ENVIRONMENTAL IMPACT STATEMENT
APPENDIX E: US Fish and Wildlife Service Final Fish and Wildlife Coordination Act Report

SAVANNAH HARBOR EXPANSION PROJECT

Chatham County, Georgia and Jasper County, South Carolina

January 2012

US Army Corps of Engineers
Savannah District
South Atlantic Division

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United States Department of the Interior
Fish and Wildlife Service
105 West Park Drive, Suite D
Athens, Georgia 30606

West Georgia Sub-Office
Post Office Box 52560
Fort Benning, Georgia 31995-2560

Coastal Georgia Sub Office
4980 Wildlife Drive, NE
Townsend, Georgia 31331

March 7, 2011

Colonel Jeffrey M. Hall
U.S. Army Corps of Engineers
Savannah District
100 West Oglethorpe Avenue
Savannah, Georgia 31401-3640
Attention: Mr. William G. Bailey, Chief, Planning Division

Dear Colonel Hall:

Enclosed you will find the Final Fish and Wildlife Coordination Act (FWCA) Report on the Savannah Harbor Expansion Project, in Chatham County, Georgia and Jasper County, South Carolina. This FWCA Report evaluates existing and future fish and wildlife resources within the Savannah Harbor area, provides the U.S. Fish and Wildlife Service (USFWS) analysis of project impacts and mitigation plans and provides the USFWS position and mitigation recommendations. The Endangered Species Act consultation is ongoing, awaiting information from the Savannah District U.S. Army Corps of Engineers (Corps). Based on the information currently available, this is the final detailed USFWS 2(b) report on the Savannah Harbor Expansion Project. However, because the Corps has not identified a recommended plan, we may provide additional 2(b) comments and recommendations after the recommended plan is identified. If you have any questions or need additional information please contact our Coastal Georgia Sub Office biologist, Bill Wikoff, at (912) 832-8739 extension 5.

Sincerely,

Sandra S. Tucker

Sandra S. Tucker
Field Supervisor

cc: Robert D. Perry, Director, Office of Environmental Programs,
South Carolina Department of Natural Resources
Dan Forster, Director, Wildlife Resources Division,
Georgia Department of Natural Resources
Pace Wilber, Ph.D., Atlantic Branch Chief, Charleston, Southeast Regional Office,
NOAA Fisheries
Jack Arnold, Deputy Assistant Regional Director - Ecological Services, USFWS
USFWS, Townsend, Georgia

FISH AND WILDLIFE COORDINATION ACT REPORT
on the
SAVANNAH HARBOR EXPANSION PROJECT

Prepared by:
Edwin EuDaly
Palmetto Ecological Consulting

Under the Supervision of
Sandra Tucker, Field Supervisor
Division of Ecological Services
Athens, Georgia

March 2011

U.S. Fish and Wildlife Service
Southeast Region
Atlanta, Georgia

EXECUTIVE SUMMARY

Savannah National Wildlife Refuge (NWR) and the surrounding estuary support nationally important fish and wildlife resources. However, cumulative impacts of previous harbor modifications, primarily salinity intrusion, have severely impacted the resources that were present when the refuge was established. A freshwater supply system for managed wetlands, installed as mitigation for previous harbor deepening and a sediment control tide gate, has failed to function adequately. Tidal freshwater marsh has been reduced from about 12,000 acres historically to about 3,300 acres currently. Striped bass reproduction and recruitment were almost eliminated during tide gate operation but have recently begun to recover. Shortnose sturgeon habitat has been greatly impacted both by salinity increase and dissolved oxygen decrease.

The current inner harbor is 42 feet in depth. Impacts of project inner harbor depths of 44, 45, 46, 47 and 48 feet were evaluated using hydrodynamic and biological models. A number of mitigation measures have been proposed by the Corps. Most of these measures are based on channel and flow modifications in the estuary. In addition, a dissolved oxygen injection system, wetland acquisition, wetland restoration, striped bass stocking and a fish bypass channel at New Savannah Bluff have been proposed.

Impacts were assessed by comparing predicted with-project conditions immediately after construction to base year (current) conditions instead of comparing project-life average annual conditions to the base year. Impacts determined on an average annual basis would be less than those based on conditions immediately after construction because predicted sea level rise would impact the tidal freshwater wetlands and other habitat even without any harbor deepening. Without the cumulative impact of harbor deepening, it is unlikely that Savannah NWR would currently be impacted by salinity or would be substantially impacted by sea level rise during the project life, even with an expected increase in the rate of rise due to climate change. Therefore, it is appropriate to determine impact and formulate mitigation by comparing predicted with-project conditions immediately after construction to base year conditions.

The Corps proposes to reassess sea level rise effects in the future and assign "advance mitigation" credits to the project for use with future actions if the rate of sea level rise exceeds the historic rate. Sea level rise would have a negligible impact in the upper estuary if not for the cumulative impacts of previous harbor deepening. The rate of sea level rise is uncertain and substantial impacts resulting from sea level rise are not likely until well into the future. Conversely, the impacts of further harbor deepening will begin within a few years of project construction. In addition, due to the complexity of the system and limitations of the models, the models may underestimate wetland impacts. "Advance mitigation" is the functional equivalent of a mitigation bank, and U.S. Fish and Wildlife Service (USFWS) Mitigation Policy (64 FR 49229-49234) does not allow the use of NWR lands for mitigation banks. Therefore, the USFWS does not support the concept of advance mitigation based on a future evaluation of the relative impacts of sea level rise.

There is a great deal of risk and uncertainty regarding impacts and the channel and flow modification and dissolved oxygen mitigation plans. The mitigation plans are unlikely to perform exactly as predicted. There could be unintended adverse consequences resulting from the channel and flow mitigation measures. All of the proposed mitigation alternatives include flow diversion as a basic and highly important component. The predicted reduction of salinity in the Middle River and Back River is due in large part to the proposed flow diversion from Front River. The Environmental Fluid Dynamics Code model uncertainty in this geographic area is of concern, particularly because most of the remaining freshwater tidal marsh and the entrance to the diversion canal are located there. Diversion of fresh water into the Back River allows salinity to move further up the Front River and into the Middle River. As a result, in the Front River and lower Middle River mean and maximum salinity would be higher with the mitigation plan than without it. The model may under predict the amount of salinity moving up Front and Middle River.

The 44- and 45-foot plans (with mitigation) avoid or minimize impacts to tidal freshwater marsh and the freshwater supply system. The 45-foot depth minimizes impacts to striped bass habitat and the 44-foot depth minimizes impacts to shortnose sturgeon. Based on the information obtained for the specific purpose of evaluating this project, it is clear that the 44- and 45-foot alternatives would have much lower impacts on fish and wildlife resources. Impacts of the project increase substantially at the 46-, 47- and 48-foot depths.

The USFWS's preferred alternative for deepening Savannah Harbor is the 45-foot alternative because it minimizes impacts to Savannah NWR, tidal freshwater marsh and fish habitat. The Corps has proposed implementing either the national economic development plan (NED) (47-foot alternative) or the locally preferred plan (LPP) (48-foot alternative). Any additional economic benefits resulting from the LPP relative to the NED plan would represent local benefits. By contrast, the additional environmental impacts associated with the LPP, and in particular the loss of an additional 114 acres of already scarce and declining freshwater tidal wetlands, would occur on a national resource, the Savannah NWR. The additional 114 acres of impact to freshwater tidal wetlands associated with the LPP represents a 50% increase in impacts over the NED plan's depth. For this reason, the USFWS does not support the LPP.

For any project implemented, the USFWS supports a comprehensive monitoring program to document actual impacts and an adaptive management plan to rectify unanticipated impacts. This report makes a number of recommendations to improve both monitoring and adaptive management. As currently proposed, Corps funding for adaptive management activities that may be required will be dependent upon the Corps' annual appropriations process. Because these adaptive management actions may be essential to correct mitigation deficiencies and insure that impacts to fish and wildlife trust resources are offset, contingency funding for any required adaptive management activities needs to be assured, and not dependent upon annual appropriations.

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INTRODUCTION

Authority

A resolution adopted by the Senate Public Works Committee on July 10, 1972, authorized the Tier 1 Savannah Harbor deepening study which the Savannah District Corps of Engineers (Corps) initiated in 1995. After the Corps completed the Reconnaissance Report in 1996, the Georgia Ports Authority (GPA) funded feasibility studies under Section 203 of Water Resources Development Act (WRDA) of 1986. The 1999 WRDA included conditional authorization of the Savannah Harbor Project, which would deepen the harbor by up to six feet. Department of Interior, Department of Commerce and Environmental Protection Agency (EPA) concurrence is required before project implementation. The Savannah Harbor Expansion Study was initiated in 1999 to complete detailed impact evaluation, mitigation plan development and economics evaluation. The Fish and Wildlife Coordination Act (48 Stat. 40l, as amended; 16 U.S.C. 661 et seq.) (FWCA) authorized the U.S. Fish and Wildlife Service's (USFWS) involvement in this study. The USFWS participated in planning throughout the study and prepared this report with funds transferred from the Corps under the National Letter of Agreement between our agencies for funding of FWCA activities.

Purpose and scope

The purpose of the Tier One GPA/Corps study was to determine whether deepening of Savannah Harbor was needed to serve navigation interests. The purpose of the Tier Two study is to complete detailed impact evaluation, mitigation plan development and economics evaluation. This FWCA Report evaluates existing and future fish and wildlife resources within the Savannah Harbor area, provides the USFWS analysis of project impacts and mitigation plans and provides the USFWS position and mitigation recommendations. Based on the information currently available, this is the final detailed USFWS 2(b) report on the Savannah Harbor Expansion Project. However, because the Corps has not identified a recommended plan, we may provide additional 2(b) comments and recommendations after the recommended plan is identified.

Prior studies and reports

The Corps and other agencies have produced numerous reports dealing with Savannah Harbor. The following discussion focuses on prior USFWS reports most relevant to the current project and a few of the more relevant Corps studies. The Corps released the Stage I Report for the Savannah Harbor Comprehensive Study (SHCS) in April 1981 and a Preformulation Report in January 1983. In September 1987, the Corps released a Draft Feasibility Report and Draft Environmental Impact Statement (DEIS) on the project. These reports proposed a two-foot deepening project for the Harbor. Completion of the study was subsequently postponed because of two general areas of concern. First, the Corps' hydrodynamic model, designed to predict salinity impacts of harbor deepening, was not adequately verified and could not be used with any confidence. Second, impacts of the tide gate on Savannah National Wildlife Refuge (Savannah NWR) were greater than predicted and needed to be addressed prior to further harbor modifications. To address these concerns, the Corps initiated a Savannah Harbor Environmental Study in early 1988.

The Corps released a revised SHCS Draft Feasibility Report and Environmental Impact Statement in April 1991. This report recommended a four-foot deepening of Savannah Harbor upstream to the Kings Island Turning Basin.

The USFWS provided SHCS Planning Aid letters to the Corps dated March 21, 1981; July 23, 1981; and September 18, 1981, expressing concerns related to dredged material disposal, Savannah NWR, harbor deepening, and harbor extension. The USFWS submitted a SHCS Planning Aid Report (PAR) on September 16, 1982, which provided: (1) an analysis of wetland resources in the study area; (2) an evaluation of the impacts of tide gate operation on Savannah NWR and striped bass habitat; and (3) a habitat evaluation procedures study of potential spoil areas. On December 1, 1983, the USFWS completed a second SHCS PAR which provided: (1) an evaluation of fish and wildlife resources on two new potential dredged material disposal areas; (2) resource categories and general mitigation goals and measures for all potential spoil areas; and (3) further analysis of freshwater supply problems on Savannah NWR.

The USFWS provided a reconnaissance level PAR on September 27, 1984, which analyzed impacts of harbor extension on fish, wildlife, and wetlands of Savannah NWR and adjacent areas. The PAR also identified information and studies needed to adequately assess impacts of harbor extension. In November 1986, the USFWS provided a Draft FWCA Report on the SHCS. This report evaluated existing and future fish and wildlife resources in the study area and identified problems, opportunities, and planning objectives for these resources. In addition, using information available at that time, the report evaluated fish and wildlife impacts of tide gate operation and harbor deepening. The report also questioned the reliability of the Corps' hydrodynamic model and recommended adequate verification before using the model for evaluation of harbor deepening.

In 1986, USFWS-funded studies were initiated to determine impacts of Savannah Harbor modifications, particularly the tide gate and New Cut, on Savannah NWR, and several reports on these studies were produced. In 1989, a report characterizing the hydrology of the lower Savannah River and impact of the tide gate on salinity levels was released (Pearlstine et al. 1989). In 1990 a report on effects of salinity on striped bass eggs and larvae was released (Winger and Lasier 1990) and a report on fishery resources, primarily striped bass, was published (Van Den Avyle et al. 1990). A report on the impacts of the tide gate on tidal freshwater marsh and development of a habitat successional model for the marsh was also published in 1990 (Pearlstine et al. 1990).

The USFWS provided a revised SHCS Draft FWCA Report in November 1990. This report concluded that deepening of Savannah Harbor in conjunction with continued operation of the tide gate project would exacerbate currently unacceptable fish and wildlife impacts. The USFWS opposed channel deepening until such time as the impacts of the tide gate project were completely offset and strongly recommended that the Corps remove the tide gate and fill New Cut. The USFWS provided a FWCA Report on Savannah Harbor - Closure of New Cut in June 1991. The USFWS supported the plan to close New Cut and take the tide gate out of operation.

The USFWS provided a Reconnaissance PAR on Port Wentworth Deepening Project in December 1993. The purpose of the Corps' study was to evaluate deepening of Savannah Harbor in the vicinity of Port Wentworth from Station 102 + 000 to Station 112 + 500.

In August 1996 the USFWS provided a Reconnaissance PAR on Savannah Harbor Expansion. The USFWS recommended that a reliable Savannah Harbor hydrodynamic model be developed to estimate impacts of the alternative plans on river system salinity patterns. The USFWS expressed concern that the project could increase salinity levels in the lower Savannah River system. An increased salinity level would adversely impact managed wetlands, tidal freshwater wetlands, and striped bass habitat on and near Savannah NWR. The USFWS also expressed concern that moderate incremental increases in the salinity level may become cumulatively significant if depth of the harbor is repetitively increased over time.

In June 1998 the USFWS provided a Planning Aid Letter on the proposed expansion project. Because of the lack of needed impact analysis model runs, the lack of an acceptable mitigation plan, and numerous concerns on potential impacts, we could not provide a FWCA report at that time. In July 1998 the Department of Interior provided comments on the Tier 1 DEIS for Savannah Harbor Expansion. The comments discussed a number of issues related to inadequate impact analysis, potential significant impacts on Savannah NWR and the lack of an adequate mitigation plan. In October 1998, the Department of Interior provided comments on the Chief of Engineers proposed report and Final Environmental Impact Statement. These comments reiterated the view that the documents were inadequate regarding impact analysis and proposed mitigation measures.

In June 2008, the USFWS provided a Plan Formulation PAR on the Savannah Harbor Expansion project. In November 2008, the USFWS provided a Draft FWCA Report on the Savannah Harbor Expansion project. Based on information available at that time, the 2008 report discussed existing fish and wildlife resources and evaluated project impacts. In addition the report evaluated the proposed mitigation options and provided USFWS recommendations to mitigate the predicted impacts.

DESCRIPTION OF THE STUDY AREA

The study area includes the Savannah Harbor and the surrounding land in Chatham County, Georgia, and Jasper County, South Carolina. The study area lies in the Coastal Plain Marine

Flatwoods region. The land surface is nearly level with broad depressions associated with drainage ways or wetlands. Elevation ranges from sea level to approximately 40 feet above sea level. Soils in the study area generally have a sandy surface layer, a high water table, and are underlain by marine sands, loams, and/or clays.

Rare natural upland forests in the study area are dominated by longleaf and slash pine. Most uplands have been converted to loblolly pine plantations or developed for residential or commercial purposes. Maritime forests, dominated by live oak with water oak and southern magnolia as associates, are found on less disturbed barrier islands and other uplands near the coastline. Estuarine emergent wetlands (salt marsh), estuarine sub-tidal wetlands, palustrine emergent wetlands (fresh marsh), palustrine forested wetlands (swamp) and riverine wetlands (freshwater rivers and creeks) are significant components of the study area.

Water flow in the Savannah River varies considerably both seasonally and annually. Discharge is typically high in winter and early spring and low in summer and fall, but regulation by upstream reservoirs has reduced natural flow variations. Average discharge (75 years) at the United States Geological Survey (USGS) Clyo gauge (Effingham County, Georgia) was 11,720 cubic feet per second (cfs) and the average for water year 2005 was 13,300 cfs with a range (daily mean) of 5,490 cfs to 30,300 cfs (Cooney et al. 2005). Tidal effects extend upstream to approximately river mile 45.

The existing authorized harbor navigation project provides for a channel 44 feet deep and 600 feet wide across the ocean bar; 42 feet deep and 500 to 600 feet wide to the vicinity of Kings Island Turning Basin; and 30 feet deep and 200 feet wide to a point l,500 feet below the Houlihan Bridge (GA Highway 25). The terminus of the existing channel for Savannah Harbor is at approximately river mile 21. The project provides turning basins for vessels at various locations in the harbor (Figure 1).

From 1977 until 1992, the project also included sediment control works consisting of a tide gate structure across Back River; a sediment basin, 40 feet deep, 600 feet wide, and about 2 miles long, with an entrance channel, 38 to 40 feet deep and 300 feet wide; a drainage canal ("New Cut") across Argyle Island, 15 feet deep and 300 feet wide; control works and a diversion canal on Little Back River. The diversion canal, a mitigation feature to supply fresh water to the Savannah NWR and adjacent private lands, was designed to replace the traditional supply, from various points on Back River that had been used for agriculture and wetland management for hundreds of years. The tide gate, essentially a series of large flap gates, opened during flood (incoming) tides and closed at high water. Therefore, ebb tidal water was forced to flow out through New Cut into Front River, increasing water velocities in the developed harbor and reducing sedimentation in the Front River. In addition, much of the sediment in the harbor was deposited in the sediment basin which is adjacent to dredged material disposal areas.

Because of unacceptable environmental impacts, the tide gate was permanently removed from operation and New Cut was closed with a sand and riprap structure in 1992. The tide gate structure is still in place but the flap gates have been removed to allow water passage at all tides.

The sediment basin is dredged periodically and it continues to trap a large quantity of sediment but less than the amount trapped when the tide gate was in operation.

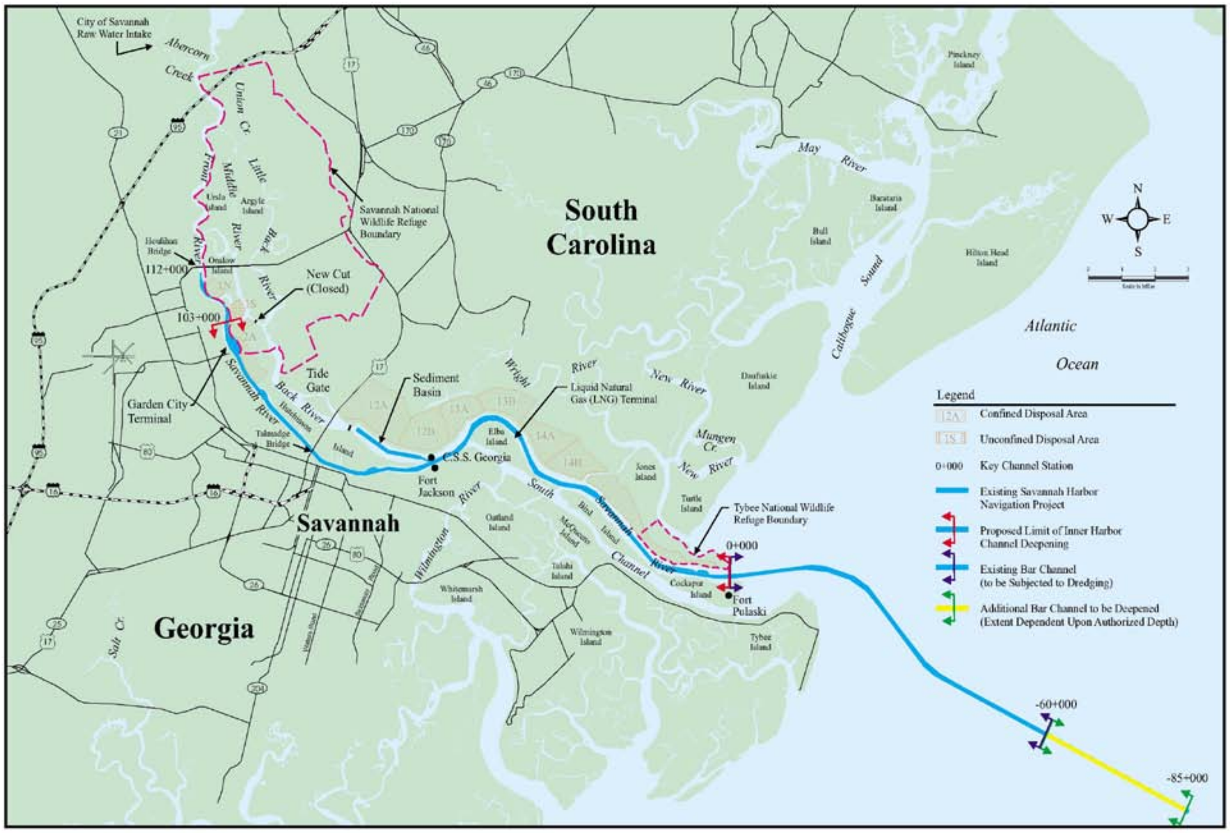

Figure 1. Existing and proposed Savannah Harbor navigation project, Georgia and South Carolina. Boundary of Savannah National Wildlife Refuge extends upstream and downstream further than shown on map. The bar channel would be extended to -98 + 600 (48-foot alternative).

Maintenance dredging in the harbor averages about 7.04 million cubic yards per year. Most of the material is placed in confined dredged material disposal areas (CDF's) north and east of the sediment basin in the Barnwell Island area of South Carolina. These disposal areas (12A, 12B, 13A, 13B, 14A, 14B) cover about 4,800 acres. Other disposal areas are located on Onslow Island (130 acres), Argyle/Hutchinson Island (185 acres), and Jones/Oysterbed Island (754 acres). All of these disposal areas were predominantly emergent wetlands (marsh) prior to being diked in the late 1950's. The material dredged to keep the bar channel at project depth is deposited in the EPA approved interim ocean disposal area, a 4.26 square mile area centered at 31^{o}56'54"N, 80^{o}45'34"W.

On March 12, 2007, Governor Sanford (South Carolina) and Governor Perdue (Georgia) signed an agreement (Term Sheet) to form a Bi-State Compact and jointly develop a new marine terminal in Jasper County, South Carolina at about Savannah River mile seven. The conceptual plan calls for a new 1,800-acre marine terminal to be located on Barnwell Island (disposal area

14A/B). The site is currently under a Corps dredged material disposal easement. Most of the existing container terminals are in Port Wentworth, Georgia between river miles 16 and 19. The Term Sheet directs Georgia Department of Transportation to transfer the land to the Bi-State Authority and requests that the Corps modify or release the disposal easements. The site currently has no infrastructure and a new rail and highway spur to the site would be required for terminal development. The proposed site is adjacent to the existing dredged channel so new channel dredging for a new terminal would be minimal.

FISH AND WILDLIFE RESOURCES

Savannah National Wildlife Refuge lies adjacent to, and upstream of, the Savannah Harbor project. Savannah NWR consists of 29,175 acres of palustrine forested wetlands, palustrine and estuarine emergent wetlands, palustrine scrub-shrub wetlands, riverine wetlands, diked waterfowl impoundments (managed wetlands) and uplands (Figure 2). About 3,000 acres of the Refuge lands are actively managed wetlands which provide excellent habitat for wintering waterfowl, shorebirds, wading birds, and wood ducks. Up to an additional 2,700 acres has some potential for water level control and may be actively managed in the future. The Refuge encompasses much of the high value fish and wildlife habitat that has been or is likely to be impacted by harbor development.

Tybee National Wildlife Refuge is located in Chatham County, Georgia, near the mouth of the Savannah River, adjacent to the navigation channel. The 400-acre migratory bird Refuge began as a one-acre oyster shoal. The Corps, while engaged in harbor deepening and maintenance, used the shoal as a dredged material disposal site and created Oyster Bed Island (the nucleus of the present Refuge).

