4.00 AFFECTED ENVIRONMENT

Viewed as a watershed, the following features are located within the Savannah River Basin:

A. Savannah River, with certain of its tributaries forms the boundary between the states of Georgia and South Carolina along its entire length of 313 miles (see Figure 4-1). There are three Federally-authorized reservoirs (Hartwell, Richard B. Russell, and J. Strom Thurmond) and the New Savannah Bluff Lock and Dam at Augusta, which are operated by the Savannah District (see Figure 4-1). These Corps dams and reservoirs largely control the freshwater flow within the Savannah River.

The Savannah River has a drainage area of approximately 9,850 square miles and an average discharge of 11,290 cubic feet per second (cfs) (U.S. Geological Survey 1960). The tidal influence extends approximately 45 miles upstream to Ebenezer Landing, Georgia.

B. The Savannah River Estuary contains the historic harbor established in 1733 and the Savannah National Wildlife Refuge. Industrial development is located on the Georgia side of the river and the sediment placement sites are located on the South Carolina side of the river. The estuary provides a gateway to upstream passage of fish. There are water quality problems within the harbor, with a very stringent Total Maximum Daily Load (TMDL) for Dissolved Oxygen.

The Savannah Harbor is a deep-draft harbor on the South Atlantic coast 75 statute miles south of Charleston Harbor, South Carolina, and 120 miles north of Jacksonville Harbor, Florida. In general, the study area for this analysis is continuous from the nearshore ocean (including the proposed ocean bar channel extension and ODMDS) upstream to the stream gage at Clyo, Georgia (located at river mile 61). The harbor and deep-draft navigation channel comprise the lower 21.3 miles of the Savannah River and 11.2 miles of channel across the bar to the Atlantic Ocean.

The Savannah River in the project area generally flows from west to east. The existing 42-foot-deep by 500-foot-wide Savannah Harbor ship channel extends through the approximate center of the river. Seven existing upland Confined Disposal Facilities (CDFs) are located along the northern border of the channel along much of its length. All of the CDFs are diked for deposition of dredged sediments; therefore, most of their terrestrial habitats are maintained in an early stage of succession. Salt marsh borders most of these CDFs and mainland in the project area.

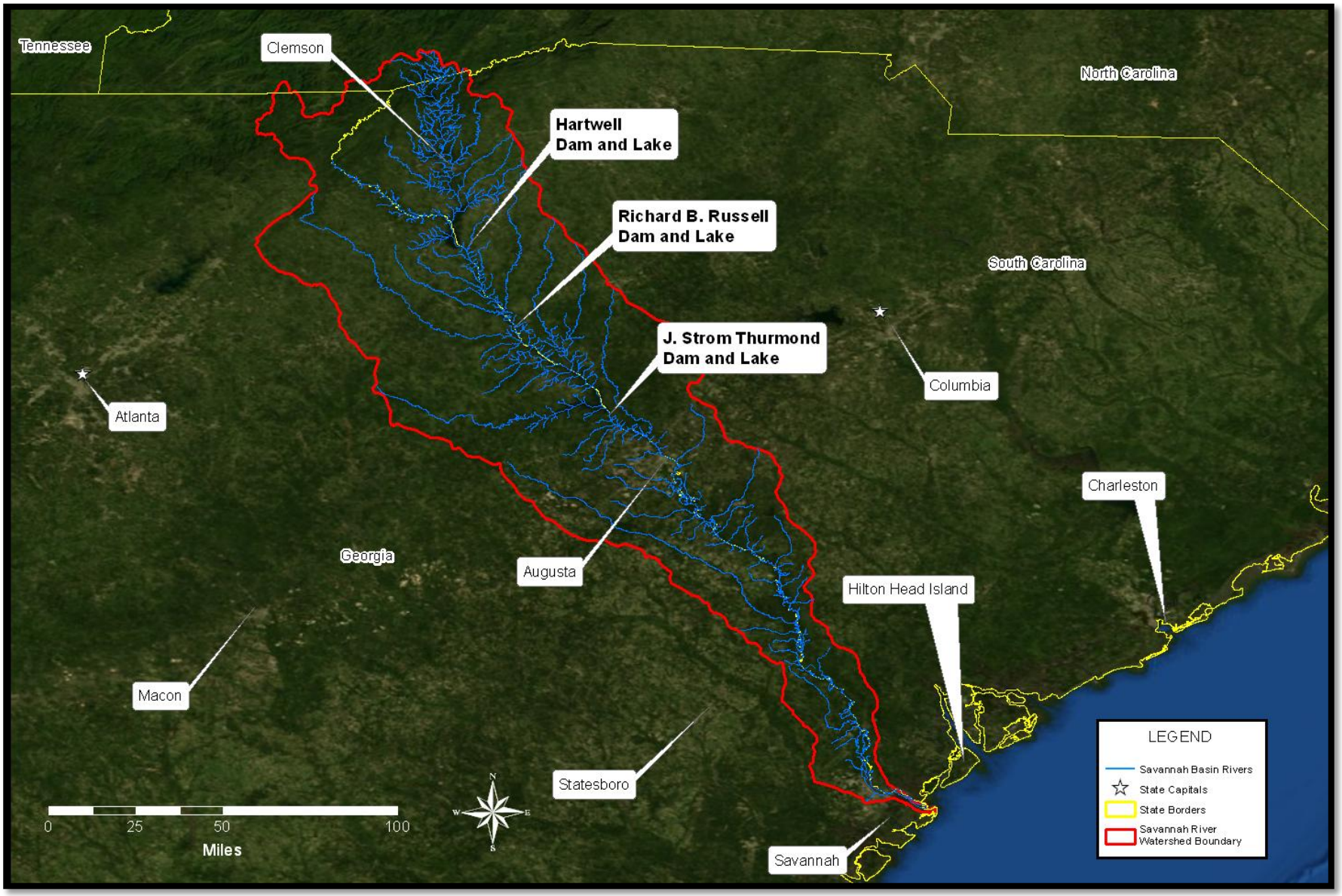

Figure 4-1. Savannah River Basin.

Savannah Harbor experiences a large semi-diurnal tide. Tidal fluctuations average 6.8 feet at the mouth of the harbor and 7.9 feet at the upper limit of the harbor. Ebb velocities are usually somewhat larger than flood velocities. Maximum velocities encountered in the navigation channel are approximately 4 feet per second on the flood tide and 5 feet per second on ebb tide.

Salinity ranges from 0 ppt in the freshwater flow coming down the river into the Savannah Harbor to seawater (35 ppt) in the ocean bar channel. The width of the river varies from roughly 2,400 feet near its mouth to 1,000 feet at the Kings Island Turning Basin (Station 100+000).

C. Watershed scale issues include surface and groundwater issues along the coast with concerns about horizontal salinity intrusion from the ocean, vertical salinity intrusion into the Upper Floridan aquifer resulting from high pumping rates, and vertical salinity seepage in the deepened navigation channel. The Tybee Island Federal Shore Protection Project at the river mouth is another landscape-scale issue, with concerns about impact to the island from the existing navigation project.

Significant resources within the project area are discussed in detail below.

4.01 Geology and Sediments

4.01.1 Geology

Savannah, Georgia is located in the Lower Atlantic Coastal Plain Physiographic Province. The majority of soils primarily have a sandy surface layer over loamy or sandy subsoil or underlying layers. These soils are nearly level or gently sloping and occur as broad, smooth areas drained by wet depressions. They generally are seasonally wet or almost always wet, except for the better drained soils on the slight ridges and dune-like relief. A band of marshes parallel the coastline and extends inland along the major streams. Limestones of tertiary and quaternary age underlying the Coastal Plain form one of the most productive aquifer systems in the country.

4.01.2 Sediments

This section characterizes the sediments found within the harbor. Information was taken from the previous report, the sediment quality evaluation conducted to assess potential contaminant impacts associated with the proposed Savannah Harbor Expansion Project, and radiological screening conducted of harbor sediments.

The maintenance sediments dredged on an annual basis from Savannah Harbor is a mixture of sands, silts, and clays. Sand is defined as grain size between 0.07 and 5.0 mm in diameter, while silt and clay measures less than 0.07 mm in diameter. Sands are dredged from the lower and upper reaches of the project, while silt is the predominant material removed from the middle harbor and sediment basin. Table 4-1 shows the most recent sediment characteristics (percentage sand versus percentage fines) by station and Table 4-2 presents a summary of historical characterization sampling events. Laboratory test results from column settling and consolidation tests performed in 1981 on the dredged sediments were used in these analyses.

The inner harbor maintenance sediments are primarily silts and clays from Station 56+000 to 103+000. The reach from Station 25+000 to 56+000 is a transition reach that has a higher percentage of sand in its distributions than the sediment distributions of the upstream reach. A notable exception is in the vicinity of Station 36+000, which has a high percentage of silts and clays and almost no sand. This location is near the confluence of the inner harbor channel and both Elba Island and Fields Cut. The inner channel sediment distributions from Station 25+000 to the mouth of the Savannah River are primarily sand, which indicates that the source of sediment from this reach is offshore.

Table 4-1. Most Recent Characterization of Bar Channel Maintenance Sediments

Station Range	No. of Samples in the Composite	Percent Sand and Gravel in the Composite	Percent Fines in the Composite
0 to -15B	5	84.8	15.2
-15 to -25B	5	87.8	12.2
-25 to -32.5B	5	87.7	12.3
-32.5 to -37.5B	5	85.2	14.8
-37.5 to -60B	5	94.2	5.8

Note: from Anamar, 2010, Sampling Conducted September 2009

Table 4-2. Summary of Historical Characterizations of Maintenance Sediments (1998 – 2002)

Station Range	Citation	% Sand and Gravel	% Silt	% Clay
+110 to +100	ENSR[3]	52.5	18.5	29
	GSRC[4]	15	48	37
+100 to +50	ENSR[3]	25.6	23.8	50.6
	GSRC[4]	25	51	24
	NOS[5]	12	51.7	36.3
+50 to +27.5	ENSR[3]	73.8	9.6	16.6
	GSRC[4]	0	65	35
	NOS[5]	22.5	47.3	30.2
+27.5 to 0	ENSR[1]	88.2		
	Dial Cordy[2]	85.2		
	ENSR[3]	89.6	6.2	4.2
	NOS[5]	93.9	2.1	4
0 to -15B	ENSR[1]	82		
	Dial Cordy[2]	77.6		
	ENSR[3]	80.4	8.8	10.8
	NOS[5]	49.4	32.6	18
-15B to -25B	ENSR[1]	87		
	GSRC[2]	82.6		
	ENSR[3]	79	8.4	12.6
	NOS[5]	73	9	17.9
-25B to -50B	ENSR[1]	78.4		
	GSRC[2]	67.6		
	ENSR[3]	75.8	9.7	14.5
	NOS[5]	57	24.2	18.8
-50B to -60B	ENSR[1]	92.7		
	GSRC[2]	91.4		
	ENSR[3]	96.3	1.4	2.3
Sediment Basin	ENSR[3]	8.6	20.7	70.7
	GSRC[4]	9	59	32

Notes:
1 All ENSR grain size data, sampling mostly in Aug 2002, all accomplished prior to dredging, sand by #200 sieve (328 samples)(ENSR 2003, Savannah Harbor O&M Grain Size Evaluation, ENSR International, Contract GS-10F-0115K, DO DACW21-02-F-0034, June 2003).
2 All Dial Cordy grain size data, sampling 13-18 Dec 2000, prior to dredging 30 Dec to 9 Mar 01, sand by #200 sieve (264 samples)(Dial Cordy, 2001, Grain Size Analysis of Maintenance Sediments in the Savannah Harbor Navigation Channel, Prepared for the Savannah District by Dial Cordy and Associates, Inc., March 2001).
3 ENSR data from limited sampling for chemistry and biotoxicity studies, sampling Aug 2002, #200 sieve (18 samples)(ENSR 2003, Savannah Harbor O&M Sediment Evaluation, ENSR International, Contract GS-10F-0115K, DO DACW21-02-F-0034, August 2003).
4 GSRC data from limited sampling for chemistry and biotoxicity studies, sampling Aug 1999, sand by #200 sieve (11 samples)(GSRC 2000, Savannah Harbor Sediment Testing, Final Report to USACE Savannah District, Gulf South Research Corporation and G.E.C., Inc., July 2000, Contract Number DACW21-98-D-0019, DO 29).
5 NOS data from sampling for metals and selected organics, sampling Dec 1998 (13 samples)(NOS, 1999, Savannah Harbor O&M Testing, Dr. Dan Bearden & Dr. Geoff Scott, National Ocean Service, and Mr. J. Edward Buxton, General Engineering Laboratories, Inc., and Dr. Walter J. Sexton, Athena Technologies, Inc., June 1, 1999, MIPR W33SJG83416218).

The entrance or ocean bar channel sediments are primarily sand with exceptions between the jetties and at Station -45+000B, which have large silt and clay components.

As discussed in Section 3, maintenance sediments dredged from the ocean bar channel (Station 0+000 to -60+000B) are deposited in the Savannah ODMDS. On occasion, some of the maintenance material from the first portion of the entrance channel is placed in a CDF. Although they have not been used in the past, the 1996 LTMS authorized the use of Site 2 and Site 3, feeder berm sites just south of the entrance channel, and the nearshore feeder berm sites (Site 2 Extension, ERDC Nearshore, MLW 200, and MLW 500) off Tybee Island for the placement of maintenance material from the entrance channel as well as the first portion of the inner harbor. Figure 3-3 shows these authorized placement sites. The LTMS also authorized the placement of suitable maintenance material directly onto the beach at Tybee Island. Since placement of maintenance material into these nearshore sites or onto the beach of Tybee Island would involve additional costs over that of the Base Plan (use of the ODMDS and Site 2 and Site 3), a cost sharing non-Federal sponsor would be required.

Samples of bottom sediments from the project area have been tested to evaluate the toxicity and bioaccumulation potential of chemical contaminants which may be associated with those maintenance sediment materials. These site-specific test results indicate that the maintenance sediments meet the testing criteria of the EPA Ocean Dumping Regulations and Criteria and are, therefore, acceptable for transportation for ocean dumping under Section 103 of the Marine Protection, Research, and Sanctuaries Act of 1972, as amended. The District completed its most recent evaluation of depositing maintenance sediments in the Savannah ODMDS in a Section 103 Evaluation in July 2010. EPA Region IV, concurred with the determination by letter dated December 22, 2010. The maintenance sediments are re-examined every 6-10 years to ensure they still meet the Ocean Dumping criteria. The sediment testing performed for this project (reported in EIS-Appendix M) indicates that the new work sediments are substantially the same as the substrate at the disposal site and the dredging site is far removed from sources of pollution, so as to provide a reasonable assurance that the material has not been contaminated by pollution. As a result, the new work sediments are acceptable for ocean disposal. Savannah District prepared an evaluation of depositing the new work sediments in the Savannah ODMDS. That evaluation is found in EIS-Appendix R. Savannah District is conducting biological testing on the new work sediments to confirm that adverse biological effects from such placement are unlikely. That testing and evaluation are still underway. The District will prepare a Section 103 Evaluation and submit it to EPA Region IV for review and approval prior to initiating dredging.

New work sediments excavated from the inner harbor will be placed in upland confined disposal sites. Use of specific sites would be determined based on their availability and planned maintenance and improvement activities. Tables 4-3 and 4-4 contain a breakdown of the amount of new work dredged sediment by reach. The volumes to be dredged shown in those tables are based on a 47-foot deepening with allowable overdepth and advance maintenance.

Table 4-3. Approximate New Work Sediment Quantities by Reach for the Inner Harbor

Station Range	Estimated Total (Cubic Yards)
0+000 to 4+000	305,674
4+000 to 6+375	174,073
6+375 to 30+000	2,759,203
30+000 to 45+000	1,802,866
45+000 to 51+000	892,307
51+000 to 57+000	1,101,114
57+000 to 67+000	1,244,681
67+000 to 80+125	1,196,291
80+125 to 90+000	946,436
90+000 to 103+000	2,533,434
TOTAL	**12,956,079**

Table 4-4 provides the estimated amounts of sediment that will be excavated for the proposed Outer Harbor (Ocean Bar Channel) from Stations 0+000 to -97+680B. The volume to be removed is based on a 47-foot deepening with 100% for overdepth and advance maintenance.

Table 4-4. Estimated New Work Sediment Quantities by Reach for the Outer Harbor (Ocean Bar Channel)

Station Range	Estimated Total (Cubic Yards)
0+000 to -10+000B	917,064
-10+000B to -20+000B	1,311,322
-20+000B to -30+000B	1,352,115
-30+000B to -40+000B	1,305,921
-40+000B to -53+500B	1,632,346
-53+500B to -57+000B	391,437
-57+000B to -97+680B	3,736,308
TOTAL	**10,646,413**

Average annual maintenance dredging requirements for the selected plan (-47 feet MLW) would essentially be the same since the side slopes of the channel will not change. Table 4-5 includes total estimated maintenance dredging requirements.

Table 4-5. Estimated Average Annual Maintenance Dredging Quantities for the 47-Foot Depth Alternative (in Cubic Yards)

Station Range	Maintenance Volume (Cubic Yards)
Entrance Channel	
-98+600B to -57+000B	124,000
-57+000B to –53+500B	3,000
-53+500B to -40+000B	54,000
-40+000B to -30+000B	325,000
-30+000B to -20+000B	281,000
-20+000B to -10+000B	163,000
-10+000B to 0+000B	155,000
+4+000 to 0+000B	76,000
Subtotal CY	**1,181,000**
Inner Harbor	
4+000 to 24+000	225,000
24+000 to 40+000	364,000
40+000 to 50+000	900,000
50+000 to 70+000	2,076,000
70+000 to 79+000	294,000
79+000 to 97+750	605,000
97+750 to 102+000	1,456,000
102+000 to 103+000	51,000
Subtotal CY	**5,971,000**
TOTAL ANNUAL	**7,038,000**

4.01.2.1 Sediment Quality (Potential Contaminant Impacts). As described earlier, maintenance sediments are tested every 6-10 years to ensure they are not contaminated to the extent that special handling is required and that they are suitable for deposition in either an upland or ocean placement site. Sediment testing had been performed as part of the Tier I EIS developed for this proposed project. The Executive Summary of the Final Sediment Quality Evaluation (found in Appendix M) performed as part of this EIS summarized that effort and more recent studies as follows: "*In 1997, sediment core samples were collected and examined for sediment physical and chemical properties. The sampling area covered the entire project*

area proposed for harbor deepening, extending from deep water in the ocean to the Kings Island Turning Basin (Station 103+000). Parameters investigated included metals, PCBs, PAHs, petroleum hydrocarbons, phenols, pesticides, dioxin congeners, cyanide, organotins, and nutrients.

The evaluation found that most of the sediments did not provide any concern for potential contaminant-related impacts associated with the proposed dredging and dredged sediment placement. However, three potential issues were identified.

One issue involved sediments near the old RACON Tower site. Polycyclic aromatic hydrocarbons (PAHs) and cadmium were detected in a sample taken at about Station - 75+000B near the old RACON Tower where a spill of fuel, batteries, and paint lacquer occurred in November 1996. Subsequent sampling conducted in 2005 revealed that sediments at that location do not pose a potential for potential contaminant-related environmental impacts.

The second issue pertained mostly to whether the sediment chemistry data for pesticides, PAH's and phenols, especially achieved detection limits, were adequate for comparison to screening criteria. This issue was addressed during the 2005 sampling. The confirmatory sampling within the channel revealed there are no potential sediment contaminant concerns related to pesticides, PAH's, phenols, or metals other than cadmium.

The final issue involved the concentration and distribution of cadmium within the new work sediments. Sampling was conducted in 2005 to address this issue. Cadmium was found to occur naturally in unusually high levels within Miocene clays that would be excavated during the SHEP dredging. Evaluation of the laboratory results could not rule out the potential for adverse impacts from sediments with elevated cadmium levels in some reaches of the channel."

As a result of those investigations, additional studies were conducted. The additional sampling, testing and detailed analyses were conducted in 2007. The potential pathways by which cadmium might enter the environment were evaluated. Further discussion of those studies and the impacts of the cadmium-laden sediment on the environment is found in Section 5.04 and Appendix M of the EIS.

4.01.2.2 Radiological Screening of Harbor Sediments. Savannah Harbor is located about 120 miles downstream from the US Department of Energy, Savannah River Site in Aiken, South Carolina. The Savannah River Site processes radioactive material and over the years, releases of radioactive materials from this site have been documented. Therefore, accumulation of these radioactive materials within the harbor sediments may have occurred.

In 2002, sediment samples were collected within the harbor and sent to the Corps of Engineers' Environmental and Materials Unit located in Marietta, Georgia and examined for radiological contamination. Test results were measured in milli-Rems per hour (mRem/hr). Background values varied between 0.01 and 0.03 mRem/hr. Values from the sediment samples ranged from 0.02 to 0.04 mRem/hr. These results are consistent with the background levels, with only a few samples exhibiting an increase of 0.01 mRem/hr over the background range. This should be anticipated, since these soils contain phosphatic and glauconitic minerals, along with other clays,

that exhibit naturally-occurring levels above background levels. These results are two orders of magnitude below acceptable action levels approved by OSHA and the US Environmental Protection Agency that range between 1 mRem/hr to 5 mRem/hr. Based on these results, the levels of gross radioactivity measured in the harbor sediments are naturally-occurring and pose no hazards to the environment as documented in the Dredged Material Physical Analysis Report 2002 (see GRR, Engineering Appendix).

4.02 Water Resources

4.02.1 Groundwater

Studies were previously conducted to determine impacts of the 1993/1994 harbor deepening on the freshwater aquifer. Borings were taken to define the soil stratum at critical locations. Information from those and other borings show that the stratum bearing the drinking water aquifer would not be impacted by maintenance of channel depths in the authorized project. More than 50 feet separate the bottom of the deepest authorized excavation from the top of that water-bearing layer. According to work performed by Paul Huddleston, Georgia Geologic Survey, the US Geological Survey; and Dr. Vernon J. Henry, Georgia State University, the surfaces of the Early Miocene and Late Oligocene Age aquifers appear to be sufficiently deep to prevent damage by even a project constructed to a depth of -50 feet MLW.

An offshore geological structure known as the Beaufort Arch created an uplift to the Tertiary sediments in the vicinity of the Savannah Light (outer end of the entrance channel). This uplift resulted in the Parachucla formation (of early Miocene Age) surfacing about -90 feet MLW which is the uppermost confined aquifer in the area. A more valuable freshwater aquifer, the Late Eocene aged Ocala Limestone (Upper Floridan) aquifer, would be expected to be at no higher elevation than -190 feet MLW in this area. The uppermost freshwater aquifer is confined by the middle Miocene clays that range in thickness from less than 30 feet near the Tybee high to 160 feet near downtown Savannah. These clays are overlain by clayey sands and soft limestones. Above the Upper Miocene are soft granular Pliocene and Pleistocene age deposits in which most of the recent harbor deepening took place, along with current soft deposits of the Holocene Age. Early reports indicated that introduction of significant volumes of water into the upper Floridan aquifer would require contact with a fissure, fault, or ancient stream channel which would lead to this strata. This is possible, but not likely. Another way for water to be introduced into the Upper Floridan aquifer would be for the entire Miocene Age cap to be removed to expose the underlying limestone. This would require dredging the harbor to -100 feet MLW. Based on this information, previous studies concluded that no impact to the upper confined freshwater aquifer or the principal confined artesian drinking water aquifer in Savannah Harbor was expected from the recent harbor deepening or from continued maintenance of the 42-foot authorized Navigation Project.

