hopper dredges would result in an instantaneous, but temporary reduction in total population numbers. Thus, the proposed action will result in a reduction of sea turtle numbers. Sea turtle mortality resulting from hopper dredges could result in the loss of reproductive value of an adult turtle. For example, an adult female loggerhead sea turtle can lay 3 or 4 clutches of eggs every 2 to 4 years, with 100 to 130 eggs per clutch. The annual loss of one adult female sea turtle, on average, could preclude the production of thousands of eggs and hatchlings, of which a small percentage is expected to survive to sexual maturity. Thus, the death of an adult female eliminates an individual's contribution to future generations, and the action will result in a reduction in sea turtle reproduction.

Considering the size of the NWA DPS, we believe the loggerhead sea turtle population is sufficiently large enough to persist and recruit new individuals to replace those expected to be lethally taken (i.e., 16 over the course of the 3-year dredging project). We use the following estimates to support our determination.

NMFS SEFSC (2009a) estimated the likely minimum adult female population size for the western North Atlantic subpopulation in the 2004-2008 time frame to be between 20,000 to 40,000 (median 30,050) female individuals, with a low likelihood of there being as many as 70,000 individuals. The estimate of western North Atlantic adult loggerhead females was considered conservative for several reasons. The number of nests used for the western North Atlantic was based primarily on U.S. nesting beaches; as such, the results are a slight underestimate of total nests because of the inability to collect complete nest counts for many non-U.S. nesting beaches. In estimating the current population size for adult nesting female loggerhead sea turtles, NMFS SEFSC (2009a) simplified the number of assumptions and reduced uncertainty by using the minimum total annual nest count over the last five years (i.e., 48,252 nests). This was a particularly conservative assumption considering how the number of nests and nesting females can vary widely from year to year, (cf., 2008's nest count of 69,668 nests, which would have increased proportionately the adult female estimate to between 30,000 and 60,000). Further, minimal assumptions were made about the distribution of remigration intervals and nests per female parameters, which are fairly robust and well-known parameters.

Although not included in the NMFS SEFSC (2009) report, in conducting its loggerhead assessment NMFS SEFSC also produced a much less robust estimate for total benthic females in the western North Atlantic, with a likely range of approximately 60,000 to 700,000, up to less than one million. The estimate of overall benthic females is considered less robust because it is model-derived, assumes a stable age/stage distribution, and is highly dependent upon the life history input parameters. Relative to the more robust estimate of adult females, this estimate of total benthic female population is consistent with our knowledge of loggerhead life history and the relative abundance of adults and benthic juveniles: the benthic juvenile population is an order of magnitude larger than adults. Therefore, we believe female benthic loggerheads number in the hundreds of thousands.

Based on the total numbers of adult females and benthic juvenile females estimated by NMFS SEFSC for the western North Atlantic population of loggerhead sea turtles (now designated as the NWA DPS), the anticipated lethal take resulting from the proposed action (i.e., worst case, up to 16 loggerhead) represent the removal of, at most, approximately 0.043 percent of the estimated adult loggerhead female population. This level of lethal take of sea turtles also represents the removal of, at most, 0.0019 percent of the estimated female benthic loggerheads population. These removals are very small and contribute only minimally to the overall mortality on the population. For adult females, the incremental effect on annual mortality rates is less than four one-hundredths of the range of possible mortality values for the species. For benthic juvenile females, the contribution to overall mortality is less. Further, these percentages are likely an overestimation of the impact of the anticipated lethal take resulting from the proposed project on loggerhead sea turtles because of the following reasons. These percentages represent impacts to adult and benthic juvenile female loggerhead sea turtles only, and not to the population as a whole. Because this estimated contribution to mortality is a tiny part of our range of uncertainty across what total mortality might be for loggerhead sea turtles, we do not believe that the small effect posed by the lethal take resulting from the proposed project will be detectable or appreciable.

The potential lethal take of up to 16 loggerheads over a 3-year period will result in reduction in numbers when takes occur and possibly by lost future reproduction, but, given the magnitude of these trends and likely large absolute population size, it is unlikely to have any detectable influence on the population objectives and trends noted above. In the event that the take is non-lethal, the take would not be expected to impact the reproductive potential, fitness, or growth of the captured sea turtle because it will be immediately released unharmed, or released with only minor injuries from which it is expected to fully recover, or be rehabilitated prior to release. Thus, the proposed action will not interfere with achieving the recovery objectives and will not result in an appreciable reduction in the likelihood of loggerhead sea turtles' recovery in the wild.

The Atlantic recovery plan for the United States population of the loggerhead sea turtles (NMFS and USFWS 1991a), herein incorporated by reference, lists the following relevant recovery objective over a period of 25 continuous years:

> The adult female population in Florida is increasing and in North Carolina, South Carolina, and Georgia, it has returned to pre-listing nesting levels (NC = 800 nests/season; SC = 10,000 nests/season; GA = 2,000 nests/season).

The potential lethal take of up to 16 loggerheads over a 3-year period will result in reduction in numbers when takes occur and possibly by lost future reproduction, but, given the magnitude of these trends and likely large absolute population size, it is unlikely to have any detectable influence on the population objectives and trends noted above. Capture of sea turtles by relocation trawlers will not affect the adult female nesting population or number of nests per nesting season. Thus, the proposed action will not interfere with achieving the recovery objectives and will not result in an appreciable reduction in the likelihood of loggerhead sea turtles' recovery in the wild.

7.2 Effect of the Action on Kemp's Ridley Sea Turtles' Likelihood of Survival and Recovery in the Wild

As demonstrated by nesting increases at the main nesting sites in Mexico, adult ridley numbers have increased over the last decade. The population model used by TEWG (2000) projected that Kemp's ridleys could reach the recovery plan's intermediate recovery goal of 10,000 nesters by the year 2015. Recent calculations of nesting females determined from nest counts show that the population trend is increasing towards that recovery goal, with an estimate of 4,047 nesters in 2006 and 5,500 in 2007 (NMFS 2007, Gladys Porter Zoo 2007). Recent nesting data indicated a population of an estimated 8,460 females in 2009 and 5,320 females in 2010 (J. Peña, Gladys Porter Zoo, pers. comm. to S. Heberling, NMFS, March 21, 2011). Based on this information, and similar to the conclusion reached for loggerhead sea turtles, the anticipated lethal take of up to 11 Kemp's ridley sea turtles would not be expected to have a detectable effect on the Kemp's ridley sea turtle population.

The lethal take of 11 Kemp's ridleys by hopper dredges over the 3-year duration of the proposed project could potentially result in short-term effects on individuals; however, these effects do not constitute an appreciable reduction in reproduction and numbers. Changes in distribution, even short-term, are not expected from non-lethal takes (interactions/releases from relocation trawling, vessel strikes, etc.) during the Savannah Harbor Expansion Project. Interactions with vessels and/or relocation trawlers may elicit startle or avoidance responses and the effects of the proposed action may result in temporary changes in behavior of sea turtles (minutes to hours) over small areas, but are not expected to reduce the distribution of any sea turtles in the action area. The removal of up to 11 Kemp's ridleys is anticipated during the proposed project. Because all potential take is expected to occur anywhere in the action area and sea turtles generally have large ranges in which they disperse, no reduction in the distribution of Kemp's ridley sea turtles is expected from the take of these individuals.

Based on the above analysis, we believe that take of Kemp's ridley sea turtles associated with the proposed action are not reasonably expected to cause, directly or indirectly, an appreciable reduction in the likelihood of survival of these species in the wild.

The following analysis considers the effects of the take on the likelihood of recovery in the wild. We consider the recovery objectives in the recovery plans prepared for each species that relate to population numbers or reproduction that may be affected by the predicted reductions in the numbers or reproduction of sea turtles resulting from the proposed action.

The recovery plan for Kemp's ridley sea turtles (USFWS and NMFS 1992), herein incorporated by reference, lists the following relevant recovery objective:

> Attain a population of at least 10,000 females nesting in a season.

The potential injury or mortality of 11 Kemp's ridley will result in a reduction in overall population numbers in any given year. We already have determined this take is not likely to reduce population numbers over time due to current population sizes and expected recruitment. Capture of sea turtles by relocation trawlers will not affect the adult female nesting population or number of nests per nesting season. Thus, the proposed action will not result in an appreciable reduction in the likelihood of Kemp's ridley sea turtles recovery in the wild.

7.3 Effects of the Action on Shortnose Sturgeons' Likelihood of Survival and Recovery in the Wild

Adverse effects to important estuarine foraging habitats for juveniles and adults will affect both life stages. These effects are expected to be sub-lethal for individual sturgeon of the existing population, but may reduce the river's overall carrying capacity and ability to provide optimal habitat for shortnose sturgeon to forage. However, based on previous studies indicating that sturgeon moved upriver to suitable habitats after a deepening event (Collins et al., 2001), NMFS believes that both adults and juveniles will move to suitable habitats further upriver after this deepening event. However, NMFS believes there may be a transitional period as the habitat adjusts to the new, higher salinity. Sturgeon are expected to use these areas for foraging once their prey have colonized and stabilized to the new environmental conditions. The adverse effects of habitat loss on young of the year juveniles will be further reduced by being spawned further upriver due to the construction of a sturgeon-friendly fish passage facility, thus giving them more time and distance to mature before reaching the lower river.

NMFS believes that the proposed action is not likely to cause a long-term reduction in reproduction. Although there may be a reduction (1-2 years, maybe longer) in spawning due to lack of fitness of spawning adults resulting from lower foraging success during a transitional period as the habitat adjusts to the new, higher salinity. However, the implementation of the timely sturgeon-friendly fish passage before the project's full impacts occur within the inner harbor will result in the addition of 20 miles of spawning habitat that is expected to result in increased spawning activity over the long term. Adding 20 miles of available habitat will also lengthen the amount of residency time of early juveniles in freshwater, thereby resulting in juveniles being older and larger when they reach the freshwater/saltwater interface and more adept at adjusting to different salinities.