Wassaw National Wildlife Refuge is located in Chatham County, Georgia about 13 miles south on the Savannah Harbor entrance channel. This 10,053-acre island consists of marine wetlands (ocean beach), maritime forest and estuarine wetlands. Loggerhead turtles (threatened) use the ocean beach for nesting and piping plovers (threatened) use the beach habitat for winter foraging and cover (John Robinette, USFWS, personal communication 2008).

Managed Wetlands

The managed wetlands were diked for purposes of rice culture, during the 18th and l9th centuries. Many of these areas remain impounded and are managed as migration and wintering habitat for waterfowl and other wetland-dependent migratory birds. Prescribed burning and water level control are two management tools used to promote desirable wetland plants of value to migratory birds. Moist soil management, which is used in most of the management units on Savannah NWR, produces the most productive waterfowl habitat. Fresh water is provided to the managed wetlands through the diversion canal on Little Back River. On Savannah NWR these managed wetlands provide the most heavily used habitat for wintering waterfowl and other migratory birds. From 1990-2002, Savannah NWR supported an average of 23% of the South Carolina waterfowl observed in the mid-winter waterfowl counts (Berryman and Webb 2003).

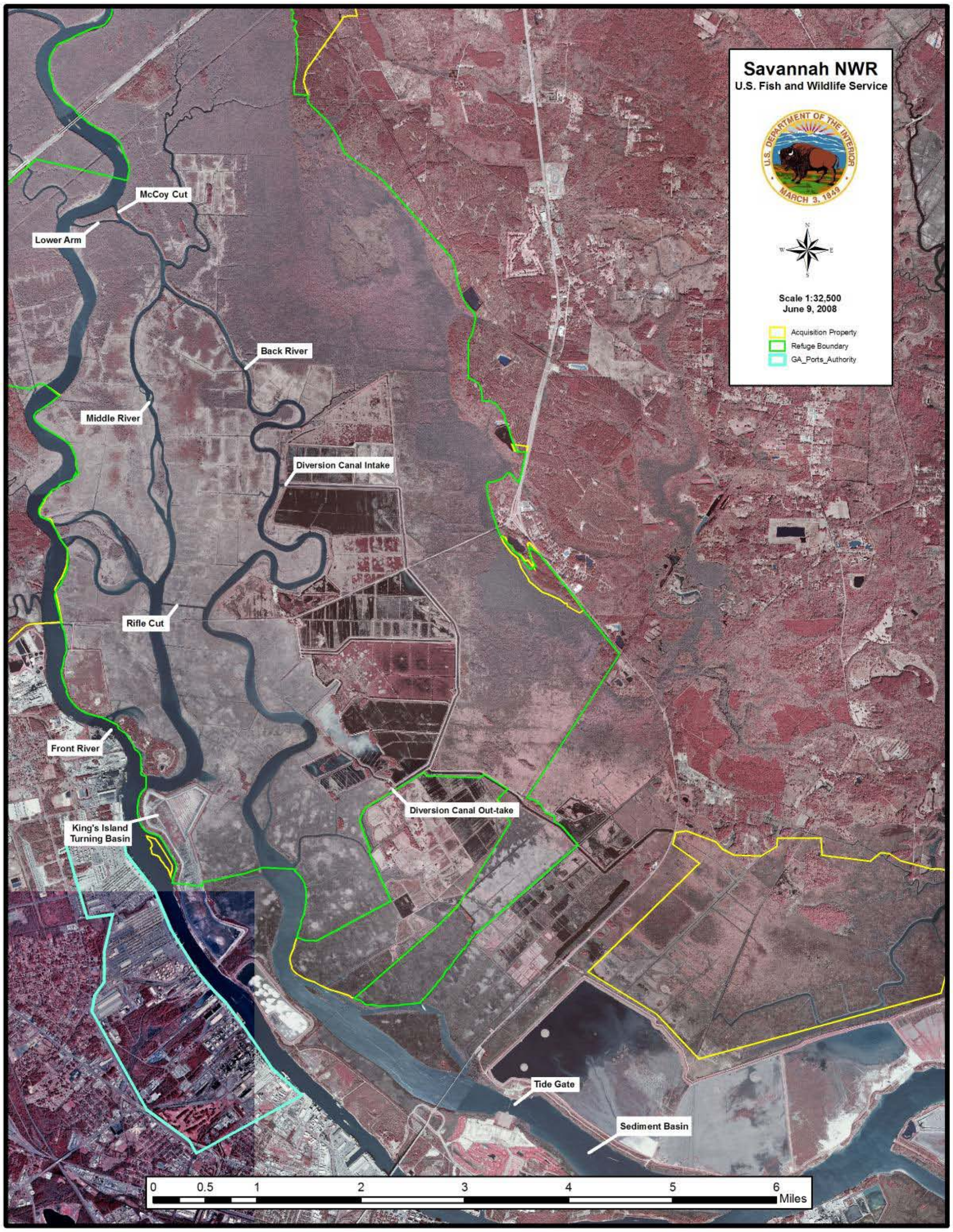

Figure 2. Savannah National Wildlife Refuge and prominent features of Savannah Harbor, May 2008. Refuge extends north along the Savannah River about 15 river miles beyond the extent of this map.

Freshwater management, with salinity less than 0.5 parts per thousand (ppt), is necessary to maintain maximum waterfowl use of the Refuge's managed wetlands. According to Tiner (1977), freshwater coastal impoundments in South Carolina produce a greater variety of marsh plants, many of which are desirable duck food, than brackish impoundments. Landers et al. (1976) in a study of South Carolina coastal impoundments found that: "Fifty-five percent of the area impounded in the general study area was freshwater marsh and 62 percent of the ducks were from freshwater impoundments. Ducks, except wigeons, gadwalls and scaups (*Anas americana*, *Aythya marila, A. affinis*) took foods that grew mostly in freshwater marsh in greater volume (about 87%) than foods from brackish and saline areas." They also found that: "Forty-five percent of the total impounded area was brackish marsh and 38 percent of the ducks were from brackish impoundments. Yet plants characteristically growing in brackish marsh composed only about 13 percent of food volumes." These studies indicate that freshwater management will produce a greater variety and quantity of desirable waterfowl food plants than brackish water management. Therefore, it is essential that the Refuge retain freshwater management to provide maximum benefits to the waterfowl resource.

Freshwater managed wetlands on Savannah NWR currently provide high quality feeding habitat for many species of wading birds, including the endangered wood stork. Several areas are managed each year specifically to provide optimum feeding opportunities for wading birds during and after the nesting season. Studies have revealed that wood storks, and many other wading bird species, select freshwater feeding sites (when available) over brackish or salt water sites. Gaines et al. (1998) found coastal nesting wood storks typically flew significantly longer distances to forage in palustrine habitats than in estuarine habitats and feeding site preference of storks from a colony on St. Simons Island was clearly skewed in favor of palustrine habitat over estuarine habitat despite lower overall availability of palustrine habitat. In addition, some species, such as white ibis (*Eudocimuns albus*), may require a fresh water food source for successful chick rearing (Johnston and Bildstein 1990). When nestling white ibis diets contain fiddler crabs (containing high salt content) nestlings experience depressed growth and increased mortality (De Santo 1992). De Santo et al. (1997) found that parental white ibis, in coastal South Carolina, concentrate their foraging efforts in freshwater swamps and impoundments at a considerable distance from the breeding colony site, despite the fact that it was more costly energetically and a greater travel time to these sites as compared to nearby salt marsh feeding sites. Freshwater impoundments are also managed to provide nesting and feeding habitat for shorebirds, and high quality feeding habitat for neotropical migrants such as the swallow-tailed kite.

Construction of the freshwater diversion canal, which provides fresh water to the Refuge and adjacent plantations, was completed as mitigation for the tide gate and harbor deepening in 1977. However, due to salinity levels much greater than predicted, the metal water control structures rusted and failed soon after construction was completed. The USFWS retrofitted the existing structures with stainless steel channels and solid stop-log structures, stainless bolts and flap-gates. This repair was the most effective and cost efficient for the USFWS to undertake at the time. The patch allowed the USFWS to provide for water needs of the Refuge and adjacent land owners for the next 27 years, but the system has never functioned as designed. The Refuge-funded repair of the structures made the act of filling or draining the canal labor intensive and expensive. Compared to the original design, which required one person and minimal time to fill or drain, it now requires three persons, heavy equipment (for lifting the solid gates) and a full day to adjust the water within the canal. In addition, the structures are systematically failing due to the channels shearing off the structure walls. There are two structures controlling the water delivery system. Currently, the south water control structure cannot be operated; all four of the 48-inch openings have failed. The north structure originally had nine pipes but two of these were permanently closed in the past leaving seven openings. The remaining seven pipes are failing. Many of the interior water control structures which supply water to the individual management units are also failing.

If the USFWS loses the ability to control water levels, within the impoundment system, the Refuge would be subject to the ebb and flow of the tides. This would result in severe damage to Refuge infrastructure; i.e., roads, dikes and internal water control structures. Severe damage to Refuge roads and dikes would result in the loss of most public use, including hiking, birding and wildlife viewing. The USFWS would lose the ability to supply fresh water for wildlife habitat management to the adjacent Fife and Clydesdale plantations. The USFWS could not fulfill the congressional mandate that the Refuge was established under - to provide for the needs of the Nation's migratory bird resources. Migratory birds that utilize the Refuge for nesting, feeding, roosting and protection would be forced to find suitable habitat on other lands. On private lands this resource would be susceptible to disturbance and increased mortality, from hunting and poaching, and land management practices that focus on agricultural, developmental or industrial uses.

The USFWS has repaired, operated and maintained this system, at great expense and manpower for over 27 years. Now the system is in disrepair once again and is susceptible to imminent failure. During planning for the Savannah Harbor Expansion project, the USFWS documented the need to repair the system, prior to any additional harbor deepening, to fulfill previous mitigation commitments. In 2009, the Corps agreed to repair the system under existing authorities. The first phase of repair, south of South Carolina Highway 170 (SC 170), was initiated in June 2010. The second phase, north of SC170, is scheduled to begin in mid-2011.

Tidal freshwater wetlands

Tidal freshwater wetlands (palustrine emergent wetlands) cover much of Savannah NWR in the vicinity of the Harbor and, in contrast to the managed wetlands, are flooded twice daily by tidal action. These marshes were either never diked or the dikes constructed for rice culture have eroded to marsh elevation allowing tidal flooding. Based on vegetation, interstitial (marsh root zone) salinity and soils studies conducted in 1999-2001, the tidal freshwater marshes in the study area are composed of a highly diverse plant community and the community composition is highly dependent on the salinity gradient in the estuary (Dusek and Kitchens 2003). Using cluster analysis, Dusek and Kitchens (2003) identified eight vegetation classes in the study area and the number of species ranged from 11 in the most saline class to 99 in the most diverse freshwater class.

Welch and Kitchens (2006) used additional (1999-2005) vegetation, interstitial and soils data and additional ecological models to classify the plant community. Their classification generally resulted in five plant communities under both drought (2002) and non-drought (2005) conditions. The communities classified under drought and non-drought conditions were similar with minor shifts in the percentages of dominant species (Table 1). The authors developed decision trees that could be used to predict the plant community at a location in the estuary based on salinity, soils and distance to a channel.

A marsh succession model (MSM) consisting of a geographic information system that displays the plant communities based on the salinity, soils and distance to a channel was developed as a tool to evaluate channel deepening impact (Welch and Kitchens 2006). The first input into the MSM is the channel salinity as predicted by the Environmental Fluid Dynamics Code hydrodynamic model (EFDC). The EFDC is a three-dimensional physics-based turbulence closure model that has been applied in a number of estuarine and riverine systems in the southeastern United States. The channel salinity is translated to interstitial salinity using a model to marsh spreadsheet application developed by data mining techniques that used channel salinity data and interstitial salinity data at several locations in the estuary (Conrads et al. 2006). The decision trees (Welch and Kitchens 2006) were used in conjunction with the environmental data to predict the plant communities in the study area. Table 2 presents the area occupied, determined by the marsh succession model, by the plant communities under current conditions (42-foot channel).

Table 1. Marsh succession model (MSM) community names, interstitial salinity (Welch and Kitchens 2006) and mean channel salinity. Channel salinity is the 50% exceedance value for average flow conditions from Environmental Fluid Dynamics Code model (Bill Bailey, Corps, written communication 2006).

MSM Non-drought Community (2005)	MSM Drought Community (2002)	Non-drought Mean Interstitial Salinity (ppt)	Drought Mean Interstitial Salinity (ppt)	Channel salinity (ppt)
100% Elemo; Galti; Saglt*	91% Elemo	<0.83	<1.0	<0.5
80% Zizmi; Polsp*	100% Zizmi; Polsp	<0.83	<1.0	<0.5
45% Zizmi; Polsp; 29% Elemo; Galti; Saglt; 26% Sciva*	45% Elemo 31% Zizmi_Polsp 23% Sciva	<0.83	<1.0	<0.5
78% Sciva	86% Sciva	0.83-3.6	1-4.2	0.5-3
78% Spasp; Sciro; Astte*	78% Spasp_Sciro 22% Sciva	>3.6	>4.2	3-9

* Elemo=Eleocharis montevidensis, Galti=Galium tinctorium, Saglt=Saggataria lancifolia, Zizmi=Zizaniopsis miliaceae, Polsp=Polygonum sp., Sciva=Scirpus validus, Spasp=Spartina spp.,Sciro=Scirpus robustus, Astte=Aster tenuifolius

Table 2. Area occupied, determined by the marsh succession model (Welch and Kitchens 2006), by the plant communities under current depth (42-foot channel) for non-drought and drought conditions.

MSM Non-drought Community (2005)	No action acreage Non-drought	MSM Drought Community (2002)	No action acreage Drought
100% Elemo; Galti; Saglt*	2081	91% Elemo	868
80% Zizmi; Polsp*	761	100% Zizmi; Polsp	476
45% Zizmi; Polsp; 29% Elemo; Galti; Saglt; 26% Sciva*	427	45% Elemo 31% Zizmi_Polsp 23% Sciva	1069
78% Sciva	2427	86% Sciva	2485
78% Spasp; Sciro; Astte*	3151	78% Spasp_Sciro 22% Sciva	3949
Total	8847		8847

Commonly used marsh classifications are usually based on average channel salinity not interstitial salinity (Odum et al. 1984). The communities in the table with a channel salinity of <0.5 ppt are considered to be tidal freshwater marsh with differing species composition. Scirpus validus (78% Sciva) is considered to be oligohaline marsh. Oligohaline marsh is described by Odum et al. (1984) as having an average annual channel salinity of 0.5 ppt–5.0 ppt. The Spartina spp, Scirpus spp, Aster tenuifolius is considered to be mesohaline marsh. The location of the 50% exceedance (% of time a specified value is equaled or exceeded) 0.5 ppt salinity contour as predicted by the EFDC model is generally located downstream of the tidal freshwater marsh predicted by the MSM in the Front River and Middle River (Figure 3). This difference could be due to prediction errors in the EFDC model, the MSM model or both. The difference amounts to about one river mile on the Front River and on the Middle River. However, the predictions on the Back River from both models are at virtually the same location.

Cumulative salinity impacts due to previous harbor deepening projects have been significant and have substantially reduced the amount of freshwater marsh in the system. Table 3 presents the location of the freshwater limit, channel depth and amount of tidal freshwater marsh at the various times. Figure 4 shows the approximate location of the freshwater interface at various times in recent history. As the salinity interface has moved upriver, the diverse tidal freshwater marsh has been converted to lower diversity brackish marsh. In 1875, there was an estimated 12,000 acres of tidal freshwater marsh, compared to only 3,269 acres in 2005, a 73% reduction. As an alternative method, the Corps projected EFDC- predicted salinity in the river channels (Front, Middle and Back) across the marsh surface based on drainage patterns determined from aerial photos. This method resulted in an estimate of 4072 acres of tidal freshwater marsh in 2005 (Corps of Engineers 2010a).

During tide gate operation (1977-1992), salinity was increased by an additional increment in Back River and Little Back River, moving the freshwater-saltwater interface six miles upriver, and marshes in that area became more brackish and less diverse (Pearlstine et al. 1990).

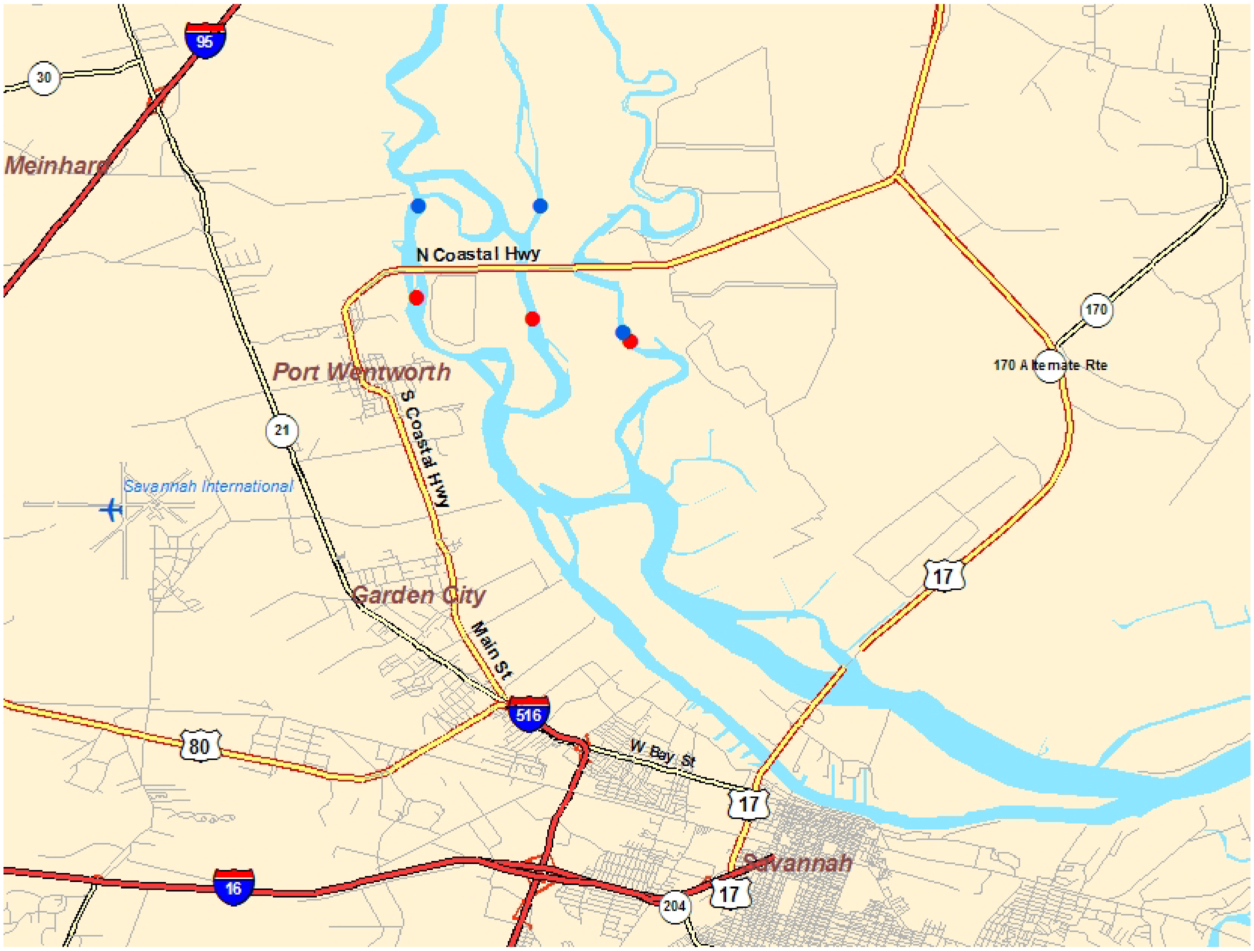

Figure 3. Location of the 50% exceedance 0.5 ppt salinity contour as predicted by the EFDC model (red points) and of the tidal freshwater marsh predicted by the MSM (blue points) in the Front River (left channel), Middle River (middle channel) and Back River (right channel).

Table 3. Location of the freshwater limit, channel depth and amount of tidal freshwater marsh in the Savannah estuary from 1875-2005.

Year	**Channel depth**	**Freshwater limit (river mile)**	**Tidal freshwater marsh (acres)**
1875	15	7 (Granger 1968)	12,000 (map estimate)
1940	28	13 (Lamar 1940)	8,000 (map estimate)
1974	34	17 (Corps of Engineers 1975)	6,007 (Tiner 1977)
2005	42	21 (EFDC prediction)	3,269 (Welch and Kitchens 2006)

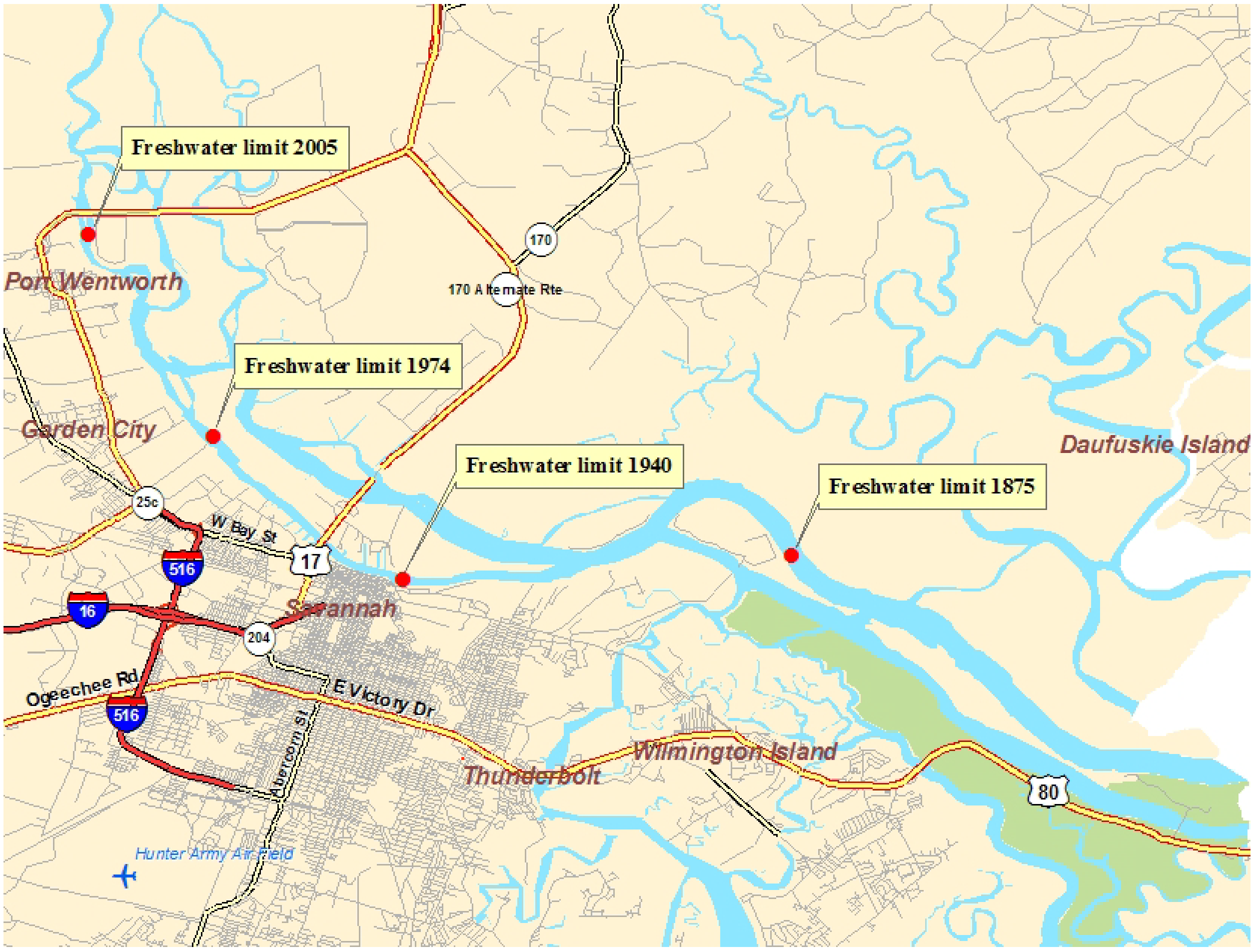

Figure 4. Location of the freshwater interface in the Savannah River from 1875-2005.