The existing diked sediment containment areas are not lined, but are constructed on top of the soil substrate that was originally on the site. In most cases, soft organic soils supporting wetland vegetation previously covered the sites. Due to the unlined nature of the facility and the short-term ponding of water within the diked areas, there is a potential for migration of water down

through the soil layers to levels of shallow groundwater. Groundwater can be found at various depths in the project vicinity, while subsurface drinking water is taken only from depths more than 100 feet below the surface. As described in the previous paragraph, clay lenses of 40 to 70 feet in thickness separate the various groundwater bearing strata. Those lenses effectively limit the depth to which migration could occur from the disposal areas.

Additional groundwater studies (including groundwater modeling) were conducted as part of the Final EIS. These studies were prepared by the Savannah District and were independently peer reviewed by representatives from USGS and Virginia Polytechnic Institute and Georgia State University. The report is entitled *Supplemental Studies to Determine Potential Ground-Water Impacts to the Upper Floridan Aquifer, Savannah Harbor Expansion Project, Final Report, June 2007* and is included in the GRR Engineering Appendix.

The field work included the following major components:

A. Detailed sub-bottom seismic survey
B. Marine and land drilling
C. Collection of porewater data
D. Collection of hydraulic conductivity data
E. Collection of head data

The results of the field work were analyzed and incorporated into a three-dimensional coupled flow and transport groundwater model. The consulting firm CDM conducted the groundwater modeling. Additionally, the field data was used to develop a comprehensive Geographic Information System (GIS) of the area.

The sub-bottom seismic survey was conducted from Stations 30+000 to -30+000B, where the Miocene confining unit is naturally thin and paleochannels are known to have further incised into the confining layer. The survey provided detailed information about all major paleochannels within the area of concern. The location, attitude, and extent of all paleochannels were mapped and incorporated into the Miocene surfaces created for the GIS and the groundwater model. These results are summarized in Chapter 5 and discussed in detail in the Engineering Appendix of the GRR.

The three-dimensional groundwater model simulated the specific effects of deepening the existing navigational channel on water quality in the Upper Floridan aquifer. Model simulations were run for no future dredging (future conditions without the project), the proposed deepening (up to 6 feet or -48 feet MLW) plus an additional 3-foot removal of confining material (i.e., up to -51 feet MLW), and varying the hydraulic conductivity of the confining layer. The reason the additional three feet was included in the model was because of inconsistencies in the equipment used to deepen the channel. As discussed previously (see Section 3.01, above), hydraulic (cutterhead pipeline and hopper) and mechanical dredges (clamshell bucket and barge) have inherent inaccuracies in their removal of sediment within the channel.

The following information was taken from USACE (2007): *The results of the groundwater model indicated that the proposed deepening activities to the -48 foot depth MLW would*

contribute a minimal amount of downward flow through the confining layer and the resulting differences between the proposed deepening (to -48 foot MLW) and no deepening scenarios were minor. The simulated chloride concentrations decrease significantly upon entering the Upper Floridan aquifer due to considerable horizontal flow of fresh water within the aquifer mixing with and diluting the relative very low volume of salt water migrating downward from the Savannah River. The model simulations also projected that regardless of the proposed deepening to -48 foot depth MLW, chloride concentrations in the Upper Floridan aquifer are expected to increase significantly in the lower reaches of the Savannah River over the next 100 to 300 years if the present rate of aquifer withdrawal remains constant. Under current conditions, the maximum expected chloride concentrations in the Upper Floridan aquifer directly beneath the river ranged from 500 to 1,400 mg/l depending on the hydraulic conductivity of the confining layer and the proposed deepening to -48 feet MLW was projected to contribute an additional 10 to 200 mg/l to these concentrations.

4.02.1.1 Fractures within the Miocene Confining Unit. Another groundwater-related issue that was identified at the end of the Tier I EIS process and during the 2002 scoping for the Final EIS, is the possible existence and influence of fractures or joints within the Miocene confining unit underlying the navigation channel. Fractures within the Miocene aquitard could significantly affect the rate of saltwater intrusion into the Upper Floridan aquifer. These issues are addressed within the report entitled *Supplemental Studies to Determine Potential Ground-Water Impacts to the Upper Floridan Aquifer, Savannah Harbor Expansion Project, Final Report, June 2007* found in the GRR and discussed in Section 5.05 of the EIS.

4.02.2 Surface Water

4.02.2.1 Surface Water Salinity. Savannah Harbor is in a partially-mixed estuary in which the vertical mixing of salt and freshwater is not complete over the length of saltwater intrusion. Surface salinities are appreciably less than the bottom salinities and there is a large zone of mixing between fresh and saltwater. Seaward of this mixing zone, the net bottom flow over a tidal cycle is upstream. Landward of this mixing zone, the net bottom flow is downstream. The converging bottom flows carry shoaling material to the location of no net bottom flow, which tends to be an area of high shoal volumes. Shoaling in the Savannah inner harbor channels oceanward of Station 28+000 is due to sand carried into the channel from the ocean by the strong bottom flood currents. The shoal material in the lower river is almost entirely sand, while the shoal material upstream of Station 28+000 is silt and clay. The sand is deposited during slack tide and the weaker bottom ebb currents cannot carry the sand back to the ocean source. Results from the physical model tests indicate that the bottom flood currents at Station 4+000 are a foot per second faster than the bottom ebb currents and that the net bottom flow in the lower portion of the harbor is upstream.

Pritchard (1967) described four hypothetical circulation patterns for estuaries, two of which may be applicable to Georgia estuaries. The *moderately stratified estuary* is one in which tidal action serves as the dominant force mixing fresh and salt waters. The Savannah River exhibits this type of circulation. In an estuary with no tide or friction, undiluted sea water would extend upstream along the bottom to a point where the river surface was approximately at sea level. The less dense fresh water would flow seaward on top of the salt water. When there is tidal action, as in

the moderately-stratified estuary, turbulence carries fresh water downward and salt water upward. The salt content of both layers increases toward the sea, but at any given point the bottom layer is more saline than the top. *Vertically homogeneous estuaries* occur where tidal mixing is vigorous and freshwater input is low. In this case, vertical salinity stratification breaks down.

There exists a definite salinity gradient with depth. The lower reaches of the estuary may have bottom salinities ranging from one-half to three times greater than surface salinities. However, turbulence within the river frequently does not allow the formation of a distinct saltwater wedge. The salinity of the estuary is constantly changing due to tidal action, freshwater inflow and wind, so that for any location within the river the salinity might range from a few parts per thousand (ppt) to almost normal ocean salinity (35 ppt).

4.02.2.2 Water Quality Classification. The water quality classifications for the states of Georgia and South Carolina are summarized below.

South Carolina Standards. South Carolina Department of Health and Environmental Control (SC DHEC), dated June 23, 2006, in its Water Classifications and Standards, Regulation 61-69, has classified the Savannah River from the headwaters of Lake Russell to the Seaboard Coastline Railroad as Class FW, from the Seaboard Coastline Railroad to Fort Pulaski as SB (Dissolved Oxygen not less than daily average 5 mg/l and minimum 4 mg/l), and from Fort Pulaski to the Atlantic Ocean as Class SA waters.

Class FW is defined as freshwaters suitable for primary and secondary contact recreation and as a source for drinking water supply after conventional treatment in accordance with the requirements of the Department. These freshwaters are suitable for fishing and the survival and propagation of a balanced indigenous aquatic community of fauna and flora. They are suitable also for industrial and agricultural uses.

Class SB is defined as tidal saltwater suitable for primary and secondary contact recreation, crabbing, and fishing, except harvesting of clams, mussels, or oysters for market purposes or human consumption. These waters are also suitable for the survival and propagation of a balanced indigenous aquatic community of marine fauna and flora. The dissolved oxygen standard for Class SB is not less than 4 mg/l.

Class SA is defined as tidal saltwater suitable for primary and secondary contact recreation. These waters are also suitable for uses listed in Class SB, with the same exceptions. The dissolved oxygen standard for Class SA is a daily average of 5 mg/l with a minimum of 4 mg/l.

The SC DHEC standards also contain a provision for cases where natural conditions may cause a depression of dissolved oxygen in surface waters while existing and classified uses are still maintained. The Department shall allow a dissolved oxygen depression in these naturally low dissolved oxygen waterbodies, defined as a waterbody that, between and including the months of March and October, has naturally low dissolved oxygen levels at some time and for which limits during those months shall be set based on a critical condition analysis. These waters shall not be

cumulatively lowered more than 0.1 mg/l for dissolved oxygen from point sources and other activities.

A fish consumption advisory has been issued by SC DHEC for mercury and includes the Savannah River within this watershed.

Georgia Standards. The State of Georgia, through its Rules and Regulations for Water Quality Control, Chapter 391-3-6, Revised January 29, 2009, has classified the Savannah River from Station 0+000 (mile 0) at Fort Pulaski to the open sea (including the littoral waters of Tybee Island) as "Recreation Waters". From Fort Pulaski (Station 0+000) to the Seaboard Coastline RR Bridge (about Station 144+672 or Mile 27.4), the river is classified as "Coastal Fishing". The latter stretch of the Savannah River used to be classified as Industrial/Navigation. However, studies were conducted by the Georgia Department of Natural Resources during the fall of 1985 which resulted in the reclassification of that stretch of the river to "Coastal Fishing".

The GA Department of Natural Resources (GA DNR) (Water Quality in Georgia, 1990-1991) lists the harbor from US Highway 17 to South Channel as not fully supporting the designated use of coastal fishing due to the violation of fecal coliform and copper criteria due to urban runoff/urban effects and municipal facilities incapable of providing sufficiently high quality effluent. In 2000, the US Environmental Protection Agency (EPA) established a Total Maximum Daily Load (TMDL) for the harbor for fecal coliform. EPA determined the critical period to be in July and August. The TMDL stated that upstream point sources were not believed to be the cause of high fecal counts in the harbor since those sources are located far enough upstream to allow their fecal coliform loads to decay to background levels.

In October 2006, EPA finalized a TMDL for Savannah Harbor to satisfy a consent decree obligation established in Sierra Club v. EPA, Civil Action No: 94-CV-2501-MHS (N.D.GA). In summary, the TMDL concluded that Savannah River cannot accept anthropogenic oxygen-demanding substances and still provide acceptable habitat for critical aquatic life that reside in those reaches of the river. This finding means that the States will have to revise their permits for point source discharges in those reaches as they expire and come up for renewal. As part of its analysis, EPA evaluated the dissolved oxygen requirements for several different fish species and the natural conditions for the river. For Savannah Harbor, the applicable DO site-specific criteria established by Georgia "are minimum instantaneous and will apply throughout the water column. The DO criteria were no less than 3.0 mg/l in June, July, August, September, and October; no less than 3.5 mg/l in May and November; and no less than 4.0 mg/l in December, January, February, March, and April."

In 2009, the State of Georgia revised its DO standard for Savannah Harbor. The new standard calls for a daily average in the dissolved oxygen to be no less than 5.0 mg/L throughout the year, with an instantaneous minimum of 4.0 mg/L. If it is determined that the "natural condition" in the water body is less than the values stated above, then the criteria will revert to the "natural condition" and the water quality standard will allow for a 0.1 mg/l deficit from the "natural" dissolved oxygen value. Up to a 10% deficit will be allowed if it is demonstrated that resident aquatic species shall not be adversely affected. These new standards apply throughout the water column and they match the South Carolina standard for waters of the same use classification.

EPA published a Revised Draft TDML for dissolved oxygen in Savannah Harbor in April 2010. This TDML requires a reduction in loading from about 600,000 lbs/day Ultimate Oxygen Demand (UOD) to about 130,000 lbs/day.

4.02.2.3 Section 401 Water Quality Certifications. The dissolved oxygen regime in Savannah Harbor is characterized by low levels of dissolved oxygen during the summer months, with much of the estuary typically dropping below the state standards. The Corps is required to monitor dissolved oxygen levels in the effluent from its sediment disposal areas, as well as in the vicinity of its dredging operations during the summer months. When dissolved oxygen levels fall to 3.0 mg/liter or less, the Corps is required to cease dredging operations unless a waiver is obtained from GA DNR-EPD.

Water Quality Certifications have been received for operation of the existing Savannah Harbor Navigation Project from both Georgia and South Carolina in their administration of Section 401 of the Clean Water Act.

Water Quality Certification -- State of Georgia. In a letter dated September 5, 1995, the State of Georgia, Department of Natural Resources, Environmental Protection Division (GA DNR-EPD) issued a Section 401 Water Quality Certification for the Long Term Management Strategy. Conditions in the certification are listed below. The District received clarification from the State on three of the conditions by letters dated February 6 and 28, 1996. The conditions below reflect those clarifications. Further discussions with GA DNR staff confirm that conditions 5 and 6 apply only to hopper dredges.

The Georgia certification was issued contingent on the following conditions:

A. All work performed during construction will be done in a manner so as not to violate applicable water quality standards.

B. No oils, grease, materials or other pollutants will be discharged from the construction activities which reach public waters.

C. No dredging operations will be conducted during the Striped bass spawning period from March 16 to May 31. This was modified in 1998 to avoid possible impacts to the Striped bass population of the Savannah River. The condition now in effect is that dredging will be restricted in the harbor (upstream of Station 63+360 or River Mile 12.0) during the period from March 16 to May 31 of each year.

D. Prior to initiation of dredging activity between July 1 and September 30, the dredge operator must establish the following procedures. Dissolved oxygen levels in the Savannah River contiguous with the immediate dredging activity will be determined at a depth of one meter above the hard bottom or 2 to 3 meters above an indeterminate bottom. This determination must be made within 24 hours prior to the commencement of dredging activity. If dissolved oxygen levels are less than 3.0 mg/l dredging activity will not be permitted.

Monitoring of the dredging activity will be conducted within 4 hours of the commencement of dredging, but no earlier than 2 hours after the commencement of dredging. In the event of 24 hour operation (around the clock) of the dredge, dissolved oxygen will be determined daily. The monitoring station will be located at mid-channel, 500 feet downstream of the ongoing dredging activity. Dissolved oxygen levels will be determined at a depth of one meter above a hard bottom or 2 to 3 meters above an indeterminate bottom. If dissolved oxygen levels fall below 3.0 mg/l, dredging will be suspended until dissolved oxygen levels are 3.0 mg/l or greater.

Results of this monitoring must be submitted to the Georgia DNR Environmental Protection Division, the Georgia Wildlife Resources Division, and the Georgia Coastal Resources Division within 30 days of the completion of each dredging operation. Failure to maintain satisfactory compliance with these conditions may result in prohibition of dredging operations in the Savannah River during the period of July 1 to September 30 upon written notice to the applicant.

E. Dredging should be conducted during December through March. These are the times when sea turtles are least abundant in the area of the Savannah Ship Channel. Dredging outside these months should be coordinated with the Georgia Department of Natural Resources (DNR) Non-game Wildlife Program. Dredging in May will require the implementation of a conservation plan approved by the Georgia DNR. This plan should include trawling to remove turtles from the path of the dredge.

F. During December through March, dredge and support vessels should have a trained whale observer on watch during daylight hours. At night, or when visibility is reduced by fog or sea states greater than Beaufort 3, dredges must slow to 5 knots or less if whales have been spotted within 15 nautical miles (nm) of the vessel's path within the previous 48 hours. Normal operational speeds can be resumed after 48 hours if visibility has not improved and no whales have been observed by dredge observers. These procedures are consistent with the "Recommended Safe Operating Procedures for Large Vessels Transiting the Right Whale Calving Area Critical Habitat Off Georgia and Florida During March-December" that have been developed by the Southeastern US Implementation Team for the Recovery of the Northern Right Whale.

Water Quality Certification -- State of South Carolina. On May 10, 1996, the State of South Carolina, Department of Health and Environmental Control (SCDHEC) issued a Section 401 Water Quality Certification for the Savannah Harbor Long Term Management Strategy (LTMS) Project. That certification included the following conditions:

A. To ensure water quality standards are maintained, the Division of Water Quality and Shellfish Sanitation must be notified and any alternate disposal site must be reviewed and approved prior to its use if the proposed disposal areas cannot be utilized by the COE or the GA DOT.

B. The applicant must implement a water quality monitoring plan to insure that the effluent is in compliance with state water quality standards and to coordinate with the Department if any discharge is violating any state water quality criteria, as proposed. The applicant must conduct monitoring in accordance with an approved sampling plan specifying the

location of sampling stations, parameters sampled, when samples will be collected, and how the sampling data will be reported. Appropriate ambient data from the Wright River must also be submitted.

C. The applicant must install flap gates at underdrain discharge points so that no effluent is discharged during low flow periods in receiving waters.

D. The applicant must monitor water quality 100 feet downstream of underdrain discharges to test for water quality standards compliance, as proposed. In addition, the applicant must conduct monitoring in accordance with an approved sampling plan specifying the location of sampling stations, parameters sampled, when samples will be collected, and how the sampling data will be reported.

E. The applicant must adhere/comply with recommendations of the SC DNR regarding the timing of placing dredged material for beach nourishment to insure continued protection of various species of sea turtles.

F. The applicant must provide compensatory mitigation for wetlands impacts associated with the proposed work. All wetlands impacts must be compensated for on at least a 1:1 basis. If mitigation includes creation, restoration, or enhancement, the plan must include monitoring. This mitigation plan must be submitted to the Water Quality Division for review and approval within 6 months of Section 404 permit issuance.

4.02.2.4 City of Savannah – Abercorn Creek Water Intake. During preparation of the 1998 Feasibility Report for the Savannah Harbor Expansion Project, Savannah City officials questioned whether chlorides may increase at the City's municipal and industrial (M&I) raw water intake on Abercorn Creek. The City's M&I water intake is located along Abercorn Creek approximately 1 mile upstream of the confluence of the creek with the Savannah River. Abercorn Creek is located upstream of the I-95 bridge (see Figure 4-2, below).

Figure 4-2. City of Savannah municipal and industrial water intake on Abercorn Creek.

Presently the City withdraws water from Abercorn Creek for both municipal and industrial uses. In the past, the City's contracts with its industrial customers included a provision that the water provided must possess a chloride concentration not greater than 12 mg/l (or 12 ppm). That criteria is not included in the present contracts, but the industries still require water with very little chlorides. Municipal water requires that chlorides be within the 250 mg/l (or 250 ppm) drinking-water standard established by the GA DNR-EPD. Seawater has a chloride concentration of about 19,400 mg/l (or 19,400 ppm).

In ATM's 1999 Report for GPA, "*preliminary evaluation of water samples collected at the City's intake shows that historically the raw water at the intake has had chloride levels in violation of the contracted maximum concentrations. These violations occur primarily during periods of low flow. To date, the industries have dealt with the violations through internal treatment and process modification.*" Because of the sensitivity of chloride levels at the City's water intake, the Corps evaluated the potential effects of harbor deepening with respect to the waters in Abercorn Creek.

4.03 Air Quality

The Georgia Department of Natural Resources, Environmental Protection Division, Air Protection Branch (GA DNR-EPD, APB) and the South Carolina Department of Health and Environmental Control, Bureau of Air Quality (SC DHEC, BAQ), have air quality jurisdiction for the project area for Chatham County, Georgia and Jasper County, South Carolina, respectively. The ambient air quality for Chatham County, Georgia and Jasper County, South Carolina has been determined to be in compliance with the National Ambient Air Quality Standards, and both counties have been designated as attainment areas (Personal Communication, 20 February 2007, Jim Kelly, GA DNR-EPD, APB and Fatina Washburn, SC DHEC, BAQ).

The Corps prepared an air quality analysis as part of the Savannah Harbor Expansion Project. A copy of this report is found in Appendix K. The analyses documented in the report describe the air emissions associated with container vessels calling on the Georgia Ports Authority (GPA) Garden City and Ocean Terminals in Savannah Harbor. Emission estimates for those operations are presented in the report for the period 2004 through 2050, both with and without implementation of the proposed harbor deepening project.

The Corps provided the 2006 Air Quality Analysis report to the EPA Region IV for review and comment. As a result of their review, EPA requested the analysis be expanded to include (1) the emissions from landside equipment that service these vessels, (2) the air toxics emitted by both the vessels and the landside equipment, and (3) similar analyses associated with the privately-owned terminals in the harbor. EPA recognized that the emissions associated from vessels calling at the privately-owned terminals were not likely to be affected by the proposed harbor deepening, but they desired the comprehensive air quality assessment of the harbor to be able to more accurately place any expected increase in emissions resulting from the proposed harbor deepening in its proper context.

As a result of EPA Region IV request, the Corps completed an Air Emission Inventory for the Port of Savannah, dated May 2008. The objective of this inventory was to expand the Corps' 2006 air quality analysis to the entire harbor to more completely assess air quality impacts from the proposed harbor deepening. This more detailed assessment evaluates the air emissions from all cargo-carrying vessels and landside cargo handling equipment at both the GPA and privately-operated terminals at the port. It also compares these emissions for both the "With" and "Without Project" (No Action) alternatives. In addition to the criteria pollutants that are traditionally evaluated when one discusses air emissions, estimates of air toxics and greenhouse gases emitted at the Port were also calculated. The primary focus of this work is a comparative assessment of the air emissions associated with the operation of the port before and after project implementation, in conjunction with consideration of the current status of air quality in the Savannah area.

This 2008 inventory was updated in 2011 in response to questions received from EPA during their review of the DEIS. The updated emission inventory and air impact assessment is found in Appendix K. Project impacts on air quality are discussed in Section 5.06 of the EIS.

4.04 Marine and Estuarine Resources

4.04.1 Fish and Shellfish Resources

The State of Georgia performed a fishery survey in the Savannah River from July 1980 to June 1985 (Schmitt and Hornsby, 1985). They found that numerically, the Striped mullet (*Mugil cephalus*) was by far the most abundant species sampled in the estuarine habitat followed by largemouth bass (*Micropterus salmoides*) and bowfin (*Amia calva*). Biomass in the estuary was composed primarily of common carp (*Cyprinus carpio*), bowfin and spotted sucker (*Minytrema melanops*). Compared to the non-game species, game fish were poorly represented in the estuarine habitat. The principal species harvested in the estuarine portion of the river were shown to be croaker/spot (*Micropogon undulatus /Leiostomus xanthurus*), White catfish (*Ictalurus catus*), Silver perch (*Bairdiella chrysura*), and Spotted seatrout (*Cynoscion nebulosus*). Weights of fish harvested were represented principally by White catfish, Red drum (*Sciaenops ocellata*), Striped bass (*Morone saxatilis*), Spotted seatrout, Hardhead catfish (*Arius felis*), Bluefish (*Pomatomus saltatrix*), and Channel catfish (*Ictalurus punctatus*). Anadromous fish collected in the estuarine habitat included Striped bass, American shad (*Alosa sapidissima*), Hickory shad (*Alosa mediocris*), and Blueback herring (*Alosa aestivalis*).

Each spring and fall, the main Savannah River, Back River, Middle River, and the numerous interconnecting tidal streams are hosts for the migration of three members of the herring family - American shad (*Alosa sapidissima*), Hickory shad (*Alosa mediocris*), and Blueback herring (*Alosa aestivals*), and the Striped bass (*Morone saxatilis*), which are very important game and/or commercial fish. American shad enter the Savannah River in mid-January and begin spawning in mid-April. The river temperature at spawning is between 54 degrees F and 70 degrees F. The young shad leave the river in autumn; all are gone by December. American shad spawn in the freshwater portion of the main river further upstream than do striped bass and well outside the

impact limits of SHEP. The American shad is the most valuable commercial anadromous fish in the southeast.