Based on the fact that NMFS does not believe the proposed action will result in a reduction in reproduction or numbers of shortnose sturgeon in the Savannah River, the proposed action will not result in a decrease in the species' distribution. Based on this information, the proposed action will not appreciably reduce the likelihood of the shortnose sturgeon's survival in the Savannah River.

In the above analysis on the effects of the action, we determined that the loss of foraging habitat for shortnose sturgeon may restrict future population growth but will not appreciably reduce the likelihood of the shortnose sturgeon's survival in the Savannah River. We will analyze 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 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. Ensure that all fish passageways permit adequate passage of shortnose sturgeon and do not alter migration or spawning behavior;
2. In each river, identify natural migration patterns of each life stage and any barriers to movement between habitats. Devise methods to pass shortnose sturgeon above/below existing barriers; and
3. Restore flows in regulated rivers during spawning periods to promote spawning success and rehabilitate degraded spawning substrate.

The proposed implementation of fish passage at the New Savannah Bluff Lock and Dam and the associated restoration of 20 miles of upstream habitat, including historic spawning habitat and providing additional habitat for the early life stages of their offspring to use as developmental and foraging habitat. By adding approximately 20 miles of habitat, the early juveniles moving down the river will have a longer length of river in which to feed and grow older and larger before reaching the saltwater/freshwater interface located in the lower Savannah River. As it has been shown by laboratory studies, even a few weeks difference in age enables juvenile sturgeon to develop a higher tolerance of salinity and lower levels of dissolved oxygen. This would help them to be better able to utilize a wider range of foraging habitat once they reach the lower river thereby reducing the negative effects caused by upriver movement of the salt wedge resulting from the deepening. The increased spawning habitat and survival of more juveniles should help to rebuild the population; thereby ensuring a stable population that can maintain continuous recruitment of individuals, will contain all life stages, and will allow the population to sustain itself in the event of unavoidable impacts.

7.4 Effects of the Action on Atlantic Sturgeons' Likelihood of Survival and Recovery in the Wild

While the expected lethal take of 4 Atlantic sturgeon by hopper dredges would result in a reduction in numbers which are considered to be low, the reduction will not decrease the overall population in the South Atlantic DPS as there are significant numbers of fish found in the rivers comprising the South Atlantic DPS range of Atlantic sturgeon.

Adverse effects to important estuarine foraging habitats for juveniles and adults will affect both life stages. These effects are expected to be sub-lethal for individual sturgeon of the existing population, but may reduce the river's carrying capacity and its overall ability to provide suitable foraging habitat for juvenile Atlantic sturgeon. NMFS also believes that both adults and juveniles will move to suitable foraging and resting habitats further upstream. The adverse effects of habitat loss on young of the year juveniles will be further reduced by being spawned further up the river due to the construction of a sturgeon-friendly fish passage structure, thus giving them more time and distance to mature before reaching the lower river.

NMFS believes that the proposed action is not likely to cause a reduction in reproduction. The implementation of the timely sturgeon-friendly fish passage before the project's full impacts occur within the inner harbor will result in the addition of 20 miles of spawning habitat that is expected to result in increased spawning activity over the long term. Adding 20 miles of available habitat may lengthen the amount of residency time of early juveniles in freshwater, thereby resulting in juveniles being older and larger when they reach the freshwater/saltwater interface and more adept at adjusting to different salinities.

Based on the fact the NMFS does not believe the proposed action will result in a reduction in reproduction or numbers of Atlantic sturgeon in the Savannah River, the proposed action will not result in a decrease in the species distribution. Based on this information, the proposed action will not appreciably reduce the likelihood of the Atlantic sturgeon's survival in the Savannah River.

Because the Atlantic sturgeon is not a listed species, there is no recovery plan. However recovery is the process by which listed species and their ecosystems are restored and their future is safeguarded to the point that protections under the ESA are no longer needed (NMFS and USFWS Recovery Planning Guidance 2010). The first step in recovering a species is to reduce identified threats; only by alleviating threats can lasting recovery be achieved (NMFS and USFWS Recovery Planning Guidance 2010). 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 even in the event of unforeseen and unavoidable impacts.

Major threats impacting the Atlantic sturgeon South Atlantic DPS were summarized in the proposed listing (75 FR 61904) and include:

1. Dams that curtail the extent of available habitat, as well as modifying sturgeon habitat downstream through a reduction in water quality.
2. Dredging that modifies the quality and availability of Atlantic sturgeon habitat.
3. Degraded water quality that modifies and curtails the extent of available habitat for spawning and nursery areas.
4. Climate change that exacerbates the effects of modification and curtailment of Atlantic sturgeon habitat caused by dams, dredging, and reduced water quality.
5. Overutilization for commercial purposes contributed to the historical drastic decline in Atlantic sturgeon populations throughout the species' range.
6. Inadequacy of regulatory mechanisms to control bycatch and the modification and curtailment of Atlantic sturgeon habitat.

In addition, the proposed implementation of fish passage at the New Savannah Bluff Lock and Dam and the associated restoration of 20 miles of upstream habitat, including historic spawning habitat should provide additional habitat for the early life stages of Atlantic sturgeon to use as developmental and foraging habitat. It has been shown by laboratory study that even a few weeks difference in age enables juvenile sturgeon to develop a higher tolerance of salinity and lower levels of dissolved oxygen. This would help them to be better able to utilize a wider range of foraging habitat once they reach the lower river, thus reducing the negative effects caused by upriver movement of the salt wedge resulting from the deepening; thereby helping to ensure a stable population that can maintain a continuous recruitment of individuals, will contain all life stages, and will allow the population to sustain itself in the event of unavoidable impacts.

8 CONCLUSION

We have analyzed the best available data, the current status of the species, environmental baseline, effects of the proposed action, and cumulative effects to determine whether the proposed action is likely to jeopardize the continued existence of the Northwest Atlantic DPS of loggerhead sea turtles, Kemp's ridley sea turtles, Atlantic sturgeon, and shortnose sturgeon.

Kemp's Ridley and Loggerhead Sea Turtles (NWA DPS)
Because the proposed action is not reasonably expected to reduce appreciably the likelihood of survival and recovery of Kemp's ridley or loggerhead (NWA DPS) sea turtles, it is our opinion that the Savannah Harbor Expansion Project is not likely to jeopardize their continued existence.

Shortnose Sturgeon
This opinion analyzed the best available data, the current status of the species, environmental baseline, effects of the proposed action, and cumulative effects to determine whether the proposed action is likely to jeopardize the continued existence of shortnose sturgeon. Review of the available data indicates that the proposed project will adversely affect shortnose sturgeon through dredging and habitat modification. These effects are expected to be nonlethal for juvenile and adult shortnose sturgeon found in the

Savannah River. NMFS believes the effects of these impacts will be reduced by timely construction of a sturgeon-friendly fish passage prior to or concurrent with project impacts occurring within the inner harbor and will result in the addition of 20 miles of spawning habitat that is expected to result in increased spawning activity. Therefore, it is our opinion that the Savannah Harbor Expansion Project is not likely to jeopardize the continued existence of shortnose sturgeon.

Conference Opinion for South Atlantic DPS of Atlantic Sturgeon
Our Atlantic sturgeon analyses focused on the impacts to and population response of the South Atlantic DPS within the Savannah River. Review of the available data indicates that the proposed project will adversely affect Atlantic sturgeon through dredging and habitat modification. These effects are expected to be nonlethal for the juvenile and adult Atlantic sturgeon found in the Savannah River. NMFS believes the effects of these impacts will be reduced by timely construction of a sturgeon-friendly fish passage prior to or concurrent with project impacts occurring within the inner harbor and will result in the addition of 20 miles of spawning habitat that is expected to result in increased spawning activity. It is therefore our opinion that the Savannah Harbor Expansion Project is not likely to jeopardize the continued existence of the South Atlantic DPS of Atlantic sturgeon.

9 INCIDENTAL TAKE STATEMENT (ITS)

Section 9 of the ESA and protective regulations issued pursuant to Section 4(d) of the ESA prohibit the take of endangered and threatened species, respectively, without a special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or attempt to engage in any such conduct. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of Section 7(b)(4) and Section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the ESA provided that such taking is in compliance with the RPMs and terms and conditions of the ITS.

Section 7(b)(4)(c) of the ESA specifies that in order to provide an incidental take statement for an endangered or threatened species of marine mammal, the taking must be authorized under Section 101(a)(5) of the MMPA. Since no incidental take of listed marine mammals is expected or has been authorized under Section 101(a)(5) of the MMPA, no statement on incidental take of endangered whales is provided, and no take is authorized. Nevertheless, the COE must immediately notify (within 24 hours, if communication is possible) NMFS' Office of Protected Resources should a take of a listed marine mammal occur.

9.1 Anticipated Amount or Extent of Incidental Take

Section 9 of the ESA and Federal regulation pursuant to Section 4(d) of the ESA prohibit take of endangered and threatened species, respectively, without special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harm is further defined by NMFS to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of ESA Section 7(b)(4) and Section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking provided that such taking is in compliance with the terms and conditions of this Incidental Take Statement.