New Cut closure and termination of tide gate operation resulted in reversal of the previous adverse trends that were caused by the gate. Some studies have indicated a gradual return to freshwater wetland vegetation characteristic of the Back River before the construction of the tide gate (Latham and Kitchens 1996, Loftin et al. 2003). Another study, during 1999-2001 found fluctuations of plant species composition and the trend toward return of freshwater vegetation was not confirmed. However, this study occurred during a period of severe drought that increased salinity throughout the study area (Dusek and Kitchens 2003).

Fish

Jennings and Weyers (2003) conducted fish sampling in the Savannah River estuary during 2000-2002 and reported a diverse and abundant fish community that depended on the availability of specific salinity-defined habitats. A total of 91 fish species were collected with bay anchovy, Atlantic menhaden, Atlantic croaker and spot being the most abundant species. Most species were estuarine habitat generalists that could tolerate a wide range of salinities. A smaller number of species were marine species restricted to areas with higher salinity (>10 ppt) and these species moved further up the estuary as salinity moved inland during periods of low river discharge.

Obligate freshwater species that could not tolerate salinity above 5 ppt were the smallest component of the fish community. The authors stated that these freshwater species would probably be at the greatest risk of population declines or range reduction if salinity increased in the estuary.

The shortnose sturgeon (endangered) is the only fish in the project area listed under the Endangered Species Act. This species is almost always located near the river bottom where it feeds on invertebrates. The shortnose sturgeon is frequently located near the fresh water/salt water interface. A recent study (1999-2000) in the Savannah estuary used acoustic transmitters to track shortnose sturgeon location and determine habitat utilization (Collins et al. 2001). Juveniles were found in two different specific locations depending on water temperature. When water temperature was less that 22º C, they were found near the intersection of Front River and Middle River (river mile 19.7), moving between both rivers. When water temperature was greater than 22º C the juveniles moved upstream of the harbor area and concentrated around river mile 29.5, where the salinity was consistently 0.1 ppt. Adult movements were similar but more extensive than the juveniles, with some adult fish moving almost to the mouth of the river during low temperature periods. During the study several fish received transmitters that measured depth and these fish were always located on or near the bottom.

Sampling during the late 1980s found that juvenile shortnose sturgeon were concentrated in the Kings Island Turning Basin (river mile 18.7) (Hall et al. 1991) but no juveniles were collected that far downriver in 1999-2000 (Collins et al. 2001). Changes in the study area include harbor deepening from 38 to 42 feet, closing New Cut and taking the tide gate out of operation. The low catch rate of juveniles in 1999-2000 indicated that natural recruitment was quite low in the Savannah River. In the southeastern U.S. 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).

One of the most important species in the lower Savannah River, both as an important sport fish and as an indicator of environmental quality, is the striped bass. Studies in the 1960's and early 1970's indicated that the primary spawning area for striped bass in the Savannah River system was the tidal fresh water zone approximately 18-25 miles from the river mouth, specifically the Little Back River (McBay 1968; Smith 1970; Rees 1973, 1974). However, recent studies using egg surrogates (gellan beads) revealed striped bass egg sampling efficiency biases due to channel morphology and other hydraulic conditions. Sampling efficiency appeared to be higher, by an order of magnitude, in the narrower, shallower Back River than in the Front River (Reinert et al. 2004). Therefore, it is probable that the amount of spawning in the Front River has been underestimated in the past.

Production of striped bass eggs in the Savannah River estuary declined by about 95% between 1977, when the tide gate was put into routine operation and 1989 (Van Den Avyle et al. 1990). Tide gate operations increased the salinity on striped bass spawning grounds and altered current velocities and pathways of water movement in the middle and lower estuary (Van Den Avyle et al. 1990, Reinert et al. 2005). Adult spawners continued to use the same spawning grounds reported prior to tide gate installation, but the amount of spawning was reduced. There was no evidence of an upstream shift of spawning as speculated by Dudley and Black (1978). These research results and Georgia Department of Natural Resources (GADNR) catch per effort for adult striped bass, indicated the reduction in spawning reflected reduced abundance of adults caused by lack of successful recruitment.

Salinities of 10 ppt or greater are toxic to striped bass larvae (Winger and Lasier 1990). Seaward of Hutchinson Island, salinity typically exceeds levels toxic to striped bass eggs and larvae. When the tide gate was operating, most striped bass eggs released in the Savannah River estuary during spawning were transported beyond Hutchinson Island in 30 to 48 hours. Striped bass eggs hatch within 40 to 60 hours post spawning, and the larvae, which are weak swimmers, are not able to avoid toxic conditions for at least 5 days post hatch.

Recovery of a viable, naturally-reproducing, Savannah River striped bass sport fishery following the 1992 tide gate project modification was expected to take many years. Because of the severe decline in brood stock, stocking of striped bass was required for population recovery. The stocking program, which was initiated in 1989 by GADNR, was continued through 2002 (Matt Thomas, GADNR, personal communication 2005). Male striped bass require three years to reach sexual maturity and females require five years (seven to eight years to become highly fecund). Assuming favorable environmental conditions, striped bass egg production was expected to increase about six years following New Cut closure, which occurred in 1992. Another five to six years was expected to be required for these naturally spawned fish to be recruited into the adult population and spawn. Studies indicated that striped bass egg production in the Savannah River remained very low from 1994-1996 (Reinert et al. 1996).

Recent studies indicate that successful striped bass natural reproduction had increased in the lower Savannah by 2001. Targeted striped bass egg sampling was conducted periodically from 1984 until 2000. By 1999-2000, there was some indication that egg abundance was increasing, from the very low levels of the mid-1990's (Reinart et al. 2005). Will et al. (2002) assessed the reproductive status of Savannah River striped bass using ultrasonography and histological samples. Oocyte development appeared to be normal and size to fecundity relationships were similar to other striped bass populations. Reproductive status in the Savannah River appeared to be equivalent to status found in healthy striped bass populations (Will et al. 2002). Jennings and Weyers (2003) reported that striped bass larvae were collected in 2001-2002 ichthyoplankton samples from freshwater and low salinity habitats, thus indicating successful reproduction in the estuary. Collins et al. (2002) reported collecting a high proportion of juvenile striped bass smaller than those stocked by GADNR in the Savannah estuary, indicating natural reproduction.

GADNR conducts regular striped bass sampling using electrofishing in the estuary and has collected striped bass spawned in 2003 and 2004. In addition, the number of striped bass age two years or more caught per hour of electrofishing has increased from 2 or less in the mid-1990's to more than 12 in the mid-2000's. The number of large striped bass (> 9 kilogram) caught per hour of electrofishing has increased from less than 0.1 in the early-1990's to more than 1.5 in 2003 (Reinert et al. 2005). Although no formal creel studies have been conducted, anecdotal evidence indicates that sport fishing catch has greatly increased (Matt Thomas, GADNR, personal communication 2005). By closing New Cut and taking the tide gate out of operation, striped bass habitat has been improved and striped bass numbers, size and reproduction are increasing in the Savannah estuary.

Endangered Species

The Savannah Harbor study area supports a number of endangered and threatened species listed under the Endangered Species Act. Listed species known to regularly occur in the project area include West Indian manatee, right whale, wood stork, piping plover, loggerhead sea turtle and shortnose sturgeon (discussed above under "Fish"). Manatees have been observed in the waterways of Savannah NWR from 1987 to 2010 and in Savannah Harbor in recent years. Coastal waters of the project area provide important right whale wintering and calving habitat. Several other listed whale species can occur in coastal waters of the project area. Wood storks regularly feed in managed wetlands on Savannah NWR. A piping plover critical habitat unit is located on the north end of Tybee Island. A small number of loggerhead sea turtles nest on the beach at Tybee Island. Other sea turtles including leatherback, Kemp's ridley, hawksbill and green also occur in coastal waters of the project area.

PROBLEMS, OPPORTUNITIES, AND PLANNING OBJECTIVES

Based on the fish and wildlife resources in the project area the following fish and wildlife planning objectives have been formulated.

1. Restoration and maintenance of tidal freshwater marsh in the lower Savannah River.

Tidal freshwater marsh is one of the most diverse wetland types and provides excellent fish and wildlife habitat. Cumulative impacts of previous deepening projects have converted most of the tidal freshwater marsh to less diverse brackish marsh. Maintenance of normal tidal and salinity patterns is a major objective of coastal refuges and management areas to allow these areas to meet their wildlife objectives (Weller 1994). Therefore, the USFWS objective is to avoid or minimize loss of tidal freshwater marsh caused by salinity increase.

2. Restoration and maintenance of spawning and nursery habitat to support a self-sustaining striped bass population.

The striped bass is a nationally important fishery resource. Prior to tide gate installation, the Savannah River supported an important population of this species. Restoration of the habitat has been initiated by closing New Cut and removing the tide gate from operation. The USFWS objective is to avoid habitat impacts that would hinder recovery of this population.

3. Maintenance of the freshwater supply for management of approximately 3,000 acres of managed wetlands on Savannah NWR and for meeting agreements to supply freshwater to adjacent land owners.

Managed wetlands on Savannah NWR are managed for wintering waterfowl, wading birds and shore birds. Dabbling ducks are especially dependent on this habitat. Conversion of freshwater impounded wetland habitats on the Refuge to brackish wetland would severely impact management efforts, would be in direct opposition to the purpose for which the Refuge was established, and therefore must be avoided. The freshwater delivery system, which was installed mitigation for the tide gate and harbor deepening, failed soon after construction due to an inadequate design. The USFWS has repaired the system at great expense and management of the freshwater system has required significant staff time and resources. The USFWS objective is to repair the system prior to any additional harbor modifications.

4. Protection of riverine, palustrine, and estuarine wetlands in the lower Savannah River basin.

Palustrine, estuarine, and riverine wetlands provide the highest quality fish and wildlife habitat in the SHCS area. These wetlands also provide habitat for wildlife of high public significance, such as waterfowl and other migratory birds. Harbor development and maintenance have resulted in loss of approximately 6,000 acres of wetlands due to filling and dredged material disposal (see page 5). The USFWS objective is to avoid or minimize the loss of these highly valuable habitats.

ALTERNATIVES

The Savannah Harbor Expansion study evaluated deepening existing channels and selected turning basins by up to 6 feet. Total actual depths consist of nominal authorized project depths, plus advance maintenance and allowable overdepth, where applicable. Authorized project depth is the nominal channel depth provided for navigation. Advance maintenance (AM) is additional depth in the channel to provide storage for shoal material and currently adds two to four feet of depth in most of Savannah Harbor. Allowable overdepth (OD) is a dredging tolerance due to the inaccuracies of the dredging process and adds another two feet of depth. Therefore, immediately after maintenance dredging, depth of the channel in most of the harbor is four to six feet deeper than the nominal depth. As sedimentation occurs the actual depth approaches the nominal depth until the next dredging cycle. Table 4 presents the alternatives evaluated by the expansion project by nominal and maximum actual inner channel depth. The entrance channel is two feet deeper than the inner channel.

The Corps analysis shows that incremental net economic benefits are maximized on the Savannah Harbor Deepening Project at a depth of 45 feet, decrease from 45 to 47 feet, and are negative at 48 feet. However, because a depth of 47 feet provides the greatest total net benefits, it is the national economic development (NED) plan. The local sponsor has proposed a locally preferred plan (LPP) of 48 feet rather than the NED plan (47 feet) because the local sponsor has stated that they believe the LPP will provide additional economic benefits justifying additional expenditures on their part.

Table 4. Authorized depths, maximum actual depths (feet below MLLW) and new dredged material quantity with the no action alternative and various depth alternatives.

Alternative	**Authorized depth (AD)**	**Maximum depth (AD+AM+OD)**	**Dredged material (cubic yards)**
No action (current conditions)	42	46-48	0
Alternative 1	44	48-50	10,300,000
Alternative 2	45	49-51	14,600,000
Alternative 3	46	50-52	19,000,000
Alternative 4	47	51-53	23,600,000
Alternative 5	48	52-54	28,300,000

PROJECT IMPACTS

Project impacts and mitigation alternatives were primarily assessed using a hydrodynamic and water quality model. The three-dimensional hydrodynamic model selected for this project is based on the EFDC, a physics-based turbulence closure model that has been applied in a number of estuarine and riverine systems in the southeastern United States. Water-quality impacts (dissolved oxygen, nutrients, temperature) are simulated using the water quality analysis simulation program (WASP) (Ambrose et al. 1993). The WASP model uses the hydrodynamic input from the EFDC model. The Savannah Harbor expansion version of the EFDC is based on the model originally developed by Tetra Tech for the EPA to determine the total maximum daily load for dissolved oxygen in the lower Savannah River. This model and the associated water quality model have been improved with an enhanced grid and other modifications. Extensive model development, coordination and peer review processes were conducted to ensure that the model was acceptable to evaluate project impacts (Corps of Engineers 2010b). The EFDC and WASP model output provide salinity and dissolved oxygen predictions in the river channels of the harbor and lower Savannah River. Salinity and dissolved oxygen predictions from the EFDC and WASP models were also applied to simple fish habitat models developed by an interagency group that included scientists from the Corps, USFWS, NOAA, South Carolina Department of Natural Resources and GADNR. Habitat models were developed for striped bass, shortnose sturgeon, southern flounder and American shad.

Impacts were assessed by comparing predicted with-project conditions immediately after construction to base year (current) conditions instead of comparing project-life average annual conditions to the base year. Impacts determined on an average annual basis would be less than those based on conditions immediately after construction because sea level rise would impact the tidal freshwater wetlands and other habitat even without any harbor deepening. Corps policy recommends determining impact and mitigation using an average annual impact approach. Available information indicates that impacts of sea level rise on tidal freshwater marsh in Savannah NWR would be negligible except for the cumulative impact of harbor deepening. A study on the Altamaha River, Georgia found no marsh changes that indicated increasing salinity from 1953 to 1993, during a period of sea level rise, and freshwater marsh occurred downstream to about river mile 8 in 1993 (Higinbotham et al. 2004). In 2005, with Savannah Harbor at the current depth of 42 feet, freshwater marsh was found downstream only to about river mile 20 on the Savannah River (Figure 3, Table 3 this report). The Altamaha River has an average annual discharge about 15 % higher and is less regulated by reservoirs than the Savannah River. More importantly the Altamaha is a naturally shallow river, as was the Savannah, and is not dredged for navigation. Most of Savannah NWR lies upstream of Savannah river mile 19. Without the cumulative impact of harbor deepening, it is unlikely that Savannah NWR would currently be impacted by salinity or would be substantially impacted by sea level rise during the project life, even with an expected increase in the rate of rise due to climate change. Therefore, it is appropriate to determine impact and formulate mitigation by comparing predicted with-project conditions immediately after construction to base year conditions.

The most significant predicted impact of the deepening project is that salinity, in portions of the lower Savannah River, will be increased. Deepening of the Front River channel will increase tidal volume and increase salinity. Moderate incremental increases in the salinity level have become cumulatively significant as depth of the harbor has been repetitively increased over time. The potential impacts of the proposed deepening project must be considered in the context of these cumulative salinity impacts. Figure 4 presented the approximate location of the freshwater interface at various channel depths and times in recent history. As the salinity interface has moved upriver, tidal freshwater marsh has been converted to lower diversity brackish marsh. Habitat for striped bass and shortnose sturgeon has been modified and most of the original habitat for these fish has been rendered unsuitable.

Another highly significant impact is the predicted decrease in dissolved oxygen concentration due to increased salinity stratification. The numerous aquatic species that utilize wetlands in the Savannah estuary are dependent on suitable water quality to complete their life cycle. Dissolved oxygen is a key water quality component and adequate dissolved oxygen concentrations are essential to support fish and other aquatic life. Project impacts without mitigation, summarized briefly in the following sections, were presented in more detail in the November 2008 FWCA Report.

Managed Wetlands

Increased salinity levels in the lower Savannah River system have a number of adverse impacts to the managed wetlands of the Savannah NWR and adjacent private lands. During times of low flow, fresh water may not be available for the managed wetland system of Savannah NWR. The presence of brackish water would increase operation and maintenance costs due to increased personnel requirements to monitor salinity levels and adjust operations to prevent frequent introduction of brackish water. Water control structures and other equipment would also require more frequent repair and/or replacement due to salinity levels. The freshwater delivery system is inadequate and water is leaking around the failing structures. The Refuge will not be able to prevent brackish water from entering the system unless repairs are completed. Evaporation tends to increase salinity levels in impoundment waters, and salt uptake by plants tends to increase soil salinity. Odum et al. (1977) state: "The floor of the freshwater marsh is composed of matted organic matter (mainly dead, non-decomposed roots and rhizomes) through which water flows. This mat will readily absorb sodium chloride and effectively increase the marsh salinity more than water level indicates." Soils frequently flooded with brackish water cannot have water removed for long periods of time because soil acidity increases beyond acceptable limits. These factors would change the plant community to less desirable plants for wildlife and preclude the ability to manage for freshwater plants. Freshwater management (salinity less than 0.5 ppt) is necessary to maintain maximum waterfowl use of the Refuge's managed wetlands.

Tidal freshwater wetlands

Increased salinity is predicted to cause conversion of tidal freshwater marsh to brackish marsh. Based on previous studies, as the marshes become more saline plant species composition becomes less diverse (Pearlstine et al. 1990, Dusek and Kitchens 2003, Welch and Kitchens 2006). In addition, tidal freshwater marsh primary productivity is high, generally falling in the range of 1,000 to 2,000 $gm/m^2/yr$ (Odum et al. 1984). The quality of primary production of the fresh marsh community is also high. Major primary producers in the salt marsh community are grasses that have little immediate nutritional value to fish and wildlife (Teal 1962). In contrast, the fleshy broad-leaf plants characteristic of fresh marshes generally are high in nitrogen and low in fiber content and there is a high incidence of direct grazing or feeding on these plants (Odum et al. 1984).

Fresh marsh vegetation contributes to the food web base that supports the study area's estuarine fishery. Dominant macroinvertebrates are likely to be amphipods and polychaetes (Odum et al. 1984). Malloy (2003) found that members of the families Cyprinodontidae (pupfishes or killifish) and Palaemonidae (grass shrimp) were the most abundant nekton (aquatic organisms with the ability to swim) utilizing the marsh surface in the upper Savannah estuary. Estuarine dependent marine species were more prevalent in the tidal freshwater areas than freshwater species. Much of the prior research in other south Atlantic tidal freshwater marshes has indicated that freshwater species are dominant (Odum et al. 1984). Salinity intrusion due to prior Savannah Harbor deepening is a factor facilitating higher use by estuarine and marine species further upstream in the Savannah estuary. Water quality sampling has established the fact that Middle River periodically serves as a conduit for high salinity water far up that river. To a lesser extent Rifle Cut carries brackish water to Back River from Middle River. Such movements of saline water are likely to be favorable for marine species to move further up the estuary than they would under natural conditions. Harbor deepening would exacerbate these trends.

Tidal freshwater wetlands provide important habitat for many bird species, including neotropical migrants (birds that summer in North America and winter in tropical America). Resident and migrating birds utilize food and shelter found in this community; some species use freshwater marshes for nesting and breeding. Studies conducted in 2000-2002 reported that more species of neotropical migratory birds were stopping over in tidal freshwater marsh habitat than in tidal saltwater habitat on Savannah NWR (Berryman and Webb 2003). Higher plant species diversity and structural diversity in the freshwater marshes compared to brackish marshes may account for the higher use.

Graves (2001) found there were 26 species of birds exclusively associated with tidal freshwater marsh in the lower Savannah River and only four species exclusively associated with salt-dominated wetlands. Lower diversity of plant species combined with less structural diversity among plant communities in brackish marsh is most likely one basis for the differences among avian species richness and composition between freshwater and brackish marshes; brackish marshes might be more advantageous to generalist species, such as red-winged blackbirds (Peterson 1992). King rails are associated with freshwater and intermediate marshes and not found in salt-influenced marsh habitats within the Savannah River estuary (Graves 2001). King rail populations are declining and are listed as a species of concern by the USFWS. Graves (2001) concluded that an increase in salinity in tidal wetlands at Savannah NWR would lead to a significant loss of avian diversity and that many bird species could be extirpated from the estuary, resulting in the continued decline of some species of management concern such as the king rail.

Waterfowl feed directly upon tidal fresh marsh vegetation. Wild rice, sedges, spike rush, wild millet, bulrushes, and duckweeds serve as prime waterfowl food, and mollusks, insects, small crustaceans, and fish found in the fresh marsh community also are fed upon by waterfowl and other birds. Various species of ducks feed in the study area fresh marshes, along with wading birds such as the great blue heron, little blue heron, green heron, snowy egret, and great egret and many species of shorebirds.

Palustrine emergent wetlands also provide excellent habitat for fur-bearing mammals including the mink and river otter. Terrestrial species from surrounding forested areas often utilize the fresh marsh edge for shelter, food, and water; these include raccoon, opossum, rabbit, and bobcat. In summary, the tidal fresh marsh on Savannah NWR supports an extremely diverse plant community providing food, cover and nesting habitat for a wide variety of wildlife species throughout the year. Conversion to brackish marsh caused by harbor deepening would substantially reduce diversity and wildlife use of these marshes.

Other tidal wetlands

A total of 15.7 acres of brackish and salt marsh (estuarine emergent wetlands) would be excavated because of channel or turning basin widening and removal of the tide gate. Even though brackish and salt marsh supports less diversity and wildlife use than tidal fresh marsh, it is of high value in supporting the estuarine food web for invertebrates and fish, sediment trapping and water quality improvement, and protecting shorelines from erosion and storm water detention. Excavation would result in a total loss of these functions.

Fish

The Savannah estuary supports a diverse fish community that utilizes the complex mosaic of tidal wetland habitat. However, only a few species of fish were selected to evaluate harbor deepening impacts. Species selected were based on their status as protected or trust resources, knowledge of habitat requirements and sensitivity to expected impacts. The shortnose sturgeon, striped bass, southern flounder, and American shad were the species chosen for evaluation.

The shortnose sturgeon is particularly vulnerable to water quality impacts, which will be most severe in deep water and will impact the fish directly as well as impacts to its invertebrate food source. In the past, shortnose sturgeon used the Kings Island Turning Basin and other locations in the Savannah estuary as nursery and foraging habitat. As the salinity increased in the estuary, due primarily to harbor deepening, these locations could no longer support shortnose sturgeon.

Current dissolved oxygen levels in much of project area are frequently marginal to support shortnose sturgeon. Shortnose sturgeon juveniles are extremely sensitive to dissolved oxygen concentrations. In a 6-hour test using 64-day-old fish and a dissolved oxygen concentration of 2.5 mg/l, a mortality rate of 86% was observed. While older juveniles appear to be more tolerant of this concentration, it has been shown that a concentration of 3.0 mg/l can alter sturgeon behavior possibly reducing the likelihood of survival in the environment (Jenkins et al. 1993).

In the Savannah River, the striped bass is dependent on habitat in the estuary for successful reproduction and recruitment into the adult population because almost no spawning has been documented upstream of the estuary. After spawning the egg and early larval stages are transported by tidal currents both upstream and downstream but the net movement is toward the ocean.

The habitat suitability model for striped bass indicates that a maximum salinity of 1.5 ppt or less is optimal for spawning (Bain and Bain 1982). Studies on the Savannah River indicate that striped bass almost exclusively spawn in areas where maximum salinity near the surface is less than one ppt (Van Den Avyle et al. 1990, Will et al. 2000). Winger and Lasier (1990) concluded that exposure to salinity greater than 15 ppt was toxic to Savannah River striped bass eggs. However, normally eggs will develop into larvae within about two days of spawning. Winger and Lasier (1990) concluded, using laboratory studies at a constant salinity, that Savannah River striped bass larvae survived well at 3-9 ppt salinity but survival decreased at higher salinity. Five-day-old larvae were able to tolerate higher salinity than two-day-old larvae. Therefore this important sport fish is very sensitive to salinity increases caused by harbor deepening.