Hickory shad enter the Savannah River in early January, begin spawning in the tributaries in March and complete spawning in April. Water temperature at spawning is between 64 degrees F and 69 degrees F. The young hatch two to three days after eggs are laid and leave the river from July to October. Blueback herring, which also enter the river in March and April, must have water temperatures of around 70 degrees F to spawn. The catadromous American eel, (*Anguilla rostrata*) is also widely distributed in the Savannah River estuary.

Anadromous striped bass enter the Savannah River for their spring spawning runs in March, April, or May. The river temperature must be between 58 degrees F and 64 degrees F, and the salinity must be less than 1.7 parts per trillion (ppt) for optimum spawning success. The Striped bass is a free spawner; the eggs must be suspended in the water, as they float with the river currents before they hatch 36-72 hours after being laid. The last eggs to be observed in the river are usually found at the end of May. Adult Striped bass leave the river in August. One group of juveniles leaves the river in October and November when the water begins to cool; a second group apparently does not migrate. The largest traditional spawning site in the Savannah River basin is in Back River, 23 miles upstream from the mouth of the Savannah River. However, population levels have been much lower in the last 20 years and a higher proportion of the spawning now appears to be occurring in the Savannah River a few miles upstream of the harbor (over 21 miles upstream from the mouth of the Savannah River).

Most Striped bass along the east coast are considered to be anadromous; however, some populations have been found to complete their lives entirely in fresh water (Scruggs and Fuller 1955, McIlwain 1968). An upstream and downstream race of Striped bass has been identified in the Cooper River, South Carolina (Raney 1952), and other races of these fish have been identified in particular rivers (Morgan et al. 1973). Studies done on Striped bass in the Savannah River indicate they spend much of the year in freshwater, much like those elsewhere in the southeast (Dudley et al. 1976). The Savannah River population appears to be primarily riverine, rather than anadromous, (Dudley, Mullis, and Terrell, 1976), and reproduces in the various river channels near Savannah. Research conducted by Environmental and Chemical Services, Incorporated, in 1983 for E. I. duPont de Nemours and Company to determine density and distribution of ichthyoplankton in the upper Savannah River, indicated that some Striped bass spawn in the vicinity of the Savannah River Plant. From the available research done on Striped bass in the Savannah River, it appears that some are riverine, while others are anadromous. A major spawning ground for Striped bass in the estuary was historically located in the Back River upstream of New Cut (Gilbert et al. 1985), while other spawning takes place in the Savannah River above the upper limits of the harbor. Back River functioned as a major spawning site prior to construction and operation of the Tide Gate. However, recent studies found very few eggs in the Back River, with most eggs collected from the harbor being found in the Front River. Low population levels have occurred in the Savannah River Striped bass population in the last 10 years.

More recent studies on Striped bass (Will and Jennings 2001) indicate that historically the Savannah River was Georgia's most important Striped bass fishery. According to Dudley and

Black (1979), "the majority of Striped bass spawning occurred in the Back River" and according to Wallin et al (1995) "nursery areas for juvenile stripers were found in the Back and Middle Rivers". Wallin et al. (1995) stated that "adult Striped bass also used the Back and Middle Rivers to over winter and spawn and younger ones used it year round." The Striped bass population suffered a severe decline in the 1980s. As stated in Will and Jennings (2001), this decline was attributed to "increased salinity in the spawning and nursery grounds in the Back River and accelerated transport of eggs and larvae to areas of toxic salinity" (Van Den Avyle and Maynard 1994). In order to decrease the salinity in the traditional Striped bass spawning and nursery areas, in 1991 the Corps removed the existing tide gate on the Back River and in 1992 filled the Cutoff Diversion Canal. Latham and Kitchens' (1996) study indicated that salinity in the historic spawning grounds in the Back River was acceptable because of "lower interstitial salinities and increased freshwater plant abundance and diversity". In the spring of 2000 (Will and Jennings 2001), "a total of 943 Striped bass eggs were collected and mean egg density for all sampling stations was 0.95 eggs/100 cubic meter (SD=4.28) in comparison to 0.21 eggs/100 cubic meter (SD=1.96) in 1999." Will and Jennings (2001) indicates that "if egg densities continue to increase in ensuring years, establishment of self-sustaining Striped bass population may only be a few years away. The viability of the self-sustaining Striped bass population probably will depend on the availability of suitable nursery habitat for the developing (Striped bass) larvae and juveniles."

In addition to the Striped bass spawning in the estuary, another location may be used by some members of the population -- near the fall line. This is evidenced by the results of the study discussed above that indicates that some Striped bass spawn in the vicinity of the Savannah River Plant. According to Martin and Paller 2007 (http://sti.srs.gov/fulltext/WSRC-MS-2007-00076.pdf), "Historically striped bass (Morone saxatilis) spawning occurred as far up the Savannah River as the Fall Line (also known as the Augusta Shoals) at about 7 river kilometer (RK) 326; however, currently striped bass have difficulty migrating in any numbers past the New Savannah Bluff Lock and Dam."

The following information (in italics) that characterizes fishery resources in the project area was taken from Johnson et al (1974): "*Most invertebrates of commercial importance (e.g., crabs, oysters, and shrimp) have been extensively studied. Following is a brief discussion of blue crabs, oysters, and brown and white shrimp.*

Studies by Durant (1970) indicate that in Georgia, oysters (Crassostrea virginica) begin to spawn when the temperature is about 73° F. Spawning was observed to begin in May and to continue until October, with peak periods in July, August, and September (Durant 1970). Larval stages last for 2-3 weeks (Wallace 1966), after which the young attach to some substrate. Galtsoff (1964) states that only soft mud and shifting sand are totally unsuitable. However oysters may convert a mud bottom to a more suitable habitat if a few settle on a hard object and themselves become objects of attachment. Galtsoff describes the soft mud bottom of the South Atlantic as being only marginally suitable for oysters. He further states that oysters need a free exchange of water salinities of 5-30 parts per thousand (ppt), and temperatures from 34°F to 86°F. Conditions are ideal for feeding when the water, free of pollution and containing a low concentration of small diatoms and dinoflagellates, moves over the bottom in a nonturbulent flow.

The negative factors influencing oyster production are described by Wallace (1966) as "pollution, predators, and people." He reports that oyster production is inversely proportional to human population growth in New England and the mid-Atlantic states. Only in the southeastern and Gulf states does oyster production even approach that of 20 years ago. Wallace (1966) concludes that pollution is the primary cause of the decline of the oyster industry. Sewage is detrimental because it covers the bottom with sludge that smothers oysters and reduces oxygen (Galtsoff 1964). When Escherichia coli, bacteria associated with fecal matter and used as an index for pollution, reach certain numbers, the oyster grounds are closed for health reasons. Industrial wastes also affect oysters. Galtsoff (1964) reports that red liquor and black liquor, both wastes from pulp mills, reduce the length of time the oyster shell remains open, thereby reducing the time available for feeding. Butler (1966) found that shell deposition is decreased in the presence of chlorinated hydrocarbon insecticides (e.g., DDT, DDD, and DDE) at concentrations as low as 10 parts per billion (ppb). Oysters are especially susceptible to pollution because of their stationary mode of existence and their ability to concentrate pollutants in their tissues. Predators include flatworms, mollusks, echinoderms, crustaceans, fish, birds, and mammals (Galtsoff 1964).

The predominant species of marine shrimp occurring in Georgia waters are the white shrimp (Penaeus setiferus) and the brown shrimp (P. aztecus), both of which are important commercially. The life cycles of white and brown shrimp are basically similar. The bottom-dwelling (benthic) adults release their eggs freely into the waters offshore. Within a short time, the eggs hatch into planktonic larvae. After passing through several intermediate stages, the young shrimp (postlarvae) move into the estuary and adopt a benthic existence (Anderson 1955). After very rapid growth, they assume the adult form. Marking studies indicate that after migrating offshore the shrimp do not move into deep water but make seasonal migrations parallel to the shoreline (Anderson 1955). White shrimp penetrate the estuary to a greater degree, arrives later, and stays for a longer period of time than the brown. Salinity optima for young penaeid shrimp are in the range of 5-20 ppt, although shrimp can tolerate salinities from 1 to 600 ppt (Kutkuhn 1966). A complex interaction of factors including circulation, temperature, salinity, and fertility of waters and type of vegetation and substratum determines distribution, survival, and growth of young shrimp (Kutkuhn 1966). Optimum conditions are approached in the nursery grounds of the marsh-estuary complex.

Nichols and Keney (1963) report that the identity and distribution of crabs of the genus Callinectes on the southeastern coast of the United States is uncertain. Rathbun (1930) reported two species, C. sapidus and C. ornatus, occurring between New Jersey and Indian River Inlet, Fla. Lunz (1958) found that only 30% of the crabs caught by trawlers in South Carolina were C. sapidus. The two species are not recognized as such by fishermen and are combined as blue crabs in catch data reported for coastal Georgia.

Van Engel (1958) reports that in the Chesapeake Bay area Callinectes sapidus begins mating early in May and continues into October. Females probably mate only once, at the time of the last molt. Sperm live in the female receptacles for at least a year and may be used as often as the female spawns (two or more times). The females migrate to saltier waters after mating, some passing out of the bay and into the ocean. Spawning is delayed at least 2 months after mating. When laid, the eggs are attached to the abdomen of the female where they remain about 2 weeks

until hatching. Van Engel (1958) reports that there are two larval stages, four or five zonal stages, and the megalops. These stages are passed through in about 1 month, after which the first crab stage is reached. Costlow and Bookout (1959) observed seven zonal stages in laboratory-reared animals. Nichols and Keney (1963), based on the occurrence of early stage larvae, believe that spawning occurs throughout the year. Peak numbers of first-stage larvae were found in Georgia waters during July, August, and September, and large numbers of first and second stage zoeae were found near the beaches with progression to advanced stage zoeae 20-40 miles offshore. Van Engel (1958) reported that early in August many crabs reach the "first crab" stage and begin migrating into waters of lower salinity. Male crabs remain in less saline waters year round.

Thus blue crabs are a part of both the benthic and planktonic communities, and they use both inshore and offshore waters."

Figure 4-3 has been adapted from a map provided by Mr. Dominic Guadagnoli, Shellfish Program Leader with the Georgia Department of Natural Resources – Coastal Resources Division and shows the two commercial shellfish lease areas and one recreational shellfish harvest area in the project area (data provided in 2009).

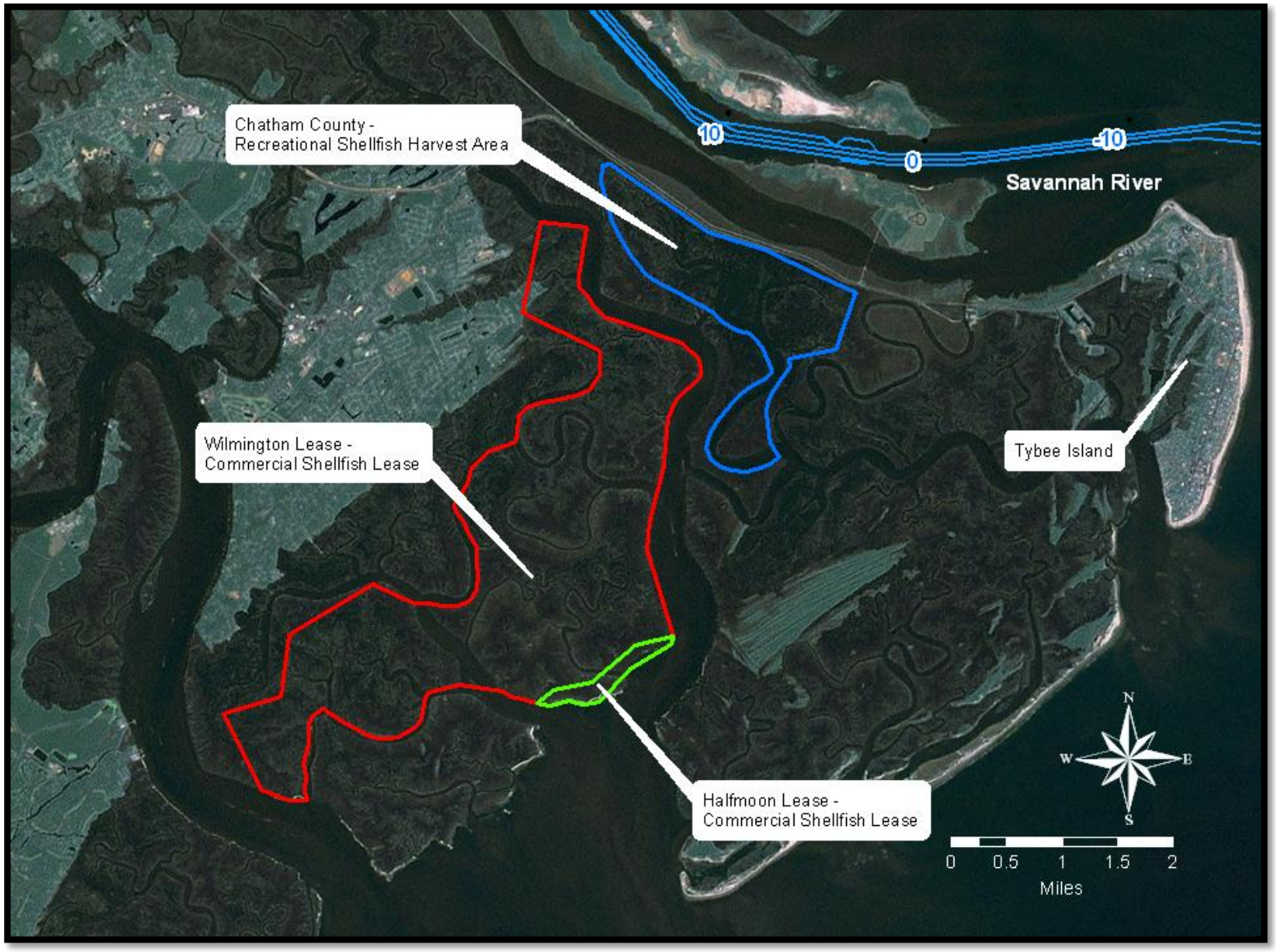

Figure 4-3. Shellfish harvest areas near Savannah Harbor.

4.04.2 Project Studies on Estuarine Dependent Fish

As part of the Savannah Harbor Expansion Project, staff at the USGS Georgia Cooperative Fish and Wildlife Research Unit conducted a two-year study of the Savannah River estuary (SRE) from 2000-2001 to document and characterize the present condition of fishery resources. The study is documented in a report titled "Temporal and Spatial Distribution of Estuarine-Dependent Species in the Savannah River Estuary" by Jennings and Weyers in 2003. Jennings and Weyers collected 91 fish species and 67,826 individuals. This study indicated the following: "Bay anchovy, Atlantic menhaden, Atlantic croaker, and spot were the most abundant species in the SRE and comprised 81% of the catch. Total two year catch from ichthyoplankton pushnets yielded 40, 299 individuals from 57 species; year 1 samples yielded 8,840 more fish than year 2 samples, but both years had the same number of species (52**)**." Fish abundance and diversity were also identified (Jennings and Weyers 2003); fish density and species richness were low in the fall, increased in late winter and summer. According to Jennings and Weyers (2003) "the largest increase in fish abundance occurred in the spring, when clupeids, sciaenids, flatfish, and gobies contributed to the assemblages." This study also indicated that "commercial and recreational species documented within the SRE included marine/estuary species Gray snapper, Red drum, Spotted seatrout, Striped bass, weakfish, ladyfish, tarpon, Spanish mackerel, Jack crevalle, and Striped mullet and freshwater species Largemouth bass, catfishes, Black crappie, sunfishes, and carp." Jennings and Weyers (2003) indicated that the majority of the fish communities were able to tolerate a wide range of salinities (5.0 to 15 ppt).

As part of the SHEP, staff at the South Carolina Department of Natural Resources conducted a similar study in the lower portion of the SRE over the same general time period. The study is documented in a report titled "Temporal and Spatial Distribution of Estuarine-Dependent Species in the Savannah River Estuary" by Collins et al (2001). The following information is summarized and the figures (Figures 4-4, Black Drum and Figure 4-5, Seatrout used by permission) were adapted from Collins et al (2001): *Members of the sciaenid family include some of the most recreationally important inshore fishes in the southeastern U.S.* This group includes the Red drum (Sciaenops ocellatus), Spotted seatrout (Cynoscion nebulosus), Weakfish (Cynoscion regalis), and Black drum (Pogonias cromis); which are target species in this study. These fishes create signature noises in a chorus to attract mates, thus allowing surveys through use of passive acoustic techniques. They are highly prized gamefish sought by recreational anglers in the Savannah River, with the Red drum being South Carolina's most important recreational fish and the Spotted seatrout being Georgia's. The populations of both are dwindling and until this study, it was not known whether they spawned in the Savannah River.

To avoid an impact on spawning aggregations of these sciaenids during dredging operations this study was conducted to determine if, when, and where these fishes spawned in the areas where the proposed harbor expansion and maintenance activities would take place. Acoustic hydrophones were used to detect male sciaenids while they were drumming and locate their spawning sites; and the habitat features of these sites were then characterized with depth, temperature, dissolved oxygen concentration, salinity, current velocity, and associations with adjacent structures.

Six large spawning aggregations of Spotted seatrout, one of Weakfish, and one of Black drum were located within a reach from River Kilometer 0 to 12.2, and all were found in mid to high (16-32 parts per thousand) salinity concentrations. Although spawning sites were in close proximity, they did not overlap one another in space and time. A Red drum spawning site was not located but they were heard in the mouth of the river and the ocean portion of the shipping channel. Water temperature appears to define the beginning and end of the spawning seasons, while day length or sunset appears to cue spawning behavior, which tends to be around dusk (from an hour before sunset to three hours after), presumably because that would make it harder for predators to see the eggs. See Figure 4-4, adapted from Collins et al (2001), for a map of spawning locations. Fertilized eggs hatch in approximately one day, depending on water temperature and the larval fish are carried with currents.

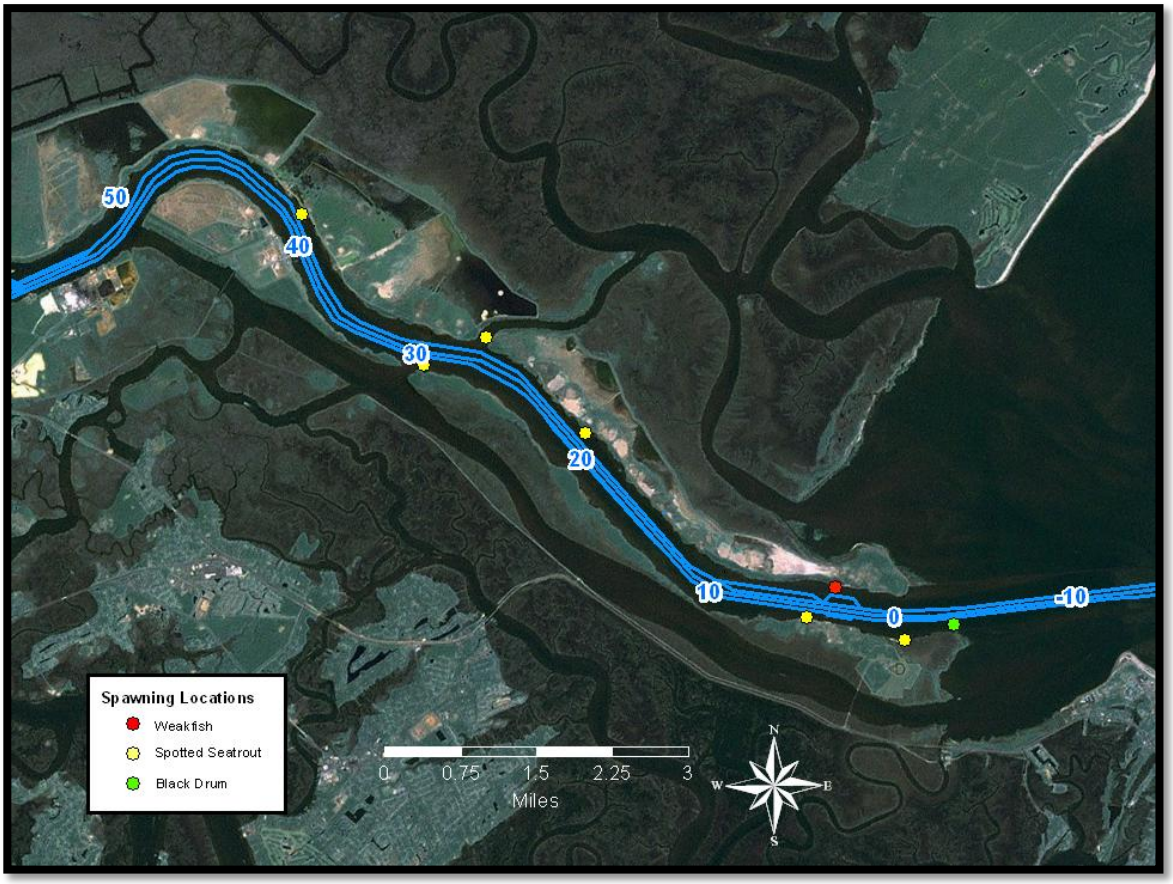

Figure 4-4. Spawning sites of Black drum, Weakfish, and Spotted seatrout (adapted from Collins, et al. (2001).

Interference with sciaenid spawning aggregations while dredging could negatively impact spawning success, thus exacerbating the problem of declining stocks. Potential disturbances include the direct increased suspended sediment loads and noise levels, as well as indirect disturbances such as decreased dissolved oxygen levels, changes in salinity regimes, and physical modification of spawning areas (temperature regime, velocities, presence/absence of eddies, and presence/absence of structures upon which aggregations orient).

This study has identified the times, places, and conditions in which sciaenid spawning occur. The results could be used to schedule certain dredging activities to minimize direct impacts to valuable fish populations.

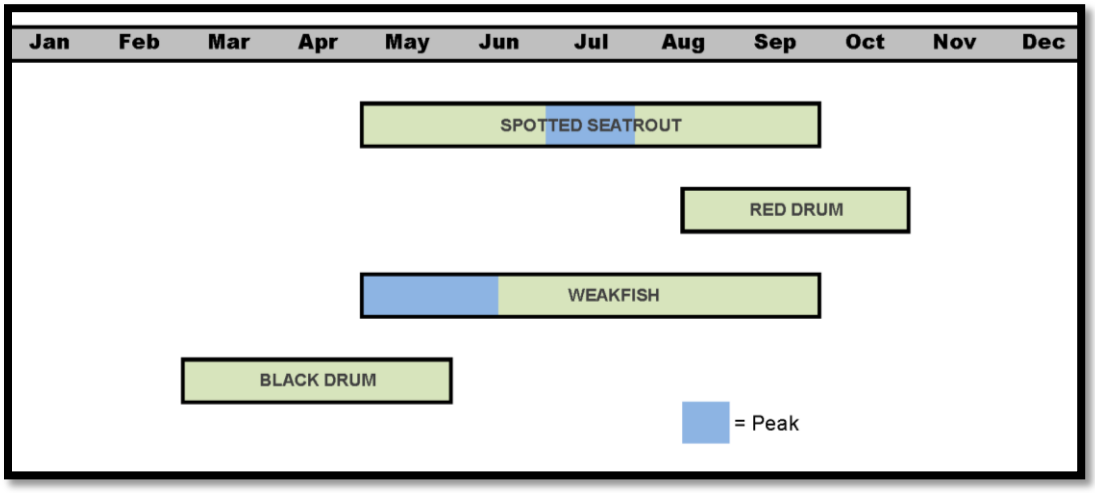

Figure 4-5. Spawning seasons of Spotted seatrout, Red drum, Weakfish, and Black drum (adapted from Collins, et al. (2001).