Sea Turtles
Based on historical distribution data, hopper dredge observer reports, and observations of past strandings, loggerhead and Kemp's ridley sea turtles may occur in the action area and may be taken by the hopper dredging operations of this project. NMFS anticipates incidental take, by injury or mortality, will consist of 27 sea turtles (11 Kemp's ridley and 16 loggerhead) during the three years of project dredging and up to 51 non-injurious takes of non-species-specific sea turtles over the three years. NMFS estimates that, overall, sea turtle trawling and relocation efforts will result in considerably less than 0.5 percent mortality of captured turtles, primarily due to their being previously stressed or diseased or if struck by trawl doors or accidents on deck.

Atlantic sturgeon
During the dredging of the offshore Entrance Channel, we expect 4 Atlantic sturgeon to be killed as a result of interactions with dredges and another 20 will be taken in relocation trawlers but released alive. According to the COE's timeline, dredging of the Entrance Channel will occur over a period of two to three years.

The loss of estuarine habitat currently used by sturgeon will result from the salt wedge moving further upriver causing salinity to increase above levels tolerated by juvenile Atlantic sturgeon. With the higher salinities located further upriver, small juveniles migrating downriver could arrive at the salt wedge too early and be subjected to salinities beyond their tolerable upper limits. This could result in mortality for these individuals. Adult sturgeon may become sick and weak if they are not able to find sufficient prey due to the loss of foraging habitat that would occur with the shift of higher salinity upriver.

An unknown number of Atlantic sturgeon may experience adverse effects due to the loss of estuarine habitat in the inner harbor, but NMFS does not expect this number to rise to a population level. Modeling of habitat loss for Atlantic sturgeon was not conducted due to their proposed listing occurring after the COE had concluded all of its data analyses, however it is generally believed that suitable habitat as determined for juvenile shortnose sturgeon would also be suitable for juvenile Atlantic sturgeon. Modeling for shortnose sturgeon indicates that with the 47-foot deepening alternative, approximately 251.0 acres of foraging and resting habitat used by juvenile shortnose sturgeon during the winter (January conditions were modeled) would be lost. This represents approximately 7.6 percent of the total habitat available to juvenile shortnose sturgeon in the lower river. Because juvenile Atlantic and shortnose sturgeon are thought to share the same foraging and resting habitat, there is a likelihood that juvenile Atlantic sturgeon would also be affected by the loss of this habitat. The most recent population estimates for Atlantic sturgeon estimated that there are 300 or less adults in the Savannah River, but there are no estimates for juvenile Atlantic sturgeon. Because no population estimates have been conducted, we are unable to determine the actual number of juvenile Atlantic sturgeon currently found in the Savannah River. However, using the loss of 7.6 percent of the total available habitat to extrapolate take of juvenile Atlantic sturgeon, we would estimate that the inner harbor deepening would adversely affect approximately 7.6 percent of the juvenile Atlantic sturgeon found in the Savannah River due to loss of foraging/nursery habitat.

Modeling also indicated that approximately 266.0 acres of foraging and resting habitat used by adult shortnose sturgeon during the winter (January conditions were modeled) would be lost. This represents approximately 6.9 percent of the total habitat available to adult shortnose sturgeon in the lower river. However, since adult Atlantic sturgeon have a wide range of salinity tolerance, we believe the majority of adult Atlantic sturgeon will not be affected and will be able to find suitable foraging habitat. Although we cannot estimate the actual number of sturgeon that would be affected, we would not expect it to rise to a population level adverse affect.

Shortnose sturgeon

NMFS has also determined that juveniles and adults within the Savannah River population of shortnose sturgeon will be affected due to loss of estuarine habitat in the lower river. An unknown number of shortnose sturgeon may experience adverse effects due to the loss of habitat, but NMFS expects this to be a small number and not on a population scale. The modeling indicates that with the 47-foot deepening alternative, approximately 251.0 acres of foraging and resting habitat used by juvenile shortnose sturgeon during the winter (January conditions were modeled) would be lost. This represents approximately 7.6 percent of the total habitat available to juvenile shortnose sturgeon in the lower river. No estimates of juvenile abundance have been conducted. Because no population estimates are available for juvenile shortnose sturgeon, we are unable to determine the actual number of juveniles currently found in the Savannah River.

Modeling also indicated that approximately 266.0 acres of foraging and resting habitat used by adult shortnose sturgeon during the winter (January conditions were modeled) would be lost. This represents approximately 6.9 percent of the total habitat available to adult shortnose sturgeon in the lower river. We believe the majority of adult shortnose sturgeon will not be affected and will be able to find suitable foraging habitat. A draft status review of shortnose sturgeon, being prepared by the Shortnose Status Review Team (2011), provides a (weak) population estimate of 2,000 adults in the Savannah River. If we use this estimate, approximately 2,000 adult shortnose sturgeon in the Savannah River could be adversely affected by the loss of suitable foraging habitat.

9.2 Effect of the Take

Sea Turtles
NMFS has determined the anticipated level of incidental take specified in Section 9.1 is not likely to jeopardize the continued existence of loggerhead (NWA DPS) or Kemp's ridley sea turtles.

Sturgeon
NMFS has determined the anticipated level of incidental take as explained in Section 9.1 is not likely to jeopardize the continued existence of shortnose sturgeon or the Atlantic sturgeon.

9.3 Reasonable and Prudent Measures

Section 7(b)(4) of the ESA requires NMFS to issue a statement specifying the impact of any incidental take on listed species, which results from an agency action otherwise found to comply with Section 7(a)(2) of the ESA. It also states the 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 that complies with the specified terms and conditions is authorized.

The RPMs and terms and conditions are specified as required, by 50 CFR 402.01(i)(1)(ii) and (iv), to document the incidental take by the proposed action and to minimize the impact of that take on ESA-listed species. These measures and terms and conditions are non-discretionary, and must be implemented by the COE in order for the protection of Section 7(o)(2) to apply. The COE has a continuing duty to regulate the activity covered by this incidental take statement. If the COE fails to adhere to the terms and conditions 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.

Sea Turtles
NMFS has determined that the following RPMs are necessary and appropriate to minimize impacts of the incidental take of sea turtles during the proposed action. The RPMs that NMFS believes are necessary to minimize the impacts of the proposed hopper dredging have been discussed with the COE in the past and are standard operating procedures, and include the use of intake and overflow screening, use of sea turtle deflector dragheads, observer and reporting requirements, and relocation trawling. The following RPM's 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. Experience has shown that injuries sustained by sea turtles entrained in the hopper dredge dragheads are usually fatal. Current regional opinions for hopper dredging require observer monitoring requirements, deflector dragheads, and conditions and guidelines for relocation trawling, which NMFS believes are necessary to minimize effects of these removals on listed sea turtle species that occur in the action area.

1. Take Reporting: Observer Requirements and Dredged Material Screening

NMFS-approved observers monitor dredged material inflow and overflow screening baskets on many projects; however, screening is only partially effective and observed, documented takes provide only partial estimates of total sea turtle mortality. NMFS believes that some listed species taken by hopper dredges go undetected because body parts are forced through the sampling screens by the water pressure and are buried in the dredged material, or animals are crushed or killed but not entrained by the suction and so the takes may go unnoticed. The only mortalities that are documented are those where body parts either float, are large enough to be caught in the screens, and/or can be identified as from sea turtle species. However, this opinion estimates that with 4-inch inflow screening in place, and 24 hour, 100 percent observer coverage will probably detect and record 66.6 percent of turtle mortality. Additionally, coordination with local sea turtle stranding networks can be a valuable adjunct monitoring method; not to directly monitor takes, but to help ensure that unanticipated impacts to sea turtles are not occurring.

2. Deflector Dragheads

V-shaped, sea turtle deflector dragheads prevent an unquantifiable yet significant number of sea turtles from being entrained and killed in hopper dredges each year. Without them, turtle takes during hopper dredging operations would unquestionably be higher. Draghead tests conducted in May-June 1993 by the COE's Waterways Experimental Station (WES), now known as the Engineering Research and Development Center (ERDC), in clear water conditions on the sea floor off Fort Pierce, Florida, with 300 mock turtles placed in rows, showed convincingly that the newly-developed WES deflector draghead "performed exceedingly well at deflecting the mock turtles." Thirty-seven of 39 mock turtles encountered were deflected, 2 turtles were not deflected, and none were damaged. Also, "the deflector draghead provided better production rates than the unmodified California draghead, and the deflector draghead was easier to operate and maneuver than the unmodified California flat-front draghead." The V-shape reduced forces encountered by the draghead, and resulted in smoother operation. V-shaped deflecting dragheads are now a widely accepted conservation tool, the dredging industry is familiar with them and their operation, and they are used by all COE Districts conducting hopper dredge operations where turtles may be present.