The effects of low dissolved oxygen on egg, larval and juvenile striped bass can be dramatic. For example, dissolved oxygen concentrations between 2.0 and 3.5 mg/l were determined responsible for the absence of striped bass eggs and larvae in the Delaware River (Bain and Bain 1982). Other studies have indicated that even moderate reductions from 5.0 to 4.0 mg/l decreased the survival of eggs and larvae and that striped bass larvae need a minimum of 3.0 mg/l dissolved oxygen to survive (Bain and Bain 1982). Juvenile striped bass exhibit no survival at a dissolved oxygen level of 1.0 mg/l, intermediate survival at 3.0 mg/l and high survival at 5.0 mg/l. Adult striped bass appear to have similar water temperature and dissolved oxygen requirements as juveniles and have been observed avoiding areas with low dissolved oxygen where the percent of saturation reaches 44% or less (Bain and Bain 1982). Increased salinity levels and reduced dissolved oxygen levels would degrade spawning and nursery habitat for striped bass and reduce the area of available habitat.

The American shad model was selected for evaluation because it is an important migratory commercial and sport fish that has been impacted throughout its range by dam construction and decreases in water quality. The predicted impacts to American shad were less than 2% for all deepening alternatives. This species model was not very sensitive to deepening impacts because the dissolved oxygen requirement was relatively low and was located in the upper half of the water column where the dissolved oxygen is generally higher than dissolved oxygen near the bottom.

Endangered Species

The Corps has initiated consultation with USFWS and NOAA under section 7 of the Endangered Species Act to determine the effect of the project on listed species. The endangered species most likely to be affected by this project is the shortnose sturgeon because it is a bottom dweller and is sensitive to water quality impacts expected from channel deepening.

Cadmium

Elevated cadmium levels have been found in several areas of the harbor from about river mile 4 to river mile 11. These elevated cadmium levels are in natural Miocene clays in the river bottom that would be dredged during construction of the expansion project (EA Engineering, Science and Technology 2008). Average cadmium concentration ranges from about 10 mg/kg to 19 mg/kg in the river reaches of most concern (Corps of Engineers 2010a). The dredging would remove these clays and place them in a confined disposal area. Therefore, the project would result in potential exposure of aquatic organisms to cadmium in the river bottom, the disposal area and waters receiving effluent from the disposal area. In addition, terrestrial organisms would be subject to cadmium exposure in the disposal area.

Cadmium is toxic to freshwater and marine organisms at various concentrations depending on the species. Sublethal effects include decreased growth, inhibited reproduction, respiratory disruption and altered enzyme levels (Eisler 1985). Birds and mammals are more resistant than aquatic organisms to the biocidal properties of cadmium requiring higher doses to cause death. Sublethal effects in birds include growth inhibition, anemia and testicular damage (Eisler 1985).

The risk assessment prepared for the Corps concluded that cadmium concentrations in new work sediments have no potential to impact the ecology of the Savannah River and are unlikely to cause adverse impacts in placement site wetlands (EA Engineering, Science and Technology 2008). The Corps believes that sediments containing as much as 4 mg/kg cadmium would be adequate to protect birds utilizing the disposal areas (Corps of Engineers 2010a). The "Ecological Soil Screening Levels for Cadmium", concentrations that are assumed to be protective of ecological receptors that commonly come into contact with and/or consume biota that live in or on the soil, are 0.77 mg/kg for upland insectivorous birds and 0.36 mg/kg for mammals (USEPA 2005). Based on detailed review of the risk assessment, the USFWS believes that short-term and long-term adverse impacts are possible on the Savannah River ecology as a result of dredging of sediments containing elevated cadmium concentrations and that adverse impacts on plants and wildlife in placement site wetlands/drainage areas and effluent-receiving waters may occur.

CORPS PROPOSED MITIGATION

Channel and flow modifications

To address salinity impacts a number of options to modify flows and channel depths in the different branches of the river were proposed for evaluation using the various models (Figure 5). Based on preliminary modeling, the options were either evaluated individually or combined to develop a number of mitigation plans. The major flow and channel options considered are as follows. A rock diversion structure in the Savannah River at McCoys Cut and dredging of small channels in the upstream portions of Little Back River and Middle River (h, Figure 5) are designed to divert water from Front River into Middle and Back River and thus reduce salinity in tidal freshwater wetlands. Filling of the sediment basin (to elevation -3.85 meters National Geodetic Vertical Datum), or allowing it to fill through sedimentation (a, Figure 5) would reduce salinity intrusion up Back River into important wetland areas. Closing of Rifle Cut (d, Figure 5) would reduce salinity intrusion into Back River because saline water flows up Middle River and through Rifle Cut. Removal of the tide gate structure and abutments (b, Figure 5) would remove restrictions to tidal flow in the Back River that may have resulted in sedimentation upstream of the gate. The tide gate has been out of operation since 1992; but, the gate structure and abutments have remained in place. Several other options were evaluated using the EFDC model but were eliminated because they were not effective, had potential adverse impacts or had too high a cost (USFWS 2008).

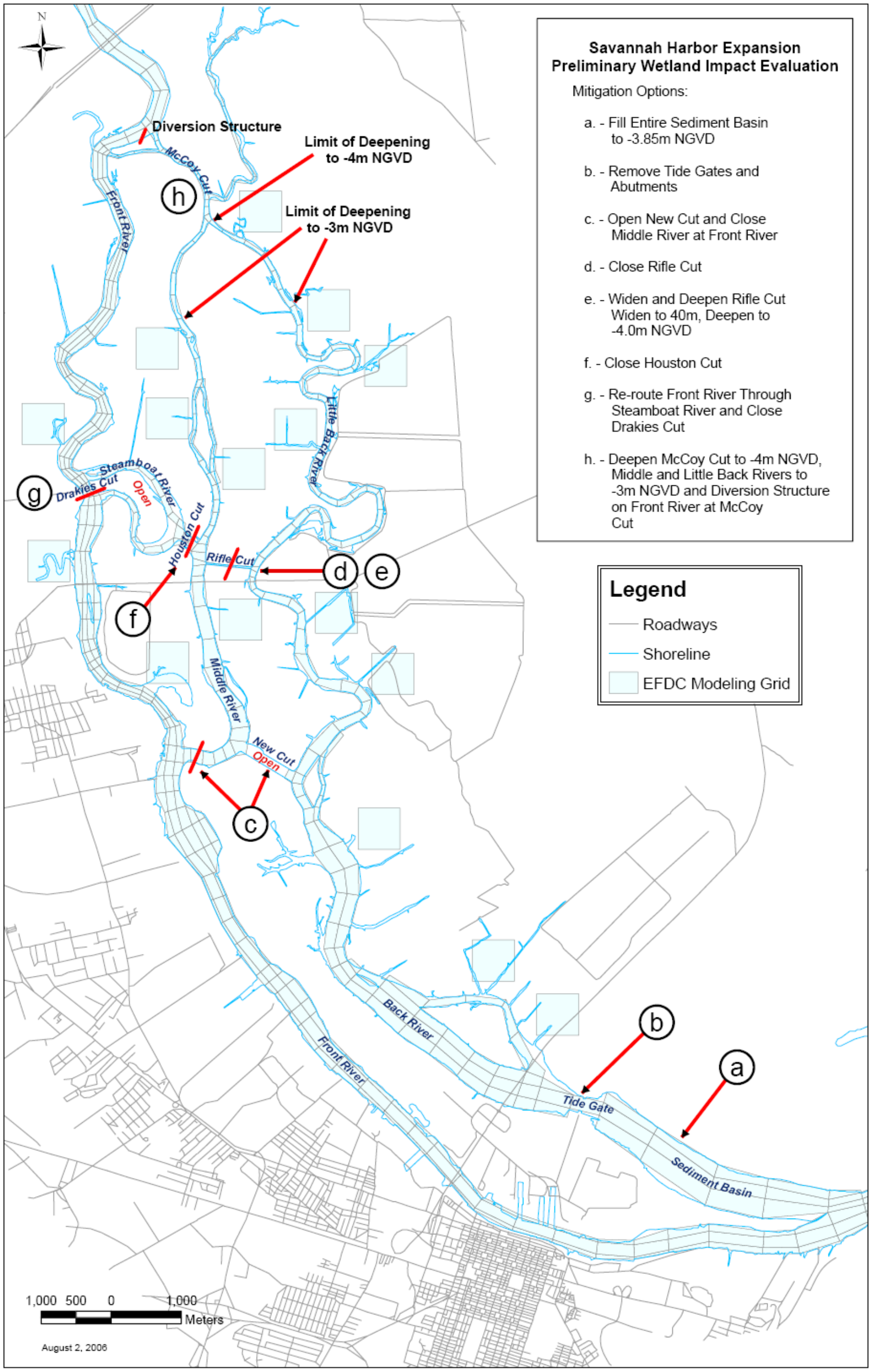

Figure 5. Flow and channel modifications evaluated as mitigation for the Savannah Harbor deepening project.

Two plans, designated 6A and 6B, were proposed by the Corps as the most effective in reducing impacts at an acceptable cost (Figures 6 and 7). Plan 6A would include the rock diversion structure in the Savannah River at McCoys Cut, dredging of small channels in the upstream portions of Little Back River and Middle River, filling of the sediment basin, closing of Rifle Cut and removal of the tide gate structure and abutments. Plan 6B would include the same features except for the dredging in Middle River and Little Back River, which would be eliminated. Both plans would close the downstream arm at McCoys Cut. Qualitative on-site observations indicate that much of the river flow entering the upstream arm of McCoys Cut enters the downstream arm and returns to the Front River. If return flow through the downstream arm were not prevented, the effectiveness of the McCoys Cut diversion structure would be reduced.

Land Acquisition

The Corps has also proposed land acquisition and management to offset tidal freshwater marsh impacts for the 45-foot and deeper alternatives. The Savannah District Standard Operating Procedures (SOP) for regulatory actions (http://www.sas.usace.army.mil/SOP.04.doc) were used by the Corps to determine loss of functional value and amount of lands needed to replace these values. After previous coordination, the Corps and USFWS agreed to acquisition amounts of 1,643 acres for the 45-foot alternative, 2,188 acres for the 46-foot alternative, 2,245 acres for the 47-foot alternative and 2,683 acres for the 48-foot alternative. The lands considered for acquisition are presented in Figure 8. The Corps has coordinated with USFWS regarding priority tracts for acquisition.

The Corps suggests that if the rate of sea level rise exceeds the historic rate, the proposed compensatory mitigation would overcompensate project impacts, because some of those acres would have converted to brackish or salt marsh without the project. The Corps proposes to reassess sea level rise effects in the future and assign “advance mitigation” credits to the project for use with future actions.

Wetland restoration

A previously used sediment placement area (CDF 1S) within Savannah Harbor was identified as having the potential to support a restored brackish marsh system. CDF 1S is located adjacent to the confluence of Front River and Middle River, and it is located within the boundaries of the Savannah NWR. Much of the site is currently upland as a result of the previous sediment disposal, which was terminated at least 20 years ago. The Corps utilized the Regulatory SOP to determine that about 29 acres that would be required for restoration to offset direct dredging impact. A portion of CDF 1S was graded down by GPA several years ago as mitigation for work at their facilities. The Corps would add the previous GPA restoration site (1.7 acres) to the currently proposed 29 acre restoration area. However, the Corps has proposed restoring a total area of approximately 42 acres and using the additional restoration area as "advance mitigation" for future harbor impacts.

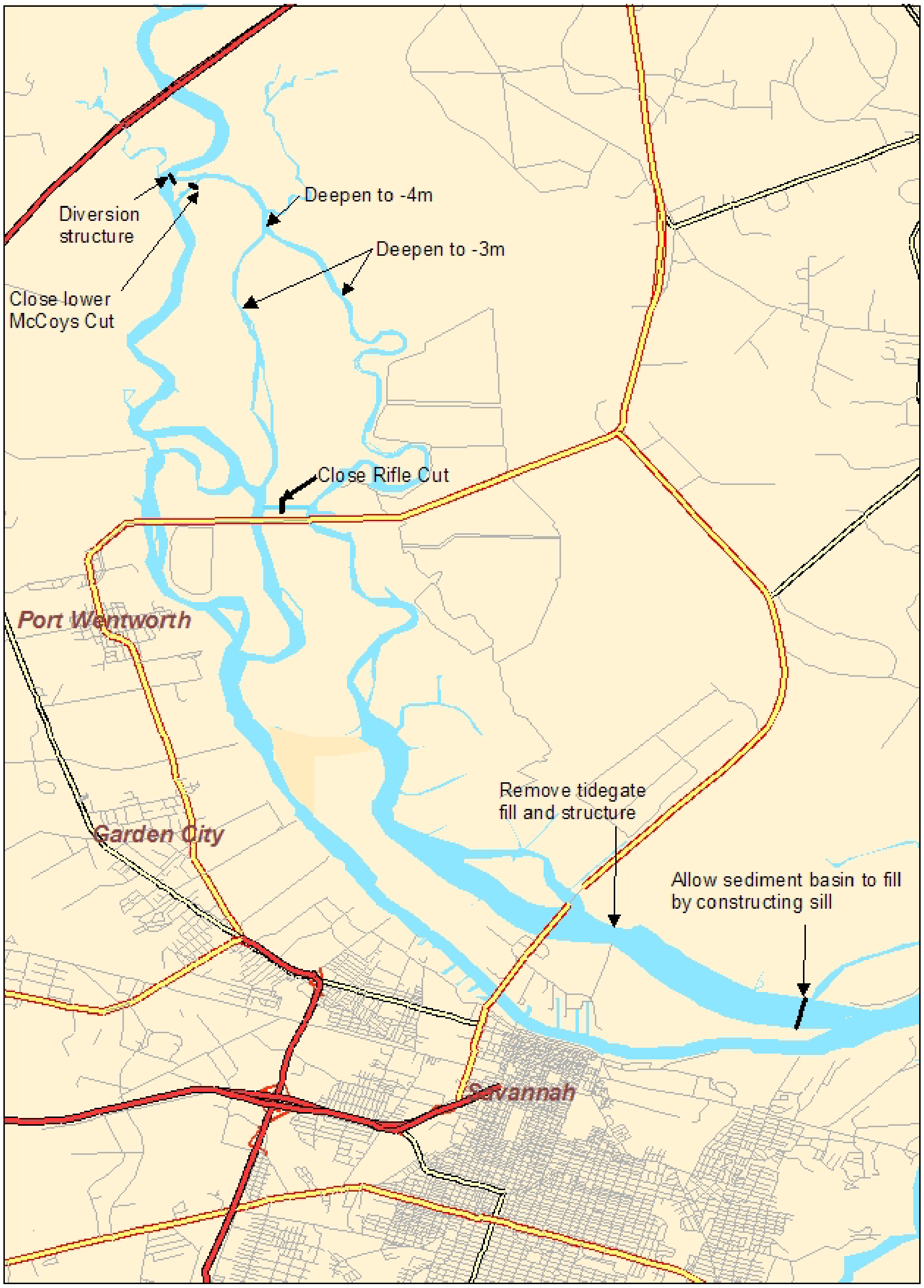

Figure 6. Savannah River estuary and mitigation plan 6A for Savannah Harbor deepening. Plan 6A includes a diversion structure at McCoys Cut, closing lower McCoys Cut, deepening of upper Back River and Middle River downstream to the points shown, closing Rifle Cut, allowing sediment basin to fill and removing tidegate.

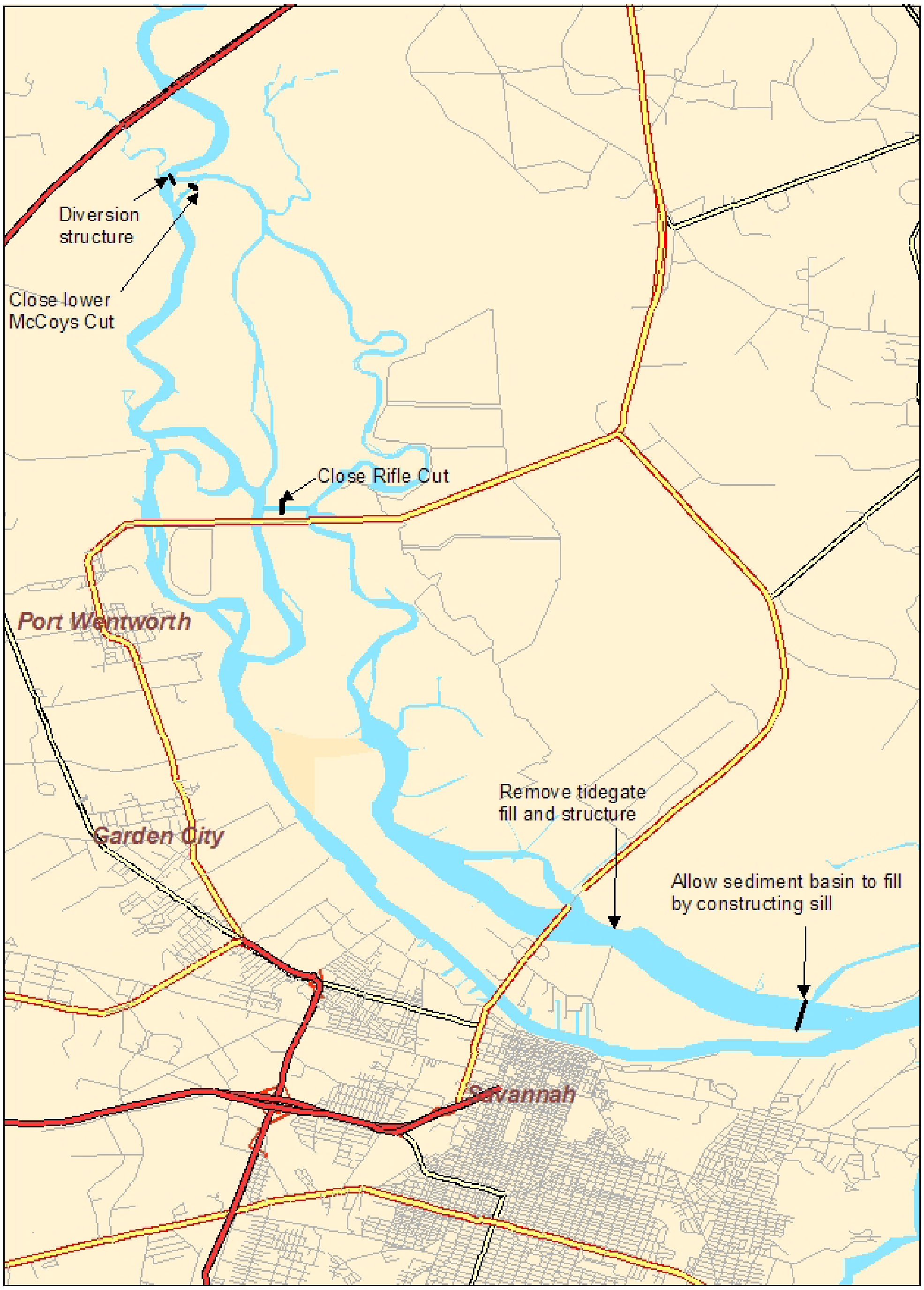

Figure 7. Savannah River estuary and mitigation plan 6B for Savannah Harbor deepening. Plan 6B includes a diversion structure at McCoys Cut, closing lower McCoys Cut, closing Rifle Cut, allowing sediment basin to fill and removing tidegate.

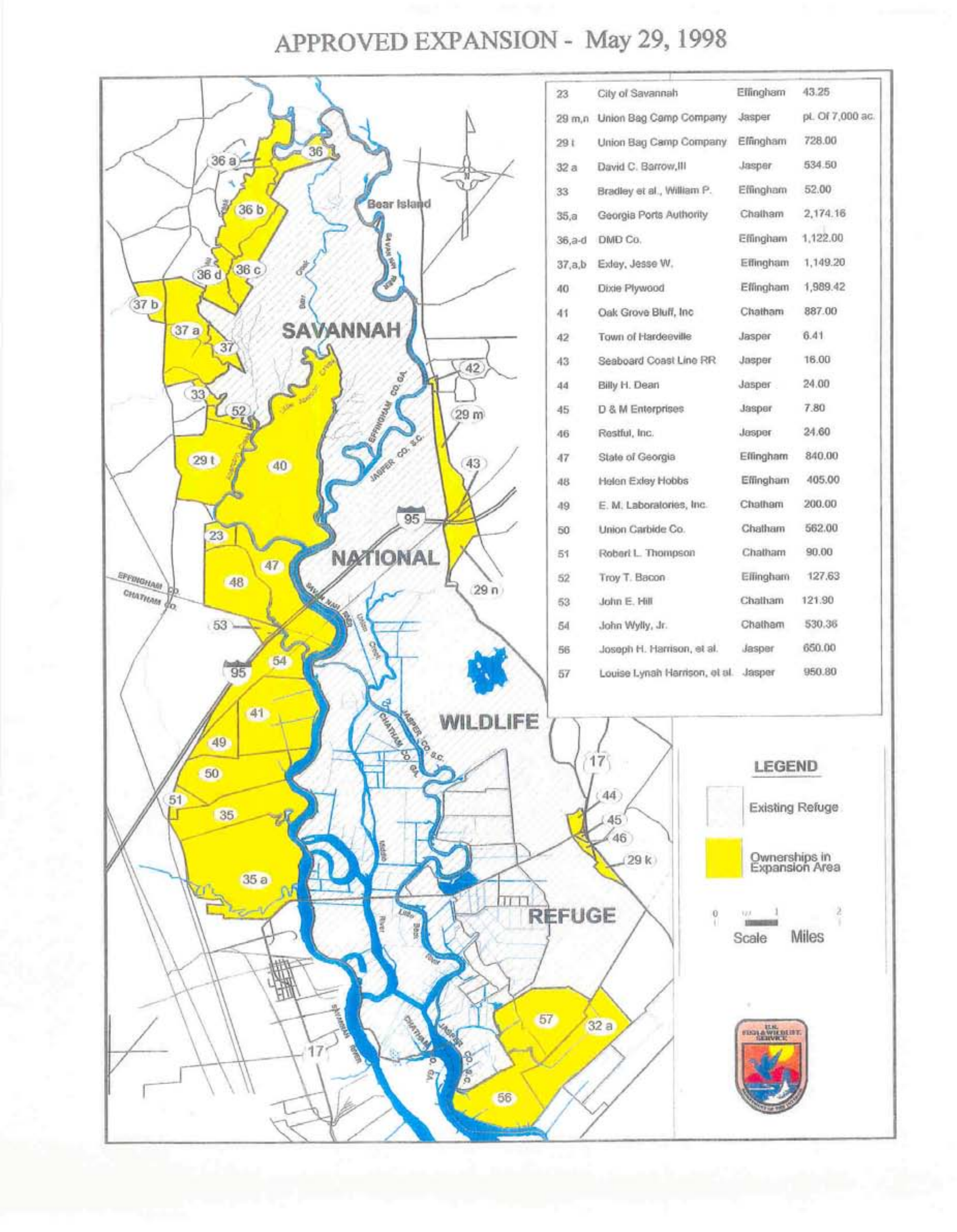

Figure 8. Lands that could be acquired and managed as compensation for Savannah Harbor deepening. All lands are within approved expansion area for Savannah NWR.

Restoration of the CDF 1S site would occur by grading it down to an elevation that would allow the growth of wetland vegetation. Appropriate elevations were identified based on the elevation of adjacent marsh. Once the new elevations have been established, the site would be allowed to naturally vegetate. If acceptable vegetation does not become established, the Corps proposes to plant *Spartina alterniflora* to provide the basis for subsequent growth across the entire site. A "feeder" creek system would also be constructed toward the interior from Middle River to support adequate tidal exchange to the interior of the restored wetland.

Dissolved oxygen

To address dissolved oxygen impacts the Corps has proposed to install and operate a re-oxygenation system using Speece cones (Tetra Tech, Inc. 2006). This system would inject oxygen near the river channel bottom at three locations. The oxygen injection locations and amounts would be selected to offset estimated dissolved oxygen reduction for each depth alternative.

Fish

Corps proposed fish mitigation measures would include constructing and operating a fish bypass channel (fishway) at the New Savannah Bluff Lock and Dam (NSBLD) near Augusta, Georgia to compensate for impacts to shortnose sturgeon habitats. This structure would be intended to allow passage of sturgeon and other migratory fish to access potential upstream spawning and nursery habitat. The Corps would also construct a 1,500-foot x 650-foot sill near the mouth of Middle River. Researchers have identified shortnose sturgeon occupying the bottom 1.5 meters of a deep hole in the Middle River approximately 2000 feet upstream from its mouth, and consider this area to be important habitat for juvenile shortnose sturgeon. The sill is intended to limit salinity movement into this habitat. In addition, funding would be provided for a striped bass stocking program to compensate for adverse impacts to striped bass spawning and nursery habitats within the estuary.