4.04.3 Representative Fish Species in the Savannah River Estuary

Savannah District consulted the Fisheries Interagency Coordination Team (ICT) to determine which estuarine fish species are critical in the estuary, which may be representative of a guild or group of similar species, and those that are likely to be sensitive to the physical changes expected to result from deepening the harbor. The Interagency Team identified the following species as being appropriate to identify potential project-induced impacts to fishery resources in the harbor:

A. Striped bass
B. Shortnose sturgeon
C. Southern flounder
D. American shad

The interagency team then defined the conditions under which the hydrodynamic and water quality models should be run to identify Suitable and Unsuitable habitat for each of those species. The criteria that the ICT developed to define acceptable habitat can be found in Appendix P (Fishery Habitat Maps). The modeling conditions required to highlight those biological criteria consist of river flow rates and time of year. The agencies determined that average river flows are most representative of conditions experienced over the long term and should, therefore, form the basis of the impact evaluations. For some species, additional runs would also be performed with high (80% exceedance) and low (20% exceedance) river flows to ensure unusual impacts would not develop during those less-typical years. Maps that show the locations of suitable and unsuitable fishery habitats for these four representative species are shown on the following pages.

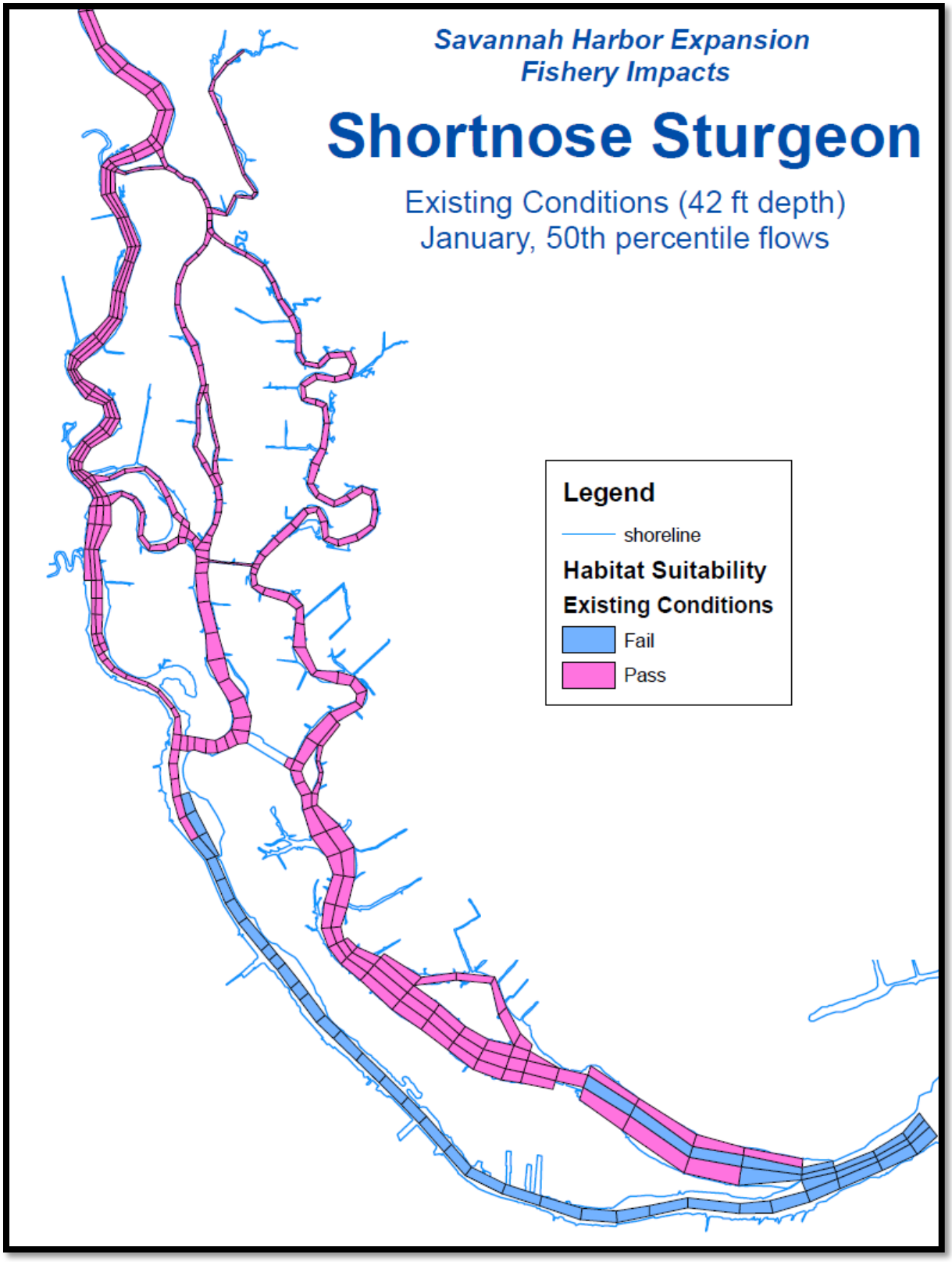

Figure 4-6. Shortnose sturgeon habitat for existing conditions (42-foot channel).

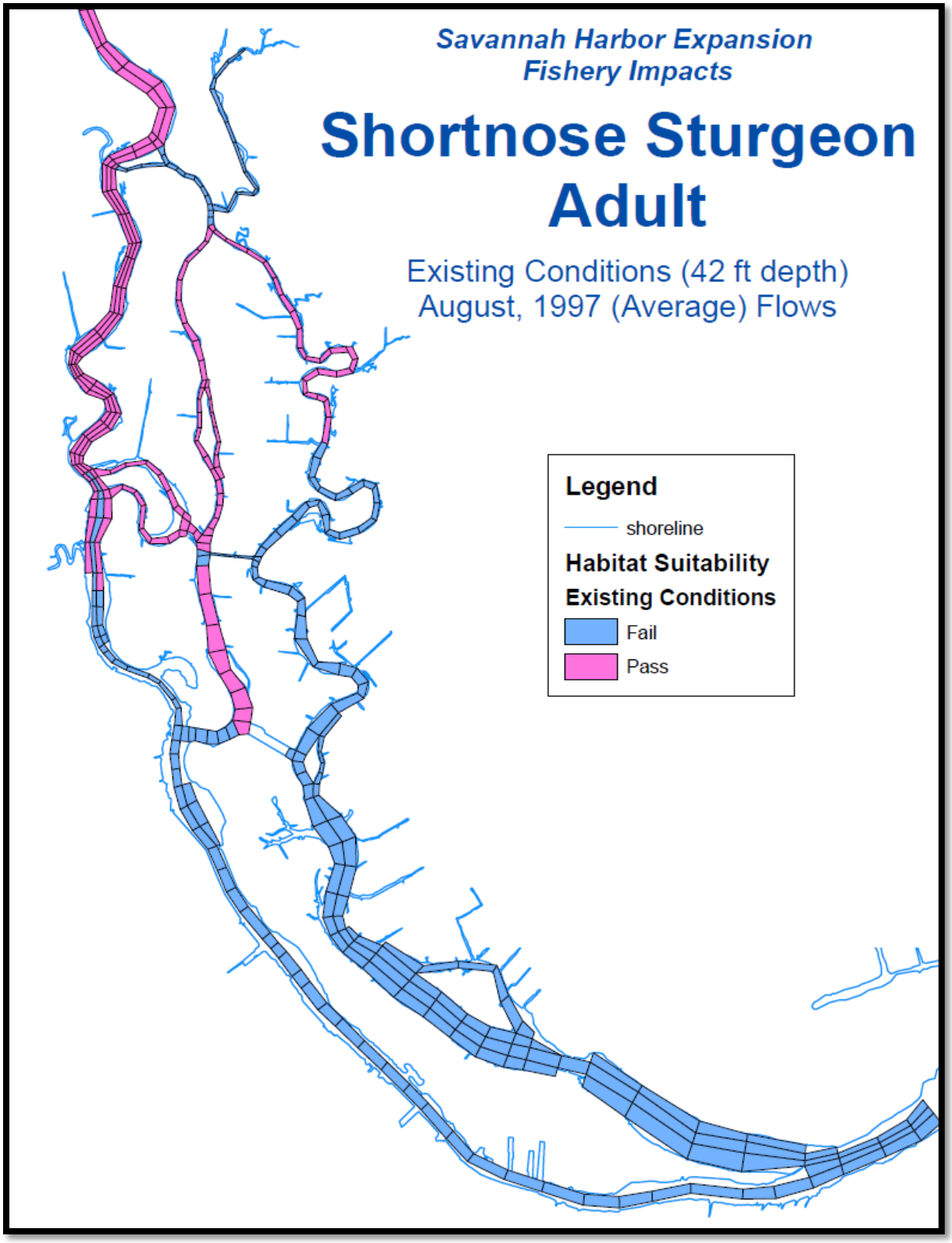

Figure 4-7. Shortnose sturgeon adult habitat for existing conditions (42-foot channel).

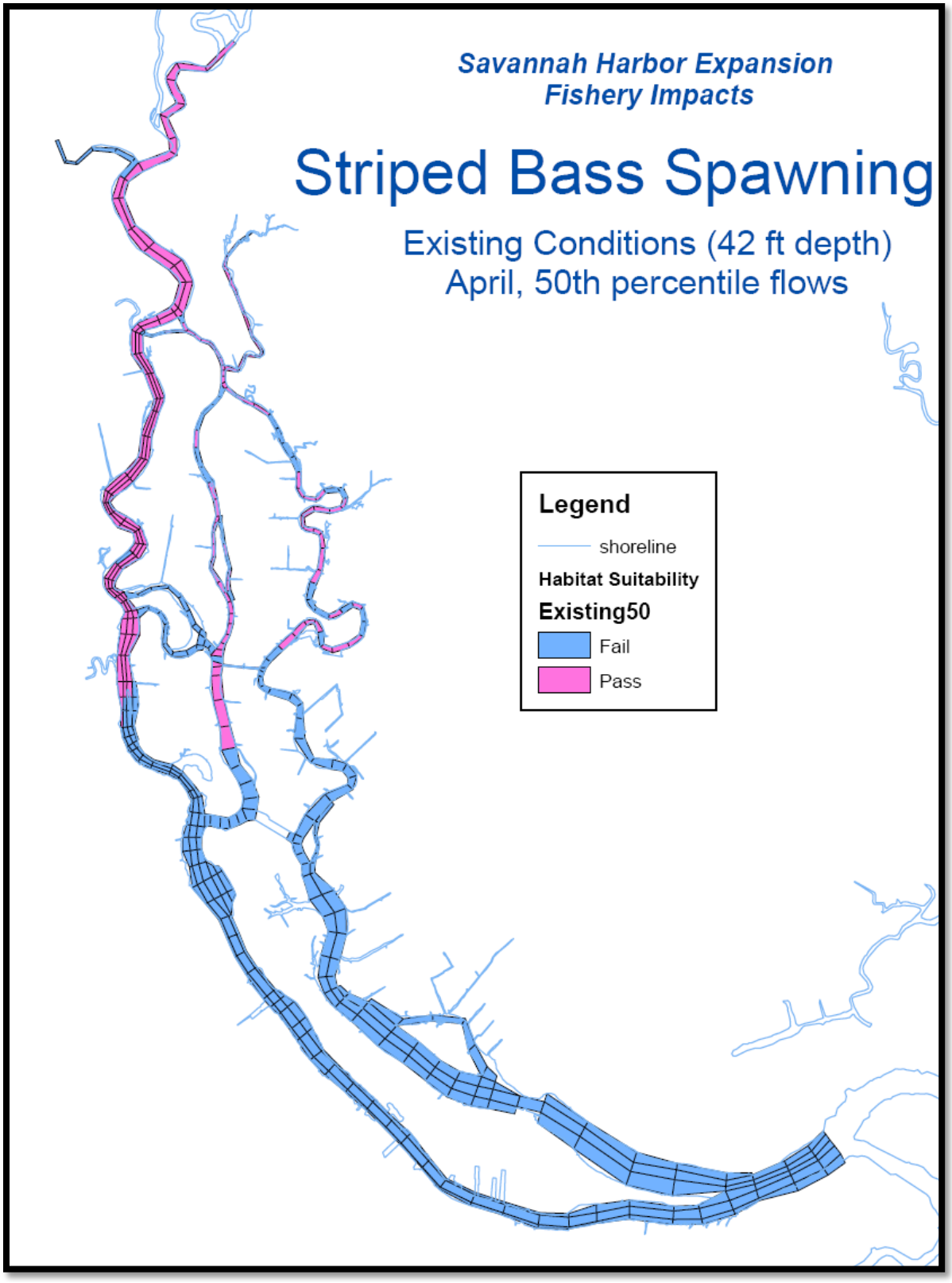

Figure 4-8. Striped bass spawning habitat for existing conditions (42-foot channel).

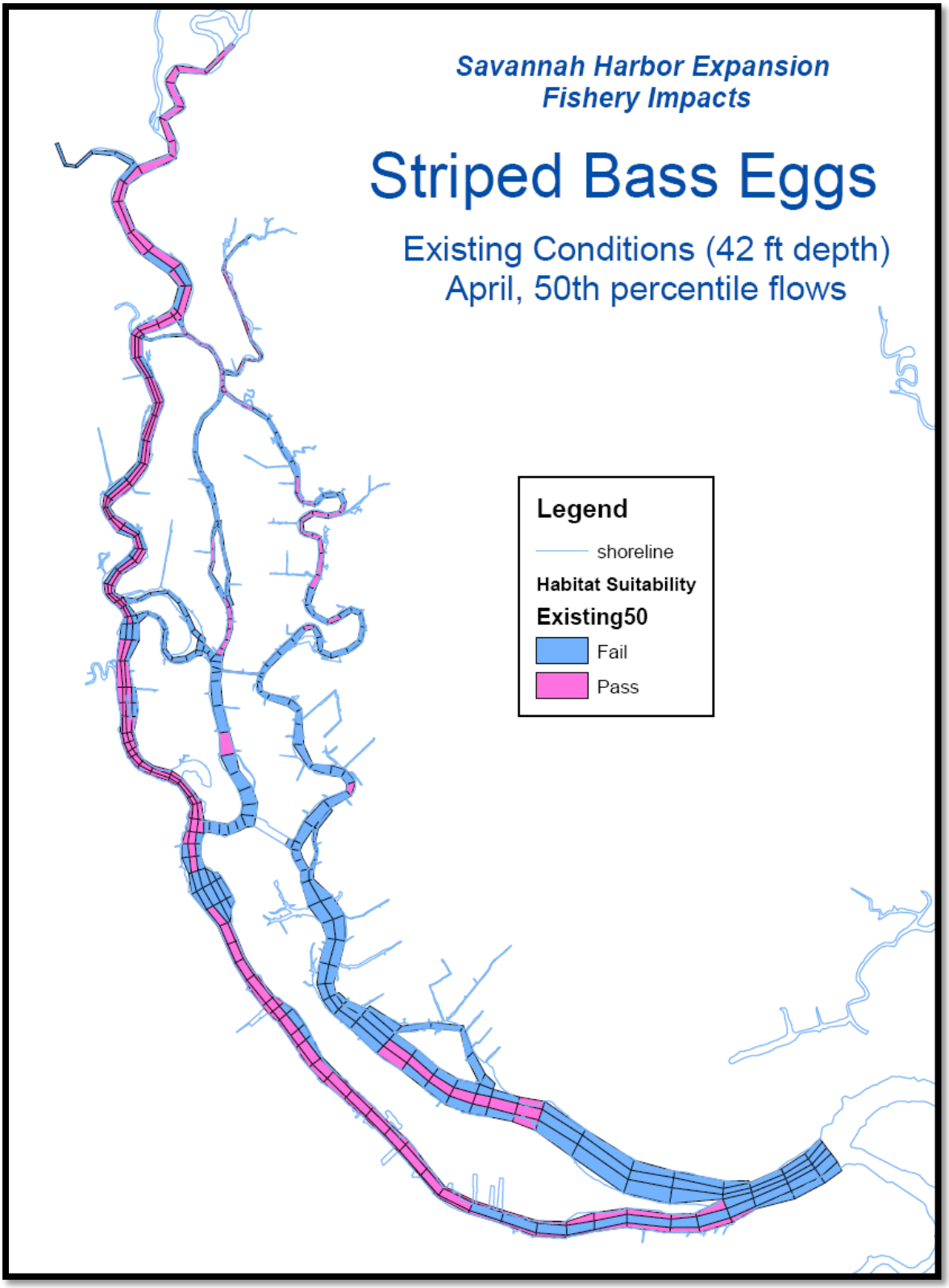

Figure 4-9. Striped bass egg habitat for existing conditions (42-foot channel).

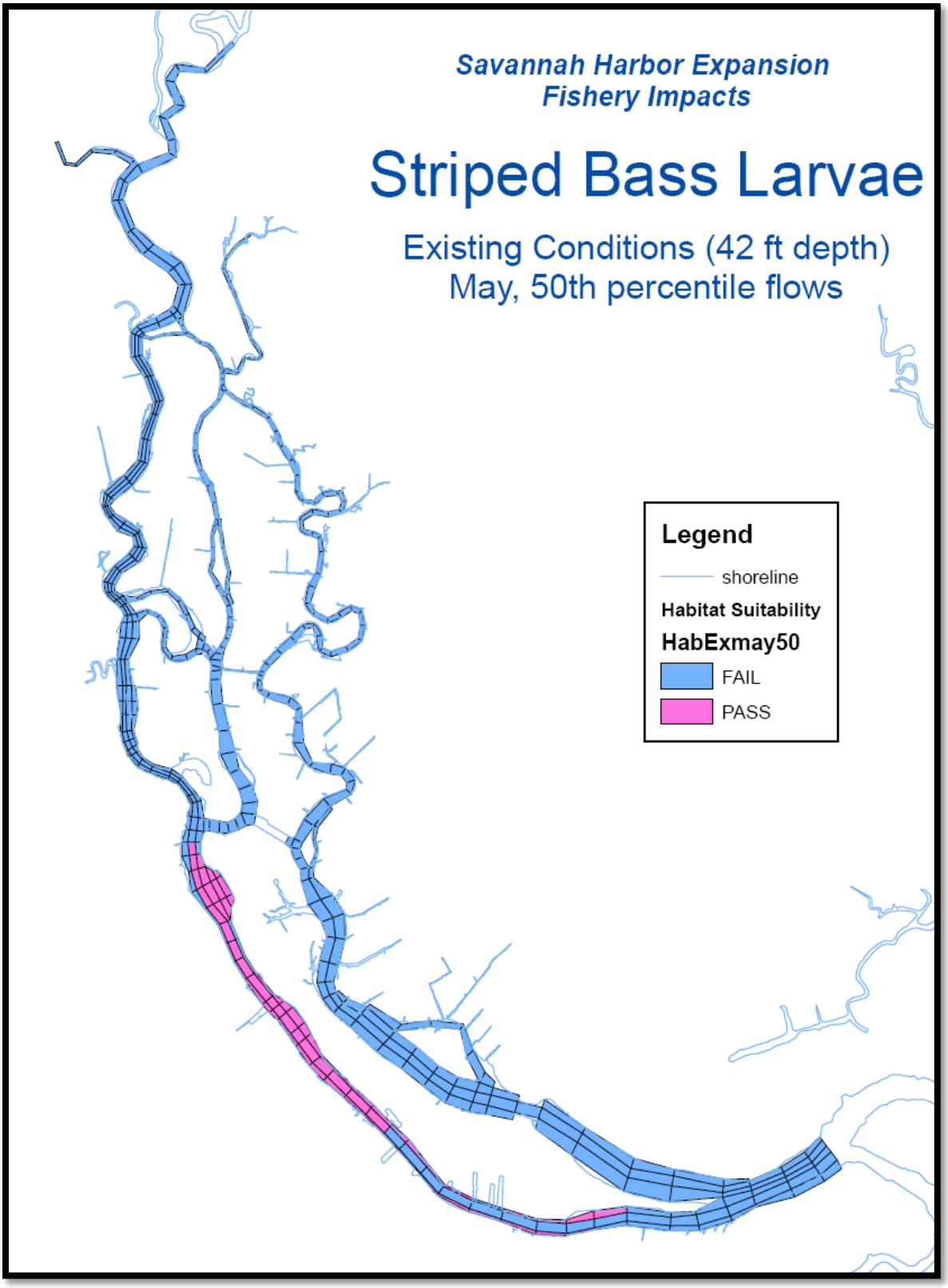

Figure 4-10. Striped bass larvae habitat for existing conditions (42-foot channel).

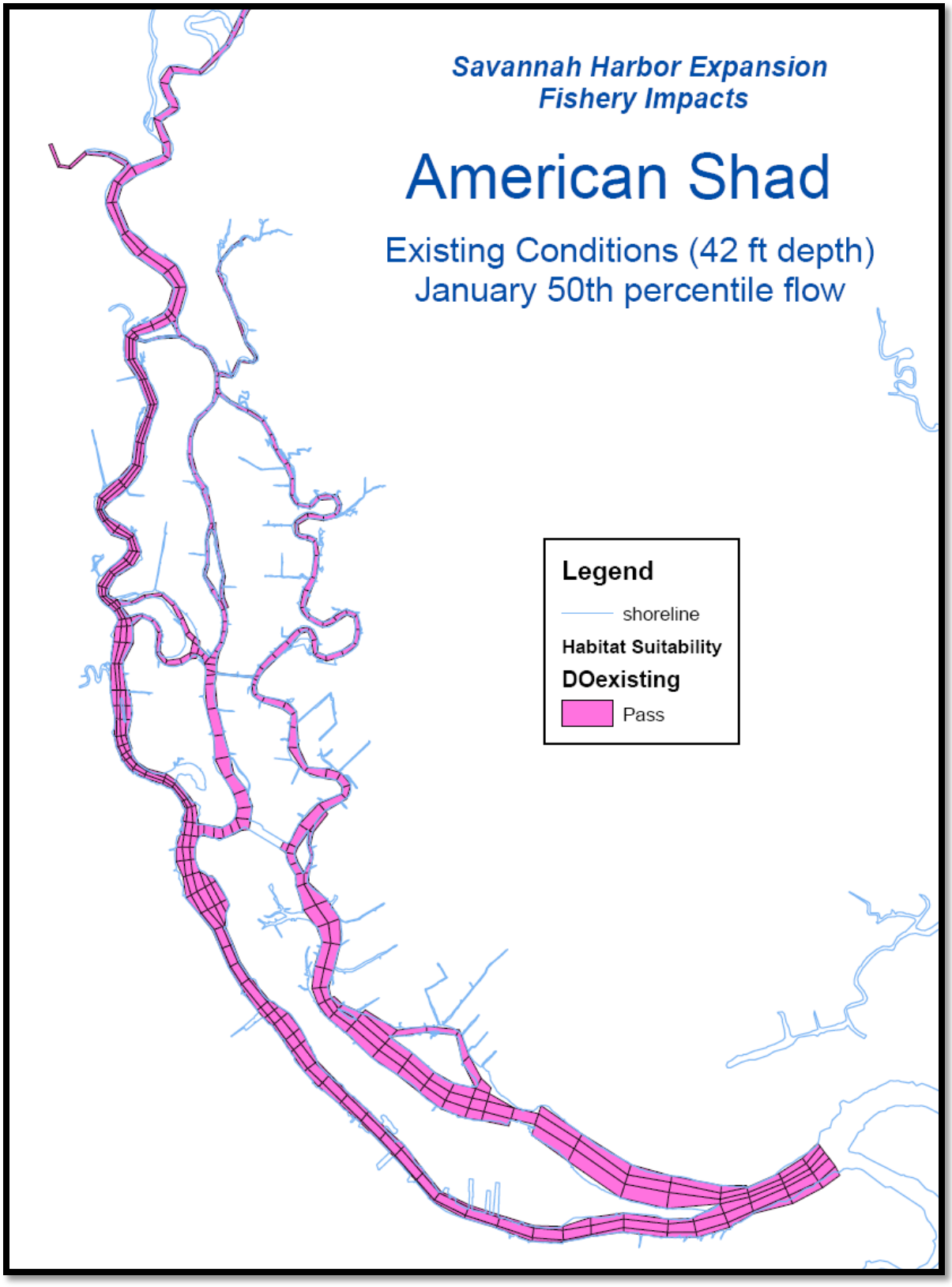

Figure 4-11. American shad habitat for existing conditions (42-foot channel) - January.