3. Relocation Trawling

Relocation trawling has proved to be a useful conservation tool in most dredging projects where it has been implemented. The September 22, 1995, RBO to the COE's New Orleans and Galveston Districts on hopper dredging of channels in Texas and Louisiana included a conservation recommendation for relocation trawling which stated that "Relocation trawling in advance of an operating dredge in Texas and Louisiana channels should be considered if takes are documented early in a project that requires use of a hopper dredge during a period in which large number of sea turtles may occur." That

RBO was amended by NMFS (Amendment No. 1, June 13, 2002) to change the conservation recommendation to a term and condition of the RBO. Overall, it is NMFS' opinion that the COE Districts choosing to implement relocation trawling have benefited from their decisions. For example, in the Galveston District, Freeport Harbor Project (July 13-September 24, 2002), assessment and relocation trawling resulted in one loggerhead capture. In Sabine Pass (Sabine-Neches Waterway), assessment and relocation trawling in July-August 2002 resulted in five loggerhead and three Kemp's ridley sea turtle captures. One turtle was killed by the dredge; this occurred while the relocation trawler was in port repairing its trawl net (P. Bargo, pers. comm. 2002). In the Jacksonville District, sea turtles have been relocated out of the path of hopper dredges operating in Tampa Bay and Charlotte Harbor or their entrance channels. During St. Petersburg Harbor and Entrance Channel dredging in the fall of 2000, a pre-dredging risk assessment trawl survey resulted in capture, tagging, and relocation of two adult loggerheads and one subadult green turtle. In February 2002 during the Jacksonville District's Canaveral Channel emergency hopper dredging project for the Navy, two trawlers working around the clock captured and relocated 69 loggerhead and green turtles in seven days, and no turtles were entrained by the hopper dredge. In the Wilmington District's Bogue Banks Project in North Carolina, two trawlers successfully relocated five turtles in 15 days between March 13 and 27, 2003; one turtle was taken by the dredge. In 2003, Aransas Pass relocation trawling associated with hopper dredging resulted in 71 turtles captured and released (with three recaptures) in three months of dredging and relocation trawling. Five turtles were killed by the dredge. No turtles were killed after relocation trawling was increased from 12 to 24 hours per day (T. Bargo, pers. comm. to E. Hawk, October 27, 2003). In 2006, trawling associated with the dredging of the Houston-Galveston Navigation Channels resulted in 7 loggerheads relocated in 60 days of trawling (COE Sea Turtle Data Warehouse; http://el.erdc.usace.army.mil/seaturtles/index.cfm). In Fiscal Year 2007, relocation trawling activities in COE channel projects in the Gulf of Mexico resulted in the capture and relocation of 67 green, 42 Kemp's ridley, and 68 loggerhead sea turtles; in the South Atlantic, 18 loggerhead and 17 Kemp's ridley sea turtles were relocated (Ibid).

This opinion authorizes the use of turtle relocation trawling. NMFS believes the use of relocation trawling should be required during all proposed hopper dredging. NMFS will provide a list of contractors who are approved by NMFS to perform this work. NMFS expects the effect of any turtle relocation trawling would be non-lethal and non-injurious.

Sturgeon

We have determined the following RPMs are necessary and appropriate to minimize the impacts of future takes on sturgeon as the COE conducts the dredging of the harbor and implements fish passage and other modifications in the project area.

1. Implement Safe and Effective Fish Passage in a Timely Manner

The implementation of fish passage at the New Savannah Bluff Lock and Dam is a measure that is expected to provide sturgeon access to upstream habitat. A delay in implementing fish passage will result in adverse effects on the year-class strength of sturgeon. Reduction in year-class is a major consequence for the late-maturing, long-lived sturgeon that spawn infrequently. The constriction of habitat in the lower Savannah River adds further urgency to prompt fish passage implementation to restore access to habitat upstream that contains high quality spawning habitat and additional foraging habitat. The COE has presented a fish passage design called an Off-Channel Rock Ramp which is expected to pass fish safely and effectively upstream and downstream. NMFS requested a review of the proposed design by Dr. Luther Aadland (Minnesota Department of Natural Resources), who provided assurance that the proposed rock ramp could effectively pass sturgeon and other anadromous species with some modification. Additionally, a comparison analysis of the performance of existing rock ramps located in other parts of the country with similar characteristics to the New Savannah Bluff Lock and Dam fish passage design may provide useful information on the spatial variation of velocities across the width of rock ramp designs. Final design information provided by the COE for the proposed fish passage should include how the velocity fields would vary with different river flows.

The development of the final design of this fish passage will need to be coordinated with NMFS. A timetable for completion of construction of the fish passage facility shall be included. The COE has agreed to immediately initiate final design work and coordinate the results of that effort with the federal and state natural resource agencies within 6 months of receiving all of the environmental approvals to implement the project. In order to consult with the other resource and sturgeon experts, NMFS will require a minimum of 2 months to provide a review of the final fish passage design.

Additional lands must also be acquired to construct the rock ramp and for an access road to the site. The COE shall initiate land acquisition prior to, or concurrent with, the start of dredging of the Savannah Harbor Entrance Channel. The COE has estimated that it will take 6 months to process the land acquisition. Construction of the fish passage shall commence prior to or concurrently with the start of inner harbor dredging and be completed within 2 years. To reduce adverse affects to sturgeon during construction of the fish passage, special provisions for the protection of sturgeon shall be implemented.

The COE will develop a Monitoring and Adaptive Management plan specifically for the fish passage as a part of the comprehensive Monitoring and Adaptive Management Plan for the project (included in RPM 3). The plan will identify detailed success criteria and triggers for passage modification. Sturgeon will be migrating to spawning habitat during the winter and returning downriver during the spring. Larval fish will also be beginning their movement downriver. To protect spawning sturgeon and their offspring, no in-water construction will be performed at the downstream entrance of the fish passage channel during the late winter/spring spawning period through the early summer larval period. In-water work and installation of sheet pile training walls (if necessary) may be performed upstream of the dam throughout the year. The COE shall employ best management practices such as silt curtains to control turbidity throughout the construction of the fish passage facility. No drawdown of water levels can occur during the late winter/spring spawning period through the early summer larval period to facilitate construction. Normal flows must be maintained.

2. Protective Measures for Sturgeon during Construction in the SHEP Project Area

To reduce adverse effects to sturgeon during construction of the flow re-routing modifications and during the deepening, special provisions for the protection of sturgeon will need to be implemented. The area of the proposed flow re-routing modifications would be located in foraging and resting habitat for sturgeon and is especially important to juvenile shortnose sturgeon during the winter. A moratorium on specific in-water work associated with the flow re-routing modifications will be necessary to protect sturgeon. The timing of the moratorium is linked to the time of year when sturgeon are most likely to occur in the construction area.

3. Development of a Comprehensive Monitoring and Adaptive Management Plan for the Savannah River Project Area

To ensure appropriate monitoring and adaptive management is conducted within the entire Savannah River Project Area a comprehensive monitoring and adaptive management plan shall be developed for assessing project effects associated with the deepening, the effectiveness of the fish passage, and for implementing corrective actions. The Plan shall contain details describing how sturgeon will be monitored. It must also address how adaptive management would be included during the construction phases. The Plan shall identify explicit success criteria and triggers. This would include a mechanism that would allow results from the monitoring to feed into decisions governing operation of the project activities and mitigation actions. If monitoring of sturgeon habitat indicates the loss of suitable habitat exceeds the amount determined by the COE's models, or if the fish passage is not functioning as intended, and these impacts cannot be addressed through adaptive management, this would trigger re-initiation of consultation with NMFS. The COE will coordinate with NMFS on development of the comprehensive plan to include measures to address these concerns.

4. Ensure Appropriate Dissolved Oxygen Levels

The proposed expansion, deepening, and modification of the Savannah Harbor through dredging will have a significant effect on the habitat of sturgeon. The COE is proposing to install oxygen injection systems on the Savannah River above and within the project area to mitigate for expected impacts to dissolved oxygen caused by deepening the harbor. NMFS believes there is a high degree of uncertainty associated with the proposed use of an oxygen injection system. These systems, known as Speece cones, will be used during the summer months to inject oxygen into the river, as needed. These systems have not been previously used in a tidal system such as the Savannah River, so their efficacy cannot be thoroughly assessed before installation. Once operational, extensive monitoring of the river to determine effectiveness of the systems is proposed and modifications may be necessary as a part of a comprehensive monitoring and adaptive management plan to be developed for the project. Analysis of projected benefits of dissolved oxygen injection indicate that while there would be improvements in portions of the Front River and Middle River, the lower portion of the Back River would still have areas of unsuitable habitat for shortnose sturgeon. If the oxygen injection system does not perform as designed, impacts to sturgeon habitat from the harbor deepening could be greater than what has been estimated by the COE's models. Contingency funding shall be included in the adaptive management plan to accommodate needed modifications to address low levels of dissolved oxygen. This measure is intended to ensure that impacts from SHEP are no worse than the COE's predictions in the DEIS. Sturgeon have been shown to be impacted by low dissolved oxygen levels, and mortality of sturgeon can occur within hours of exposure to low dissolved oxygen (Campbell and Goodman 2004). The three-level dissolved oxygen criteria for shortnose sturgeon recommended by the interagency fisheries group and applied by the COE to identify areas with suitable sturgeon habitat include rare (<1% of the time) excursions of summertime dissolved oxygen to less than 2 mg/Liter, infrequent excursions (<5%) to less than 3mg/Liter, and occasional excursions (<10%) below 4 mg/Liter. Thus, these are already relatively permissive standards that allow exposure of sturgeon to very depressed dissolved oxygen levels even in the areas designated as suitable habitat. Given the physiological threat posed to sturgeon from low dissolved oxygen combined with high thermal stress in the summer (water temperatures in the summer average 25°-28°C), monitoring and adaptive management of dissolved oxygen shall ensure that the oxygen injection systems perform as intended to offset impacts due to deepening the harbor and ensure the amount of suitable habitat identified as summer suitable habitat (Figure 30) meet these established dissolved oxygen criteria.

5. Tissue Sampling, Tags and Reporting Take

Tissue samples taken of any sturgeon handled or stranded will be processed per Appendix C. All sturgeon encountered will need to be scanned for a PIT tag. The PIT tag reader should be able to read both 125 kHz and 134 kHz tags. Sonic tags, or some other type of state-of-the-art tracking device, will be placed on sturgeon captured during relocation trawling, or alive by the hopper dredge, only by NMFS-approved personnel under the authority of this biological opinion. The COE will need to notify NMFS of any and all sturgeon injuries or mortality occurring during the dredging/construction activities within 24 hours of the take.

9.4 Terms and Conditions

In order to be exempt from the prohibitions of Section 9 of the ESA, the COE must comply with the following terms and conditions, which implement the reasonable and prudent measures described above and outline required reporting and monitoring requirements. These terms and conditions are non-discretionary.