Cadmium

Sediments from cadmium-laden reaches would be placed in CDF's 14A and 14B and capped with two feet of clean sediment from other reaches. All sediment deposited in CDF's 14A and 14B as part of the harbor deepening project would not be used in the future for dike raising or borrow material. After sediment placement but before capping, 86 grab samples would be collected from the top 15 cm of each disposal area used to deposit sediments predicted to contain > 14 mg/kg cadmium. After capping, another 86 grab samples would be collected from the top 15 cm of these disposal areas. If the capping sediments within the disposal sites have more than 25 acres containing cadmium concentrations at or exceeding 4 mg/kg, the Corps will make covering those locations with maintenance-dredged sediments a priority. Maintenance sediments are low in cadmium and this covering would reduce potential for wildlife exposure to unacceptable cadmium levels. After capping, the Corps would conduct tissue sampling of birds utilizing the confined disposal facilities.

Recreational boating and fishing

Closing Rifle Cut for mitigation will make small boat access to Back River and Little Back River more difficult. Boaters will still be able to access Little Back River from Middle River or McCoys Cut but a longer run (8-10 additional miles or more) will be required to reach parts of the Back River. The Corps is proposing to construct a public boat ramp on Hutchinson Island to provide Back River access.

Summary

Table 5 presents a summary of the proposed fish and wildlife mitigation measures. The Corps proposes to implement the mitigation measures concurrent with project construction. Channel and flow modification and wetland acquisition are intended to mitigate for tidal freshwater marsh impacts. Wetland restoration is intended to address direct dredging impacts on brackish and salt marsh. The dissolved oxygen system using Speece cones is intended to offset the dissolved oxygen reduction caused by increased salinity stratification. The fish bypass channel and striped bass stocking are intended to mitigate impacts to shortnose sturgeon and striped bass habitat, respectively.

Table 5. Summary of Corps proposed fish and wildlife mitigation measures for the Savannah Harbor project.

		CHANNEL DEPTH ALTERNATIVE			
	44-FOOT	**45-FOOT**	**46-FOOT**	**47-FOOT**	**48-FOOT**
Channel and flow modification	Plan 6B	Plan 6A	Plan 6A	Plan 6A	Plan 6A
Wetland acquisition	0	1,643 acres	2,188 acres	2,245 acres	2,683 acres
Wetland restoration	29 acres	29 acres	29 acres	29 acres	29 acres
Dissolved oxygen system	33,075 lbs/day	28,685 lbs/day	30,870 lbs/day	35,280 lbs/day	39,690 lbs/day
Fish bypass channel at NSBLD	Yes	Yes	Yes	Yes	Yes
Striped bass stocking funds	$1,654,000	$280,000	$485,000	$2,621,000	$2,710,000
Cadmium capping and monitoring	Yes	Yes	Yes	Yes	Yes
Construct boat ramp	Yes	Yes	Yes	Yes	Yes

USFWS EVALUATION WITH MITIGATION

Each channel and flow modification feature has positive and negative impacts (Table 6). A necessary result of salinity reduction in selected areas of the estuary is the increase in other areas. The goal of the flow diversion plan was to reduce the salinity in Back River to minimize impacts to tidal freshwater marsh and the freshwater supply system. Therefore, most of the mitigation measures would increase salinity in Front River. Filling of the sediment basin would reduce salinity intrusion up Back River but would require more frequent maintenance dredging in the navigation channel. These issues are discussed further in the risk and uncertainty section in this report.

Table 6. Summary of positive and negative impacts for channel and flow modifications (Figure 5) evaluated for mitigation of Savannah Harbor deepening.

Mitigation	Positive impact	Negative impact
Install diversion structure (h)	Reduces salinity in Little Back River and upper Middle River	Increases salinity in Front River
Dredge Little Back River/Middle River (h)	Reduces salinity in Little Back River and upper Middle River	Increases salinity in Front River; dredging impacts on habitat and water quality
Close Drakies Cut/reroute through Steamboat (g)	Decrease salinity in Front River	Increase salinity in Middle River
Close Houston Cut (f)	Reduces salinity in Middle River	Reduces tidal range in Back River and Middle River
Close Rifle Cut (d)	Reduces salinity in Little Back River	Increases salinity in lower Middle River; limits small boat access to Back River
Close Middle River/ open New Cut (c)	Reduces salinity in Back and Middle River	Reduces tidal range in Back River and Middle River
Remove tide gate (b)	Increases tidal exchange and sediment flushing in Back River; improves small boat access	Temporary blasting impacts
Fill sediment basin (a)	Reduces salinity in Back River	Increases salinity in Front River; Increases maintenance dredging in Front River

Channel and flow modifications - Managed wetlands

Table 7 presents model predicted salinity levels at the freshwater diversion canal entrance on Little Back River with the existing and alternative channel depths with Savannah River year 2001 flow and a mid-range sea level rise (25 cm). All depth alternatives except the 47-foot alternative were modeled for these conditions. The Corps modeled the 47-foot depth alternative under average freshwater flow conditions and existing sea level rise but did not model low flow and 25 cm sea level rise for the 47-foot depth alternative. However, they believe that the 47-foot interpolation between the modeled 46- and 48-foot alternatives is sufficient to reasonably predict salinity under the conditions because the data trends are obvious and the fact that the 47-foot estimate is bound by two modeled scenarios (Bill Bailey, Corps, written communication 2011).

Table 7. Predicted salinity (ppt) at the freshwater diversion canal entrance at current and alternative Savannah Harbor channel depths. Conditions modeled were low Savannah River flow (2001) and a 25 cm sea level rise.

Depth	Mitigation plan	Salinity ppt 50% exceedance	Salinity ppt 10% exceedance
42 (current)	None	0.31	0.95
44	6B	0.11	0.61
45	6A	0.12	0.65
46	6A	0.14	0.73
47	6A	0.16	0.82
48	6A	0.18	0.91

Predicted salinity at the entrance ranges from 0.11 to 0.95 ppt under these conditions. Of the information available, the salinity 10% exceedance (% of time a specified value is equaled or exceeded), which would occur under low river flows, provides the best comparison of the plans. The salinity 50% exceedance would occur during higher flows which are unlikely to occur during the fall when most water is needed in the managed wetlands.

The average salinity of water entering the diversion canal would likely be between the 10% exceedance and the 50% exceedance predictions. The model predicts that none of the depth alternatives, with proposed mitigation, increase the salinity at the diversion canal entrance. Therefore, the proposed flow diversion mitigation appears to avoid impacts to managed wetlands. Because of the cumulative impacts of repetitive harbor deepening, even at the current channel depth the average salinity of water entering the diversion canal is likely to exceed the freshwater limit (0.5 ppt) as sea level rises (Table 7). With the associated mitigation plans, the 44-foot, 45-foot and 46-foot alternatives would be most likely to maintain freshwater conditions at the entrance and in the managed wetlands.

Channel and flow modifications - Tidal freshwater wetlands

The model to marsh spreadsheet application (M2M) used for impact analysis was developed by data mining techniques that used channel salinity data and interstitial salinity data at several locations in the estuary (Conrads et al. 2006). However, this empirical model uses relations among marsh salinity and channel salinity based on existing channel morphology and flow patterns. All of the mitigation alternatives include substantial changes in channel morphology and flow patterns. Because the alteration of the channel configuration changes the relations used in the M2M, it could not be used with any confidence to evaluate mitigation plans. Use of the marsh succession model was dependent on the M2M; therefore, the MSM could not be used to evaluate the mitigation plans.

As an alternative method, EFDC- predicted salinity in the river channels (Front, Middle and Back) was projected across the marsh surface based on drainage patterns determined from aerial photos. Marsh acreage in each salinity category was calculated by the geographic information system used for project analysis (Corps of Engineers 2010a). As discussed earlier in this report and presented in Table 1, commonly used marsh classifications are usually based on average channel salinity not interstitial salinity (Odum et al. 1984). The communities with a channel salinity of <0.5 ppt are considered to be tidal freshwater marsh with differing species composition. We focused our analysis on minimizing conversion of tidal freshwater marsh (0-0.5 ppt) to higher salinity marsh. The magnitude of marsh change predicted by the EFDC with the various depth alternatives and mitigation plans is presented in Table 8.

Table 8. Area of existing tidal freshwater marsh, predicted tidal freshwater marsh and predicted impact due to salinity changes, at current sea level, in the Savannah estuary for the project with and without mitigation.

Depth	Existing acres	Project acres without mitigation	Impact without mitigation (acres)	Mitigation plan	Project acres with mitigation	Impact with mitigation (acres)
44	4072	3521	-551	6B	4394	**+322**
45	4072	3105	-967	6A	4040	**-32**
46	4072	3015	-1057	6A	3871	**-201**
47	4072	2895	-1177	6A	3849	**-223**
48	4072	2860	-1212	6A	3735	**-337**

Based on model-predicted salinity impacts, the 44-foot channel and plan 6B would result in an increase of tidal freshwater marsh. With the 45-foot channel, tidal freshwater marsh impacts would be almost offset by plan 6A; the predicted loss is 32 acres. The 46-foot channel with the Corps proposed plan 6A would result in a loss of 201 acres of tidal freshwater marsh. The 47-

foot channel with the Corps proposed plan 6A would result in a loss of 223 acres of tidal freshwater marsh. The 48-foot channel with the Corps proposed plan 6A would result in a loss of 337 acres of tidal freshwater marsh.

Land Acquisition

Resource agencies and the Corps attempted to identify areas where tidal freshwater marsh could be restored in the Savannah estuary but no suitable sites were located. Therefore land acquisition was proposed to compensate for impacts. Because the impacted lands are Federal property and are open for appropriate public use, fee title acquisition is the only way to ensure replacement of public use value. The most suitable tracts are near or adjacent to Savannah National Wildlife Refuge. Therefore, these lands would be provided to the Refuge for protection, wildlife management and appropriate public use. However, USFWS objects to the proposal for advance mitigation, because sea level rise would have a negligible impact in the upper estuary if not for the cumulative impacts of previous harbor deepening. The rate of sea level rise is uncertain and substantial impacts resulting from sea level rise are not likely until well into the future. Conversely, the impacts of further harbor deepening will begin within a few years of project construction. In addition, due to the complexity of the system and limitations of the models, the USFWS has concerns that the models may underestimate wetland impacts. The USFWS regards "advance mitigation" as the functional equivalent of a mitigation bank, and our Mitigation Policy (64 FR 49229-49234) does not allow the use of Refuge lands for mitigation banks to compensate for the effects of activities authorized by the Department of the Army under Section 404 of the Clean Water Act and Section 10 of the Rivers and Harbors Act. Therefore, the USFWS does not support the concept of advance mitigation based on a future evaluation of the relative impacts of sea level rise.

Wetland restoration

Successful wetland restoration is dependent on three primary factors: soil, hydrology and vegetation. The proposed restoration site (1S) is located on an area that was predominantly wetland prior to use as a dredged material disposal area. When the dredged material is removed to initiate restoration, most of the exposed soil is likely to be similar to the original wetland soil. Therefore, it is likely that soil in the restoration will be suitable to support wetlands. Hydrology in the restoration area will be restored by removing the dredged material to match the elevation of adjacent marshes. In addition a "feeder" creek system would also be constructed toward the interior of the restoration site from Middle River to support tidal exchange to the interior of the restored wetland. Therefore, hydrology, as planned, in the restoration area is likely to be suitable to support wetlands if tidal sheet flow through adjacent marshes and flow through the feeder creek is sufficient. Conversely, if tidal flow is insufficient, less desirable vegetation may occupy the site. Also, depending on variables during construction, elevation of the site as constructed could vary from the planned elevation. A difference in elevation of only a few inches could result in the establishment of invasive vegetation (e.g. tallow tree) with almost no wildlife value rather than desirable wetland vegetation with high wildlife value. The desired vegetation outcome is to establish a mixed brackish marsh, similar to adjacent marsh, on the site.

The monitoring and adaptive management plan includes monitoring vegetation coverage of the 1S restoration site and the Corps proposes to plant *Spartina alterniflora* to provide the basis for subsequent growth across the entire site if vegetation does not become established. The plan needs to be modified to specify that establishment of native wetland plants is necessary for successful restoration. In addition, the plan needs to include specific monitoring and management protocols to detect and control exotic and invasive species.

The “advance mitigation” proposed by the Corps is the functional equivalent of a mitigation bank, and USFWS Mitigation Policy (64 FR 49229-49234) prohibits the use of Refuge lands in mitigation banks. Therefore the USFWS cannot support credit for "advance mitigation". Restoration could be limited to the 29 acres needed to offset impacts of the proposed project. Coordination with USFWS and other interested agencies during continued planning, construction and monitoring would help insure successful restoration.

Dissolved Oxygen

Dissolved oxygen in the estuary will be reduced by harbor deepening and the Corps plans to mitigate this impact by using Speece cones to inject oxygen into the harbor and offset the incremental oxygen impact. In August-September 2007 a full scale test on two Speece cones was conducted in Savannah Harbor and oxygen was injected over a 39 day period. The contractor report on the test concluded that the system could improve dissolved oxygen deficit by 0.6-0.7 mg/l, enough to effectively mitigate the dissolved oxygen impact of harbor deepening (MACTEC 2008). An independent peer review by USGS found that this conclusion is not supported by monitoring data. It is important to note that the USGS review does not conclude that the Speece cone system could not be effective. However, the USGS review found that analysis of data in the report and other monitoring data did not convincingly quantify improvement of dissolved oxygen during the test period. The review indicated that the natural tidal cycle accounted for most of the variation in dissolved oxygen level during the demonstration (Paul Conrads, USGS written communication 2008). Another review of the test report and available data found that dissolved oxygen increased only at moderate temperatures at mid-depth at the point of injection and concluded that the Speece cones had a very limited effect on dissolved oxygen level (Civilized Engineering 2007). Therefore it is difficult to assess how effective the oxygen injection would be at reducing the dissolved oxygen impact.

Fish

The predicted impacts to shortnose sturgeon habitat for depth alternatives with associated mitigation plans are presented in Table 9. These predictions were formulated by comparing habitat criteria developed by an interagency team of biologists to results of the Corps water quality model runs. The results of this analysis were presented in the Corps DEIS for the Savannah Harbor Expansion Project (Corps of Engineers 2010a).

After development of the original habitat criteria, NOAA recommended changing the salinity criterion for juvenile shortnose sturgeon and this change was accepted by the interagency team. The Corps has conducted additional analysis of juvenile impacts based on the revised criterion. However, NOAA has recommended additional modifications in the habitat analysis (Bill Bailey, Corps, personal communication 2011). Because there is currently no agreement on the revised juvenile habitat impact, the results presented in the Corps DEIS were considered appropriate for use in this report. Continued coordination between the Corps and NOAA is expected and may result in revised impact predictions for juvenile shortnose sturgeon.

Predicted impacts are caused by salinity changes in the various branches of the river system. Oxygen injection using Speece Cones is predicted by the models to offset impacts on dissolved oxygen. Winter habitat for juveniles is predicted to change 2% or less either positive or negative. Winter habitat for adults is predicted to decrease by 6% for the 44-foot/6b alternative and to decrease by 11% for the 48-foot/6a alternative. Adult summer habitat is expected to increase by 13% for the 44-foot/6b alternative and to decrease by 8% for the 48-foot/6a alternative. The cumulative impact on shortnose sturgeon was calculated by using a procedure for independent events (Sokol and Rohlf 1969, USFWS 2008). Impacts with the mitigation plan ranged from +7% for the 44-foot plan to -20% for the 48-foot plan. It is difficult to assess how effective the Corps proposed fishway would be as mitigation. This measure, if effective, would provide shortnose sturgeon access to the Augusta shoals and other riverine spawning areas. A much more effective measure would be removal of the NSBLD which would provide unrestricted spawning access as well as river restoration.

Table 9. Predicted impact to shortnose sturgeon juvenile winter (January) habitat, adult winter (January) habitat and adult summer (August) habitat and cumulative impact for depth alternatives with associated mitigation plan.

Channel depth/ Mitigation plan	**Juvenile winter percent change**	**Adult winter percent change**	**Adult summer percent change**	**Cumulative impact**
42 feet (baseline)	0	0	0	0
44 feet/6b	+1	-6	+13	+7
45 feet/6a	+2	-7	-1	-6
46 feet/6a	0	-9	-2	-11
47 feet/6a	-1	-9	-7	-16
48 feet/6a	-2	-11	-8	-20

The predicted impacts to striped bass spawning, egg and larval habitat for depth alternatives with associated mitigation plans are presented in Table 10. Predicted impacts are due to salinity changes in the various branches of the river system. For successful recruitment, all of these habitat components are needed.

Table 10. Striped bass spawning habitat, egg habitat, larval habitat and cumulative impact predicted for Savannah Harbor deepening at the 50%-tile flow.

Channel depth	Spawning habitat impact	Egg habitat Impact	Larval habitat Impact	Cumulative impact (%)
42 feet (baseline)	0	0	0	0
44 feet/6B	-3	-9	-6	-17
45 feet/6A	-9	+5	+2	-3
46 feet/6A	-10	0	+6	-5
47 feet	-14	-11	-5	-27
48 feet/6A	-16	-11	-4	-28

To assess overall impact to striped bass we used the mean flow (50^{th} percentile) as recommended by the GADNR. Cumulative impact was calculated by using a procedure for independent events (Sokol and Rohlf 1969, USFWS 2008). Table 10 summarizes the striped bass impacts for depth alternatives and associated mitigation plan. The 45-foot and 46-foot depths with plan 6A are predicted to have the least overall impact (-three and -five percent). The 47-foot and 48-foot alternatives have higher impacts, a 27% and 28% loss of habitat, respectively. GADNR believes the higher impacts (27-28% habitat loss at 47-48-foot depth) will have a significant effect on annual recruitment. The resulting permanent loss of critical spawning and nursery habitat will eventually lead to a collapse of the fishery due to the continued impacts on year class strength. They also believe that cumulative impacts would preclude the restoration of a naturally reproducing population of striped bass in the Savannah River. This complete failure of natural recruitment will require stocking striped bass in the Savannah River in perpetuity. GADNR concludes that to mitigate the impacts of the Savannah Harbor Expansion Project on striped bass habitat, a complete stocking and monitoring program should be fully funded for the life of the project. The Corps proposed to provide funding to GADNR for the striped bass stocking program in late 2015 or early 2016. To offset project impacts that begin when construction is complete, GADNR must have stocking capacity in place in the first spawning season following construction. The USFWS believes that the Corps should transfer funding for the striped bass stocking program when dredging is initiated, which should provide enough lead time to develop stocking capacity.

The models forecast an increase of between 52% and 74% in southern flounder habitat with mitigation, primarily because of predicted dissolved oxygen increase due to the Speece cone system. The American shad model predicted impacts of less than 2% for all depth alternatives and associated mitigation plans.

Cadmium

Although the USFWS maintains that the best available data does not support the Corps' determination that a cadmium concentration of >4mg/kg "is the lowest defensible estimate of a dry sediment cadmium level of potential concern," we recognize the uncertainty associated with the risk assessment model and the subsequent determination of a "protective" cadmium concentration. Due to the inherent uncertainties in ecological risk assessment, the USFWS is willing to accept the Corps' use of a cadmium concentration of >4mg/kg for monitoring purposes during dredging operations and following placement of the cover layer, to trigger priority in rotation for placement of maintenance sediments and to initiate vegetation monitoring. We recommend taking samples of the cap material to a depth of 30 cm instead of the 15 cm depth proposed.

However, as a condition of acceptance of the 4 mg/kg level, wildlife activity monitoring and bird tissue monitoring must be conducted to ensure that habitat within the CDFs is not harmful to wildlife. The USFWS believes the activity and tissue sampling are essential because of the uncertainties in risk assessment and because the CDFs will be managed to attract birds. Wildlife activity monitoring should begin with sediment placement and continue as long as all other monitoring of the CDFs. Tissue monitoring should occur: 1) prior to sediment placement to collect baseline data; 2) during sediment placement; and 3) post placement until 3 consecutive years of samples contain cadmium concentrations that are less than the potential adverse effect level, which is to be determined.

Summary plan evaluation

The 44-foot, 45-foot and 46-foot alternatives with associated mitigation plans would be most likely to maintain freshwater conditions at the diversion canal entrance and managed wetlands. Based on model predictions, tidal freshwater marsh impacts of the 44-foot channel would be eliminated by mitigation plan 6B and would result in an increase of tidal freshwater marsh. With the 45-foot channel, tidal freshwater marsh impacts would be almost offset by plan 6A; 32 acres would be impacted. The 46-foot channel and proposed plan 6A would result in a loss of 201 acres of tidal freshwater marsh. The 47-foot channel and proposed plan 6A would result in a loss of 223 acres of tidal freshwater marsh. The 48-foot channel with the Corps proposed plan 6A would result in a loss of 337 acres of tidal freshwater marsh. Because of the cumulative loss and high wildlife value of tidal freshwater marsh in the Savannah estuary, the USFWS places emphasis on avoiding or minimizing additional loss of this rare habitat. The only plans that accomplish this objective are the 44-foot and 45-foot depths with associated mitigation plans.

The American shad model predicted impacts of less than 2% for all depth alternatives and associated mitigation plans. Shortnose sturgeon habitat is expected to increase by 7% for the 44-foot/6B alternative, decrease by 6% for the 45-foot/6A alternative, 11% for the 46-foot/6A alternative, 16% for the 47-foot/6A alternative and 20% for the 48-foot/6a alternative. Striped bass habitat is expected to decrease by 17% for the 44-foot/6B alternative, 3% for the 45-foot/6A alternative, 5% for the 46-foot/6A alternative, 27% for the 47-foot/6A alternative and 28% for the 48-foot/6A alternative.

Table 11 summarizes impacts of the various plans on important fish and wildlife resources. The 44 and 45-foot plans (with mitigation) avoid or minimize impacts to tidal freshwater marsh and the freshwater supply system. The 45-foot depth minimizes impacts to striped bass habitat and the 44-foot depth minimizes impacts to shortnose sturgeon. The loss of freshwater marsh could be compensated by land acquisition as proposed by the Corps. However, land acquisition will not replace the wetland ecosystem function and diversity lost due to project impacts. Striped bass loss could be compensated to some degree by stocking. However this action does not address habitat degradation or meet the USFWS goal of restoration and maintenance of a self-sustaining striped bass population. In addition, it would not be practical to stock enough striped bass to equal the numbers of striped bass that could be produced by a healthy self-sustaining striped bass population. Based on the information obtained for the specific purpose of evaluating this project, it is clear that the 44- and 45-foot alternatives would have much lower impacts on fish and wildlife resources. Impacts of the project increase substantially at the 46-, 47- and 48-foot depths.

Table 11. Tidal freshwater marsh (0-0.5 ppt) predicted impact, striped bass habitat impact and shortnose sturgeon habitat impact for the Savannah Harbor project alternatives.

Alternative	Tidal freshwater marsh impact	Striped bass habitat impact	Shortnose sturgeon habitat impact
44-foot	+332 acres	-17%	+7%
45-foot	-32 acres	-3%	-6%
46-foot	-201 acres	-5%	-11%
47-foot	-223 acres	-27%	-16%
48-foot	-337 acres	-28%	-20%

UNCERTAINTY AND RISK

The EFDC model, the primary tool to evaluate project impacts and mitigation alternatives, is a mathematical representation of the Savannah River estuary, a highly complex system. The spatial, physical, chemical and biological complexity makes modeling of this system a significant challenge. The high tidal range, significant and variable freshwater inflow, salinity stratification and highly branched channel geometry with marsh storage result in a non-linear system that continuously varies over time and space. The EFDC/WASP model has known errors in its simulation of actual measured conditions and the simulation of the mitigation scenarios are an extrapolation of the model to an imagined system. It is unlikely that a model of this complexity will provide predictions that are accurate for all conditions and in all geographic areas. If there are errors in the model simulating the dynamics of the existing conditions, there will be greater errors in simulating a completely different system as represented by the mitigation alternatives. Caution needs to be used in interpolating mitigation scenarios, especially ones that are substantially different than the existing system. The most responsible use of the model is for inference of the possible impacts to the system and not as an absolute prediction of the impacts. Although the EFDC/WASP model provides the best available estimate of mitigation effectiveness, the model salinity and dissolved oxygen predictions may be quite different from the post-project measured impacts in the estuary.