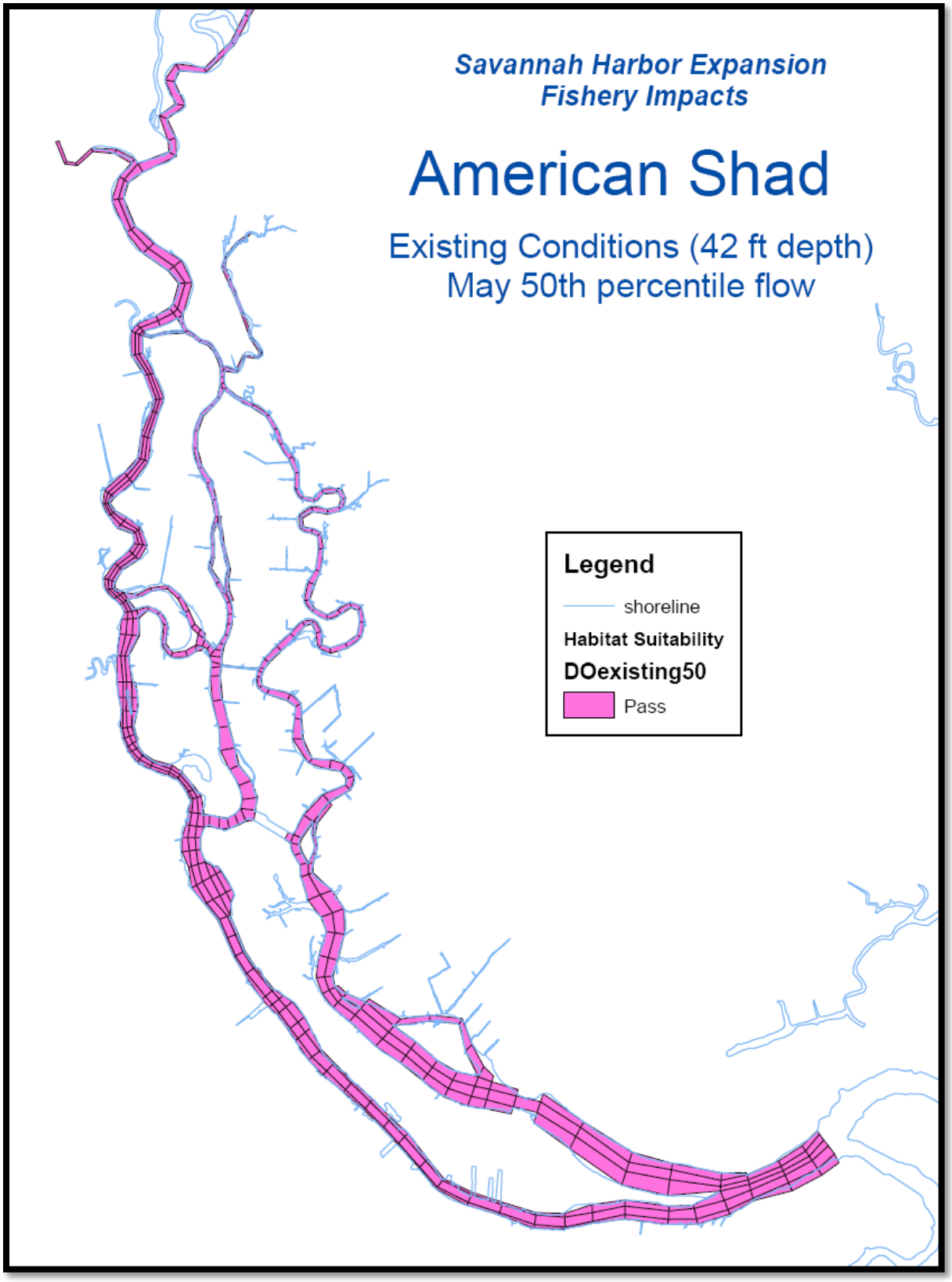

Figure 4-12. American shad habitat for existing conditions (42-foot channel) – May.

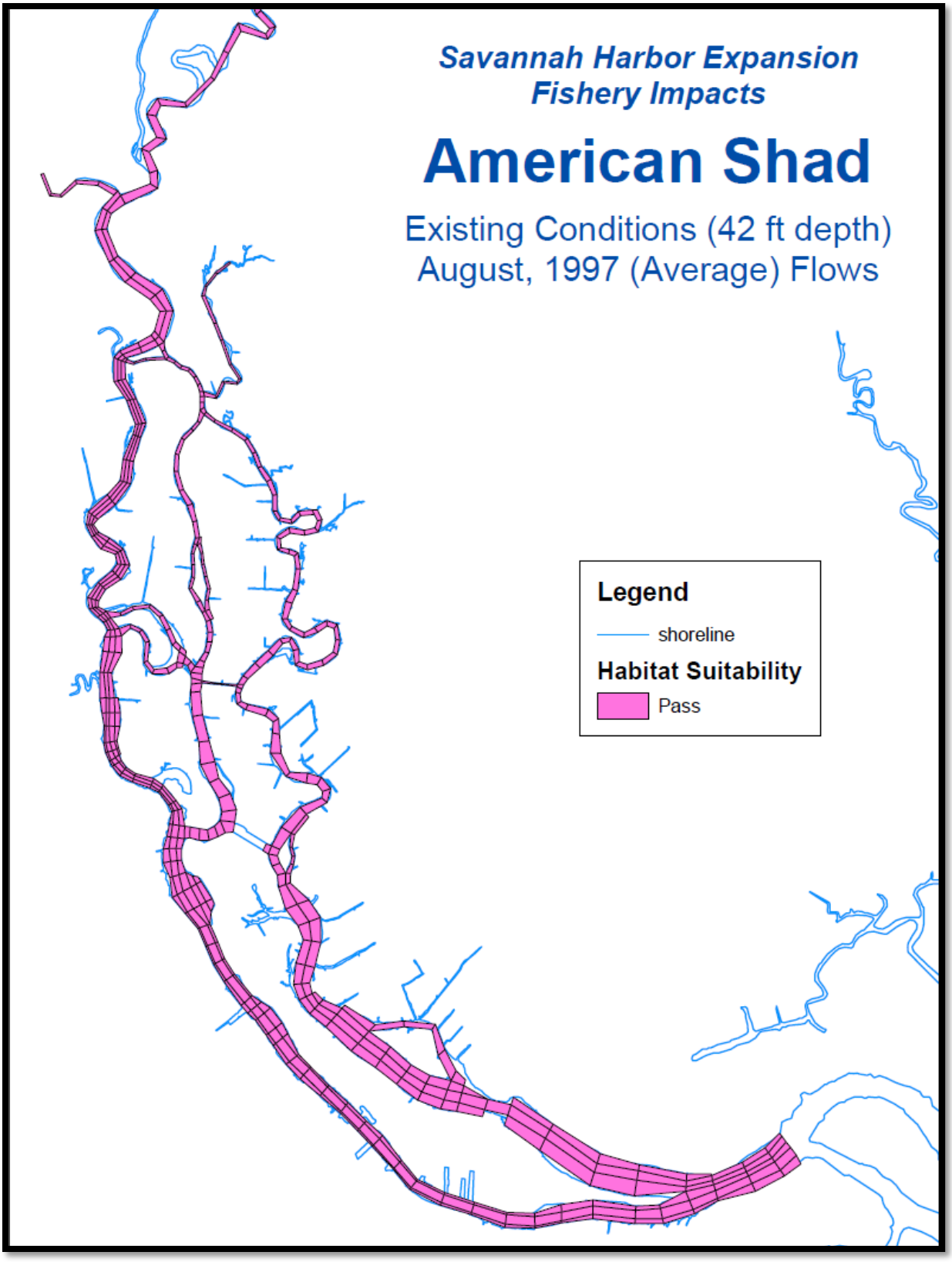

Figure 4-13. American shad habitat for existing conditions (42-foot channel) – August.

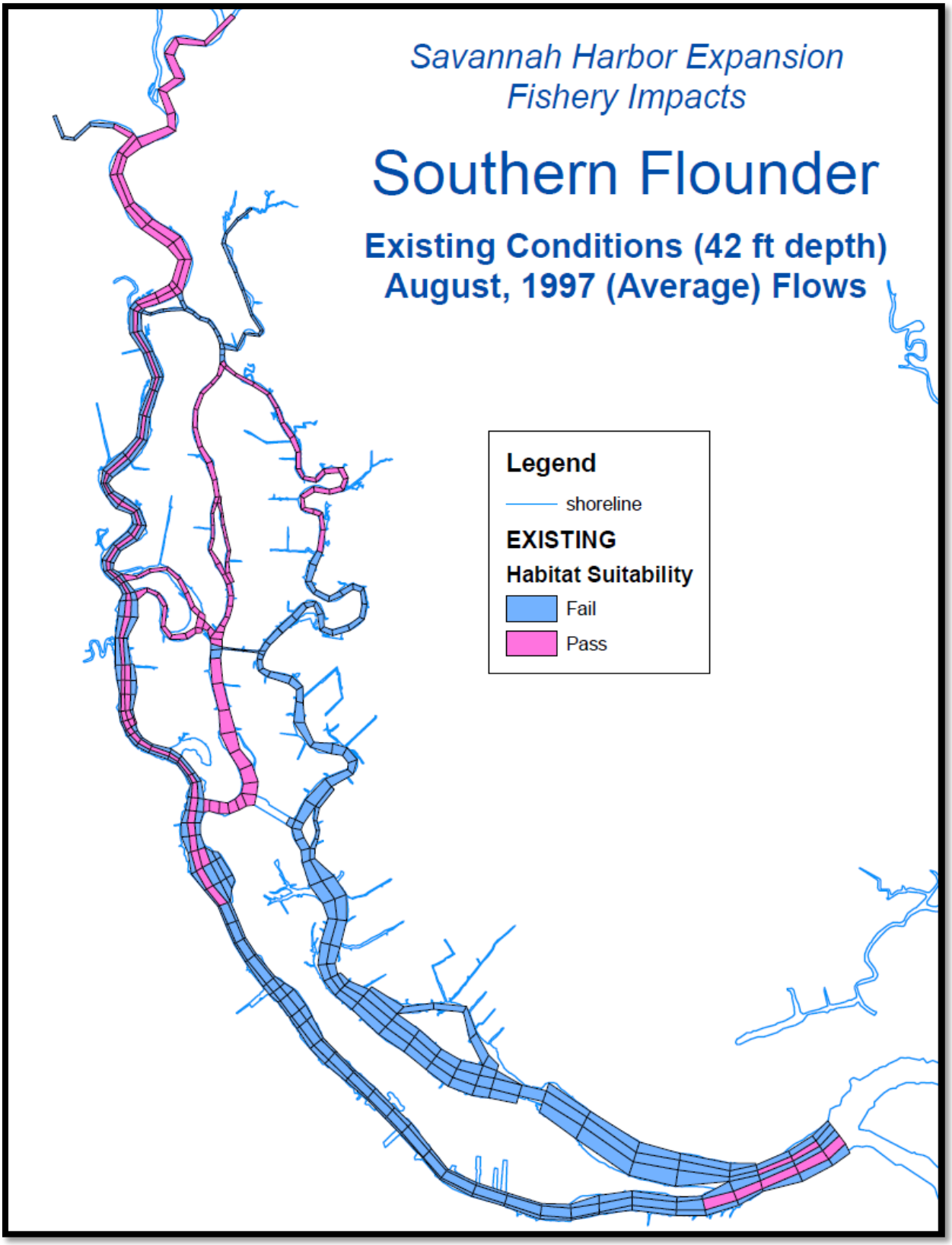

Figure 4-14. Southern flounder habitat for existing conditions (42-foot channel).

4.04.4 Plankton Community Characterization

The following information was also taken from Collins et al (2001): "In addition to fish eggs, plankton tows yielded many larval sciaenids, including Red drum, Spotted seatrout, croaker, weakfish, Black drum, and spot. In fall tow catches also typically included bay anchovies (Anchoa mitchilli), larval Atlantic menhaden (Brevoortia tyrannus), other larval fish including sea robin (Prionotus spp.), and invertebrates including ctenophores (also called comb jellies or jelly balls), copepods, grass (Palaemonetes pugio and Palaemonetes vulgaris), and other shrimp (Penaeus spp.), mysids, isopods (Agathoa spp.), jellyfish, larval crabs and other crustaceans. In the mouth of the river, ctenophores overwhelmingly dominated the catch in all seasons. They were less dominant by volume in the upriver sites, yet still very abundant. Mysids, grass shrimp, and other small invertebrates captured in plankton tows are favored prey of the juvenile target sciaenid species (Daniel 1988)."

4.04.5 Benthic Community Characterization

In June 2001, Barry A. Vittor & Associates conducted benthic sampling and analysis in about 2,500 acres of the nearshore area south of the entrance channel for Savannah Harbor. Their report states that the benthic habitats of that nearshore area were "a uniform sand or gravel (shell hash)/sand sediment with a macroinvertebrate assemblage typical of the region" (Barry A. Vittor & Associates 2001). They found no significant difference in station density or taxa richness within the sampled area. Polychaetes, malacostracans, gastropods, and bivalves were the most numerous taxa collected. Spionid polychaetes were the most abundant family in this area representing 14% of the total number of individuals collected. The study agreed with previous work conducted on the Atlantic continental shelf and coastal waters that found that coarse-grained sediments generally support greater numbers of macroinfauna than fine-grained sediment. Vittor & Associates also conducted a benthic macroinvertebrate assemblage sampling near Brunswick Harbor, Georgia (Vittor and Associates 2000) and near Hilton Head Island, South Carolina (Vittor and Associates 2001). The results of these studies indicate that the benthic assemblages at both Brunswick and near Hilton Head, South Carolina were similar to those found in Savannah Harbor.

4.05 Essential Fish Habitat

The 1996 amendments to the Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA) set forth requirements for the National Marine Fisheries Service (NMFS), regional Fishery Management Councils (FMC), and other federal agencies to identify and protect important marine and anadromous fish habitat. These amendments established procedures for the identification of Essential Fish Habitat (EFH) and a requirement for interagency coordination to further the conservation of Federally-managed fisheries. Table 4-6 lists the Federally-managed fish species of Georgia and South Carolina for which Fishery Management Plans have been developed by the South Atlantic Fishery Management Council (SAFMC), Mid-Atlantic Fishery Management Council (MAFMC), and NMFS. In addition, this table shows EFH by fish life stage and ecosystem type for those species that have designated EFH. Tables 4-7 and 4-8 show the categories of EFH and Habitat Areas of Particular Concern (HAPC) for managed

species which were identified in the Fishery Management Plan Amendments affecting the South Atlantic area. The fish species and habitats shown in these tables require special consideration to promote their viability and sustainability. The potential impacts of the proposed action on these fish and habitats are discussed in Section 5.03.

Essential Fish Habitat areas are identified in Fishery Management Plan Amendments for the South Atlantic and Mid-Atlantic Fishery Management Councils. Geographically Defined Habitat Areas of Particular Concern are identified in Fishery Management Plan Amendments affecting the South Atlantic Area. Areas listed in the table were derived from "Essential Fish Habitat: A Marine Fish Habitat Conservation Mandate for Federal Agencies" February 1999 (Revised 10/2001) (Appendices 4 and 5).

Table 4-6. Essential Fish Habitat (EFH) Species for the Project Area (Georgia and South Carolina)

Management Plan Agency	Fishery Management Plan (FMP)	Common Name of Species	Scientific Name of Species	EFH for Life Stages by Ecosystem		Habitat Areas of Particular Concern
				Marine	Estuarine	Identified by SAFMC
SAFMC	Snapper Grouper	Black Sea Bass	*Centropristis striata*			
SAFMC	Coastal Migratory Pelagics	Cobia	*Rachycentron canadum*	ELPJA	LPJA	Snapper Grouper HAPC- oyster shell, inlets, state nursery areas
SAFMC	Snapper Grouper	Crevalle Jack	*Caranx hippos*			
SAFMC	Red Drum/Habitat	Red drum	*Sciaenops ocellatus*	ELPJSA	PJSA	Red Drum HAPC-tidal inlets, state nursery habitats, spawning areas
SAFMC	Snapper Grouper	Sheepshead	*Archosargus probatocephalus*			
SAFMC	Shrimp	Brown shrimp	*Farfantepenaeus aztecus*	ELA	PJA	Penaeid Shrimp HAPC – tidal inlets, state nursery and overwintering habitats
SAFMC	Shrimp	White shrimp	*Lilopenaeus setiferus*	LA	PJS	
SAFMC	Coastal Migratory Pelagics	Spanish mackerel	*Scomberomorous maculatus*	JA	J	
SAFMC	Snapper Grouper	Gray snapper	*Lutjanus griseus*	LA	PJA	
SAFMC	Snapper Grouper	Lane snapper	*Lutjanus synagris*	A	J	
SAFMC	Council Authority (no FMP)	American Shad	*Alosa sapidissima*	A	ELPJS	
SAFMC	Council Authority (no FMP)	Hickory Shad	*Alosa mediocris*	A	ELPJS	
SAFMC	Council Authority (no FMP)	Blueback Herring	*Alosa aertivalis*	A	ELPJS	
SAFMC	Council Authority (no FMP)	Striped Bass	*Morone saxatilis*	A	ELPJS	
SAFMC	Council Authority (no FMP)	Shortnose Sturgeon	*Acipenser brevirostrum*	A	ELPJS	
SAFMC	Council Authority (no FMP)	Atlantic Sturgeon	*Acipenser oxyrinchus*	A	ELPJS	
MAFMC	Bluefish	Bluefish	*Pomatomus saltatrix*	LJA	JA	
MAFMC	Summer Flounder	Summer flounder	*Paralichthys dentatus*	LJA	LJA	
NMFS	Highly Migratory Species	Atlantic sharpness shark	*Rhizoprionodon terraenovae*	J		
NMFS	Highly Migratory Species	Blacknose shark	*Carcharhinus acronotus*	J		
NMFS	Highly Migratory	Bonnethread	*Sphyrna tiburo*	JA		

Management Plan Agency	Fishery Management Plan (FMP)	Common Name of Species	Scientific Name of Species	EFH for Life Stages by Ecosystem		Habitat Areas of Particular Concern
				Marine	Estuarine	Identified by SAFMC
	Species	shark				
NMFS	Highly Migratory Species	Bull shark	*Carcharhinus leucas*	J		
NMFS	Highly Migratory Species	Dusky shark	*Carcharhinus obscurus*	J		
NMFS	Highly Migratory Species	Finetooth Shark	*Carcharhinus isodon*	ELPJSA		
NMFS	Highly Migratory Species	Lemon Shark	*Negaprion brevirostris*	J		
NMFS	Highly Migratory Species	Sandbar shark	*Carcharhinus plumbeus*	J		
NMFS	Highly Migratory Species	Sandtiger shark	*Odontaspis taurus*	J		
NMFS	Highly Migratory Species	Scalloped hammerhead	*Sphyrna lewini*	J		
NMFS	Highly Migratory Species	Spinner shark	*Carcharhinus brevipinna*	JA		

Note: **1**. These Essential Fish habitat species were compiled from *Essential Fish Habitat: A Marine Fish Habitat Conservation Mandate for Federal Agencies*: February 1999 (Revised 10/2001) Appendices 2, 3, 6, 7, and 8). Although 49 species are listed in Appendix 3 under National Marine Fisheries Service management, only 35 of these species have EFH listed in Appendix 8.

2. Organizations responsible for Fishery Management Plans include: SAFMC = South Atlantic Management Council; MAFMC = Mid-Atlantic Fishery Management Council; NMFS = National Marine Fisheries Service.

3. Life stages include: E = Eggs, L = Larvae, P = PostLarvae, J = Juveniles, S = SubAdults, A = Adults

Table 4-7. Categories of Essential Fish Habitat in the Project Vicinity and Potential Impacts

	Potential Presence		Potential Impacts	
	In/Near Project Vicinity	Project Impact Area	Dredge Plant Operation	Sediment Placement Activities
Estuarine Areas				
Estuarine Emergent Wetlands (Loss through direct impact)	Yes	Yes	Moderate	No
Estuarine Emergent Wetlands (Impact through salinity changes only)*	Yes	Yes	Significant	No
Estuarine Scrub/Shrub Mangroves	No	No	No	No
Submerged Aquatic Vegetation (SAV)	No	No	No	No
Oyster Reefs & Shell Banks	Yes	No	No	No
Intertidal Flats	Yes	No	No	No
Palustrine Emergent & Forested Wetlands (Impact through salinity changes only)*	Yes	Yes	Yes	No
Aquatic Beds	No	No	No	No
Estuarine Water Column	Yes	Yes	Minor and Temporary	Minor and Temporary
Marine Areas				
Live/Hard Bottoms	Nearshore	Yes	No	Possible
Coral & Coral reefs	Offshore	No	No	No
Artificial/Manmade Reefs	Offshore	No	No	No
Sargassum	Offshore	No	No	No
Water Column	Yes	Yes	Temporary	Temporary

* Potential long term impacts of the proposed deepening on estuarine emergent, palustrine emergent, and forested wetlands in the Savannah River estuary are discussed in Section 5.01 and in the Mitigation Plan found in Appendix C.

Table 4-8. Habitat Areas of Particular Concern in the Project Vicinity and Potential Impacts

	Potential Presence		Potential Impacts	
	In/Near Project Vicinity	**Project Impact Area**	**Dredge Plant Operation**	**Sediment Placement Activities**
Area Wide				
Council-designated Artificial Reef Special Mgt Zones	Yes	No	No	No
Hermatypic (reef-forming) Coral Habitat & Reefs	Offshore	No	No	No
Hard Bottoms	Nearshore Ocean	No	No	No
Hoyt Hill	Distant Offshore	No	No	No
Sargassum Habit	Offshore	No	No	No
State –designated Areas of Importance of Managed Species (PNAa)	Yes	No	No	No
Submerged Aquatic Vegetation (SAV)	No	No	No	No
Georgia				
Gray's Reef	Offshore	No	No	No
South Carolina				
Charleston Bump	Distant Offshore	No	No	No
Hurl Rocks	Distant Offshore	No	No	No
Broad River	Distant Coastal	No	No	No

4.06 Invasive Species

The introduction of non-native or invasive species can have detrimental effects on an ecosystem. As defined by Executive Order 13112 (February 3, 1999) an invasive species is an alien species whose introduction does or is likely to cause economic or environmental harm or harm to human health. Invasive species may be spread through several pathways including ballast water, aquaria release, boat hulls, accidental release from aquaculture or research facilities, bait dumping, and intentional introduction for biological controls (GA DNR 2009). E.O. 13112 charges the Federal government with not authorizing, funding, or carrying out actions that it believes are likely to cause or promote the introduction or spread of invasive species in the United States or elsewhere unless, pursuant to guidelines that it has prescribed, the agency has determined and made public its determination that the benefits of such actions clearly outweigh the potential harm caused by invasive species; and that all feasible and prudent measures to minimize risk of harm will be taken in conjunction with the actions.