Sea Turtles

1. Observers (RPM 1): The COE shall arrange for NMFS-approved protected species observers to be aboard the hopper dredges to monitor the hopper bin, screening, and dragheads for sea turtles and their remains. Observer coverage sufficient for 100 percent monitoring (i.e., two observers) of hopper dredging operations is required aboard the hopper dredges throughout the proposed project.

2. Screening (RPM 1): 100 percent inflow screening of dredged material is required and 100 percent overflow screening is recommended. If conditions prevent 100 percent inflow screening, inflow screening may be reduced gradually, as further detailed in the following paragraph, but 100 percent overflow screening is then required.

   a. Screen Size: The hopper's inflow screens should have 4-inch by 4-inch screening. If the SAD, in consultation with observers and the draghead operator, determines that the draghead is clogging and reducing production substantially, the screens may be modified sequentially: mesh size may be increased, for example, to 6-inch by 6-inch, then 9-inch by 9-inch, then 12-inch by 12-inch openings. Other variations in screening size are allowed, with prior written approval by NMFS. Clogging should be greatly reduced with these flexible options; however, further clogging may compel removal of the screening altogether, in which case effective 100 percent overflow 4-inch screening is mandatory. The COE shall notify NMFS beforehand if inflow screening is going to be reduced or eliminated, and provide details of how effective overflow screening will be achieved.

   b. Need for Flexible, Graduated Screens: NMFS believes that this flexible, graduated-screen option is necessary, since the need to constantly clear the inflow screens will increase the time it takes to complete the project and therefore increase the exposure of sea turtles to the risk of impingement or entrainment. Additionally, there are increased risks to sea turtles in the water column when the inflow is halted to clear screens, since this results in clogged intake pipes, which may have to be lifted from the bottom to discharge the clay by applying suction.

3. Dredging Pumps: Standard operating procedure shall be that dredging pumps shall be disengaged by the operator when the dragheads are not firmly on the bottom, to prevent impingement or entrainment of sea turtles within the water column. This precaution is especially important during the cleanup phase of dredging operations when the draghead frequently comes off the bottom and can suck in turtles resting in the shallow depressions between the high spots the draghead is trimming off.

4. Sea Turtle Deflecting Draghead (RPM 2): A state-of-the-art rigid deflector draghead must be used on all hopper dredges at all times. Alternate draghead designs shall not be used unless prior, written approval is given by NMFS.

5. Dredge Take Reporting and Final Report: Observer reports of incidental take by hopper dredges must be faxed to NMFS' Southeast Regional Office (phone: 727/824-5312, fax: 727/824-5309), and reported by electronic mail to: (**takereport.nmfsser@noaa.gov**) by onboard NMFS-approved protected species observers, the dredging company, or the COE within 24 hours of any sea turtle or other listed species take observed.

   A final report summarizing the results of the hopper dredging and any documented sea turtle or other listed species takes must be submitted to NMFS within 30 working days of completion of the dredging project. Reports shall contain information on project location (specific channel/area dredged), start-up and completion dates, cubic yards of material dredged, problems encountered, incidental takes and sightings of protected species, mitigative actions taken, screening type (inflow, overflow) utilized, daily water temperatures, name of dredge, names of endangered species observers, percent observer coverage, and any other information the SAD deems relevant.

6. Sea Turtle Strandings (RPM 1): The SAD Project Manager or designated representative shall notify the Sea Turtle Stranding and Salvage Network (STSSN) state representative (contact information available at: http://www.sefsc.noaa.gov/seaturtleSTSSN.jsp) of the start-up and completion of hopper dredging operations and bed-leveler dredging operations and ask to be notified of any sea turtle strandings in the project area that, in the estimation of STSSN personnel, bear signs of potential draghead impingement or entrainment, or interaction with a bed-leveling type dredge.

   Information on any such strandings shall be reported in writing within 30 days of project end to NMFS' Southeast Regional Office. Because the deaths of these turtles, if hopper dredge or bed-leveler dredge related, have already been accounted for in NMFS' jeopardy analysis, the strandings will not be counted against the COE's take limit.

7. Reporting - Strandings: The COE shall provide NMFS' Southeast Regional Office with a report detailing incidents, with photographs when available, of stranded sea turtles that bear indications of draghead impingement or entrainment and/or bed-leveler interactions.

8. Relocation Trawling (RPM 3)(if applicable): Prior to turtle relocation trawling, the COE shall develop and submit to NMFS detailed specifications on the final selected turtle relocation trawling gear sufficiently ahead of planned dredging activities for NMFS to review and comment on the plans. NMFS fisheries gear specialists may be able to provide technical assistance in developing specifications. The use of relocation trawling will be required during all proposed hopper dredging during December 1 through March 31.

Non-capture relocation trawling ("sweep trawling") may be used if prior, written approval is given by NMFS, after NMFS ensures that the proper net design and sweep trawling procedures will be used. Sweep-trawling trawl net design and trawling procedures are inherently and fundamentally different from capture-trawling trawl net design and procedures.

9. Relocation Trawling Report (RPM 3)(if applicable): The COE shall provide NMFS' Southeast Regional Office with an end-of-project report within 30 days of completion of any relocation trawling. This report may be incorporated into the final report summarizing the results of the hopper dredging project.

10. Additional Relocation Trawler Requirements (RPM 3) (if applicable): Any capture-type or sweep-type relocation trawling conducted or contracted by the COE to temporarily reduce or assess the abundance of these listed species during a hopper dredging project in order to reduce the possibility of lethal hopper dredge interactions, is subject to the following conditions as listed below. In the event that trawling does result in the capture of a sea turtle, the COE or its contractors may employ a separate chase boat to relocate the turtle at a distance of no less than 3 miles from the centerline of the navigation channel at the capture site.

    a. Handling: Sea turtles recovered by observers on modified relocation trawlers (e.g., turtles incidentally captured in modified trawl gear, injured turtles recovered on the surface, etc.) shall be handled in a manner designed to ensure their safety and viability, and shall be released over the side of the vessel, away from the propeller, and only after ensuring that the vessel's propeller is in the neutral, or disengaged, position (i.e., not rotating). Resuscitation guidelines are attached (Appendix B).

    b. Captured Sea Turtle Holding Conditions: Sea turtles may be held up to 24 hours for the collection of important scientific measurements, prior to their release. Captured sea turtles shall be kept moist, and shaded whenever possible, until they are released.

    c. Scientific Measurements and Data Collection: When safely possible, all turtles shall be measured (standard carapace measurements including body depth), tagged, weighed, and a tissue sample taken prior to release. Any external tags shall be noted and data recorded into the observer's log. Only NMFS-approved protected species observers or observer candidates in training under the direct supervision of a NMFS-approved protected species observer shall conduct the tagging/measuring/weighing/tissue sampling operations. External mounting of satellite tags, radio transmitters, data loggers, crittercams, etc. may be done under the authority of this opinion by NMFS-approved, trained personnel, after approval from NMFS SERO PRD (see Terms and Condition #10.g., Other Sampling Procedures).

NMFS-approved protected species observers may conduct more invasive scientific procedures (e.g., bloodletting, laparoscopies, external tumor removals, anal and gastric lavages, etc.) and partake in or assist in "piggy back" research projects but only if the observer holds a valid federal sea turtle research permit (and any required state permits) authorizing the activities, or the observer is acting as the duly-designated agent of the permit holder, and has first notified NMFS' Southeast Regional Office, Protected Resources Division.

d. Injuries: Injured sea turtles shall be immediately transported to the nearest sea turtle rehabilitation facility. Minor skin abrasions resulting from trawl capture are considered non-injurious. The COE shall ensure that logistical arrangements and support to accomplish this are pre-planned and ready, and is responsible for ensuring that dredge vessel personnel comply with this requirement. The COE shall bear the financial cost of sea turtle transport, treatment, rehabilitation, and release.

e. Flipper Tagging: All sea turtles captured by relocation trawling shall be flipper-tagged prior to release with external tags which shall be obtained prior to the project from the University of Florida's Archie Carr Center for Sea Turtle Research. This opinion serves as the permitting authority for any NMFS-approved protected species observer aboard these relocation trawlers to flipper-tag with external tags (e.g., Inconel tags) captured sea turtles. Columbus crabs or other organisms living on external sea turtle surfaces may also be sampled and removed under this authority.

f. PIT-Tag Scanning: This opinion serves as the permitting authority for any NMFS-approved protected species observer aboard a relocation trawler to PIT-tag captured sea turtles. PIT tagging of sea turtles is not required to be done if the NMFS-approved protected species observer does not have prior training or experience in said activity; however, if the observer has received prior training in PIT tagging procedures and is comfortable with the procedure, then the observer shall PIT tag the animal prior to release (in addition to the standard external tagging):

Sea turtle PIT tagging must then be performed in accordance with the protocol detailed at NMFS' Southeast Fisheries Science Center's Web page: http://www.sefsc.noaa.gov/seaturtlefisheriesobservers.jsp. (See Appendix C on SEFSC's "Fisheries Observers" Web page);

Unless otherwise approved in advance by NMFS SERO PRD, PIT tags used must be sterile, individually-wrapped tags to prevent disease transmission. PIT tags should be 125-kHz, glass-encapsulated tags–the smallest ones made. Note: If scanning reveals a PIT tag and it was not difficult to find, then do not insert another PIT tag; simply record the tag number and location, and frequency, if known. If for some reason the tag is difficult to detect (e.g., tag is embedded deep in muscle, or is a 400-kHz tag), then insert one in the other shoulder.