The EFDC model was extensively reviewed by scientists from a number of agencies including the USFWS, USGS, EPA, South Carolina Department of Health and Environmental Control (SCDEHEC) and GADNR. These agencies concluded that the EFDC model was adequate to evaluate the deepening project, but certain cautions were identified. The USFWS stated in letter of July 5, 2005: “Therefore, even if a model is judged to be acceptable for use there will always be some level of uncertainty in its performance. One important area of uncertainty will be in evaluating the predicted effects of mitigation plans involving flow diversions from the Front River to the Middle and Back River.” The USGS stated in letter of June 28, 2005: “Modeling of the Middle, Little Back and Back Rivers is very difficult due to the complexity of this branched network of shallow tidal rivers and creeks…The flow predictions have improved from previous applications of the model but are only satisfactory. Possible mitigation scenarios include diverting a portion of the flow from the Savannah River to the Middle and Little Back Rivers. The inability of the model to capture the ebb-tide flow dynamics should be remembered while interpreting scenarios where increased flows in the vicinity of SNWR are significant.” The SCDHEC, in letter of March 10, 2006, discussing the under prediction of ebb flows in the Middle River and Back River, stated: “…this issue is not considered significant …for application to deepening impacts; however, application to mitigation scenarios that alter channel connections—and attempt to predict resulting changes to the flow regime and the effect on salinity—may require additional evaluation of model capability.”

All of the proposed mitigation alternatives include flow diversion as a basic and highly important component. The predicted reduction of salinity in the Middle River and Back River is due in large part to the proposed flow diversion from Front River. The model uncertainty in this geographic area is of concern, particularly because most of the remaining freshwater tidal marsh and the entrance to the diversion canal are located in the Back River. In addition the diversion structure is modeled by constricting the Front River at McCoys Cut. Even though this constriction is essentially what a diversion structure would do, when the structure is actually constructed it may not alter flow distribution as predicted in the model. The design and construction of a diversion structure that would quantitatively alter flows exactly as predicted in the model is highly unlikely. Flow into the Little Back River will also be influenced by channel gradient and tidal progression in the river system (Wiley Kitchens, USGS, personal communication, 2005).

Another area of concern involves the potential for increased sedimentation in McCoys Cut, Middle River and Little Back River caused by the diversion structure at McCoys Cut. Several studies indicate that increasing flow into river cutoff bends increases the siltation rate in the bend and decreases its duration as an aquatic system (Shields 1987). While the tributaries involved are not cutoff bends, sedimentation patterns are likely to be similar. Diversion structures divert most water when river flows and sediment loads are high. As sediment laden water reaches areas of lower velocity, sediment is deposited. The risk of sedimentation is high in the vicinity of McCoys Cut and Little Back River near Union Creek because of the presence of a tidal null point in this location. Large sediment bars are currently at this location and diversion of water from the Front River may accelerate sedimentation. If sedimentation increases, periodic maintenance dredging would be required to maintain the mitigation features. Maintenance dredging has impacts on benthic invertebrates and potential impacts on wetlands; depending on how dredging is performed and where dredged material is placed.

All of the mitigation features based on flow modification are intended to reduce salinity in the Back River because much of the tidal freshwater marsh and the freshwater diversion system are located in this branch. However, diversion of fresh water into the Back River allows salt water to move further up the Front River and into the Middle River. As a result, in the Front River and lower Middle River mean and maximum salinity would be higher with the mitigation plan than without it. Closing of Rifle Cut helps address the risk of salinity increase in Back River by preventing flow from Middle River to Back River. The model may under predict the amount of salinity moving up Front and Middle River. Even a slight error in the model could result in salinity moving into Little Back River from the Middle River near McCoys Cut or entering McCoys Cut from Front River. If either event occurred, impacts to tidal freshwater wetlands, the freshwater diversion system and striped bass would be higher than expected. Tree mortality in tidal forested wetlands along Front River would occur if salinity increases more than predicted. In addition, shortnose sturgeon, and striped bass which utilize the Front River and lower Middle River could be impacted more than expected. Salinity increases more with greater channel depth and the margin for error is reduced before impacts would occur to the Little Back River. Therefore, risk and uncertainty are highest with the 48-foot alternative.

As discussed earlier in this report, there is a high degree of uncertainty as to how effective oxygen injection would be. The fish habitat model results are based on predictions from the EFDC/WASP model. If the Speece cones are not as effective as previously assumed, the model predictions of harbor deepening impacts on fish would be underestimated. Because dissolved oxygen is a key component of all aquatic habitats, underestimation of harbor deepening impact would be important. In addition, if the number of Speece cones had to be increased, the cost of this mitigation feature could increase substantially.

Another area of uncertainty is how the planned Jasper County Terminal would impact fish and wildlife resources and the potential to avoid upstream impacts that would occur through development of this project. Deepening of the harbor only to river mile 7 would have much less impact on salinity intrusion into Savannah NWR and dissolved oxygen in the harbor compared to deepening the river an additional 12 miles to river mile 19. Mitigation cost of the project would be substantially reduced because it is likely that most of the mitigation features to address salinity intrusion and dissolved oxygen would be unnecessary. In addition dredging quantity would be greatly decreased reducing initial cost and prolonging the life of dredged material disposal areas. However, because of the need to replace lost dredged material disposal capacity, there could be other mitigation costs associated with the Jasper County Terminal.

MONITORING AND ADAPTIVE MANAGEMENT

The Corps has proposed pre-construction monitoring (one year), monitoring during construction (three years) and post-construction monitoring (five years). The monitoring would include water quality, channel morphology, wetlands, shortnose sturgeon tagging and tracking in the estuary, and fish passage at the New Savannah Bluff fishway. The wetland monitoring would be similar to pre-project impact evaluation studies that were initiated in the late 1990's and were carried on for several years. The shortnose sturgeon estuary monitoring would be similar to pre-project impact evaluation studies that were initiated in the late 1990's and were carried on for two years. The monitoring plan is described in detail by the Corps (2010a).

The USFWS strongly supports the proposed comprehensive monitoring program. In addition to a post-construction monitoring plan, a post-construction monitoring data-analysis plan needs to be established. It will be difficult in a highly altered system, as represented by the mitigation plans, to analyze the post-construction monitoring data and to determine the efficacy of the mitigation measures. A recent example of the need for such a plan is the re-oxygenation demonstration project. Monitoring data was collected but there was not an effective data analysis approach in place to analyze the data and quantify the impact of the demonstration project on the highly variable dissolved oxygen dynamics of the system. There are a number of other concerns with the proposed monitoring plan.

Pre-construction monitoring for one year is intended to create or supplement a pre-project baseline. However, information based on only one year of data may not provide an adequate baseline. Use of available long-term salinity data sets, from the end of the last harbor deepening construction to the start of any new deepening construction, as baseline salinity conditions to supplement the one year of pre-construction water quality monitoring would help address this problem. Two existing water quality stations on Back River (021989784 and 021989791), and one on Front River (02198920), that have long-term salinity data should be included in the baseline. Similarly, wetland and fishery studies performed during project planning represent useful baseline information. The plan needs to describe in greater detail developing baseline conditions for the various monitoring parameters. If construction is delayed for more than one year after a decision for harbor expansion, pre-construction monitoring should be continued until construction begins.

A recent Savannah River drought with four years duration occurred during 1998-2002. Other droughts of two-three years duration are not uncommon. Periods of exceptionally high river flow also occur periodically and can last for several years. If the post-construction period coincides with a prolonged drought or high flow period, the monitoring data would be of limited value.

After a prolonged drought or high flow period, wetland vegetation will take some time to respond to the salinity change. Therefore, we believe that the post-construction wetland and continuous water quality monitoring needs to be increased from five years to ten years.

No monitoring is proposed for striped bass, but there is a great deal of uncertainty on the impact predictions. A post-project assessment of striped bass habitat using the water quality monitoring data and updated water quality simulations is needed. Model updates are already planned that would facilitate a low-cost assessment using the established striped bass habitat criteria. Habitat impact could be assessed during the fourth year of post-project monitoring. If the post-project impacts are higher than pre-construction predicted habitat impacts then funding for striped bass stocking should be increased in proportion to the impact.

The Corps proposes to fund four long-term water monitoring stations to determine whether the mitigation features are functioning as intended. A fifth station, Station 021989784, is located at the intake of the freshwater supply system for the 3,000 acres of managed wetlands on Savannah NWR and is therefore especially important for monitoring project impacts to the Refuge. Therefore this station should be added to the long-term stations.

The Corps (2008b) described the following potential adaptive management measures as part of the Savannah Harbor Expansion Project.

- Enlarging the diversion structure at the mouth of McCoys Cut;
- Enlarging the deepened area at McCoys Cut, Middle & Back Rivers;
- Constructing a diversion structure at the junction of Middle and Back Rivers;
- Removing the tidegate sill;
- Raising or lowering the height of the submerged sill at the Sediment Basin;
- Improving fish passage at the NSBLD fish bypass;
- Acquisition of additional freshwater wetlands;
- Constructing and operating additional dissolved oxygen systems;
- Modifying the submerged sill across Middle River
- Modifying the wetland restoration area at former disposal area 1S;
- Preferential placement of maintenance sediments into CDF's 14A and 14B

Many of these measures are proposed because of uncertainty regarding the channel and flow modifications. Post-construction monitoring and consultation with the Federal Cooperating Agencies would determine the need to implement these measures (Corps of Engineers 2010a). We support the proposed adaptive management plan but a number of improvements are needed.

The plan describes an informal inter-agency review process for monitoring data and reports during the five year post-construction monitoring period. Within one year after the five year post-construction monitoring period, the Corps would prepare a consolidated report of the various monitoring programs, followed by 30 days of agency review, an unspecified time period for further report revision, public review, and a potential elevation process. This time-line for making decisions on adaptive management actions would likely require a minimum of 1.5 years after the five year post-construction monitoring period, and could take much longer. This process needs to be compressed so that final decisions on corrective actions are reached within one year after the monitoring period. In addition, because we are recommending extending the duration of post-construction monitoring from five years to ten years, a consolidated report of the various monitoring programs at the end of five years, and again at the end of ten years following project construction needs to be prepared and coordinated, to ensure that adaptive management decisions can be made when it becomes apparent that a problem exists, and in a timely manner.

The Federal modeling performance goals in the Corps plan are generally those provided by review agencies in 2001 during hydrodynamic model development. Because the agencies were aware of the complexity of the system and model limitations, we allowed considerable latitude in the performance of the models. We are concerned that adopting the same tolerances for the performance of the constructed project is inappropriate, because actual impacts could differ substantially from the predicted impacts without triggering remedial action. Based on earlier coordination, the Corps modified the tolerances for achieving a goal of <1 ppt salinity to +/- 0.1 ppt, and we support this change. The goal for salinity in the range of 1-5 ppt has not been modified, and would allow considerable impact without triggering action. As proposed, a range of 0.5 to 1.5 ppt is acceptable for a salinity goal of 1 ppt (+/- 50%), while a range of 0.89 to 1.09 ppt is acceptable for a salinity goal of 0.99 ppt (+/- 10%). Modifying the goal for salinity in the range 1-5 ppt to +/- 10 % (not +/- 0.5 ppt as the Corps proposed) to make it more consistent with other goals and triggers for adaptive management would be appropriate.

The Corps proposes to monitor the performance of corrective actions under the adaptive management program for one year. It is unlikely that one year of post-construction monitoring would be sufficient to determine the outcome of the action in a system as dynamic as the Savannah estuary. A minimum of three years of post-construction monitoring of adaptive management actions is needed to determine the success of implemented actions.

The plan states that the "Corps would seek and obtain its funds for this phase each year through the normal budget process". It is relatively certain that impacts to USFWS trust resources would occur following construction, but the effectiveness of the mitigation features is much less certain. Unless contingency funding for monitoring/adaptive management activities is assured the proposed mitigation plan may not adequately address project impacts.

SUMMARY AND CONCLUSIONS

Savannah NWR and the surrounding estuary support nationally important fish and wildlife resources. However, cumulative impacts of previous harbor modifications, primarily salinity intrusion, have severely impacted the resources that were present when the Refuge was established. A freshwater supply system for managed wetlands, installed as mitigation for the tidegate, has failed to function adequately. Tidal freshwater marsh has been reduced from about 12,000 acres to about 3,300 acres. Striped bass reproduction and recruitment were almost eliminated during tide gate operation but have recently begun to recover. Shortnose sturgeon habitat has been greatly impacted both by salinity increase and dissolved oxygen decrease.

The current inner harbor is 42 feet in depth. Impacts of project depths of 44, 45, 46, 47 and 48 feet were evaluated using hydrodynamic, water quality and biological models. A number of mitigation measures have been proposed by the Corps. Many of these measures are based on channel and flow modifications in the estuary. In addition, a dissolved oxygen injection system, wetland restoration, wetland acquisition, striped bass stocking and a fish bypass channel at New Savannah Bluff have been proposed.

There is a great deal of risk and uncertainty regarding success of the channel and flow modification and dissolved oxygen mitigation plans. The mitigation plans are unlikely to perform exactly as predicted. There could be unintended adverse consequences resulting from the channel and flow mitigation measures. All of the proposed mitigation alternatives include flow diversion as a basic and highly important component. The predicted reduction of salinity in the Middle River and Back River is due in large part to the proposed flow diversion from Front River. The EFDC model uncertainty in this geographic area is of concern, particularly because most of the remaining freshwater tidal marsh and the entrance to the diversion canal are located there. Diversion of fresh water into the Back River allows salinity to move further up the Front River and into the Middle River. As a result, in the Front River and lower Middle River mean and maximum salinity would be higher with the mitigation plan than without it. The model may under predict the amount of salinity moving up Front and Middle River.

Based on the available information, there is a high degree of uncertainty as to how effective oxygen injection would be. The fish habitat model results are based on predictions from the EFDC/WASP model. If the Speece cones are not as effective as previously assumed, the model predictions of harbor deepening fish impacts would be underestimated. Because dissolved oxygen is a key component of all aquatic habitats, underestimation of this harbor deepening impact would be important. In addition, if the number of Speece cones had to be increased the cost of this mitigation feature could increase substantially.

The 44 and 45-foot plans (with mitigation) avoid or minimize impacts to tidal freshwater marsh and the freshwater supply system. The 45-foot depth minimizes impacts to striped bass habitat and the 44-foot depth minimizes impacts to shortnose sturgeon. Based on the information obtained for the specific purpose of evaluating this project, it is clear that the 44 and 45-foot alternatives would have much lower impacts on fish and wildlife resources. Impacts of the project increase substantially at the 46-, 47- and 48-foot depths. For any project implemented, the USFWS supports a comprehensive monitoring program to document actual impacts and an adaptive management plan to rectify unanticipated impacts.

RECOMMENDATIONS AND POSITION

The following recommendations and position are provided to the Corps pursuant to the FWCA, which requires the Corps to give full consideration to the report and recommendations of the Secretary of Interior and to any report of State Wildlife agencies. In addition, Department of Interior concurrence in the project is required before implementation, as provided for in the 1999 conditional Congressional authorization. Acceptance of the following recommendations and position would be the primary factor in determining USFWS and Departmental concurrence.

Recommendations

1. Determine project impact and formulate mitigation by comparing predicted with-project conditions immediately after construction (rather than average annual) to base year conditions.

2. Eliminate the "advance mitigation" proposed by the Corps for acquisition and additional restoration on site 1S. Restoration of site 1S could be limited to the amount needed to offset impacts of the proposed project.

3. Complete repair of the Savannah NWR freshwater supply system prior to harbor deepening construction.

4. Initiate mitigation land acquisition no later than initiation of harbor construction and complete acquisition in a timely manner (within two years of start).

5. Install a fish passage facility at New Savannah Bluff Lock and Dam or remove the dam to restore the river. Continue coordination with resource agencies to optimize design of any fish passage facility.

6. Transfer Corps striped bass stocking program funding to GADNR when harbor construction is initiated in order to provide enough lead time to develop stocking capacity.

7. Continue coordination with the USFWS to define the scope of vegetation, wildlife activity and bird tissue monitoring in the CDFs 14A and 14B.

8. Add Station 021989784, located at the intake of the freshwater supply system on Savannah NWR, as a long-term monitoring station.

9. Continue coordination with resource agencies to develop a data analysis and information delivery plan as part of the monitoring program.

10. Increase post-construction wetland and continuous water quality monitoring from five years to ten years and prepare a consolidated report of the various monitoring programs at the end of five years, and again at the end of ten years following project construction.

11. In the adaptive management plan, describe in greater detail how baseline conditions will be developed for the various monitoring parameters. Make maximum use of existing long-term water quality stations and all planning biological studies. If construction is delayed for more than one year after a decision for harbor expansion, continue pre-construction monitoring until construction begins.

12. Modify the monitoring and adaptive management plan to include a striped bass habitat impact assessment during the fourth year of post-project monitoring. If the post-project impacts are higher than pre-construction predicted habitat impacts then increase funding for striped bass stocking in proportion to the impact.

13. Modify the adaptive management plan to specify that establishment of native wetland plants is necessary for successful restoration. Include specific monitoring and management protocols to detect and control exotic and invasive species. Continue coordination with USFWS and other interested agencies during planning, construction and monitoring of wetland restoration site 1S.

14. Compress the adaptive management decision-making process so that final decisions on corrective actions are reached within one year after the monitoring period.

15. In the adaptive management plan, modify the performance goal for salinity in the range of 1-5 ppt to +/- 10 % (not +/- 0.5 ppt) to make it more consistent with other goals and triggers for adaptive management.

16. Perform three years of post-construction monitoring of any implemented adaptive management actions.

Position

The USFWS's preferred alternative for deepening Savannah Harbor is the 45-foot alternative. This alternative 1) minimizes the loss of already limited freshwater tidal wetlands; 2) minimizes impacts to Savannah NWR; and 3) minimizes risk and uncertainty of impacts on fish and wildlife resources.

Any additional economic benefits resulting from the LPP relative to the NED plan would represent local benefits. By contrast, the additional environmental impacts associated with the LPP, and in particular the loss of an additional 114 acres of already scarce and declining freshwater tidal wetlands, would occur on a national resource, the Savannah NWR. The additional 114 acres of impact to freshwater tidal wetlands associated with the LPP represents a 50% increase in impacts over the NED plan's depth. For this reason, the USFWS does not support the LPP.

As currently proposed, Corps funding for adaptive management activities that may be required will be dependent upon the Corps' annual appropriations process. Because these adaptive management actions may be essential to correct mitigation deficiencies and insure that impacts to fish and wildlife trust resources are offset, contingency funding for any required adaptive management activities needs to be assured, and not dependent upon annual appropriations.

COORDINATION WITH STATE AND FEDERAL WILDLIFE AGENCIES

A draft of this FWCA report was provided to SCDNR, GADNR and NOAA for review and their responses are included in Appendix A. The Corps released the final version of the DEIS at the same time as this draft report was under review. The DEIS contained new or revised information on sea level rise, advance mitigation and adaptive management. Therefore, the final version of this FWCA report was revised to address the changes in the DEIS and a number of recommendations have been modified or added. The final version of this report added nine recommendations to the seven in the review draft. However, none of these changes affected the conclusions of the report or the Service position.

SCDNR generally concurred with the Service report and stated that the project should be limited to a maximum authorized depth of 44 or 45 feet in order to minimize environmental impacts. They also agreed that there was considerable uncertainty with the models used to predict impacts and with the proposed oxygen injection system. SCDNR concurred with what are recommendations 3, 4, 7, 10, 13 and 15 (modified) in the final version of the report. SCDNR did not concur with recommendation five in the final version of the report and they state that passage for shortnose stugeon is unproven and difficult to support. At the time of review, SCDNR did not support fish passage at NSBLD or removal of the dam.

GADNR commented on loss of spawning habitat that will likely preclude restoration of a naturally sustaining striped bass population in the Savannah River. They supported the proposed striped bass management program and requested that striped bass mitigation be made prior to project impacts. Recommendations 6 and 12 were added to address timely funding, monitoring and adaptive management of striped bass.

NOAA provided a number of detailed comments, many related to shortnose sturgeon. They did not make any recommendations about the acceptability of the proposed alternatives because they believe impacts to shortnose sturgeon and other resources need to be better understood. The Service revised this report to address several of their specific comments. NOAA and the Corps are continuing endangered species consultation and essential fish habitat consultation to address impacts and mitigation to resources under NOAA jurisdiction.

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APPENDIX A - AGENCY RESPONSE LETTERS

South Carolina Department of
Natural Resources

1000 Assembly Street Room 310A
PO Box 167
Columbia, SC 29202
803.734.3766 Office
803.734.9809 Fax
perryb@dnr.sc.gov

John E. Frampton
Director
Robert D. Perry
Director, Office of
Environmental Programs

December 17, 2010

Ms. Sandra S. Tucker
Field Supervisor
US Fish and Wildlife Service
105 West Park Drive, Suite D
Athens, Georgia 30606

REFERENCE: USFWS Log Number 2011-0140 Savannah Harbor Expansion Project Fish and Wildlife Coordination Act Report

Dear Ms. Tucker,

Personnel of the South Carolina Department of Natural Resources (DNR) have reviewed the Draft Fish and Wildlife Coordination Act (Draft FWCA) Report for the proposed Savannah Harbor Expansion Project (SHEP) and offer the following comments.

The Draft FWCA Report accurately characterizes the major environmental impacts of the proposed SHEP, as presented in the Draft Environmental Impact Statement (DEIS) for this project. Should SHEP be authorized, and contingent on the final DNR position on the DEIS for the project, DNR concurs with recommendations 1 and 2 and 4-7 included in the FWCA Report regarding the implementation, mitigation and long-term monitoring of this project. In addition, DNR reiterates support for grading down former disposal area 1S as compensatory mitigation for any direct loss of saltwater wetlands due to bend widening or other excavation related to SHEP. DNR also supports the construction of a public boat ramp on Hutchinson Island as compensatory mitigation for diminished recreational boating access to the Back River resulting from the proposed closure of Rifle Cut.

DNR agrees the project should be limited to a maximum authorized depth of 44 or 45 ft (MLW) in order to minimize impacts of increased salinity intrusion and decreased dissolved oxygen levels on fish, wildlife, freshwater wetlands, and water quality in the lower Savannah River and its tributaries. The 44 ft alternative (with mitigation) would minimize impacts to tidal freshwater wetlands and suitable habitat for the federally endangered shortnose sturgeon (*Acipenser brevirostrum)* (SNS); whereas, the 45 ft alternative, with mitigation, would minimize impacts to striped bass (*Morone saxatilis*) habitat, but result in some loss of tidal freshwater wetlands and SNS habitat. As stated in the report, the loss of tidal freshwater wetlands could be offset by the acquisition and transfer of suitable tracts of land to the Savannah National Wildlife Refuge for protection, wildlife management, and appropriate public use. The US Army Corps of Engineers

(USACE) proposes to partially offset the loss of SNS habitat by constructing and operating a fish bypass system at the New Savannah Bluff Lock and Dam (NSBLD), which theoretically would allow SNS and other anadromous fish to access upstream spawning and nursery habitat. Fish passage for SNS is unproven and difficult to support. The US Fish and Wildlife Service (USFWS) and the National Marine Fisheries Service (NMFS) believe a much more effective measure would be to remove the NSBLD entirely, which would provide access to upstream spawning and nursery habitat in this reach of the Savannah River. At this time and due to the substantial aquatic resource impacts associated with the proposed SHEP, DNR does not support either fish passage at NSBLD or removal of this dam.

DNR agrees that there is considerable uncertainty associated with the models used to predict environmental impacts of the proposed deepening project and other hydrological modifications proposed as mitigation for those impacts. Particularly there is considerable uncertainty associated with the effectiveness of the oxygen injection system that is proposed as compensation for projected decreases in dissolved oxygen resulting from the project. Therefore, DNR also agrees that adequate contingency funding for any required adaptive management activities needs to be assured, and not dependent upon annual appropriations to the USACE.