Shipping moves over 80% of the world's commodities and transfers approximately 3 to 5 billion tons of ballast water internationally each year (http://globallast.imo.org/). A similar volume may also be transferred domestically within countries and regions each year. Ballast water is essential to the safe and efficient operation of modern shipping, providing balance and stability to un-laden ships (http://water.epa.gov/type/oceb/habitat/invasive_species_factsheet.cfm). Ballast water is water from a port or other location that is taken onboard a ship and stored in tanks to add weight, thereby maintaining the ship's trim and stability. For example, ballast water is often taken onboard as cargo is unloaded, and discharged as cargo is loaded. Depending on where the ballast water is taken onboard, it may be freshwater, brackish, or saltwater, and might contain organisms that are not native to the port area where ballast water will be discharged. Prior to departure or while en route, a ship may need to take ballast water onboard to maintain its stability and safety or to maximize its propulsion efficiency. On entry into a port, the ship may need to discharge ballast water to lighten the ship in order to maintain clearance under the keel in navigational channels or berthing areas, or to offset additional weight resulting from the loading of cargo or fuel (http://water.epa.gov/type/oceb/habitat/invasive_species_factsheet.cfm).

Ballast water is a major source for introducing non-native species into aquatic ecosystems where they would not otherwise be present (Georgia DNR 2009). Invasive species are characterized by high reproduction rates, long life spans, broad diets, and the ability to withstand a wide range of environmental factors (Power et al 2008). If the non-native species become established, they can adversely impact the economy or the environment, or cause harm to human health (Power et al 2008).

Although ballast water exchange is not 100% effective, at present it is the most cost-effective management tool to reduce the risk of ballast-mediated invasion. Ballast water exchange involves replacing coastal water with open-ocean water during a voyage. This process reduces the density of coastal organisms in ballast tanks that may be able to invade a recipient port, replacing them with oceanic organisms with a lower probability of survival in nearshore waters (http://www.serconline.org/ballast/fact.html).

Other ballast water treatment technologies, such as filtration, heating, ultraviolet light and certain biocides have the potential to help reduce the risk of ballast-mediated invasion, however, at this time, mid-ocean ballast water exchange is the only ballast water treatment strategy approved by the United States Coast Guard as required by Federal regulation (Albert et al 2010). Until new treatments and strategies are available and approved, ships that have operated outside the United States Exclusive Economic Zone (EEZ) must either retain their ballast on board or must undergo ballast water exchange (http://www.serc.si.edu/labs/marine_invasions/vector_ecology/bw_exchange.aspx).

4.06.1 Locally Occurring Invasive Species

Three invasive species have been documented to occur on Tybee Island, the green porcelain crab (*Petrolisthes armatus),*the green mussel (*Perna viridis)* and the titan acorn barnacle (*Megabalanus coccopoma)* (Alan Power, pers. Comm. 2008). The green mussel is a native of the Indo-Pacific region. It was first documented in Tampa Bay, Florida in 1999 with ballast water being the most likely means of introduction (Power et. al. 2004). In 2003, it was recorded in Jacksonville Beach, Florida and in the offshore waters of Brunswick, GA (Power et. al. 2004). The first green mussel was found on Tybee in November 2003 (Power et. al. 2004). It is believed the mussel was introduced to Georgia from boats and equipments being transferred between coasts without adequate cleaning of attached organisms and draining of bilge water (Power et. al. 2004).

In 2006, the University of Georgia, Marine Extension Service received a grant from the National Aquatic Invasive Species Council to monitor (as well as other topics) for aquatic invasive species in the Port of Savannah (Georgia DNR, 2009). That study was completed in October 2009 and is available at: http://www.anstaskforce.gov/Meetings/2009_November/Georgia%20Aquatic%20Nuisance%20Species%20Management%20Plan%20Sept%2009.pdf. Of the eight objectives of the Plan, one applies directly to SHEP. It is "Coordinate local, state, regional, federal and international activities and programs pertaining to aquatic nuisance species."

As discussed in Section 5.20, the risk of ballast-mediated invasives is managed by the US Coast Guard. All vessels entering the Port of Savannah comply with National Aquatic Invasive Species Act (NISA) and the US Coast Guard guidelines mandated by this regulation.

Additionally, the Wildlife Resources Division of the Georgia Department of Natural Resources published the Georgia Invasive Species Strategy in August 2009. This publication is available on their website (http://www.georgiawildlife.com/assets/documents/GeorgiaInvasiveSpeciesStrategy.pdf).

4.06.2 National Invasive Species Act (NISA)

In response to national concerns about aquatic nuisance species (ANS) within ballast water, the National Invasive Species Act of 1996 (NISA) was enacted. This NISA required the US Coast Guard to establish mandatory ballast water management guidelines. The US Coast Guard is the primary Federal agency charged with establishing controls on ballast water discharges. It is

working closely with EPA and other Federal agencies to improve ballast water management by ships and to reduce the potential for introduction of invasive species by ships. The US Coast Guard requires vessel operators to submit mandatory ballast water reports under the rules of 33 CFR 151. In June 2004, the US Coast Guard published regulations establishing penalties for ships headed to the U.S. that fail to submit water management reporting forms. These regulations also increase the number of vessels subject to these provisions by expanding the reporting and the recordkeeping requirements on ships, increasing the Coast Guard's ability to determine the patterns of ballast water movement as required by NISA.

In recent years there has been increased focus on Ballast Water Management (BWM) due to the ecological, economic, and potential health threats caused by the spread of ANS from ballast water. The Coast Guard is responding to these concerns through a comprehensive national BWM program. This program applies to all vessels equipped with ballast water tanks that operate in U.S. waters and are bound for ports or places in the U.S. Highlights of the program are: (1) requires mandatory ballast water management practices for all vessels that operate in U.S. waters; (2) establishes additional practices for vessels entering U.S. waters after operating beyond the EEZ; and (3) requires the reporting and recordkeeping of ballasting operations by all vessels.

The following mandatory practices apply for all vessels with ballast tanks on all waters of the US (for a list of exemptions, refer to the US Coast Guard, http://www.uscg.mil/hq/cg5/cg522/cg5224/bwm.asp):

A. Avoid ballast operations in or near marine sanctuaries, marine preserves, marine parks, or coral reefs.
B. Avoid or minimize ballast water uptake:
    1. Where infestation, harmful organisms and pathogens are located.
    2. Near sewage outfalls.
    3. Near dredging operations.
    4. Where tidal flushing is poor or when a tidal stream is known to be more turbid.
    5. In darkness when organisms may rise up in the water column.
    6. In shallow water or where propellers may stir up the sediment.
    7. Areas with pods of whales, convergence zones and boundaries of major currents
C. Clean ballast tanks to remove sediment regularly.
D. Only discharge minimal amounts of ballast water in coastal and internal waters.
E. Rinse anchors and anchor chains during retrieval to remove organisms and sediments at their place of origin.
F. Remove fouling organisms from hull, piping, and tanks on a regular basis and dispose of any removed substances in accordance with local, state and federal regulations.
G. Maintain a vessel specific ballast water management plan.
H. Train vessel personnel in ballast water and sediment management and treatment procedures.

There are additional mandatory practices for all vessels transiting to US waters with ballast water that was taken on within 200 nautical miles of any coast after operating beyond the US Exclusive Economic Zone. They are that the vessel must conduct one of the following:

A. conduct mid-ocean ballast water exchange prior to entering U.S. waters;
B. retain the ballast water on board while in U.S. water; or
C. use a Coast Guard approved alternative environmentally sound method to treat the ballast water.

The following describes the vessel's reporting and recordkeeping requirements:

The master, owner, operator, person in charge, or vessel agent of any vessel equipped with ballast water tanks that is bound for ports or places of the United States, must ensure complete and accurate Ballast Water Reporting Forms are submitted in accordance with 33 CFR 151.2041, and signed ballast water records are kept on board the vessel for a minimum of two years in accordance with 33 CFR 151.2045.

The Coast Guard may impose a civil penalty of up to $27,500 per day or Class C Felony charge for non-submittal of ballast water records. Vessels are strongly encouraged to electronically submit ballast water management reporting forms via email and/or web-based methods available at the National Ballast Information Clearinghouse web site:
http://invasions.si.edu/nbic/submit.html

Vessel Discharges Require a Permit Beginning February 6, 2009. On December 18, 2008, EPA issued a new NPDES general permit to regulate 26 types of discharges from vessels operating in U.S. waters. Approximately 61,000 domestically flagged commercial vessels and 8,000 foreign flagged vessels need to comply with the permit starting February 6, 2009.

As a result of a court ruling and a subsequent extension, vessel owners and operators who have previously been exempt from Clean Water Act requirements for the last 35 years were required to obtain a permit by February 2009.

"EPA met the deadline and delivered a protective and practical permit to protect the nation's waterways from ship-borne pollution and to avoid an environmental and economic shipwreck," said Assistant Administrator for Water Benjamin H. Grumbles. The permit covers non-recreational vessels 79 feet in length or longer, such as cruise ships or oil and cargo tankers, but excludes fishing vessels of any length, unless they discharge ballast water. The new permit incorporates the Coast Guard's mandatory ballast water management and exchange standards, and provides technology-based and water-quality-based effluent limits for other types of discharges, including deck runoff from rain or cleaning, ballast water used to stabilize ships and "gray water" from showers, sinks and laundry machines. It also establishes specific corrective actions, inspections and monitoring, recordkeeping and reporting requirements.

In 2009, Congress responded to the court ruling in part by enacting a law to exempt recreational vessels from the permitting requirement and requiring further analysis and action by EPA and the Coast Guard.

4.06.3 International Regulation of Invasive Species

The International Maritime Organization (IMO) developed a treaty in February 2004 that, once it goes into effect, will help control the discharge of ballast water and sediments from ships on international voyages in order to reduce the risk of introduction of invasive species.

The International Convention for the Control and Management of Ships Ballast Water & Sediments was adopted by consensus at a Diplomatic Conference at IMO in London in February 2004. The Conference was attended by representatives of 74 States, one Associate Member of IMO; and observers from two intergovernmental organizations and 18 non-governmental international organizations. The main features of the Convention are outlined below.

A. Entry into force. The Convention will enter into force 12 months after ratification by 30 States, representing 35 percent of world merchant shipping tonnage.

B. General Obligations. Parties undertake to give full and complete effect to the provisions of the Convention and the Annex to prevent, minimize and ultimately eliminate the transfer of harmful aquatic organisms and pathogens through the control and management of ships' ballast water and sediments.

C. Survey, Certification, and Inspection. Ships are required to be surveyed and certified and may be inspected by port State control officers who can verify that the ship has a valid certificate; inspect the Ballast Water Record Book; and/or sample the ballast water. If there are concerns, then a detailed inspection may be carried out and "the Party carrying out the inspection shall take such steps as will ensure that the ship shall not discharge Ballast Water until it can do so without presenting a threat of harm to the environment, human health, property or resources."

D. Annex – Section A General Provisions. This includes definitions, application and exemptions. Under Regulation A-2 General Applicability: "Except where expressly provided otherwise, the discharge of Ballast Water shall only be conducted through Ballast Water Management, in accordance with the provisions of this Annex."

Ships are required to have on board and implement a Ballast Water Management Plan. The Ballast Water Management Plan is specific to each ship and includes a detailed description of the actions to be taken to implement the Ballast Water Management requirements and supplemental Ballast Water Management practices.

Ships must have a Ballast Water Record Book to record when ballast water is taken on board; circulated or treated for Ballast Water Management purposes; and discharged into the sea. It should also record when Ballast Water is discharged to a reception facility and accidental or other exceptional discharges of Ballast Water.

Other methods of ballast water management may also be accepted as alternatives to the ballast water exchange standard and ballast water performance standard, provided that such methods ensure at least the same level of protection to the environment, human health, property or

resources, and are approved in principle by IMO's Marine Environment Protection Committee (MEPC).

E. Annex – Section B Management and Control Requirements for Ships. Under Regulation B-4 *Ballast Water Exchange*, all ships using ballast water exchange should:

Whenever possible, conduct ballast water exchange at least 200 nautical miles from the nearest land and in water at least 200 meters in depth, taking into account Guidelines developed by IMO;

In cases where the ship is unable to conduct ballast water exchange as above, this should be as far from the nearest land as possible, and in all cases at least 50 nautical miles from the nearest land and in water at least 200 meters in depth.

Other pathways for invasive species to enter the Savannah Harbor through vessel operations include insects in pallets and plants, and seeds in soil on/in containers. Various measures are undertaken to minimize the spread of invasive species through these avenues. The Animal and Plant Health Inspection Service-Plant Protection and Quarantine (APHIS- PPQ) of the US Department of Agriculture inspects container cargo agricultural products for invasive species, as well as places monitoring traps around the port environment for early detection of new species. The APHIS-PPQ also develops and implements response plans, along with state cooperators, for eradicating, controlling or managing new invasive species when they are discovered (Georgia Invasive Species Strategy 2009).

4.07 Terrestrial Resources

Several environmental resources exist in the harbor that deserve special recognition and concern. Actions which could impact those areas may affect multiple resources, such as water quality, wetlands, aquatic species, benthic communities, and wildlife. To ensure these areas receive the recognition and concern which they warrant, they will be described separately and potential impacts to those sites will be evaluated separately. The special resources which warrant special concern include the Savannah National Wildlife Refuge, the Tybee Island National Wildlife Refuge, Turtle Island Wildlife Management Area, and the Confined Sediment Placement/Disposal Facilities (CDFs).

4.07.1 Savannah National Wildlife Refuge

The Savannah National Wildlife Refuge is located in the upper portion of the harbor and consists of 29,175 acres of freshwater marshes, tidal rivers and creeks, and bottomland hardwoods. The Refuge was established in 1927 and is managed primarily for waterfowl and wildlife observation. The facility contains both impounded and unimpounded wetlands.

The Refuge is located at the upstream end of the harbor and both its location across the river from highly developed port facilities and its original purpose as a freshwater refuge presents significant challenges to harmonious operation of the harbor with adjacent landowners. Refuge habitats have been impacted by increases in salinity which has accompanied previous harbor

improvement projects, primarily channel deepening which allows saline water to travel further upriver. A Freshwater Control System was constructed in 1977 to mitigate for the salinity increase expected from the harbor deepening and sediment control features authorized in 1965. The Tidegate was removed from operation in 1990 and New Cut closed to alleviate impacts caused by those structures. The extensive unimpounded marshes are most susceptible to salinity impacts.

4.07.1.1 Unimpounded Refuge Marshes. The Refuge also contains extensive unimpounded wetlands along the Savannah, Middle and Back Rivers. Wetlands located below US Highway 17 are vegetated predominantly by salt marsh and brackish marsh species, while those above that point are predominantly freshwater or brackish species. It is the unimpounded wetlands which have experienced the most impact from development of the harbor, as the additional channel depths have introduced salinity further upstream. Operation of the Tidegate also allowed saline water to progress further up Back River.

Savannah District funded monitoring of tidal marsh adjacent to Back River by the USFWS to record changes after the closure of New Cut and removal of the Tidegate from operation. Four sites within unimpounded Refuge wetlands were evaluated as follows:

FORMER SALINITY REGIME	APPROXIMATE LOCATION
Freshwater (less than 0.5 ppt Salinity)	9,000 feet upstream of U.S. Highway 17
Oligohaline (from 0.5 to 5.0 ppt)	1,500 feet upstream of U.S. Highway 17
Strongly Oligohaline	2,200 feet downstream of U.S. Highway 17
Mesohaline (from 5.0 to 18.0 ppt)	500 feet downstream from Clydsdale Creek

Field sampling performed in June and October 1993 found that interstitial water salinities were lower at each of the four sites observed, with freshwater conditions (less than 0.5 ppt) being observed at all sites. Vegetation changes at formerly oligohaline and mesohaline sites indicate that freshwater conditions have been restored. Changes in species composition were most evident at the strongly oligohaline site. Based on this monitoring, closure of New Cut and removal of the Tidegate from operation was found to reduce salinity levels in Back River and its adjacent marshes. Restoration of Refuge unimpounded wetlands to freshwater species has been found to take longer than changing salinity levels in the tidal waters. The range of salinities in which some vegetation can grow, as well as competition for open soil substrates on which to grow caused the vegetative response to be slower than the water quality response to the closure of New Cut and removal of the Tidegate from operation.

4.07.1.2 Impounded Refuge Marshes. The USFWS currently manages 5,700 acres of diked impoundments for waterfowl in the Refuge. Those impoundments include 3,000 acres of freshwater pools. Two management schemes are primarily used for the impoundments; draw-down pools and permanently flooded pools. The draw-down pools are drained annually between March 15 and May 15 and manipulated to promote growth of emergent waterfowl food plants. These areas are re-flooded in the fall of each year. Permanent pools remain flooded all year to promote growth of submerged aquatic plants and to provide wood duck brood rearing and

alligator habitat. Permanently flooded pools are drained, dried, burned, and mowed when undesirable vegetation becomes a problem or productivity of desirable plants decreases. These pools may require additional water at any time to make up for transpiration and evaporation. The USFWS also has an agreement with local landowners to provide them with freshwater after the first 20 days of each month.

Since the Tidegate was taken out of operation and the salinity decreased in Back River, freshwater is available for flooding of the impoundments at all times during average and high river flow conditions. Under low flow conditions, the Refuge staff must still time the flooding of the pools around the lunar cycle as unacceptable salinity levels still occur at the intake during some portions of the month.

4.07.2 Tybee National Wildlife Refuge

The Tybee National Wildlife Refuge was established in 1938 as a breeding area for migratory birds and other wildlife. The Refuge consists of 400 acres of wetlands and diked low lands located at the mouth of the Savannah River across the river from the Fort Pulaski National Monument. Much of the site is diked and is used for placement of sediment dredged from the Savannah Harbor Navigation Project. The vegetated portions of the upland areas are densely covered with red cedar, wax myrtle, and groundsel. Saltwater marsh borders parts of the island. The low tide shoreline provides feeding and resting areas for shorebirds and migratory birds. The site is closed to public use.

4.07.3 Turtle Island Wildlife Management Area (WMA)

The Turtle Island WMA is located adjacent to the Tybee National Wildlife Refuge on its northern side and is operated by the SCDNR. The 1,700-acre island was donated to the state in 1976 for waterfowl management purposes. The site is within Unit SC10P of the Coastal Barrier Resources System, so it receives protection from development which is specified in the Coastal Barrier Resources Act. The WMA contains 1,170 acres of low salt marsh, 90 acres of palm/palmetto forest with a wax myrtle and yaupon understory, and 50 acres of beach and dunes. High ground is situated in roughly parallel strips which encircle 420 acres of high salt marsh. The high salt marsh provides the best habitat for waterfowl management and hunting. Public use includes waterfowl hunting, marsh hen hunting, beachcombing, fishing, bird watching, picnicking and camping (designated areas only). Public use is generally low since access is available only by boat.

4.07.4 Confined Sediment Placement/Disposal Facilities (CDFs)

The existing sediment placement/disposal facilities (CDFs) that are used by the Navigation Project are shown in Figure 3-1.

4.07.4.1 Flora. The majority of the undeveloped uplands found along the harbor consist of the CDFs used for harbor operations and generally located on the north side of Savannah Harbor. As a result of dredged sediment deposition, the CDFs are expected to continue to support mixed early successional stage plant communities within diked areas. These communities will probably

continue to be dominated by common reed (*Phragmites communis*), broundsel (*Baccharis halimifolia*), and *Tamarisk* species.

4.07.4.2 Fauna. The CDFs are also inhabited by numerous species of wildlife similar to those found at the Savannah NWR and surrounding areas. Nesting terns and plovers can be found on the more sandy areas during spring and summer. Along the canals and inner ditches, wading birds and shore birds congregate and feed. Depending on the amount of water available and time of year, large numbers of waterfowl can be found in the impounded CDFs. A portion of one CDF extends onto the Tybee National Wildlife Refuge. Reptiles and amphibians that inhabit the area include toads, green tree frogs, moles, various turtles, various snakes including rat snakes, diamond-backed rattlesnakes, water moccasins, banded watersnakes, black racers, king snakes, and rough green snakes. Feral hogs, deer, raccoons, bobcats, armadillos, opossums, otters, mink, coyote, rodents, and other mammals are also found in the areas.

4.07.4.3 Migratory Birds. Many species of migratory birds use the harbor's CDFs. A variety of species of birds are regularly observed in the scrub/brush habitat that surrounds the confined sediment placement/disposal facilities. That habitat is present to some degree on other uplands throughout Chatham and Jasper Counties. However, the existing CDFs provide unique habitat in the Project area for certain species of migratory birds. The sediment placement areas provide nesting habitat for only a limited number of migratory bird species; but, those species include some of special concern such as least tern, black-necked stilt, and Wilson's plover. Many other species of birds use the CDFs outside the breeding season, some in high numbers.

Avian use of the disposal areas can be viewed in several ways. First, the CDFs provide important nesting habitat for a number of waterbirds, and birds associated with beaches and bare ground (referred to by the general term "shore birds"). This group is broken down below into those species that are currently common nesters and those that either nest infrequently or in low numbers. In the species entries, where no fledging times are available, 28 days is assumed to be the fledging period (time in which flightless young would be present at the site). It is also assumed necessary to have nesting habitat available two weeks prior to egg laying for courtship and nest site selection. Many other species of birds nest within the disposal areas. Survey efforts have not concentrated on these species. Only their names are provided below.

The disposal areas also provide feeding habitat for a large number of waterfowl and shorebirds. High counts for these species are provided below. Survey efforts on shorebird and waterfowl use are continuing.

4.07.4.4 Common Nesting Waterbirds/Shorebirds. This group consists of those birds which are known to breed in the CDFs on a regular basis.

Least tern. The nest for Least terns is a shallow depression, usually in sand. Egg dates are April 28 to August 3 (COE CDF data). Chicks are expected to leave the nest within one day of hatching, but remain in area. Fledging is reported to occur 20 days after hatching (Wilbur, 1974, in COE, 1980). Flightless young would be expected no later than about August 23.

A. Nesting habitat: High, open sandy areas, especially with scattered pebbles and small shells. Generally nest on gradual hillside slopes. Areas usually have sparse scattered vegetation and other wood debris. Nesting area should be available April 10 to August 31.

B. Feeding habitat: Open water. Often seen feeding in the Wright River area. Have also been seen feeding in deep water within the CDFs.

C. Resting habitat (after nesting is complete): Open flats and bars associated with shallow water.

Black-necked stilt. Nests are usually loose collections of decaying plant stems. These may be formed of loose collections of shell and clay fragments. Egg dates are April 21 to July 14 (COE CDF data) and estimated to extend to July 27. Chicks are expected to leave the nest within 1 day. Flightless young are expected no later than about August 27.

A. Nesting habitat: Nesting areas should be available April 9 to August 31. This species has been observed to nest in several different habitats within the CDFs; (1) sandy ridges with scattered vegetation close to open water ditches, (2) silt/clay substrates, (3) bare mounds in rough broken terrain within 50 yards of open shallow water; mounds are generally 1 to 4 feet in diameter and raised 1 to 2 feet above the surrounding dirt, (4) small (no more than 1 by 2 foot) slightly elevated bare mounds surrounded by open shallow water, (5) open flats, and (6) in scattered vegetation at the foot of dikes where water is being held. Nests may also be built on mounds with scattered vegetation. Howe (1989) lists the following nesting sites as being typical for this species:

1. Open flats or the edge of short grassy vegetation, usually where visibility is excellent in all directions.
2. Clustered nesting (semi-colonial) rather than evenly distributed in suitable habitat. "Interest distance" may be 10 to 100 feet, as the birds adjust nest density to habitat conditions.
3. Small islands in large pools are particularly favored nest sites.