g. Other Sampling Procedures: All other tagging and external or internal sampling procedures (e.g., bloodletting, laparoscopies, external tumor removals, anal and gastric lavages, mounting of satellite or sonic transmitters, or similar tracking equipment, etc.) performed on live sea turtles are not permitted under this opinion unless the observer holds a valid sea turtle research permit authorizing the activity, either as the permit holder or a designated agent of the permit holder, or unless the observer (or person performing the procedure, in the case of piggy-back research by the COE or other federal or state government agency or university personnel) receives prior, written approval by NMFS SERO after a thorough review by PRD of their credentials, experience, and training in the proposed procedures.

h. PIT-Tag Scanning and Data Submission Requirements: All sea turtles captured by relocation trawling or dredges shall be thoroughly scanned for the presence of PIT tags prior to release using a multi-frequency scanner powerful enough to read multiple frequencies (including 125-, 128-, 134-, and 400-kHz tags) and read tags deeply embedded in muscle tissue (e.g., manufactured by Trovan, Biomark, or Avid). Turtles whose scans show they have been previously PIT tagged shall nevertheless be externally flipper tagged. Sea turtle data collected (PIT tag scan data and external tagging data) shall be submitted to NOAA, National Marine Fisheries Service, Southeast Fisheries Science Center, Attn: Lisa Belskis, 75 Virginia Beach Drive, Miami, Florida 33149. All sea turtle data collected shall be submitted in electronic format within 60 days of project completion to Lisa.Belskis@noaa.gov and Sheryan.Epperly@noaa.gov. Sea turtle external flipper tag and PIT tag data generated and collected by relocation trawlers shall also be submitted to the Cooperative Marine Turtle Tagging Program (CMTTP), on the appropriate CMTTP form, at the University of Florida's Archie Carr Center for Sea Turtle Research.

i. Handling Fibropapillomatose Turtles: NMFS-approved protected species observers are not required to handle viral fibropapilloma tumors if they believe there is a health hazard to themselves and choose not to. When handling sea turtles infected with fibropapilloma tumors, observers must maintain a separate set of sampling equipment for handling animals displaying fibropapilloma tumors or lesions.

11. Requirement and Authority to Conduct Tissue Sampling for Genetic and Contaminants Analyses: This opinion serves as the permitting authority for any NMFS-approved protected species observer aboard a relocation trawler or hopper dredge to tissue-sample live- or dead-captured sea turtles without the need for an ESA Section 10 permit.

All live or dead sea turtles captured by relocation trawling and hopper dredging (for both COE-conducted and COE-permitted activities) shall be tissue-sampled prior to release. Sampling shall continue uninterrupted until such time as NMFS determines and notifies the COE in writing.

Sea turtle tissue samples shall be taken in accordance with NMFS' SEFSC procedures for sea turtle genetic analyses, and, as specified, for contaminants (e.g., heavy metals) analyses. Protocols for tissue sampling to be utilized in contaminants analyses are currently being developed by Dr. Dena Dickerson, ERDC. The COE shall ensure that tissue samples taken during the dredging project are collected and stored properly and mailed every three months until completion of the dredging project to: NOAA, National Marine Fisheries Service, Southeast Fisheries Science Center, Attn: Lisa Belskis, 75 Virginia Beach Drive, Miami, Florida 33149.

12. Training - Personnel on Hopper Dredges: The COE must ensure that all contracted personnel involved in operating hopper dredges (whether privately-funded or federally-funded projects) receive thorough training on measures of dredge operation that will minimize takes of sea turtles. It shall be the goal of the hopper dredging operation to establish operating procedures that are consistent with those that have been used successfully during hopper dredging in other regions of the coastal United States, and which have proven effective in reducing turtle/dredge interactions. Therefore, COE Engineering Research and Development Center experts or other persons with expertise in this matter shall be involved both in dredge operation training, and installation, adjustment, and monitoring of the rigid deflector draghead assembly.

13. Dredge Lighting: All lighting aboard hopper dredges and hopper dredge pumpout barges operating within 3 nm of sea turtle nesting beaches shall be limited to the minimal lighting necessary to comply with U.S. Coast Guard and/or OSHA requirements. All non-essential lighting on the dredge and pumpout barge shall be minimized through reduction, shielding, lowering, and appropriate placement of lights to minimize illumination of the water to reduce potential disorientation effects on female sea turtles approaching the nesting beaches and sea turtle hatchlings making their way seaward from their natal beaches.

14. Best Management Practices: The COE will be required to conduct activities in compliance with NMFS' March 23, 2006, *Sea Turtle and Smalltooth Sawfish Construction Conditions* (Appendix D).

Sturgeon

The following Terms and Conditions implement the RPMS above, which are designed to minimize the adverse impacts of the expected take from the proposed action, and to provide for monitoring and validation of the impacts associated with the proposed action, and must be collectively implemented.

1. <u>Develop a Plan for Safe and Effective Fish Passage</u> (RPM 1): The implementation of a safe and effective fish passage shall be coordinated by the COE in consultation with sturgeon experts with NMFS, FWS, SCDNR, and GADNR. The COE has presented a fish passage design called an Off-Channel Rock Ramp. Using the proposed off-channel rock ramp design as its basis, the COE will work with these agencies to develop the final design details. The COE shall conduct a comparison analysis of the performance of existing rock ramps located in other parts of the country with similar characteristics to the proposed New Savannah Bluff Lock and Dam fish passage conditions to review information on the spatial variation of velocities across the width of rock ramp designs. The COE has agreed to expeditiously initiate final design work and would coordinate the results of that effort with the federal and state natural resource agencies within 6 months of receiving all of the environmental approvals to implement the project. NMFS will need a minimum of 2 months to review the final fish passage design. The proposed final design shall require NMFS' final review to validate that the design meets the requirements specified in the Biological Opinion. The goal of the fish passage alternative is to achieve at least 75 percent upstream passage effectiveness for both shortnose and Atlantic sturgeon, at least 85 percent downstream passage effectiveness, and cause no serious injury to sturgeon that come into contact with the passage or dam structures. The fish passage must maintain velocities comparable to those found in the upstream habitat that the sturgeon are expected to access upon completion of the fish passage facility (at Augusta Shoals).

2. <u>Timeline for Construction of the Fish Passage</u> (RPM 1): Fish passage construction shall commence prior to or concurrently with initiation of inner harbor dredging and be completed within two years.

3. <u>Land for Fish Passage</u> (RPM1): The COE or project sponsor shall purchase any additional land necessary for construction of the fish passage and for an access road to the site. The land acquisition process must be initiated prior to, or concurrent with, commencement of entrance channel dredging actions.

4. <u>Fish Passage Construction Guidelines</u> (RPM 1): To protect spawning sturgeon and their offspring, no in-water fish passage construction downstream of the New Savannah Bluff Lock and Dam shall occur during the late winter/spring spawning period and early summer larval period between February 1 and May 31 of any year. In-water construction of the fish passage may be performed upstream of the dam throughout the year.

5. <u>In-water Work During Construction of the Fish Passage</u> (RPM 1): The COE shall adhere to the following protective measures during construction of the fish passage:

- Appropriate erosion and turbidity controls shall be utilized wherever necessary to limit sediments from entering the water.
- Dredging and construction shall be conducted with minimum environmental impact.
- No construction debris shall be allowed to enter the water.
- To ensure passage throughout the habitat, adequate pathways must be provided at all times so that fish can migrate between foraging habitat and spawning habitat; no blocking of the channel is allowed.
- Normal water flows must be maintained throughout the construction areas.
- The COE shall not reduce flows during spring/early summer to aid in the construction of the fish passage.

6. Fish Passage Effectiveness Monitoring and Adaptive Management (RPM 1): The COE shall develop a Monitoring and Adaptive Management Plan specifically for the fish passage that will, to the maximum extent practicable, ensure the performance criteria described in sturgeon term and condition no.1 above will be achieved. The plan will also identify detailed triggers for passage modification. Post-construction monitoring shall be designed and conducted to assess the effectiveness of the fish passage in safely passing sturgeon upstream and downstream. The COE shall consult with NMFS and the other federal and state resource agencies in the completion of the Plan within 6 months of receiving all environmental approvals to implement the project. NMFS shall have final review of such plan. If it is determined that sturgeon are not safely and effectively passing upstream and downstream through the fish passage, measures shall be taken to identify the source of the problem, and corrective actions approved by NMFS shall be taken to rectify the problem.

7. Timing of Construction of the Flow Re-routing Modifications (RPM 2): The construction of the diversion structure associated with the flow re-routing modifications has the potential to cause injury to sturgeon. The impact to sturgeon shall be minimized by constructing the diversion structure while most sturgeon are congregated upstream of the construction area between May 15 and November 1.

8. Protection of Sturgeon during In-water Construction in the Lower Savannah River (RPM 2): The COE shall adhere to the following measures to protect sturgeon during deepening of the harbor and widening of the channel; and during the modifications associated with the flow re-routing, which include plugging Rifle Cut, filling the Sediment Basin, closing the lower arm of McCoy Cut, construction of a flow diversion structure at McCoy Cut, and the dredging of the upper Middle and Back River.

    - Appropriate erosion and turbidity controls shall be utilized wherever necessary to limit sediments from entering the water.

- Dredging and construction shall be conducted with minimum environmental impact.
- No construction debris shall be allowed to enter the water.
- No blocking of the channel is allowed, except where included as part of the flow re-routing modifications.