In conclusion, DNR commends the USFWS for its thorough review and analysis of all major environmental impacts of the proposed project, and supports most recommendations and positions as presented in the FWCA Report. DNR will provide additional comments on specific aspects of the SHEP directly to the USACE as part of the public review process for the DEIS, and nothing herein binds DNR relative to forthcoming comments on the DEIS. DNR anticipates continuing coordination with the USFWS, as well as NMFS, in formulating any additional recommendations or comments related to this proposed project. If your office will require any further information regarding this transmittal, please contact Priscilla Wendt at wendtp@dnr.sc.gov or 843-953-9305.

Sincerely,

Bob Perry
Director, Office of Environmental Programs

c: Jay Herrington – USFWS
Pace Wilber – NMFS
Bob Lord - USEPA
Barbara Neale – DHEC-OCRM
Heather Preston – DHEC-ECQ
Michael G. McShane – Chairman DNR Board
John Frampton
Don Winslow
Robert Boyles
Priscilla Wendt

GEORGIA
DEPARTMENT OF NATURAL RESOURCES
WILDLIFE RESOURCES DIVISION

JAN 0 3 2011

JAN 0 3 2011

MARK WILLIAMS
COMMISSIONER

DAN FORSTER
DIRECTOR

December 30, 2010

Sandra Tucker, Field Supervisor
Division of Ecological Services
US Fish and Wildlife Service
Coastal Georgia Sub-Office
4980 Wildlife Drive
Townsend, Georgia 31331

Subject: Comments on Draft Fish and Wildlife Coordination Act (FWCA) Report

Dear Ms. Tucker:

Thank you for the opportunity to review and provide comment on the Draft Fish and Wildlife Coordination Act (FWCA) Report for the proposed Savannah Harbor Expansion Project (SHEP). The Georgia Department of Natural Resources, Wildlife Resources Division (WRD) continues to work closely with Bill Wikoff and other Fish and Wildlife Service staff throughout this process and appreciate the level of cooperation and inclusion and data sharing that has occurred between our respective agencies. Much of our effort has been directed toward fishery resources, including the very popular striped bass fishery. This once thriving population nearly collapsed in the late 1980's due to changes in bathymetry and increased salinity levels in critical spawning grounds located in the Back River. WRD has made a long-term commitment to the recovery of the Savannah River striped bass population and has made tremendous strides towards recovering this fishery. Recovery efforts included closing new cut, removing the gates from the tide gate structure, closing the fishery to harvest, and an intense stocking program that continues to this day. The fishery was successfully re-opened to limited harvest in October 2005.

The FWCA Report does a thorough job identifying predicted impacts at project depths of 44, 45, 46, 47, and 48 feet and chronicling the predicted effectiveness of mitigation options at these depths. Methodologies used to assess cumulative impacts at the locally preferred plan of 48 feet predict significant impact to the remaining critical striped bass spawning habitat in the Savannah River estuary. Permanent loss of remaining spawning habitat will likely preclude restoration of a naturally sustaining striped bass population in the Savannah River. Furthermore, flow and channel modification mitigation options do not ameliorate predicted project impacts. To compensate for the predicted impacts to striped bass, we concur with the FWCA Report in that the Savannah River striped bass management program should be funded and request that striped bass mitigation be made prior to further degradation of critical habitat caused by river dredging. We agree with your assessment that an adaptive and comprehensive monitoring program will be necessary to document project impacts and address corrective measures.

Sincerely,

Dan Forster

Dan Forster

DF/tab

cc: John Biagi

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE

Southeast Regional Office
263 13th Avenue South
St. Petersburg, Florida 33701-5505
(727) 824-5317; FAX (727) 824-5300
http://sero.nmfs.noaa.gov/

February 16, 2011 F/SER4:PW/pw

(Sent via electronic mail)

Sandra Tucker
Fish and Wildlife Service
105 West Park Drive, Suite D
Athens, Georgia 30606

Attention: Bill Wikoff

Dear Ms. Tucker:

NOAA's National Marine Fisheries Service (NMFS) reviewed your letter dated November 15, 2010, requesting comments on the *Draft Fish and Wildlife Coordination Act Report on the Savannah Harbor Expansion Project* (FWCA Report) in Chatham County, Georgia, and Jasper County, South Carolina. On December 13, 2010, Kay Davy, from our Protected Resources Division, and Pace Wilber, from our Habitat Conservation Division, met with Ed Eudaly from your office. During this meeting we reviewed the report page-by-page, discussed our comments, and indicated NMFS's current position on the major points made by the Fish and Wildlife Service in the draft report. Several short, follow-up communications occurred after the meeting. The attached list provides a record of the comments that were provided during the meeting and follow-up communications. Also attached for easy reference is a copy of the letter NMFS provided the U.S. Army Corps of Engineers on January 25, 2011, that summarizes NMFS' position on several key questions raised in the FWCA Report.

NMFS greatly appreciates the effort the Fish and Wildlife Service has put into the FWCA Report and other facets of the planning for the Savannah Harbor expansion, and thank you for the opportunity to provide comments on the draft report. Related correspondence should be directed to the attention of Pace Wilber (843-762-8601 or Pace.Wilber@noaa.gov) or Kay Davy (954-356-6791 or Kay.Davy@noaa.gov).

Sincerely,

Pace Wilber

/ for

Miles M. Croom
Assistant Regional Administrator
Habitat Conservation Division

cc:
Ed Eudaly, peconsulting@knology.net
FWS, Bill_Wikoff@fws.gov, Sandy_Tucker@fws.gov
SCDNR, WendtP@dnr.sc.gov, PerryB@dnr.sc.gov
SER3, SER4

NMFS comments and questions on the *FWCA Report for the Savannah Harbor Expansion Project,* dated January 2011

Preface: To avoid redundancy in our comments, we are not commenting on the *Executive Summary* and assume that any changes needed to the *Executive Summary* based on the comments below would be made. Also, citations provided below refer to citations provided in the FWCA Report unless otherwise specified.

Prior Studies and Reports (section begins page 1)

1. May want to add to this section a discussion of the continuous impacts of the navigation project on diadromous fish and estuarine fish and shellfish. For example, the dredged material disposal areas are a continuous impacts on estuarine and tidal freshwater ecosystems due to the fill and blockage of extensive tidal creek systems formerly connected to the river.

Fish and Wildlife Resources (section begins page 6)

2. In the absence of management, how would habitats described as "freshwater managed wetlands" be characterized; specifically the impounded areas shown in Figure 2 associated with the diversion canal, Fife Plantation, and Clydesdale Plantation? Recommend Figure 2 be modified to include a polygon and labels that identify the freshwater managed wetlands referenced. This would also increase the precision of acreage calculations.

Fish and Wildlife Resources, Tidal freshwater wetlands (section begins page 9)

3. In this section and elsewhere, brackish marshes are described as having "lower diversity" than tidal freshwater marshes. While we agree that brackish marshes have fewer plant species than tidal freshwater marshes, the FWCA Report should not suggest that this difference equates to a difference in value when all ecosystem components (e.g., nursery habitat for fish, crabs, and shrimp) are considered. Assessments of wetland value are made with respect to a purpose, and FWS' view of what the purpose of these wetlands is should not be viewed as determinative.
4. Page 11 includes acreage for tidal freshwater marsh as far back as 1875. The source of these acreages should be provided; polygons would be preferable to increase precision and use in the adaptive management program.
5. Page 11 references Bill Bailey for a personal communication in 2008 on a major point – the amount of tidal freshwater marsh present in 2005 using a method based on drainage patterns. Such an important point should have a source that is more available for others to review.

Fish and Wildlife Resources, Fish (sections begins page 13)

6. The reference to Collins et al. (2001) is incomplete. They say "During 1988-1992, juveniles were concentrated in Kings Island Turning Basin. It appears that harbor modifications (deepening; tide gate removed from service; New Cut closed) since then have changed the hydrographic conditions and caused the fish to move from that area. No juveniles were found as far downriver as the turning basin in this study." The FWCA Report should include this suggested explanation. We also are aware of a study by The Nature Conservancy that suggests shortnose sturgeon avoid large portions of Back River (*Draft Report on the Movements of Shortnose Sturgeon in the Savannah River, GA/SC: 2006-2009*. In prep. by Amanda Wrona Meadows, Bill Post, and Jason Moak. The final version of the FWCA Report should include the results from this study.
7. Also should note the study by Collins et al. (2001) refers to adults and larger juveniles, not post-larval and early juvenile life stages that may be in shallower small tidal freshwater sloughs and creeks.

Fish and Wildlife Resources, Endangered species (sections begins page 16) AND *Project Impacts, Endangered species* (sections begins page 23)

8. Reference to the section 7 consultation with NMFS should indicate the consultation <u>is</u> underway, as opposed to just indicating that NMFS is responsible for working with the COE on the consultation.

NMFS also is working with the COE on how to address impacts to Atlantic sturgeon, which has been proposed for listing under the Endangered Species Act (ESA).

9. The list of species subject to ESA jurisdiction for this project is incomplete. North Atlantic right whale, Atlantic sturgeon, smalltooth sawfish, and all five species of sea turtles (Kemp's ridley, leatherback, green, hawksbill, and loggerhead) should also be included in addition to shortnose sturgeon. The final report should indicate that section 7 consultation with NMFS is underway for these species and a Biological Opinion will be prepared.

Problems, Opportunities and Planning Objectives (section begins page 16)

10. Bullet 1 says "maintenance of normal tidal and salinity patterns is a major objective of coastal refuges and management areas." The managed freshwater wetlands referenced earlier in the report should be referenced as an exception.
11. Bullet 4 indicates 6,000 acres of wetlands have been lost due to filling and dredging. Recommend the basis of this determination be provided, preferably as a set of polygons with acreages that show this difference.

Alternatives (section begins page 17)

12. Recommend the table caption state the values provided do not include allowable overdepth since many references in the news media and elsewhere do. We also recommend the table caption explicitly indicate the volumes listed to include the dredging needed to extend the Ocean Bar Channel. The FWCA Report generally avoids discussion of the Ocean Bar Channel and the issues associated with its lengthening, so it should be clear when this aspect of the project is covered.

Project Impacts (section begins page 18)

13. After briefly describing the hydrodynamic and water quality models, the first paragraph of this section says "extensive model development, coordination and peer review processes were conducted to ensure that the model was acceptable to evaluate projects impacts." No citation for the model evaluation is provided. If FWS has determined that the models are suitable for evaluating the impacts from Savannah Harbor Expansion Project, the report should describe how FWS came to this conclusion.
14. The reference to the habitat suitability models should indicate these models were meant to focus on a few species that may be indicative of the impacts from salinity or dissolved oxygen to species guilds or to the broader ecosystem. The models do not address impacts from other causes nor do they focus on all habitats likely to be impacted by the channel deepening, for example tidal freshwater marsh or nearshore habitat. In short, the habitat suitability models are useful tools, but they only assess a small portion the impacts likely from the proposed project.
15. At the bottom of page 18, the paragraph begins by saying "the most significant predicted impact of the deepening project is that salinity . . . will be increased." While we agree that this impact is significant, its relationship to other impacts is complex and involves multiple environmental mandates. Accordingly, we do not support its designation as "the most significant" since the FWCA Report is limited to the impacts from the Savannah Harbor Expansion Project that will occur in the harbor and does not address the impacts expect to occur in nearshore and offshore areas.

Project Impacts, Tidal freshwater wetlands (section begins page 19)

16. The discussion of productivity at the top of page 20 is limited to primary production and does not include detritus-based food chains.
17. Middle of page 20 states "salinity intrusion due to prior Savannah Harbor deepening is a factor facilitating higher use by marine species . . . . [and that] harbor deepening would exacerbate these trends." These statements are not supported by the baselines studies done by the SC Department of Natural Resources and others that show the great majority of the species collected in tidal creeks were estuarine, not marine.

Project Impacts, Fish (section begins page 21)

18. What is the source of the information regarding historical use of the Kings Island Turning Basin by shortnose sturgeon as nursery and foraging habitat? Is it Hall et al. 1991 "*Movements and habitats of Shortnose sturgeon,* Acipenser brevirostrum *in the Savannah River*."
19. The mortality figure is partially correct. What was actually stated in the paper was: Jenkins et al. (1994) observed 86 - 100% mortality for 25-64 day old fish in an acute 6 **hr** exposure to 2.5 mg/l at 22.5 C (30% saturation). Older juveniles 100-310 days old experienced 12-20 % mortality under the same conditions.
20. The comments on "safe temperature" is a little confusing. The temperatures quoted concern the identification of a "safe temperature" for gill netting (for sampling purposes). Ziegeweid et al. (2008b) found that shortnose sturgeon acclimated to higher temperatures are more tolerant of elevated temperatures and that tolerance to elevated temperatures and low dissolved oxygen concentrations also appears to increase with age (body size). Anecdotal field observations indicate possible latitudinal variation in thermal tolerance. Atlantic sturgeon from southern river systems have been safely captured in gill nets at temperatures exceeding 30°C (Doug Peterson, University of Georgia, pers. comm.).
21. Is the "oxygen squeeze" discussed in the FWCA Report similar to what has been reported for shortnose sturgeon in the hypoxic areas of Chesapeake Bay and Hudson River? Additional explanation is needed.

Projects Impacts, Cadmium (section begins page 23)

22. The risk assessment that was reviewed should be cited.

Mitigation, Acquisition (section begins page 25)

23. Recommend that lands adjacent to shortnose sturgeon concentrations in the river be given a high priority for acquisition. NMFS would be happy to work with FWS on specific locations that meet this criterion.

Mitigation, Wetland restoration (section begins page 29)

24. The proposed restoration area is 42 acres, but Table 5 shows only 29 acres would be restored. This should be clarified.
25. Including creeks in the restoration marsh was proposed by multiple agencies, not just FWS. The recommendations would be stronger if it were based on input from multiple agencies.

Mitigation, Dissolved oxygen (section begins page 29)

26. The report cited, Tetra Tech (2006), does not reflect the placements provided in Tetra Tech (2010), which are the locations for the DO injectors in the Draft environmental Impact Statement. The FWCA Report should be amended to indicate the most recent locations.
27. FWS should explicitly and precisely state what the goals of the DO injection are with respect to its trust resources. This clarity by FWS and other resource agencies is needed to judge the likely success of the injection and for the public to weigh the cost of this expensive mitigation feature with respect to its importance and likelihood of success.

Mitigation, Fish (section begins page 29)

28. On page 29, the hole within Middle River should not be characterized a "nursery habitat" but rather more generally as a place where shortnose sturgeon concentrate during certain times of the year and environmental conditions.

Mitigation, Cadmium (section begins page 31)

29. NOAA is deferring to FWS and SC Department of Natural Resources evaluations of the adequacy of the proposed monitoring plan.

Alternatives Evaluation With Mitigation (section begins page 32)

30. The description, in Table 6, of the effects from each mitigation option is limited to salinity and boating access. The COE's reports of the effects of the hydrologic mitigation without DO injection show the hydrologic mitigation also effects DO concentrations, particularly in upper portions of Middle River where DO concentrations are expected to decrease.
31. Table 6 describes open water disposal of dredged material in the sediment basin as a negative impact. Not clear why this action is described in this manner given that open water disposal would be used to construct the plug at the seaward end of the sediment basin.

Alternatives Evaluation With Mitigation, Managed wetlands (section begins page 32)

32. The source of the predictions referenced in Table 7 should be provided. Model predictions for the 47-foot alternative are listed as "estimated," as opposed to actual model runs. The source of these estimates should be provided along with a short description of how the estimation was done.

Alternatives Evaluation With Mitigation, Tidal freshwater wetlands (section begins page 34)

33. The alternative to M2M for evaluating mitigation plans is not well described, ultimately referring to personal communication from the COE. More substantive citations should be given if available.
34. The GIS layers used for calculating the acreages in Table 8 should be made publically available. FWS staff have told us these acreages do not include sea level rise, where as Table 7 says 25 cm is sea level rise is included. Table 8 should be equally explicit on this point.

Alternatives Evaluation With Mitigation, Fish (section begins page 35)

35. As noted before, NOAA and the COE are revising the habitat predictions for shortnose sturgeon, so FWS may want to revise the FWCA Report when those predictions are complete.
36. NOAA agrees that removal of New Savannah Bluff Lock and Dam (NSBLD) is more likely to be a more effective measure than the fish passage currently proposed. As currently proposed the COE's fish passage is not likely to be successful in passing sturgeon to justify its use as mitigation against the much more certain impacts of the harbor deepening. If a fish passage structure is to be used as mitigation for impacts of the harbor deepening there will need to be extensive changes to the proposed design. Even if an effective design can be agreed upon, the fish passage structure would require maintenance and repair in perpetuity. The removal of the NSBLD is our preferred method to allow sturgeon access to upstream habitats. In comparison to the uncertain success and impermanence of the proposed passage structure, removal of the NSBLD would certainly restore access to upriver habitat in perpetuity.
37. Tables 8, 9, and 10 have predictions for a 47-foot alternative, but does not label these predictions as "estimates" as in Table 7. Please clarify.

Alternatives Evaluation With Mitigation, Summary plan evaluation (section begins page 37)

38. As noted before, NOAA and the COE are revising the habitat predictions for shortnose sturgeon, so FWS may want to revise the FWCA Report when those predictions are complete.

Uncertainty and Risk (section begins page 38)

39. As noted before, NOAA and the COE are revising the habitat predictions for shortnose sturgeon, so FWS may want to revise the FWCA Report when those predictions are complete.
40. For the reasons cited in the report, NOAA agrees with FWS that there is a high degree of uncertainty as to how effective the oxygen injection system would be.

41. NOAA agrees with FWS that calculating the impacts to salinity and DO concentrations for the deepening the harbor only to river mile 7 would enhance the evaluations within the Environmental Impact Statement.

Monitoring and Adaptive Management (section begins page 41)

42. While NOAA generally supports the Monitoring and Adaptive Management Plan described in DEIS Appendix D, NOAA believes further elaboration is needed in two areas: (1) the plan should specify criteria for evaluating the success of mitigation measures and should clearly articulate triggers for implementing corrective action as indicated by monitoring results and determined necessary in coordination with the resource agencies and (2) the plan presently proposes to monitor wetlands and marshes for use by finfish but does not include monitoring of invertebrates such as shrimp and crab that are key components of the ecosystem and necessary for NOAA to understand the response of the estuary to the new dynamic equilibrium that will be established following construction.

Recommendations and Position (section begins page 45)

43. Until the impacts of the project to shortnose sturgeon and other resources are better understood, NOAA is unable to make any recommendations about the acceptability of any of the proposed deepening alternatives.

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Southeast Regional Office
263 13th Avenue South
St. Petersburg, FL 33701-5505
(727) 824-5305; FAX (727) 824-5308
http://sero.nmfs.noaa.gov

JAN 25 2011 F/SER

Colonel Jeffrey M. Hall
District Commander
U.S. Army Engineer District, Savannah
ATTN: PD
Post Office Box 889
Savannah, Georgia 31402-0889

Dear Colonel Hall:

The National Oceanic and Atmospheric Administration's (NOAA) National Marine Fisheries Service (NMFS), Southeast Region has received the *Draft Tier II Environmental Impact Statement for the Savannah Harbor Expansion Project, Chatham County, Georgia and Jasper County, South Carolina* (DEIS) and *Draft General Re-evaluation Report for the Savannah Harbor Expansion Project, Chatham County, Georgia and Jasper County, South Carolina* (DGRR). NMFS Southeast Region is a cooperating agency with the Corps of Engineers, Savannah District (COE), for this project under the National Environmental Policy Act, and NMFS is also engaged in consultation with the COE for the project's effects on essential fish habitat (EFH) and endangered and threatened species, under the Magnuson-Stevens Fishery Conservation and Management Act and the Endangered Species Act (ESA), respectively. Further, the Water Resources Development Act of 1999 authorizes the Secretary of Commerce to approve the selected plan and determine that the associated mitigation plan adequately addresses the potential environmental impacts of the project.

Over the last two years NMFS has provided comments on the proposed project, as well as requests for information needed to better understand the potential impacts of the project on NMFS' trust resources. Many of these issues have been addressed through ongoing discussions with the COE, but some key issues remain outstanding. Enclosed we provide comments on the project, based on the DEIS and DGRR, which address project concerns related to EFH and ESA trust resources. We believe these remaining issues need to be resolved, and the resulting revised information incorporated into the Final Environmental Impact Statement. We will continue to work with the COE to seek mutually acceptable resolution of remaining issues.

Of paramount importance to NMFS is assuring the impacts of the project do not threaten the continued existence of the shortnose sturgeon, an endangered species that still persists in the Savannah River. The sturgeon's remaining foraging and refuge habitat is largely within the Harbor, and the dredging and hydrological changes of the project will degrade large portions of this habitat, rendering it unsuitable for shortnose sturgeon. The two deficiencies of the DEIS and mitigation plan relating to shortnose sturgeon highlighted here are preventing us from fully evaluating project impacts on this species and significantly affecting the adequacy of the proposed mitigation plan.

Habitat Suitability Assessment for Shortnose Sturgeon

The habitat suitability assessment provided in the DEIS for shortnose sturgeon contains inconsistencies and deficiencies, which we have identified in discussions with the COE on multiple occasions. Thank you for your personal involvement in proposing and participating in yesterday's video conference to clarify these issues. We look forward to receiving the information and analyses we requested as soon as possible so we can have a complete assessment of the project's impact to shortnose sturgeon habitat, which is necessary for us to be able to comment meaningfully on the different project alternatives. At this time, we are unable to make any recommendations about the acceptability of any of the proposed deepening alternatives. However, we may offer specific depth recommendations after receiving the information and analyses that we discussed on the call and highlighted in the enclosure.

These inconsistencies and deficiencies in the sturgeon habitat assessment are also preventing us from initiating consultation on the project under section 7 of the ESA. NMFS expects to issue a biological opinion on project impacts within 135 days of the date these issues are resolved.

Mitigation for Sturgeon Impacts at the New Savannah Bluff Lock and Dam

While the impacts of the proposed project on endangered shortnose sturgeon cannot be fully understood prior to completing section 7 consultation, proposed dredging and hydrological changes are expected to have substantial adverse effects on that species' foraging and refuge habitat. Adequately mitigating for this habitat loss will require re-establishing access to habitat above the New Savannah Bluff Lock and Dam (NSBLD). The NSBLD is the lowest dam on the Savannah River and impedes the sturgeon's movement upstream. Because the SHEP is expected to remove downstream habitat, without additional access upstream, overall habitat will be greatly reduced. Access to currently unavailable upstream habitat will mitigate this habitat constriction.

As currently proposed the COE's fish passage is not likely to be successful in passing sturgeon to justify its use as mitigation against the much more certain impacts of the harbor deepening. If a fish passage structure is to be used as mitigation for impacts of the harbor deepening there will need to be extensive changes to the proposed design. Even if an effective design can be agreed upon, the fish passage structure would require maintenance and repair in perpetuity. The removal of the NSBLD is our preferred method to allow sturgeon access to upstream habitats. In comparison to the uncertain success and impermanence of the proposed passage structure, removal of the NSBLD would certainly restore access to upriver habitat in perpetuity. Additionally, cost information we included in our enclosed comments indicates removal would be the less expensive option in the short- and long-term. Such action would be consistent with the

COE Savannah District's recommendation in the September 2000 report on the NSBLD disposition study.

We are aware that, as a Congressionally-authorized structure, the COE would be required to seek Congressional authorization to remove the NSBLD. However, the COE must also seek authorization for the increased costs of the Savannah Harbor Expansion Project. Combining these authorization requests presents an ideal opportunity to redress the environmental damage of the COE's legacy dam while advancing the modern economic benefits of the project.

With respect to the EFH consultation, NMFS believes three key topics of information require further attention, and we request this information be included in the FEIS.