B. Feeding habitat: Open shallow water and water edges within the CDFs. Adults have also been seen feeding at low tide on mud flats along Wright River.

C. Resting habitat (after nesting is complete): Open flats, bars, open shallow water, water edges, gently sloping grass hillsides (late in season).

Wilson's plover. The nest is a shallow depression in sand, often associated with wood debris and sometimes lined with small pebbles. Egg dates recorded in the Corps' CDF Data include: April 28, 1993, 2 eggs; and July 30, 1993, 1 egg and 2 chicks. Bent (1926) lists egg dates of April 14 to June 21. Chicks are expected to leave the nest within 1 day. Flightless young might be expected no later than about August 28.

A. Nesting habitat: Similar to the least tern, but may include areas with taller vegetation and more debris. Nesting habitat should be available from April 12 to August 28. According to Howe (1989), nests are rarely closer together than 35 m.

B. Feeding habitat: Seen foraging in nesting habitat. Also seen foraging in open damp areas adjacent to open shallow water.

C. Resting habitat (after nesting is complete): Generally the same as the feeding habitat. Most often seen resting on open flats and flats with scattered vegetation.

Willet. The nest is made of grasses and placed on the ground in open grassed areas or open areas with scattered grass and herbs, usually under overhanging grass stems. Earliest egg date in the CDFs is 18 April (based on nest with 4 eggs found on April 21). Latest egg date is presumed to be about July 5 (based on 2 small chicks seen on July 7, 2001). Chicks expected to leave nests within 1 day. Flightless young are expected no later than about July 20 (based on two small flightless juveniles seen in the CDFs on July 13, 2007).

A. Nesting habitat: Nests within the disposal areas in tall grass areas (1 to 2 feet tall) where the grass grows in clumps, usually nests on road shoulders and sometimes in open flat sandy areas with scattered herbs and grass clumps. Nesting habitat should be available March 1 to July 14. According to Howe (1989), willets nest throughout the high marsh and neighboring grassy dunes or man-made upland habitats, but ideal nesting cover is dense *Spartina patens*.

B. Feeding habitat: Within the CDFs, feeds on damp and wet flats with or without scattered vegetation. The birds were also seen feeding along edge of water.

C. Resting habitat (after nesting is complete): Generally the same as the feeding habitat. Most often seen resting on open flats and flats with scattered vegetation.

Nighthawk. Egg dates for the CDFs are from Apr 28 (1 egg in 1995) to July 15 (2 nests in 2009). Small downy chicks have been found as late as July 18 (1 in 1995), indicating eggs should be present well into July. Young are expected to remain flightless for about 3 weeks (Bent, 1926).

A. Nesting habitat: Adults are seen on sand hills and flat sandy areas with scattered wood debris. Young chicks are found in open sandy area near wood debris and scattered weeds. Nesting habitat should be available April 14 to about August 5.

B. Feeding habitat: Open air. Catches insects while flying. Feeds in open areas or above woods.

C. Resting habitat: Seen resting on wood debris in open areas with sparse vegetation. Will also rest in trees with open branches and on bare ground.

Killdeer. The nest is an open depression lined with pebbles or shell fragments. Egg dates range from March 8 (nest with 2 eggs in 2007) to August 28 (adult incubating 2 eggs on August 28, 1995. Chicks are expected to leave the nest within one day. Flightless young are expected usually no later than about August 6, but may occur as late as about September 25.

A. Nesting habitat: Nests in open areas. Areas may or may not contain scattered to moderate grasses and weeds. Nesting habitat should be available March 1 to August 31.

B. Feeding habitat: Seen feeding in nesting habitat. Also frequents damp flats and edges of water, with or without scattered short vegetation.

C. Resting habitat: Same as feeding habitat.

Common moorhen (common gallinule). Reported egg dates are from April 9 to July 18 (Post & Gauthreaux, 1989). Nesting evidence in the CDFs ranges from May 24 (adult seen incubating in nest in salt cedar in 2007) to October 14 (adult with large downy flightless chick found in 2005). Young are expected to leave the nest within 1 day of hatching. Flightless young could be expected until about October 31. Nesting habitat consists of damp and wet areas with tall vegetation. Found mostly in areas that stay wet for a long time. Feeding and resting areas would be the same. Nesting habitat should be available March 26 to October 31.

Mottled duck. Few nests have been found within the CDFs. However, flightless young have been seen between April 8 (hen with 10 small ducklings seen in 1997) and August 15 (hen with 6 medium flightless ducklings seen in 2007). These birds are generally thought to be descendants of released birds. No egg dates are reported. Nesting habitat consists of damp and wet areas with tall vegetation. This species is found mostly in areas that stay wet for a long time. Feeding and resting areas would be the same. Occasionally seen resting on grassed dike shoulders. Nesting habitat should be available from early March to August 31.

Mallard. The status of the wild population has become unclear with the appearance since 1997 and 1998 of apparently released birds. USFWS collected 7 dead and dying ducks in the Areas, all banded with SCWA bands, on June 28, 1999. Nesting evidence ranges from April 24 (hen with 6 ducklings in 12A in 2005) to July 6 (hen with 7 juveniles in 2003 and hen with 5 juveniles in 2006).

4.07.4.5 Sporadic/Uncommon Nesters. This group consists of those birds which are known to breed in the CDFs, but not on a regular basis.

Gull-billed tern. Has been observed nesting on bare sand mounds within CDF 12A during the general period of 1970 to 1974 (USFWS, John Robinette, personal communication). Has nested on the CDF 14B and CDF 12A nesting islands when they are clear of vegetation and surrounded by water. Nest building has been observed as early as April 23 (one pair in 2005), presumed incubation seen as early as May 7 (10 birds in 2006). The latest incubation was recorded on July

29 (1 bird in 1999). Did not nest in the areas in 2008, but did nest in the areas in 2009-2011. It is estimated that nesting habitat should be available from April 9 to August 31. Feeds on insects while flying low over marshes. Also seen carrying anoles and fiddler crabs.

Black skimmer. Has been observed nesting on bare sand mounds within CDF 12A during the general period of 1970 to 1974 (US FWS, John Robinette, personal communication). Egg dates in South Carolina are from May 10 to July 20 (Post & Gauthreaux, 1989). Has nested on the bird islands within CDFs 14B and 12A when they were free of vegetation and surrounded by water. Apparent incubation has been recorded as early as 29 April (1 bird in 2010). The earliest nests were found on May 20 (3 in 2005). The latest eggs were documented on August 20 (7 nests found in CDFs 14B in 1999). One large downy flightless juvenile was still present on the CDFs 14B nesting island on September 1, 1999. It is estimated that nesting habitat should be available from April 12 to September 8. This species would be expected to feed on small fish, primarily on the surface of tidal creeks outside the CDFs.

Least bittern. Has recently been observed nesting in cattails in CDF 13B (US FWS, John Robinette, personal communication). One flightless juvenile was found in CDF 12A on June 17, 2008, and another in CDF 14A on July 20, 2006. Egg dates in South Carolina are April 17 to July 20 (Post & Gauthreaux, 1989). It is estimated that nesting habitat should be available from April 3 to August 16. Nests are placed in cattails and other vegetation above shallow water (Bent, 1923). This species would be expected to feed in wet, but exposed areas within the CDFs.

Pied-billed grebe. Sightings of downy young were reported in the CDF 13B in 1993 (US FWS, John Robinette, personal communication). Egg dates in South Carolina are April 5 to September 18. Nesting evidence within the CDFs ranges from June 5 (3 juveniles seen in CDF 14A in 2005) to August 21 (one bird seen sitting on a nest in CDF12A in 1996). It is estimated that nesting habitat should be available from March 22 to October 16. Floating nests are usually built over water less than 3 feet deep (Bent, 1919). This species would be expected to feed in inundated vegetated areas within the CDFs.

Black-bellied whistling duck. First seen in 2001. Three breeding records: a pair with about 18 small ducklings (estimated to have recently hatched) was seen in 12A on July 26, 2007 (the pair was also seen in CDF 12A with 14 small/medium ducklings on August 15, 2007. Two adults and two half-grown juveniles were seen in Area 14A on 11 November, 2005, along with 16 other adults. Two adults with 3 half-grown ducklings were seen in CDF 13B on September 5, 2008. The juveniles were re-sighted almost fully grown, along with one more juvenile, on September 19, 2008.

Double-crested cormorant. Breeding evidence ranges from July 6 to September 22. Two nests, one with one juvenile, were seen in the CDF 14A rookery on July 6, 2006. Single adults have been seen sitting on nests in CDF 14A on August 17, 2006, and on September 8 and 22, 2006. Nesting of the species, along with the Anhinga, herons, egrets, and ibis depends on the presence of woody vegetation surrounded by water. Little of this habitat has been present in the areas in recent years.

Anhinga. Nesting evidence includes adults seen nest building on April 1, 2002, and on nests and presumed to be incubating eggs from April 29 (1 in 1999) to August 20 (1 in 1999). On September 13, 1999, the latter nest was observed to contain 2 half-grown downy chicks with dark wing and tail feathers. Juveniles have been seen in the rookery as late as September 18 (15 juveniles in the CDF 13A rookery in 2001).

Great egret. Often nests in rookeries in shrubbery surrounded by water within the disposal areas. Nesting activity has been found from May 3 (3 nests in CDF 14A in 1997) to July 20 (one adult incubating in 2006) and August 25 (one juvenile seen in the CDF 13B rookery in 2000).

Snowy egret. Often nests in rookeries in shrubbery with cattails and other tall grasses surrounded by water within the disposal areas. Nesting activity recorded from April 17 (about 190 individuals perched in CDF 14A rookery, at least 11 on nests in 2005), to September 7 (one juvenile was on a nest in the CDF 14A rookery in 2003, and 2 adults and 4 juveniles were present in the CDF 13A rookery in 2003).

Little blue heron. Nesting activity recorded from April 18 (two individuals perched in rookery in CDF 14A) and May 9 (4 seen on nests 9 May 06) to July 27 (one adult was seen incubating on a nest in CDF 14A in 2003) and August 18 (3 juveniles seen in the CDF 13B rookery in 2000).

Tricolored heron. Nesting activity has been recorded from April 14 (17 birds seen sitting on nests in cattails in CDF 14A in 1997) to August 24 (one juvenile seen in a nest in CDF 14A in 2003) and September 7 (two juveniles seen in the CDF 14A rookery in 2003).

Cattle egret. Breeding evidence ranges from May 14 (2 birds on nests in 1997) to September 7 (1 adult seen on nest in CDF 14A in 2003, at least 4 other juveniles seen in the rookery).

Green heron. Nesting evidence ranges from April 20 (adult standing next to nest in CDF 12B in 2003) and May 10 (adult incubating on nest in 14A in 2007) to August 14 (2 flightless young seen in CDF 12B brush pile in 2003 were still in the brush pile, but much larger, on August 30, 2003).

Black-crowned night heron. Breeding evidence ranges from April 17 (2 birds sitting on nests in the 14A rookery in 2005) and July 27 (2 adults on nests in 2003), to August 30 (two juveniles seen in separate nests in CDF14A in 2003) and September 13 (3 juveniles seen in the CDF14A rookery in 2003).

Yellow-crowned night heron. Breeding evidence ranges from May 18 (one individual observed carrying nesting material to a salt cedar in CDF 13B in 1999) to July 27 (5 adults and 14 juveniles recorded in the CDF14A rookery in 1999).

White ibis. Breeding evidence ranges from May 13 (6 individuals on nests in the CDF14A rookery in 2006) to August 17 (one nest with 4 medium juveniles and 65 other juveniles in trees in CDF 14A in 2006) and September 22 (one juvenile seen sitting in shrubbery in the CDF 14A east rookery in 2006).

Glossy ibis. Breeding evidence ranges from April 17 (3 birds were seen sitting on nests in the CDF 14A rookery in 2005) to July 20 (1 adult was seen on a nest in CDF 14A in 2003) and August 25 (1 adult was seen feeding a juvenile in the CDF 13B rookery on August 25, 2000).

Purple gallinule. A pair with 4 medium sized downy chicks was seen in CDF14A on September 1, 1999. One adult was seen feeding a chick what appeared to be a small minnow. Reported as being seen in the disposal areas in a list dated 1970-1977 (Pat and Sam Young, Tom Smith, Gerald Knighton*1).

Coot. There are four nesting records from May 30 (adult on nest in 1996) to July 27 (adult on nest in shading position in 2003).

Blue-winged teal. Nesting evidence ranges from June 3 (hen with 7 ducklings in CDF 12B in 2003) to June 27 (hen with two small ducklings in 12B in 2003).

Ruddy Duck. There are seven breeding records from June 3 (pair with 5 small ducklings seen in CDF 12A in 2008) to September 6 (hen with 5 small ducklings seen in 13A in 2000).

Laughing gull. Have nested in small numbers on the CDF14B bird nesting island. Breeding evidence ranges from May 19 (one bird nest building in 2000) to July 7 (one bird apparently incubating in 2001). Maximum number of nests is 15 on May 27, 2011 on the CDF 12A south island.

Although not part of the CDFs, Tomkins Island, the offshore bird nesting island (east of Turtle Island, SC, and just north of the entrance channel jetties), provides bare ground nesting habitat for a number of species, many of which have not nested within the CDFs. Nesting species include: brown pelican, American oystercatcher, royal tern, and laughing gull. Occasional nesters include the gull-billed tern and black skimmer.

4.07.4.6 Other Nesting Birds. Several other species nest in vegetation within the CDFs. Many other species nest within older vegetation existing along the outside of the dikes. A list of confirmed nesting species is shown below. Those found nesting inside the CDFs are marked with an asterisk.

Pied-billed grebe*
Double-crested cormorant* (6 July 06 in CDF 14A).
Anhinga*
Least bittern*
Great egret*
Snowy egret*
Little blue heron*
Tricolored heron*
Cattle egret*
Green heron*
Black-crowned night heron*
Yellow-crowned night heron*

White ibis*
Glossy ibis*
Turkey vulture*
Canada goose*
Black-bellied whistling duck*
Mottled duck*
Blue-winged teal*
Wood duck*
Ruddy duck*
Osprey
Redtail
Bobwhite
Purple gallinule*
Common gallinule*
Coot*
Wilson's plover*
Killdeer*
Black-necked stilt*
Avocet* (eggs found, but did not nest successfully)
Willet*
Laughing gull*
Gull-billed tern*
Least tern*
Black skimmer*
Mourning dove*
Yellow-billed cuckoo
Nighthawk*
Chuck-wills-widow
Red-bellied woodpecker
Eastern kingbird
Rough-winged swallow
Fish crow
Carolina wren
Blue-gray gnatcatcher
White-eyed vireo*
Common Yellowthroat*
Yellow-breasted chat*
Catbird*
Mockingbird
Brown thrasher*
Cardinal*
Blue grosbeak*
Indigo bunting*
Painted bunting*
Towhee*
Red-winged blackbird*

Boat-tailed grackle*
Brown-headed cowbird*
Common grackle
Orchard oriole*

It is highly likely, because they are seen commonly throughout the summer, but confirmed nesting has not been documented (2): Ground Dove* pair (old nests found) June 2007, Marsh Wren* agitated, many empty nests, Downy Woodpecker, Carolina Chickadee.

4.07.4.7 Non-breeding Birds. This group consists of non-breeding birds that have been observed in the CDFs.

Shorebirds. At least 37 species of shorebirds have been recorded in the CDFs in recent years. Peak spring migratory periods for the southeast are reported as late March to late May (Helmers, 1992) and mid-April to late May (Howe, 1989). Peak fall migration is reported as August to early November (Helmers, 1992) and mid-July to mid-September (Howe, 1989). The highest numbers of migrating shorebirds in the CDFs have recently been observed to occur between late April to early June (highest in May) and early July to early November (highest from July to September). The highest number of species usually occurs in late April, May, and July. Bird counts often exceed 20,000 to 30,000 birds during peak migration. Highest counts of wintering shorebirds occur from December to February, including stilt sandpipers.

The CDFs are well known for attracting large numbers of migrating shorebirds, with several species being recorded there in larger numbers than anywhere else in South Carolina. Post & Gauthreaux (1989) list the harbor's CDFs as the location for the highest counts of avocets (450) and black-necked stilts (450). Recently (July 16, 1993), 976 black-necked stilts were observed in the CDFs. Other shorebird species have recently been recorded in the CDFs in numbers that exceed the maximums listed for South Carolina in Post & Gauthreaux (1989). The species for which this has occurred are as follows (in bold):

A. Black-bellied plover. A maximum of **859** was seen on March 8, 2007 (recorded on film).

B. Wilson’s plover. A maximum of **47** was seen on June 27, 2009.

C. Semipalmated plover. A spring maximum of **1,600** was seen on May 18, 1993. The previous record was 1300 in May 1984 (P&G, 1989).

D. Killdeer. A maximum of **355** birds was seen in one flock in 12A on October 30, 1996 (ties maximum record).

E. Black-necked stilt. A maximum of **976** was recorded on July 16, 1993.

F. Avocet. A maximum of **1,120** was recorded on November 12, 2008.

G. Solitary sandpiper. A spring maximum of **60** birds was recorded on April 24, 2009.

H. Greater yellowlegs. A maximum of 237 was observed on November 11, 2006. A winter (Dec-Jan) maximum of **162** was observed on December 5, 1996, with 73 observed on January 10, 1997. The spring maximum is 115 seen on March 13, 2006.

I. Lesser yellowlegs. Highest numbers are usually recorded in the spring, with a maximum of **4,823** birds recorded on April 28, 1995. The fall maximum is 2862 found on August 3, 1999. A near-winter maximum of 465 was seen on November 11, 2000. Winter maxima (Dec-Jan) are **299** birds seen on December 21, 1996, and **298** seen on January 29, 1998. The previous winter record was 22 recorded on December 22, 1980 (P&G, 1989).

J. Semipalmated sandpiper. A maximum of **29,115** was found on May 19, 2000.

K. Western sandpiper. The spring maximum is 3860 recorded on April 2, 2004, and fall maximum is **7,500** birds recorded on November 21, 2004.

L. Least sandpiper. A maximum of **9,730** birds was recorded on April 23, 2000.

M. White-rumped sandpiper. Maximum spring count is **171** birds on June 4, 1993. Maximum fall count is 57 birds on September 6, 2000. The previous record was 35 in May 1986 (P&G, 1989).

N. Pectoral sandpiper. The fall maximum is **244** birds on August 18, 2000.

O. Dunlin. A maximum of **5,500** was recorded on November 12, 2003.

P. Stilt sandpiper. A spring maximum of **1,169** was recorded on May 14, 2011. The fall maximum is **898** recorded on July 27, 1999. The previous record was 40 in 1984 (P&G, 1989).

Q. Buff-breasted sandpiper. Rare spring migrant. Three records: April 13, 2002(1), April 28, 2005(1), and May 5, 2011(1). A maximum of **42** birds was recorded on September 8, 2007.

R. Long-billed dowitcher. A spring maximum of **910** was recorded on April 27, 2003. The fall maximum is 490 recorded on October 24, 2004. Winter maxima are **505** (January 23, 2008) and 395 (December 31, 2007).

S. Common snipe. A maximum of **470** was recorded in one large flock at the east end of disposal area 14B on January 18, 1995.

T. Wilson's phalarope. May 3, 1997 (**37**, high count). There are many fall records for the CDFs. Only one fall record is listed for South Carolina in Post and Gauthreaux, 1989 (William Post and Sidney A. Gauthreaux, Jr. Status and Distribution of South Carolina Birds.1989. Contributions from the Charleston Museum, 18).

Waterfowl (ducks, geese, and swans). Thirty-four species of waterfowl have been recorded in the CDFs. Dominant species migrating or wintering in the areas are blue-winged teal (HC 2,150 on October 13, 2003), northern shoveler (HC 6,300, November 22, 2003), green-winged teal

(HC 7,450, February 18, 1998), ring-necked duck (HC 6,595, November 19, 2005), lesser scaup (HC 3,455, March 6, 2008), hooded merganser (HC 2,495, November 26, 2008), and ruddy duck (HC 3,991, January 23, 2008).

Herons, egrets, ibis, and wood stork. Most species, except the cattle egret and wood stork can be expected to occur in the CDFs throughout the year, but more commonly during the summer months. Highest numbers are usually encountered from May to June and September to October. Cattle egrets are most likely to be seen during the summer, while wood storks are most likely to occur from August to October. High counts for the most abundant species are: great egret – 731, September 18, 2009, snowy egret – 3,049, September 18, 2009, August 31, 2007, tricolored heron – 680, June 9, 2000, white ibis – 2,370, September 8, 2007, and glossy ibis – 645, July 12, 2000. The high counts for roseate spoonbill is 372 on September 9, 2009, and the high count for the wood stork is 415 on October 17, 2008.

Gulls and terns. Various gulls feed near the head section discharge pipe when sediment placement operations are underway, primarily laughing gull, ring-billed gull, and a few herring gulls. Open flat areas, usually near water, serve as resting areas for many species throughout the year. With the exception of least terns gull-billed terns, black skimmers, and laughing gulls, which nest in the CDFs, other species of gulls and terns feed and rest on open flats and bars at various times throughout the year. Twenty-three species of gulls and terns have been recorded in the CDFs. The most abundant species are laughing gull (HC 2,300, July 28, 2011), Bonaparte's gull (HC 595, March 5, 1997), ring-billed gull (HC 1,586, April 7, 2011, Caspian tern (HC 411, October 13, 2003), Forster's tern (HC 542, September 5, 2008, least tern (HC 978, July 24, 2008), black tern (HC 906, August 31, 2009), gull-billed tern (HC 266, June 9, 2000), royal tern (HC 291, August 15, 2002), and black skimmer (HC 639, July 21, 2011).

Other birds. The woodlands and grassy areas bordering the CDFs contain a large variety of birds, with the species composition and numbers dependent on the time of the year. Large numbers of tree swallows feed at the CDFs at certain times of the year (over 10,000 individuals have been seen feeding over the CDFs in October, and 140,000 in April), and the northern waterthrush has been observed in the winter.

The scrub areas inside and outside the CDFs provide important habitat for a number of neotropical migrants including catbird (HC 721, October 13, 2003, yellow warbler (HC 212, August 8, 2008, prairie warbler (HC 68, August 8, 2008), palm warbler (HC 202, September 29, 2010), northern waterthrush (HC 60, August 28, 2002), and common yellowthroat (HC 329, October 5, 2002). In addition, small numbers of many uncommon species have been sighted in the areas from time to time.

Several distinct areas constitute the existing major bird habitat features at the middle harbor CDFs. Sandy areas at the head sections are generally available and used for nesting by least terns and other species. None of the areas are isolated from predators and some nesting islands surrounded by water are generally available each year. Least terns, gull-billed terns, and black skimmers have nested on these islands successfully. Savannah District has produced approximately 14.6 acres of successful ground nesting habitat in the past five years. At least 3 acres of successful sandy nesting area have been present each year. An additional area of at least

50 acres of black-necked stilt habitat is generally available, although it is usually subject to drying and nesting failures. At least 100 acres of spring and fall migrant shorebird feeding habitat has been available, and probably the same amount of winter waterfowl/shorebird habitat.

Analyses were performed to identify the amount of acreage of various bird habitats which occur for some period of time within each middle harbor CDFs. Those analyses are summarized in Table 4-9.