9. Ensure Appropriate Monitoring and Adaptive Management within the Lower Savannah River Project Area (RPM 3): A comprehensive monitoring and adaptive management plan shall be developed for assessing project effects associated with the deepening, the flow re-routing modifications, the injection of dissolved oxygen, and for implementing corrective actions. The comprehensive plan would also include monitoring and adaptive management for the fish passage as described in T&C 6. The Plan shall identify explicit success criteria and triggers. The COE shall coordinate with NMFS and other federal and state resource agencies in the completion of the Plan within 6 months of receiving all environmental approvals to implement the project. NMFS shall have final review of such plan. The Plan shall include monitoring to determine whether the predicted amount of habitat loss, as determined by the COE's models, is being exceeded. If the monitoring indicates that habitat loss to any species within NMFS' ESA authority is being exceeded, this will trigger re-initiation of consultation with NMFS. Preconstruction monitoring would begin in time to allow one year of work to be complete before dredging occurs in the inner harbor.

10. Ensure Appropriate Dissolved Oxygen Levels (RPM 4): Monitoring and adaptive management for dissolved oxygen levels shall ensure that the oxygen injection systems perform as intended to offset impacts due to deepening the harbor and ensure the amount of suitable habitat as predicted in the COE's modeling of the three-level summer habitat suitability criteria for sturgeon (Table 7) are not reduced. During the monitoring and adaptive management period if dissolved oxygen excursions below minimal levels in the modeled river cells are longer in duration than specified in the criteria, corrective action will be taken immediately, if practicable, for example by increasing or adjusting the operation of the Speece Cone system or cessation of dredging in the area of concern. If short-term responses are not practicable, potential engineering solutions shall be identified and implemented as soon as possible, and not later than July 1, following discovery of the poor oxygen levels.

11. Tissue Sampling (RPM 5): A tissue sample shall be taken of any sturgeon handled or stranded per Appendix C; samples shall be shipped to the address provided in Appendix C within one month.

12. PIT Tag Scanning (RPM 5): All sturgeon encountered shall be scanned for a PIT tag; codes shall be included in the take report submitted to NMFS. The PIT tag reader shall be able to read both 125 kHz and 134 kHz tags.

13. Lethal Take (RPM 5): If a lethal take occurs, COE shall arrange for contaminant analysis of the carcass. If this requirement is implemented, the carcass should be frozen and NMFS contacted immediately to provide instructions for shipping and preparation.

14. Tagging (RPM 5): Sonic tags, or some other type of state-of-the-art tracking device, shall be placed on sturgeon captured during relocation trawling, or alive by the hopper dredge, by NMFS-approved personnel only, under the authority of this biological opinion.

15. Take Reporting: Observer reports of incidental take by hopper dredges and relocation trawls must be faxed to NMFS' Southeast Regional Office (phone: 727/824-5312, fax: 727/824-5309), and reported by electronic mail to: (**takereport.nmfsser@noaa.gov)** by onboard NMFS-approved protected species observers, the dredging company, or the COE within 24 hours.

10 CONSERVATION RECOMMENDATIONS

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

Sea Turtles

Pursuant to Section 7(a)(1) of the ESA, the following conservation recommendations are made to assist the COE in contributing to the conservation of sea turtles by further reducing or eliminating adverse impacts that result from dredging.

1. Draghead Modifications and Bed-Leveling Studies: The COE should supplement other efforts to develop modifications to existing dredges to reduce or eliminate take of sea turtles, and develop methods to minimize sea turtle take during "cleanup" operations when the draghead maintains only intermittent contact with the bottom. Some method to level the "peaks and valleys" created by dredging would reduce the amount of time dragheads are off the bottom. NMFS is ready to assist the COE in conducting studies to evaluate bed-leveling devices and their potential for interaction with sea turtles, and develop modifications if needed.

2. Draghead Evaluation Studies and Protocol: Additional research, development, and improved performance is needed before the V-shaped rigid deflector draghead can replace seasonal restrictions as a method of reducing sea turtle captures during hopper dredging activities. Development of a more effective deflector draghead or other entrainment-deterring device (or combination of devices, including use of acoustic deterrents) could potentially reduce the need for

sea turtle relocation or result in expansion of the winter dredging window. NMFS should be consulted regarding the development of a protocol for draghead evaluation tests. NMFS recommends that COE coordinate with ERDC, the Association of Dredge Contractors of America, and dredge operators (Manson, Bean-Stuyvesant, Great Lakes, Natco, etc.) regarding additional reasonable measures they may take to further reduce the likelihood of sea turtle takes.

3. Continuous Improvements in Monitoring and Detecting Takes: The COE should seek continuous improvements in detecting takes and should determine, through research and development, a better method for monitoring and estimating sea turtle takes by hopper dredge. Observation of overflow and inflow screening is only partially effective and provides only partial estimates of total sea turtle mortality.

4. Overflow Screening: The COE should encourage dredging companies to develop or modify existing overflow screening methods on their company's dredge vessels for maximum effectiveness of screening and monitoring. Horizontal overflow screening is preferable to vertical overflow screening because NMFS considers that horizontal overflow screening is significantly more effective at detecting evidence of protected species entrainment than vertical overflow screening.

5. Preferential Consideration for Horizontal Overflow Screening: The COE should give preferential consideration to hopper dredges with horizontal overflow screening when awarding hopper dredging contracts for areas where new materials, large amounts of debris, or clay may be encountered, or have historically been encountered. Excessive inflow screen clogging may in some instances necessitate removal of inflow screening, at which point effective overflow screening becomes more important.

6. Section 10 Research Permits, Relocation Trawling, Piggy-Back Research, and 50 CFR Part 223 Authority to Conduct Research on Salvaged, Dead Specimens: NMFS recommends that COE ERDC apply to NMFS for an ESA Section 10 research permit to conduct endangered species research on species incidentally captured during traditional relocation trawling. SERO shall assist the COE with the permit application process.

   NMFS also encourages the COE to cooperate with NMFS' scientists, other federal agencies' scientists, and university scientists holding appropriate research permits to make fuller use of turtles taken or captured by hopper dredges and relocation trawlers pursuant to the authority conferred by this opinion. NMFS encourages "piggy-back" research projects by duly-permitted or authorized individuals or their authorized designees.
   Important research can be conducted without a Section 10 permit on salvaged dead specimens. Under current federal regulations (see 50 CFR 223.206 (b): Exception for injured, dead, or stranded [threatened sea turtle] specimens), "Agents…of a Federal land or water management agency may…salvage a dead

specimen which may be useful for scientific study." Similar regulations at 50 CFR 222.310 provide "salvaging" authority for endangered sea turtles.

7. Draghead Improvements - Water Ports: NMFS recommends that the COE require or at least recommend to dredge operators that all dragheads on hopper dredges contracted by the COE for dredging projects be eventually outfitted with water ports located in the top of the dragheads to help prevent the dragheads from becoming plugged with sediments. When the dragheads become plugged with sediments, the dragheads are often raised off the bottom by the dredge operator with the suction pumps on in order to take in enough water to help clear clogs in the dragarm pipeline, which increases the likelihood that sea turtles in the vicinity of the draghead will be taken by the dredge. Water ports located in the top of the dragheads would relieve the necessity of raising the draghead off the bottom to perform such an action, and reduce the chance of incidental take of sea turtles.

   NMFS supports and recommends the implementation of proposals by ERDC and COE personnel for various draghead modifications to address scenarios where turtles may be entrained during hopper dredging (Dickerson and Clausner 2003). These include: (1) An adjustable visor; (2) water jets for flaps to prevent plugging and thus reduce the requirement to lift the draghead off the bottom; and (3) a valve arrangement (which mimics the function of a "Hoffer" valve used on cutterhead type dredges to allow additional water to be brought in when the suction line is plugging) that will provide a very large amount of water into the suction pipe thereby significantly reducing flow through the visor when the draghead is lifted off the bottom, reducing the potential to take a turtle.

8. Economic Incentives for No Turtle Takes: The COE should consider devising and implementing some method of significant economic incentives to hopper dredge operators such as financial reimbursement based on their satisfactory completion of dredging operations, or X number of cubic yards of material moved, or hours of dredging performed, without taking turtles. This may encourage dredging companies to research and develop "turtle friendly" dredging methods; more effective, deflector dragheads; pre-deflectors; top-located water ports on dragarms; etc.

9. Sodium Vapor Lights on Offshore Equipment: On offshore equipment (i.e., hopper dredges, pumpout barges) shielded low-pressure sodium vapor lights are highly recommended for lights that cannot be eliminated.

Shortnose Sturgeon

COE should support future research on the biology and life history of shortnose sturgeon throughout the Savannah River.

Recommended research includes:

1. Estimating population size and structure.

2. Identification of spawning sites and substrate.

3. Assessment of areas upstream NSBLD as spawning habitat.

4. Effects of regulated flow on spawning habitat.

5. Effects of water quality changes on shortnose sturgeon and their resting and foraging habitats.

Specific research should include:

1. A study to examine prey composition and availability in the Savannah River would improve knowledge of the distribution of preferred foraging habitat of sturgeon.

2. As the implementation of fish passage at the New Savannah Bluff Lock and Dam would trigger implementation of fish passage at the dams located upstream, it would be useful to acquire data identifying the best design for fish passage at these facilities. Accommodating passage of sturgeon at these dams would restore access to additional former spawning habitat and assist in the recovery of the species.

3. COE should support future research that evaluates the relationship between flow, water temperature, and sturgeon migration. Additional information on this relationship would provide a better indicator of conditions that cue and successfully initiate sturgeon spawning movement. COE could apply this information to determine future adequate flow rates within Savannah River and the geographic range of the species. The Nature Conservancy (TNC) has taken an active role in shortnose sturgeon research and restoration in the South. In the Savannah River, TNC is working with the COE to identify effects of water release on sturgeon spawning habitat; shortnose sturgeon implanted with ultrasonic transmitters are being tracked to assess impacts of flow and identify spawning areas. The COE should continue to support and encourage more of this type of research.