- First, the Ocean Bar Channel Extension is a project feature added relatively late to the project design. One consequence of the feature is that hardbottom habitat may be adversely affected by dredging the channel extension. In addition, additional dredge material will need to be placed in the area of the potential hardbottom dredging impact. To date, the COE has assured NMFS that surveys will be completed of the bar channel extension and that this survey information will be adequate to describe potential impacts of dredging to hardbottom habitat. Further, the areas where the additional dredged material will be placed support important managed species including red snapper. The dredge material has been proposed to be placed and configured in a way that would provide suitable fishery habitat in the impacted hardbottom areas. To fully assess the likely success of this mitigative measure, NMFS requests plans be included in the FEIS for the dredge material placement and configuration as well as information on monitoring the effectiveness and durability of these features.
- Second, dredge material is proposed for placement at a feeder berm near Tybee Island. This material is intended to replenish the beaches of Tybee Island downstream of the feeder berm. To ensure this result is likely, NMFS requests modeling be conducted to demonstrate the likely fate and disposition of the material placed at the Tybee Island feeder berm.
- Third, although considerable progress has been made in developing the Monitoring and Adaptive Management Plan described in DEIS Appendix D, NMFS requests further elaboration in two areas:
    - The Plan should specify criteria for evaluating the success of mitigation measures and should clearly articulate triggers for implementing corrective action as indicated by monitoring results and determined necessary in coordination with the resource agencies.
    - The Plan presently proposes to monitor wetlands and marshes for use by finfish but does not include monitoring of invertebrates such as shrimp and crabs. As key components of the ecosystem and as managed stocks (in the case of white shrimp), NMFS believes it is very important to understand the response of these species to the altered dynamic equilibrium that will be established in the estuary following project construction.

We appreciate the COE's efforts to identify and resolve the many technical and conservation issues associated with this large, complex, and potentially very important project. We will continue to provide interagency coordination on this project under all our authorities and to work with the COE to bring the remaining issues to resolution. Our primary contact for endangered species issues is Ms. Kay Davy. She may be reached by phone at (954) 356-6791 or by e-mail at Kay.Davy@noaa.gov . Questions regarding EFH may be addressed to Pace Wilber at (843) 762-8601 or by e-mail at Pace.Wilber@noaa.gov .

Sincerely,

James E. Weaver

for Roy E. Crabtree, Ph.D.
Regional Administrator

Enclosure

National Marine Fisheries Service (NMFS) Comments on:
Draft Tier II Environmental Impact Statement for the Savannah Harbor Expansion Project, Chatham County, Georgia and Jasper County, South Carolina (DEIS) and Draft General Re-evaluation Report for the Savannah Harbor Expansion Project, Chatham County, Georgia and Jasper County, South Carolina (DGRR)

January 25, 2010

As indicated in our letter dated November 24, 2010, NMFS is conducting a joint consultation pursuant to the essential fish habitat (EFH) provisions of the Magnuson-Stevens Fishery Conservation and Management Act and section 7 of the Endangered Species Act of 1973, as amended, on the Savannah Harbor Expansion Project (SHEP).

Section 7 of the Endangered Species Act (ESA)

NMFS Protected Resources Division has reviewed information included in the DEIS, the DGRR, and subsequent information that has been provided by the Savannah District Army Corps of Engineers (COE). The following comments on the protection of endangered species under NMFS' authority are based on the current information available. We will be providing additional comments with the issuance of the upcoming Biological Opinion.

Affected Species

Sea Turtles

Deepening of the Savannah Harbor Entrance Channel and construction of the Channel Extension will require dredging to be conducted over a long project period. The COE has proposed the use of hopper dredges for the offshore dredging in the project area. NMFS believes the use of hopper dredges over an extended time period greatly increases the chances of impact with sea turtles and may make it necessary to use relocation trawling as an aid in their protection. The revision of the new South Atlantic Regional Biological Opinion (SARBO) is underway and may contain additional measures to be implemented. Regardless of whether or not the SARBO is completed by the time the project dredging is to begin; the COE should be pro-active in its commitment to protect sea turtles. The Biological Opinion to be issued in conjunction with our review of SHEP is likely to provide additional recommendations and estimates on turtle take.

North Atlantic Right Whales

NMFS has strong concerns about the proposed use of hopper dredges and the adherence to speed limits in the project area. The COE provided project-specific information regarding their proposal to adhere to the 10-knot speed restriction and provided a statement that can be found in Appendix B, page 99 of the DEIS. The information states that the COE will adhere to the 10-knot speed restriction for hopper dredges during calving season and adhere to the new South Atlantic Regional Biological Opinion (which addresses vessel speeds), once it is finalized.

NMFS acknowledges the COE's commitment to adhere to the 10-knot speed restriction. However, we note that on page 181 of Appendix B of the DEIS it states: "...hopper dredges will be restricted to 10 knots when loaded with material transiting to disposal areas and to 12 knots when light-loaded returning from disposal areas during the calving season." Subsequent personal communication with staff within the COE's South Atlantic Division confirmed that the vessel speed when loaded and when light-loaded will be 10 knots. The information should be correctly stated in the FEIS to reflect the COE's commitment to adhere to the 10-knot speed restriction.

Recent Proposed Listing of Atlantic Sturgeon

The Atlantic sturgeon was recently proposed for listing. If the listing becomes final before section 7 consultation is concluded, a discussion of the project effects on the species will be included in the Biological Opinion. If a decision has not been reached, Atlantic sturgeon will be included by Conference under section 7 of the ESA.

Since so very little information is known about Atlantic sturgeon in the Savannah River, we will need to make some basic assumptions based on the best available data. It is known that adult Atlantic sturgeon can tolerate high salinities and are often found in the ocean, so we can assume that they would also be found utilizing the entire lengths of the Front, Middle, and Back Rivers. Project effects could impact Atlantic sturgeon. Low dissolved oxygen could limit the availability of acceptable habitat and the proposed hydrological modifications for flow re-routing (i.e., the closure of Rifle Cut and the filling of the Sediment Basin), may have additional impacts on this species as they may not be able to use the Back River for moving between their upriver spawning habitat and their downstream foraging habitat in the estuary. Some of the measures proposed for mitigating impacts to shortnose sturgeon would also be appropriate for Atlantic sturgeon.

Shortnose Sturgeon

<u>Habitat Suitability Modeling</u>
Through extensive prior coordination NMFS has been working with the COE to develop the best modeling of existing habitat of the shortnose sturgeon, use of the most appropriate habitat criteria, and to evaluate potential project effects associated with the different deepening scenarios. During meetings held in 2001 to discuss SHEP, the Fisheries Interagency Coordination Team provided guidance on fisheries issues and developed a conservative set of parameters for modeling habitat suitability for the shortnose sturgeon. The Fisheries Coordination Team determined the conditions (in Appendix P) which the water quality and hydrodynamic models would use to identify acceptable and unacceptable habitat. River flow rates and time of year were also specified. Average river flows were used to represent long term conditions, but additional models were run to represent drought years.

Overall, the habitat suitability maps produced using the habitat criteria indices for adult shortnose sturgeon showed reasonably good agreement with previous field data collected on shortnose sturgeon, however, the maps produced for juvenile sturgeon did not show good agreement between documented habitat, as determined by field research, and the modeled results. In using a conservative maximum salinity index of <= 4 ppt, as developed by the Fisheries Coordination Team, the output excluded documented habitat for the larger juvenile shortnose sturgeon. It is believed this occurred due to the ability of larger juveniles to tolerate salinities higher than 4 ppt, whereas higher salinities have been proven to be detrimental to small juveniles in lab experiments. In order to generate maps that would include available habitat of the large juveniles, NMFS proposed that the maximum salinity index should be increased to <= 14.9 ppt, which was the maximum salinity measured during research conducted by Collins et al. (2001), where large juveniles (measuring 32.3 cm to 47.6 cm fork length) were located. (It is important to note that sampling of smaller juveniles has not been conducted in the lower Savannah River, although they are presumed to occur there.) The COE acknowledged our request to revise the salinity criteria. Once the new criteria were used in the modeling of habitat, the mapped results showed a more accurate depiction of acceptable habitat, particularly in the area of the lower Middle River, which includes a deep hole (~7.9 meters depth) used by large juvenile and adult sturgeon during the winter, and also within the Front River at the confluence with the lower Middle River to above Steamboat Creek.

Ground-truthing of the habitat suitability maps was based on field research conducted in the lower Savannah River, which indicated that large juvenile shortnose sturgeon prefer the Front River from just above the deeper Kings Island Turning Basin to the mouth of Abercorn Creek (located near Interstate 95). During the winter, they also heavily utilize the deep hole located in the lower Middle River and adjacent portions of the Middle River. They have not been documented in the Back River. Within the project area, adult shortnose sturgeon have been found to utilize the entire length of the Front River, the entire length of the Middle River, the uppermost reaches of the Back River, and the Sediment Basin/Tide Gate area within the lower Back River. They migrate upriver to the base of the New Savannah Bluff Lock and Dam for spawning. They have not been shown to use the full length of the Back River and recent tracking data, conducted by The Nature Conservancy, indicates adult sturgeon may enter the Sediment Basin from the lower end of the Back River or access it by traveling through Rifle Cut, which connects the Middle and Back Rivers. According to personal accounts from biologists conducting research in the Back River and a bathymetry map of the project area produced by the COE, there are portions of the middle section of the Back River above Rifle Cut that have depths that may be too shallow for the passage of sturgeon during certain tide stages. Firsthand accounts by these same biologists also report that portions of the Sediment Basin have become too shallow to navigate.

The COE performed analyses using the habitat criteria for the existing conditions (-42 feet) and for the five deepening scenarios (-44, -45, -46, -47, and -48 feet). The models predicted outcomes with and without the proposed flow re-routing and dissolved oxygen injection. (Flow re-routing mitigation was proposed to offset potential impacts to the adjacent Savannah National Wildlife Refuge. It is important to note that over 160 different flow re-routing models were conducted to evaluate the effects of each mitigation plan. The proposed injection of dissolved oxygen as mitigation is addressed later in this document.)

In addition to the modeling runs shown in the DEIS, the COE performed other analyses that included parameters such as high dissolved oxygen loading superimposed on the habitat parameters for adult shortnose sturgeon during the summer and winter and also for large juvenile shortnose sturgeon during winter conditions. Other scenarios included project effects with the deepening only, deepening plus hydrological modifications, and deepening with the hydrological modifications and dissolved oxygen injection. While NMFS appreciates the time and effort by the COE to produce the modeled outputs, there is much uncertainty in the results and maps depicting suitable habitat have conflicting information. This is probably due to the highly complex nature of the modeling design. NMFS remains hopeful that the COE will be able to deliver model outputs that provide accurate predictions of the project effects, but at this time we do not have these products. A preliminary assessment based on information in the tables provided in the DEIS (although they may not be entirely accurate) show that the 47-foot (National Economic Development Plan)and 48-foot (Maximum Authorized Plan) deepening alternatives would result in significant habitat loss for adult shortnose sturgeon during January conditions (439 acres lost) and August conditions (113 acres lost). There would also be loss of juvenile shortnose sturgeon habitat during January conditions (21.6 acres lost). Specific measures to address the predicted loss of foraging habitat for shortnose sturgeon within the project area were not identified in the DEIS.

Some of the proposed flow re-routing modifications include closing Rifle Cut and allowing the Sediment Basin to fill-in. The COE's assessment of the habitat suitability models with the flow re-routing modifications indicate that areas above the Sediment Basin within the Back River will become "suitable habitat" for shortnose sturgeon. However, NMFS is concerned that this is an inaccurate assessment as the elimination of Rifle Cut, which connects the Middle and Back Rivers, coupled with the shallow depth of the Sediment Basin, could result in the Back River becoming a dead end for adult sturgeon trying to migrate between their upriver spawning habitat and downstream foraging habitat. Juvenile shortnose sturgeon already cannot enter through the lower end of the Back River due to the high salinities found there. We have concerns that what the COE is showing as habitat gained in some areas of the Back River (and we are still evaluating usage of the area) would produce an inaccurate assessment of the mitigation effects. While more habitat may be created, that could be classed as "suitable" when based on salinity and dissolved oxygen parameters, it may be located in areas not used by sturgeon or in areas that will become inaccessible to sturgeon after the flow re-routing modifications have been completed. Therefore, the "gain" would have no value to sturgeon.

COE-Proposed Measures to Address Impacts to Shortnose Sturgeon

Dissolved Oxygen Injection

Measures to address impacts to water quality associated with the project deepening have been proposed. Project impacts include a decrease in dissolved oxygen (DO) levels associated with the increase in channel depth, the increase in the volume of water over the project area, and the decrease in average river velocity, which will reduce mixing of oxygen throughout the water column. With the decrease in DO, the ability of the river system to handle introduced point source and non-point source loads of pollutants will also be decreased. DO typically drops during the summer months in the Savannah River associated with a lower oxygen diffusion rate and a higher uptake from biological organisms.

The area the COE identified as of primary concern for low DO is located between Fort Pulaski and the Seaboard Coastline Railroad Bridge, a length of approximately 27 river miles. This also includes the primary areas identified as important foraging habitat for the shortnose sturgeon within the lower Savannah River. According to the DEIS, model predictions from the SHEP studies indicate that further deepening will have additional impacts on the dissolved oxygen regime in the Savannah Harbor. Using guidance provided by the Water Quality Interagency Coordination Team, the analyses conducted were based on average drought river flow conditions (August 1999). Other sensitivity analyses included average river flows (August 1997) and 2004 point source loads. Project impacts to DO were found to be higher during drought conditions than during average flow conditions. Supplemental model runs provided to NMFS after the publication of the DEIS have shown that when the 2004 point source loads are added to average river flows, there is an additional loss of acceptable habitat in the Front River adjacent to and upriver from the confluence with the lower Middle River. While this is a preliminary assessment and may not be completely based on accurate data, it may show that compounded effects of high point source loads and deepening of the harbor may result in additional loss of habitat for shortnose sturgeon. To offset the decrease in DO associated with the project, the injection of DO using Speece cones is proposed. The injection systems would be located along the banks of the Savannah River at three sites: the Georgia Pacific facility, located above the project area; and at International Paper within the project area on the West and East sides of Hutchinson Island along the Front River and Back River. The systems would be operated during July through September to provide the needed amount of oxygen. The cost to operate the systems would use a large portion of the mitigation budget. NMFS has previously expressed a concern to the COE about whether the on-going cost to operate the systems can be maintained in perpetuity. In its response, the COE stated that funding for any portion or feature of the project, whether mitigation or navigation, is subject to the normal budgetary process and appropriation by the US Congress. The COE stated they cannot predict or speculate on the amount of appropriations that a future Administration or Congress may provide to operate the Savannah Harbor Navigation Project. Without funds to operate the Navigation Project, the COE said they would have no funds to operate the project's mitigation features. They further stated that failure to operate all aspects of the project as described in the EIS and the Record of Decision (including its mitigation features) would subject the COE to legal challenges that it is operating the project outside its NEPA clearances. NMFS is concerned that the environmental impacts will continue in perpetuity, while the mitigation measures will only be operational as long as funding is available. The COE's record of not providing adequate maintenance of the mitigation features within the Savannah National Wildlife Refuge partially substantiates this concern.

NMFS also questions the efficacy of the injection systems to actually increase DO in the areas of concern. It is critical for the continued existence of shortnose sturgeon that DO remains at levels acceptable to shortnose sturgeon, particularly for juveniles which cannot tolerate low DO, even for short duration. The DEIS states that the injection system has been designed to remove the incremental effect of a deeper channel in 97 percent of the bottom half of the water column. Using the bottom half instead of the deepest layer of the water column for the modeling design may not benefit shortnose sturgeon since they are bottom feeders and they would encounter the lowest DO along the deepest portions of the river. If the current design and placement of the injection system does not provide any benefit for the foraging shortnose sturgeon, its use as a measure to offset impacts to shortnose sturgeon is negated. **NMFS continues to be concerned that this is a very risky operation with a high degree of uncertainty.**

Proposed Sill at Lower Middle River

Recent discussion with the COE has raised concern about the proposed construction of a higher sill within the lower Middle River. A low sill currently exists, but as a measure to block the salt wedge from entering the lower Middle River after the deepening, construction of a higher sill is proposed. It is important to protect the deep hole, which is heavily utilized by shortnose sturgeon, and located just beyond the existing sill, from receiving the higher salinities that will occur with the deepening in the Front River. It was thought that by raising the height of the sill, the heavier, more saline water would be prevented from entering the area surrounding the deep hole. While NMFS believes that construction of the sill could benefit the shortnose sturgeon, **NMFS is also concerned that the maintenance requirements needed to keep the sill functioning properly have not been included in the COE's budget. Monitoring of the sill should also be included in the Monitoring and Adaptive Management Plan.**

Fish Passage at New Savannah Bluff Lock and Dam

While NMFS agrees with the COE that there are impacts to shortnose sturgeon associated with the inaccessibility to spawning habitat above the New Savannah Bluff Lock and Dam and that providing access to this habitat would benefit sturgeon, we disagree with the proposal to construct a fish passage bypass around the dam, as currently designed. The construction of a bypass facility to pass shortnose (or Atlantic) sturgeon at this site may not be successful. Unlike shad and herring which swim high in the water column and orient to surface currents, sturgeon are primarily found on the bottom and have distinctly different swimming behavior. Shortnose sturgeon may not be able to adapt to the currently proposed facility. The construction of the proposed design for the purpose of passing sturgeon could be a failed venture that would require additional mitigation measures as a part of adaptive management.

According to the COE, the construction of a fish bypass at the New Savannah Bluff Lock & Dam would involve the least cost and would be the most environmentally acceptable method of providing a measure to offset impacts to the shortnose sturgeon. Information on page 65 of Appendix C of the DEIS states that the cost of removing the lock and dam would exceed the cost to construct a fishway. However, the COE did not include the total costs associated with providing fish passage at the New Savannah Bluff Lock and Dam in their estimates. The lock and dam also need extensive repairs and rehabilitation, which in 2001 was estimated to cost approximately $6.8 million. According to the Congressional authorization, fish passage construction and rehabilitation of the lock and dam are linked. The rehab cost ($6.8 M at 2001 prices) plus the estimated cost of fish passage construction ($6.3 M), well exceed the cost of dam removal ($7.5 M). Other costs to consider are the monitoring for detection of sturgeon, the monitoring and maintenance of the fishway, and the construction of a mixing tower to aid in temperature adjustment between the mixing bodies of water. Additionally, there is a need to have a greater flow than the proposed 5 percent attraction flow for shortnose sturgeon. Shortnose sturgeon may require an attraction flow of 10 percent of the available flow during all river conditions. Shortnose sturgeon would require a wider and deeper facility than is currently designed. Additionally, with the recent proposed listing of the Atlantic sturgeon, this species would also need to be accommodated and would require a wider and deeper fish passage facility. In addition to the costs associated with the rehabilitation of the lock and dam, and the upfront costs associated with the construction of a fish bypass and its infrastructure, there would be continual maintenance needed for the bypass and for the lock and dam. There are no proven results that indicate that the COE would maintain the lock and dam as it has not had maintenance provided for a long time. There is also no guarantee that funds would be available to provide needed maintenance of the fish passageway in perpetuity. NMFS recommends that the COE re-address the cost estimates to better reflect all of the associated costs involved in construction and maintenance of the fish bypass and lock and dam.

The regional resource agencies were recently contacted (on October 1, 2010) by the COE to provide input on the proposed fish passage design. The responses received from the agencies clearly indicated that there is concern about the design and that the best alternative would be removal of the lock and dam. Comments provided about the design emphasized the lack of its proven effectiveness to pass sturgeon. Previous comments provided to the COE by NMFS explained how a single miscalculation or any combination of the various attributes of the design could cause it to fail. For example, a lack of adequate water flow, an inadequate attraction flow to direct sturgeon to the bypass, wrong placement of boulders or resting places within the bypass, the wrong slope of the rock ramp, or inadequate depth and width characteristics could contribute to the structure not being successful in passing sturgeon.

From a risk management perspective, NMFS continues to strongly support removal of the lock and dam and believes this is the best and most meaningful mitigation offered that will result in a benefit for the endangered shortnose sturgeon.

Essential Fish Habitat provisions of the Magnuson-Stevens Fishery Conservation and Management Act

The NMFS Habitat Conservation Division has reviewed the DEIS, the DGRR, and information subsequently provided by the COE. With the exceptions noted below, these documents and information provide sufficient information to complete the EFH consultation and to develop appropriate EFH conservation recommendations.

Project Impacts

Entrance Channel (Ocean Bar Channel) Deepening and Extension
In November 2009, the Savannah District first advised NMFS of the need to extend the Ocean Bar Channel seaward of station -60+000B (this station marks the seaward limit of the existing channel). The length and dredging needed for this extension depend on the project depth (DEIS Table 3-1). Under the locally preferred plan (LPP), the channel would be lengthened 38,600 feet and require approximately 4,212,500 cubic yards of dredging (DEIS Table 3-9). This material would be disposed at two locations, referred to as "Site 11" and "Site 12" in the DEIS, and configured in a manner to serve as an artificial reef attractive to fish. Within the footprint of the existing Ocean Bar Channel (i.e., landward of station -60+000B), 9,113,013 cubic yards would be dredged. This material, along with some additional material from near the harbor entrance, would be placed in seven to nine nearshore areas (DEIS Section 3.07 and Section 5.13) near Tybee Island. Currents and waves would separate sandy material from silty material, remove the silty material from the area, and transport the sandy material onto the beach at Tybee Island.

As indicated in past correspondence with the COE (most recently September 9, 2010 and November 24, 2010) NMFS Habitat Conservation Division requests additional information to complete evaluation of this portion of the project as it is currently proposed, including:

- Surveys for hardbottom habitat within and near the Ocean Bar Channel extension, Site 11 and Site 12;
- Designs for the mounds that would be constructed at Sites 11 and 12;
- Projections of the design life of the mounds at Sites 11 and 12 along with descriptions of any maintenance that would occur;

- Monitoring plans for evaluating the success and durability of the mounds at Sites 11 and 12 and descriptions of how monitoring results would inform maintenance of the mounds and determine if corrective actions are needed, should the mounds not perform as designed;
- Clarification on the projected use of Sites 5 and 6, which are shown in figures (e.g., Figure 3-2) describing the nearshore placement areas but which are not discussed in the text;
- Verification that hardbottom habitat does not occur in or near the nearshore placement areas;
- Estimates of the amount of material expected to be transported to the beach from the nearshore mounds near Tybee Island and descriptions of the fate of the remaining material (e.g., will the eroded fine material affect borrow areas used for traditional beach nourishment projects);
- Discussion of the feasibility of placing material during winter months only into the nearshore mounds to avoid impacting benthic communities during periods of peak production and foraging by fishery resources;
- An element of the Adaptive Management Program that focuses on monitoring the nearshore placement of dredge material to evaluate the success of nearshore placement, assesses the impacts from the placement, and describes how monitoring results would inform maintenance and guide corrective actions, should the mounds not perform as designed.

While this additional information is needed for the NMFS Habitat Conservation Division to complete its evaluation, we offer below some general comments. Given the past and previous detrimental effects of the navigation channel on the beaches of Tybee Island, the NMFS Habitat Conservation Division supports plans to ameliorate those impacts. Assuming the dredged material from the extension of the Ocean Bar Channel is beach quality, the surest manner to address the impacts at Tybee Island would be to place the material from the channel extension directly onto the beach at Tybee Island. Dredged material from more landward areas that is not of sufficient quality for direct beach placement could be placed into the offshore dredge material disposal site. If the upcoming surveys of the Ocean Bar Channel extension show hardbottom habitat would be impacted by the project, these impacts could be addressed via options such as the State of Georgia's artificial reef program. However, if the COE is committed to disposing material at Sites 11 and 12 in manners that may provide suitable fish habitat, NMFS will work with the COE on the design of the mounds and the monitoring that will gauge effectiveness and inform maintenance decisions.

Monitoring and Adaptive Management

By letter dated July 31, 2009, NMFS provided the COE with a detailed review of the adaptive management program and the monitoring needed to implement the program. DEIS Appendix D provides a revised plan for the adaptive management program. While the revised plan provides some additional detail on the monitoring and includes an updated budget, principal omissions from the last review remain in the current version of Appendix D:

- The plan does not provide explicit criteria for evaluating the success of mitigation measures or triggers for initiating corrective actions. The plan should include a mechanism that ensures results from monitoring feed into operation of the dredges and the oxygen injection system. Also, the success criteria and triggers would need to take into account expected rates of sea level rise and the new hydrodynamic regime that would be established in the estuary as a result of project construction.

- The plan does not include monitoring of the marshes for use by crabs, shrimp, and other invertebrates that provide the forage base for fishery species. We do note, however, that since our letter from July 2009, the COE has added fish monitoring of the marshes, but only for the post-construction phase of SHEP. Monitoring for fish and invertebrates should be conducted in synchronization with the marsh vegetation monitoring.