4. COE should develop and coordinate a basin-wide research plan to obtain better results in understanding sturgeon population dynamics and movement. A basin-

wide flow regimen should be developed to ensure adequate water quality for the sturgeon during drought, and a conservative approach to storing excess water for later use.

11 REINITIATION OF CONSULTATION

This concludes formal consultation on the proposed deepening of the Savannah Harbor federal navigational channel. As provided in 50 CFR 402.16, reinitiation of formal consultation is required where discretionary federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) The amount or extent of taking specified in the incidental take statement is exceeded; (2) new information reveals effects of the action may affect listed species or critical habitat in a manner or to an extent not previously considered; (3) the identified action is subsequently modified in a manner that causes an effect to listed species or critical habitat that was not considered in the biological opinion; or (4) a new species is listed or critical habitat designated that may be affected by the identified action. In instances where the amount or extent of take is exceeded, COE must immediately request reinitiation of formal consultation.

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APPENDIX A

Summary of annual incidental take levels anticipated under the incidental take statements associated with NMFS' existing biological opinions in the action area. Note that while these activities overlap the action area, the takes include the entire range of the activity which often far exceeds the geographical scope of the action area.

Federal Action	**Sea Turtle Species (numbers represents lethal takes unless otherwise noted)**				
	Loggerhead	**Leatherback**	**Green**	**Kemp's Ridley**	**Hawksbill**
Coast Guard Vessel Operation	1 (combined)				
Navy – SE Ops Area[1]	91	17	16	16	4
COE Dredging – S. Atlantic	35	0	7	7	2
Dolphin/Wahoo Fishery	16 (No more than 2 lethal)	16 (No more than 1 lethal)	2 (No more than 1 lethal)	2 (No more than 1 lethal)	2 (No more than 1 lethal)
Monkfish Fishery	6 (No more than 3 lethal)	1	1	1	0
Summer Flounder, Scup, and Black Sea Bass Fishery	15 (No more than 5 lethal)	3	3	3	3
Shrimp Fishery[2]	163,160 (No more than 3,948 lethal)	3,090 (No more than 80 lethal)	155,503 (No more than 4,208 lethal)	18,757 (No more than 514 Lethal)	640[3] (All lethal)
Weakfish Fishery	20	0	0	2	0
Atlantic HMS-Shark Fisheries (**Note: this is 3-year take, not annual**)	679 (No more than 346 lethal)	74 (No more than 47 lethal)	2 (No more than 1 lethal)	2 (No more than 1 lethal)	2 (No more than 1 lethal)
Coastal Migratory Pelagic	33 (No more than 33 lethal)	2 (No more than 2 lethal)	4 (No more than 4 lethal)	14 (No more than 14 lethal)	2 (No more than 2 lethal)

[1]Total estimated take includes acoustic harassment
[2]Represents estimated take (interactions between sea turtles and trawls). Lethal take in parentheses.
[3]Actual mortalities of hawksbills, as a result of sea turtle/trawl interactions, is expected to be much lower than this number. This number represents the estimated total number of mortalities of hawksbill sea turtles from all sources in areas where shrimp fishing takes place.

APPENDIX B

Sea Turtle Resuscitation Guidelines

If a turtle appears to be unconscious or comatose, attempt to revive it before release. Turtles can withstand lengthy periods without breathing; a living comatose sea turtle may not move, breathe voluntarily, or show reflex responses or other signs of life. In other cases, a lightly comatose turtle may show shallow breathing or reflexes such as eyelid or tail movement when touched. Use the following method of resuscitation in the field if veterinary attention is not immediately available:

- **Place the turtle on its plastron (lower shell) and elevate the hindquarters approximately 15 - 30 degrees to permit the lungs to drain off water for a period of 4 up to 24 hours. A board, tire or boat cushion, etc. can be used for elevation.**

- **Periodically, rock the turtle gently left to right and right to left by holding the outer edge of the carapace and lifting one side about 3 inches, then alternate to the other side.**

- **Keep the turtle in the shade, at a temperature similar to water temperature at capture. Keep the skin (especially the eyes) moist while the turtle is on deck by covering the animal's body with a wet towel, periodically spraying it with water, or by applying petroleum jelly to its skin and carapace. Do not put the turtle into a container with water.**

- **Do not put the turtle on its carapace (top shell) and pump the plastron (breastplate) or try to compress the turtle to force water out, as this is dangerous to the turtle and may do more harm than good.**

- **Periodically, gently touch the corner of the eye or eyelid and pinch the tail near the vent (reflex tests) to monitor consciousness.**

- **Sea turtles may take some time to revive; do not give up too quickly. Turtles that are successfully resuscitated benefit from being held on deck as long as possible (up to 24 hours) to fully recover from the stress of accidental forced submergence.**

- **Release successfully resuscitated turtles over the stern of the boat, when fishing or scientific collection gear is not in use, the engine is in neutral, and in areas where they are unlikely to be recaptured or injured by vessels. A turtle that has shown no sign of life after 24 hours on deck may be considered dead and returned to the water in the same manner.**

NMFS/SEFSC Photos

References:

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July 2009

APPENDIX C

Protocol for tissue sampling for genetic analysis.

Tissue samples should be a small (1.0cm2) fin-clip collected from soft pelvic fin tissue using a pair of sharp scissors. Tissue samples should be preserved in individually labeled vials containing either alcohol (70 to 100%) or SDS-UREA.

Data to accompany tissue sample should include species, important morphological Information (TL, SL, weight, sex if known), date, and capture location. Record condition of fish upon release. Keep tissue sample out of direct sun, refrigeration not necessary.

Send samples and supporting data within one month to:

Julie Carter
NOAA/NOS
219 Ft. Johnson Road
Charleston, SC 29412
PH: (843)762-8547

APPENDIX D

SEA TURTLE AND SMALLTOOTH SAWFISH CONSTRUCTION CONDITIONS

The permittee shall comply with the following protected species construction conditions:

a. The permittee shall instruct all personnel associated with the project of the potential presence of these species and the need to avoid collisions with sea turtles and smalltooth sawfish. All construction personnel are responsible for observing water-related activities for the presence of these species.

b. The permittee shall advise all construction personnel that there are civil and criminal penalties for harming, harassing, or killing sea turtles or smalltooth sawfish, which are protected under the Endangered Species Act of 1973.

c. Siltation barriers shall be made of material in which a sea turtle or smalltooth sawfish cannot become entangled, be properly secured, and be regularly monitored to avoid protected species entrapment. Barriers may not block sea turtle or smalltooth sawfish entry to or exit from designated critical habitat without prior agreement from the National Marine Fisheries Service's Protected Resources Division, St. Petersburg, Florida.

d. All vessels associated with the construction project shall operate at "no wake/idle" speeds at all times while in the construction area and while in water depths where the draft of the vessel provides less than a four-foot clearance from the bottom. All vessels will preferentially follow deep-water routes (e.g., marked channels) whenever possible.

e. If a sea turtle or smalltooth sawfish is seen within 100 yards of the active daily construction/dredging operation or vessel movement, all appropriate precautions shall be implemented to ensure its protection. These precautions shall include cessation of operation of any moving equipment closer than 50 feet of a sea turtle or smalltooth sawfish. Operation of any mechanical construction equipment shall cease immediately if a sea turtle or smalltooth sawfish is seen within a 50-ft radius of the equipment. Activities may not resume until the protected species has departed the project area of its own volition.

f. Any collision with and/or injury to a sea turtle or smalltooth sawfish shall be reported immediately to the National Marine Fisheries Service's Protected Resources Division (727-824-5312) and the local authorized sea turtle stranding/rescue organization.

g. Any special construction conditions, required of your specific project, outside these general conditions, if applicable, will be addressed in the primary consultation.

Revised: March 23, 2006

APPENDIX E

South Atlantic Division Corps of Engineers
Hopper Dredging Protocol for Atlantic Coast
FY 98 - FY 03

1. Sea turtle deflecting dragheads will be used at all times.

2. Districts will inspect sea turtle deflecting dragheads systems to ensure that they are fully operational, prior to initiation of work.

3. Districts will ensure that draghead operators know how to properly use the sea turtle deflecting system.

4. Maintenance dredging at Savannah, Brunswick and Kings Bay Harbors must be restricted to 15 December through the end of March. Maintenance dredging at Charleston and Wilmington Harbors must be restricted to 1 December through the end of March where the sea turtle deflecting draghead system can not be used effectively. Dredging may begin as soon as mid-November in those portions of the Wilmington and Charleston Harbor channels where the sea turtle deflecting draghead can be used effectively. All Districts will cooperate to ensure that their scheduling of hopper dredging contracts, does not interfere with this Division priority work area.

5. Sea turtle observers, inflow screens and overflow screens will be used during all dredging operations, except for the months of January and February, which are optional. Variations from this provision may be granted by Division, but must be justified from a technical perspective.

6. All sea turtle takes will be reported promptly to SAD-ET-CO/PD and posted at usace.sad.turtle newsgroup on the Internet.

7. If two sea turtle takes occur within 24 hours, you should immediately notify the Division POC so that he can initiate reconsultation with National Marine Fisheries Service.

8. If a third take occurs on the project the district will cease operations and notify the South Atlantic Division. Continuation of dredging will occur only after cleared by Division. Upon taking three turtles, District will develop a risk assessment along with an appropriate risk management plan, and submit that to Division for assessment. Generally relative abundance and relocation trawling would be an integral part of a risk assessment and management plan. Should a total take of 5 sea turtles occur, for whatever reason, all work will be terminated unless other prior agreements had been reached with Division.