Table 4-9. Approximate Acreage of Bird Habitat Middle and Lower Harbor Confined Disposal Facilities (in acre-years)

Placement Area	Usable Size	Bare Ground Nesting	Wetland Nesting	Shorebird Feeding	Waterfowl Feeding
12A	990	12.1	264.4	304.2	367.2
13A	1,307	--	1.2	8.3	2.6
13B	520	1.4	92.8	70.8	73.7
14A	728	0.8	285	125.5	197.3
14B	725	0.5	55.6	52	9.5
J/O	890	--	111	72.4	21.8
TOTAL	5,820	14.8	1,194	633.2	672.1

NOTE: Useable areas determined from 2008 surveys. Figures are based on averages of 2006-2010 data.

The estuarine marshes which line the Savannah River at locations along its entire length are also areas which support wildlife. Cormorants, seagulls, mergansers, hawks, herons, egrets, ibis, rails and terns can be found resting and feeding in many of these areas. Diamondback terrapins and occasionally alligators also inhabit these estuarine wetlands, along with such mammals as otters, raccoons and minks.

4.07.5 Shoreline Erosion

Erosion is experienced on an ongoing basis along the Savannah River and the ocean shoreline near the harbor entrance. In some locations, that erosion is severe, with rates as high as 20 feet per year occurring at some of the CDFs on the South Carolina side of the river. Other areas experience much slower erosion rates, but the erosion still results in significant impacts because the eroding land is highly valued or protects nearby structures. Concerns were expressed about this erosion during the scoping for the SHEP studies performed after completion of the Tier I EIS. The proposed harbor deepening could increase the present shoreline and/or beach erosion along the channel shoreline, from Savannah to Tybee Island. As a result of these concerns, Savannah District conducted several investigations, including the following: Ship Wake Analysis, Bank Erosion Analysis, and the Coastal Erosion Study at Tybee Island. The results of those analyses are discussed in Section 5.09, Existing Shorelines Adjacent to the Federal Navigation Channel.

4.08 Wetlands and Floodplains

Wetlands are those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support a prevalence of vegetation typically adapted for life in saturated soil conditions (33 C.F.R. § 328.3). Wetlands possess three essential characteristics: hydrophytic vegetation, hydric soils, and wetland hydrology.

4.08.1 Wetlands

The 1982 Planning Aid Report, prepared by the U. S. Fish and Wildlife Service, for the Savannah Harbor Comprehensive Study included detailed mapping of wetland resources in the harbor area. The imagery used for the wetland assessment was taken in about 1979. The Tidegate was put in operation in 1977 at the same time the harbor was deepened to a 38-foot authorized depth. Therefore, the data reflect a wetland system that was likely still in a state of transition. However, the findings still provide value in their general characterization of wetland communities in the Savannah estuary. That 1982 report defined the following cover types as occurring in the Savannah Harbor area.

A. Salt marsh cordgrass: estuarine intertidal emergent wetland dominated by *Spartina alterniflora*.

B. High salt marsh one: estuarine intertidal emergent wetland vegetated primarily with one or more of the following*: Salicornia* spp., *Distichlis spicata, Batis maritima, Spartina alterniflora.*

C. High salt marsh two: estuarine intertidal emergent wetland vegetated primarily with *Borrichia frutescens* and/or *Iva frutescens*.

D. Black needlerush: estuarine intertidal emergent wetland dominated by *Juncus roemerianus.*

E. Giant cordgrass: estuarine intertidal emergent wetland dominated by *Spartina cynosuroides*.

F. Sand/mud: estuarine intertidal unconsolidated shore with sand or mud substrate.

G. Spoil: dredged sediments placed on a diked area. May be vegetated or unvegetated depending on time since last dredging cycle.

H. Giant cutgrass: riverine tidal emergent and estuarine intertidal emergent wetland dominated by *Zizaniopsis miliacea*.

I. Mixed fresh marsh: riverine tidal emergent wetland vegetated with species such as: *Amaranthus cannabinus, Carex* spp., *Cladium jamaicense, Cyperus* spp., *Eleocharis* spp., *Erianthus giganteus, Orontium aquaticum, Peltandra virginica, Pontedaria cordata, Sagittaria*

spp., *Scirpus validus, Scirpus* spp., *Spartina cynosuroides, Typha* spp., *Zizania aquatica* and *Zizaniopsis miliacea*.

J. Cypress: palustrine forested wetland dominated by *Taxodium* spp.

K. Gum: palustrine forested wetland dominated by *Nyssa aquatica, Nyssa sylvatica* and *Liquidambar styraciflua*.

L. Cypress/gum: palustrine forested wetland dominated by *Taxodium* spp., *Nyssa* spp., and *Liquidambar styraciflua*.

M. Deciduous forested: palustrine forested wetland with species such as: *Acer rubrum, Quercus nigra, Quercus michauxii, Nyssa* spp., *Liquidambar styraciflua* and *Fraxinus pennsylvanica*.

N. Scrub-shrub: palustrine scrub-shrub wetland vegetated by such species as: *Cephalanthus occidentalis, Taxodium* spp., *Nyssa* spp., *Acer rubrum* and *Salix* spp.

O. Mixed brackish marsh: estuarine intertidal emergent wetland vegetated with such species as: *Cladium jamaicense, Juncus* spp., *Scirpus* spp., *Spartina cynosuroides* and *Typha* spp.

P. Bullrush/cattail: estuarine intertidal emergent wetland dominated by *Scirpus* spp. and *Typha* spp.

Q. Deciduous forest: greater than 50 percent cover of upland hardwood (not wetland).

R. Diked impoundments: shallow impoundments formed by diking off estuarine emergent or riverine tidal emergent wetland.

S. Pine forest: greater than 50 percent cover of pines (not wetland).

T. Open water: primarily estuarine, subtidal, unconsolidated bottom wetlands but includes borrow pits located in upland areas.

U. Mixed fresh marsh/scrub-shrub: mixture or interspersion of types 9 and 14.

V. Pasture: included old fields in addition to pasture (not wetland).

W. Developed: residential/commercial areas including some small gardens/truck farms adjacent to housing (not wetland).

That USFWS report also included (as Table 2) the following information on the extent of emergent wetlands:

Table 4-10. Marsh Vegetative Coverage Types for Emergent Wetlands

No.	Cover Type	Acreage	Percent
1	Salt marsh Cordgrass	2,160	9.5
2	High Salt marsh One	217	1.0
3	High Salt marsh Two	431	1.9
4	Black Needlerush	3,908	17.2
5	Giant Cordgrass	2,025	8.9
8	Giant Cutgrass	1,068	4.7
9	Mixed Fresh Marsh	4,572	20.1
15	Mixed Brackish Marsh	2,407	10.6
16	Bullrush/cattail	1,774	7.8
18	Diked Impoundment	4,157	18.3
Total		22,719	100.0

The USFWS report included (as Table 3) the following information on the extent of forested wetlands:

Table 4-11. Marsh Vegetative Coverage Types for Forested Wetlands

No.	Cover Type	Acreage	Percent
10	Cypress	349	4.1
11	Gum	1,463	17.0
12	Cypress-Gum	4,330	50.5
13	Deciduous Forested	230	2.7
14	Scrub-Shrub	2,205	25.7
Total		8,577	100.0

It is likely that the percentages of those various wetland community types have changed over time. However, the Corps is not aware of similar information that is more recent. Some studies have identified vegetative distributions within small portions of the estuary (such as the SNWR), while other studies have examined the acreage of a subset of the community types.
The following information shows how vegetation in the tidal marsh on the Savannah National Wildlife Refuge has changed over the past 25 years (Kitchens, 2003).

Table 4-12. Changes in Vegetation Types in Savannah Marshes

	Percent of Mapped Refuge Area			
Map Class and Community Type	**1986-1987**	**1993**	**July 2000**	**October 2000**
Shrub/Forest	5.8	8.1	7.7	8.8
Zizaniopsis/Shrubs	1.5			
Zizaniopsis/Fresh Mix/Shrubs			20.9	15.2
Fresh Mix/Shrubs			5.2	
Fresh Mix	8.3			
Zizaniopsis/Aster/Fresh Mix				14.1
Zizaniopsis/Scirpus/Aster/Fresh Mix		8.5		
Zizaniopsis/Scirpus/Fresh Mix		3.0	18.2	
Zizaniopsis	10.7			
Zizaniopsis/Scirpus	19.5			14.3
Zizaniopsis/Scirpus/Typha/Salix		21.0		
Typha/Zizaniopsis/Scirpus	11.9			
Scirpus/Zizaniopsis/Typha			9.5	
Scirpus validus	22.8			
Scirpus/Spartina	4.6			
Scirpus/Spartina/Typha and/or *Zizaniopsis*		41.0	25.3	28.3
Spartina spp.	2.3			3.9
Spoil/Developed	0.8	3.9	1.0	3.2
Water	11.9	14.5	13.1	12.3

4.08.2 Floodplains

The 100-year floodplain is established by the Federal Emergency Management Agency (FEMA) and is identified on Federal Insurance Rate Maps. Base flood elevations for flood zones and velocity zones are also identified by FEMA, as are designated floodways.

In general, development initially occurs outside the floodplain on lands that are not subjected to the risk of flooding. Some land uses -- such as commercial shipping -- are tied closely to the water and are located adjacent to the harbor. Development of lands along the harbor to support such activities usually includes filling the site to raise the ground elevation above the 100-year floodplain.

The historic portion of the City of Savannah is located on a bluff along the river. Development started on the bluff but expanded to low-lying areas that were filled. Much of the land along the northern side of the harbor remains low-lying wetlands. Some of those lands are now within the Savannah National Wildlife Refuge and are expected to remain in a natural state. Other lands along the South Carolina shore closer to the ocean were filled to create sediment placement sites. With the legal protections that have been provided to wetlands, large-scale filling of wetlands within the floodplain are not expected in the future.

4.09 Threatened and Endangered Species

Pursuant to Section 7 of the Endangered Species Act of 1973, lists of Federally Threatened and Endangered (T&E) species for the project area were obtained from NMFS (Southeast Regional Office, St. Petersburg, FL) and the USFWS (Field Office, Charleston, SC and Athens, GA). These were combined to develop the following composite list, which includes T&E species that could be present in the area based upon their geographic range (see Table 4-13). However, the actual occurrence of a species in the area would depend upon the availability of suitable habitat, the season of the year relative to a species' temperature tolerance and migratory habits, and other factors.

Savannah District prepared a Biological Assessment for Threatened and Endangered Species (BATES) (see EIS-Appendix B) to evaluate the potential impacts of the proposed action on Federally threatened and endangered species. That document was coordinated with the USFWS and NMFS pursuant to Section 7 of the Endangered Species Act of 1973, as amended. Additionally, the BATES discusses the potential impacts of the project on Georgia and South Carolina State-listed species of concern. Appendix Z contains the responses from the USFWS and NMFS. The USFWS concurred with the BATES. The NMFS concurred with the BATES for some of the species and stated that the project, with implementation of reasonable and prudent measures, would not jeopardize the continued existence of the four other species of concern under its purview.

Table 4-13. Federally Threatened and Endangered Species Potentially Present in Chatham County, Georgia and Jasper County, South Carolina

Species Common Name	Scientific Name	Federal Status
Vertebrates		
Kirtland's warbler	*Dendroica kirtlandii*	Endangered
Bachman's warbler	*Vermivora bachmanii*	Endangered
Right whale	*Eubaleana glacialis*	Endangered
Sei whale	*Balaenoptera borealis*	Endangered
Sperm whale	*Physeter macrocephalus*	Endangered
Blue whale	*Balaena musculus*	Endangered
Finback whale	*Balaenoptera physalus*	Endangered
Humpback whale	*Megaptera novaeangliae*	Endangered
Shortnose sturgeon	*Acipenser brevirostrum*	Endangered
Atlantic sturgeon	*Acipenser oxyrinchus*	Endangered
Green sea turtle	*Chelonia mydas*	Threatened
Hawksbill turtle	*Eretmochelys imbricate*	Endangered
Kemp's Ridley sea turtle	*Lepidochelys kempii*	Endangered
Leatherback sea turtle	*Dermochelys coriacea*	Endangered
Loggerhead sea turtle	*Caretta caretta*	Threatened
West Indian manatee	*Trichechus manatus*	Endangered
Piping plover	*Charadrius melodus*	Threatened
Red-cockaded woodpecker	*Picoides borealis*	Endangered
Wood stork	*Mycteria americana*	Endangered
Eastern indigo snake	*Drymarchon corais couperi*	Threatened
Flatwoods salamander	*Ambystoma cingulatum*	Threatened
Vascular Plants		
Pondberry	*Lindera melissifolia*	Endangered
Chaffseed	*Schwalbea Americana*	Endangered
Canby's dropwort	*Oxypolis candyi*	Endangered

[1]Green turtles are listed as threatened, except for breeding populations in Florida and on the Pacific Coast of Mexico, which are listed as endangered.

KEY:
Endangered - A taxon "in danger of extinction throughout all or a significant portion of its range."
Threatened - A taxon "likely to become endangered within the foreseeable future throughout all or a significant portion of its range."
Proposed –"are those candidate species that were found to warrant listing as either threatened or endangered and were officially proposed as such in a *Federal Register* notice after completion of a status review and consideration of other protective conservation measures."

Table 4-14 below is a list of Georgia's known occurrences of special concern animals and plants near Savannah Harbor. The list was obtained from the Georgia Department of Natural Resources, Wildlife Resources Division, Nongame Conservation by email dated January 4, 2010.

Table 4-14. Georgia's Known Occurrences of Special Concern Animals and Plants On or Near Savannah Harbor, Chatham County, Georgia**

Status	Species Scientific Name	Species Common Name
Animals		
US	*Caretta caretta*	Loggerhead
GA	*Clemmys guttata*	Spotted turtle
US	*Eubalaena glacialis*	Northern Right whale
GA	*Haematopus palliates*	American oystercatcher
GA	*Haliaeetus leucocephalus*	Bald eagle
	Himantopus mexicanus	Black-necked stilt
	Nycticorax nycticorax	Black-crowned Night heron
	Passerina ciris	Painted bunting
	Pseudacris brimleyi	Brimley's Chorus frog
	Pseudorca crassidens	False Killer whale
GA	*Rynchops niger*	Black skimmer
GA	*Sterna antillarum*	Least tern
GA	*Tyrannus dominicensis*	Gray kingbird
US	*Trichechus manatus*	West Indian manatee
	Ammodramus maritimus	Seaside sparrow
GA	*Charadrius wilsonia*	Wilson's plover
	Crotalus adamanteus	Eastern Diamond-backed rattlesnake
GA	*Gopherus polyphemus*	Gopher tortoise
GA	*Moxostoma robustum*	Robust redhorse
	Nyctanassa violacea	Yellow-crowned Night heron
GA	*Passerina ciris*	Painted bunting
GA	*Rana capito*	Gopher frog
	Stereochilus Marginatus	Many-lined salamander
	Umbra pygmaea	Eastern mud minnow
Plants		
GA	*Forestiera segregate*	Florida Wild privet
	Physostegia leptophylla	Narrowleaf Obedient plant
GA	*Sarracenia minor*	Hooded pitcherplant
GA	*Sageretia minutiflora*	Climbing buckthorn
GA	*Sapindus marginatus*	Soapberry
	Scutellaria mellichampii	Mellichamp's skullcap
	Sporobolus pinetorum	Pineland dropseed

** "US" indicates species with federal status (Protected, Candidate or Partial Status). Species that are federally protected in Georgia are also state protected. "GA" indicates Georgia protected species. All other are "species of concern" in Georgia.

The following list of Georgia's Conservation Areas near Savannah Harbor was provided by the Georgia Department of Natural Resources, Wildlife Resources Division, Nongame Conservation in 2006 and revised based on US FWS comments in 2012.

Conservation Areas

Fort Pulaski National Monument [National Park Service]	near project area
Greenspace [Chatham County]	near project area
Hunter Army Airfield [U.S. Department of' Defense]	near project area
Little Tybee-cabbage Island Natural Area [Georgia DNR]	near project area
Savannah NWR [U.S. Fish and Wildlife Service]	on site
Savannah River [High Priority Stream]	on site
Skidaway Island State Park [Georgia DNR]	near project area
Tybee Island Tract [Georgia DNR]	near project area
Tybee National Wildlife Refuge [U.S. Fish and Wildlife Service]	on site
Wormsloe Historic Site [Georgia DNR]	near project area

Table 4-15 shown below is a list of South Carolina's Rare, Threatened, and Endangered Species of Jasper County. The list was obtained from the South Carolina Department of Natural Resources website at the following website: https://www.dnr.sc.gov/pls/heritage/county_species.select_county_map.

Table 4-15. South Carolina's Rare, Threatened, and Endangered Species of Jasper County (Date of information – January 4, 2010)**

Legal Status	Global Rank	State Rank	Scientific Name	Common Name
Animals				
FE/SE	G3	S3	*Acipenser brevirostrum*	Shortnose sturgeon
SC	G3	S3	*Aimophila aestivalis*	Bachman's sparrow
FT/SE	G2G3	S1	*Ambystoma cingulatum*	Flatwoods salamander
SC	G4	S?	*Anodonta couperiana*	Barrel floater
ST	G5	S5	*Clemmys guttata*	Spotted turtle
SE	G3G4	S2?	*Corynorhinus rafinesquii*	Rafinesque's Big-eared bat
SC	G4	S3	*Crotalus adamateus*	Eastern Diamondback rattlesnake
SC	G2G3	S?	*Elassama okatie*	Bluebarred Pigmy sunfish
SC	G4	S?	*Elliptio congaraea*	Carolina slabshell
SE	G3	S1	*Gopherus polyphemus*	Gopher tortoise
SE	G4	S2	*Haliaeetus leucocephalus*	Bald eagle
SC	G2	S?	*Heterodon simus*	Southern Hognose snake
SC	G5	S5	*Hyla avivoca*	Bird-voiced treefog
SC	G5	S?	*Kinosternon baurii*	Striped mud turtle
SC	G4	SA	*Kogia breviceps*	Pygmy Sperm whale
SC	G3G4	S?	*Lampsilis cariosa*	Yellow lampmussel
SC	G3	S?	*Lampsilis splendid*	Rayed Pink fatmucket
FE/SE	G4	S1S2	*Mycteria Americana*	Wood stork
SC	G5	S3S4	*Neotoma floridana*	Eastern woodrat
SC	G5T5	S3S4	*Neotoma floridana floridana*	Eastern woodrat

Legal Status	Global Rank	State Rank	Scientific Name	Common Name
Animals				
SC	G3	S?	*Ophisaurus mimicus*	Mimic Glass lizard
FE/SE	G3	S2	*Picoides borealis*	Red-cockaded woodpecker
SC	G4T3?	S2	*Pitouphis melanoleucus mugitus*	Florida Pine snake
ST	G5	S2	*Pseudobranchus striatus*	Dwarf siren
SC	G5T4	S3S4	*Pseudotriton montanus flavissimus*	Gulf Coast mud salamander
SC	G5	S?	*Pyganodon cataracta*	Eastern floater
SC	G5	S4	*Sciurus niger*	Eastern Fox squirrel
SC	G5	S?	*Seminatrix pygaea*	Black Swamp snake
ST	G4	S3	*Sterna antillarum*	Least tern
SC	G5	S?	*Utterbackia imbecillis*	Paper pondshell
SC	G4	S?	*Villosa delumbis*	Eastern creekshell
Plants				
SC	G4?	S?	*Agalinis linifolia*	Flax Leaf false-foxglove
SC	G4G5	S1	*Agarista populifolia*	Carolina dog-hobble
SC	G4G5	S?	*Aletris obovata*	White colicroot
SC	G4	?	*Andropogon brachystachyus*	Short-spike bluestem
SC	G5T3T4	S1	*Andropogon perangustatus*	Narrow-leaved bluestem
SC	G5	S?	*Anthaenantia rufa*	Purple silkyscale
SC	G4?	S?	*Aristida condensata*	Piedmont Three-awned grass
SC	G3G5	S1	*Bacopa cyclophylla*	Coastal-plain water-hyssop
SC	G4	S?	*Balduina uniflora*	One-flower balduina
SC	G4?	S4	*Canna flaccida*	Bandana-of-the-everglades
SC	G5	S?	*Carex amphibola*	Narrowleaf sedge
SC	G4	S?	*Cayaponia boykinii*	Cay aponia
SC	G4G5	S?	*Cliftonia monophylla*	Buckwheat-tree
SC	G3G5	S?	*Coreopsisgladiata*	Southeastern tickseed
SC	G5	S?	*Crotonopsis linearis*	Narrowleaf tickseed
SC	G4	S?	*Cyperus tetragonus*	Piedmont flatsedge
SC	G4G5	S1	*Dicerandra odoratissima*	Rose balm
SC	G4G5	S?	*Dichanthelium aciculare*	Broomsedge
SC	G2G3	SR	*Eupatorium anomalum*	Florida thorough-wort
SC	G4	S1	*Forestiera segregata*	Southern privet
SC	G5	S1	*Halesia diptera*	Two-wing silverbell
SC	G?	S?	*Halesia parviflora*	Small-flowered silverbell-tree
RC	G2G3	S1	*Hypericum adpresum*	Creeping St. John’s wort
SC	G4G5	S?	*Lepuropetalon spathulatum*	Southern lepuropetalon
SC	G4G5	S?	*Licania michauxii*	Gopher-apple
SC	G4	S?	*Listera austalis*	Southern twayblade
SC	G3	S3	*Listea aestivalis*	Pondspice
SC	G5	S1	*Lyonia ferruginea*	Rusty lyonia
SC	G5	S1	*Lysimiachia hurida*	Land-leaf loosestrife
SC	G2G3	S?	*Macbridea caroliniana*	Carolina bird-in-a-nest
SC	G4G5	S	*Nyssa ogeche*	Ogeechee tupelo
SC	G3G4	S?	*Orbexilum lupinellum*	Sampson snakeroot; scurf pea
SC	G5?	SR	*Panicum neuranthum*	Needleleaf Rosette grass
SC	G3	S?	*Plantago aparsiflora*	Pineland plantain
SC	G3G4	S2	*Platanthera intefra*	Yellow Fringeless orchid
SC	G3	S1	*Polygala hookeri*	Milkwort
SC	G5	S1S2	*Polygala nana*	Dwarf milkwort
SC	G5	S?	*Potamogeton foliosus*	Leafy pondweed
SC	G2	S2	*Pteroglossaspis ecristata*	Crestless Plum orchid

Legal Status	Global Rank	State Rank	Scientific Name	Common Name
Plants				
SC	G5?	S?	*Pycnanthemum nudum*	Pinelands Mountain mint
SC	G5	S?	*Quercus myrtifolia*	Myrtle-leaf oak
SC	G3G5	S1	*Rudbeckia mollis*	Soft-hair coneflower
SC	G4	S2	*Sageretia minutiflora*	Tiny-leaved buckthorn
SC	G5T2	S?	*Sagittaria graminea va weatherbiana*	Grassleaf arrowhead
FESE	G2	S2	*Schwalbea americana*	Chaffseed
SC	G4	S1S2	*Scleria baldwinii*	Baldwin nutrush
SC	G3	S?	*Spiranthes langilabris*	Giant Spiral ladies' tresses
SC	G3	SR	*Sporobolu floridanus*	Florida dropseed
SC	G4	S?	*Thalia dealbata*	Powdery thalia
SC	G5T4T5	SR	*Xyris difformis var floridana*	Florida Yellow-eyed grass
SC	G3G4	SR	*Xyris serotina*	Acid-swampy Yellow-eyed grass

G RANK: The Nature Conservancy rating of degree of global endangerment:
G1 - Critically imperiled globally because of extreme rarity or because of some factor(s) making it especially vulnerable to extinction
G2 - Imperiled globally because of rarity or factor(s) making it vulnerable
G3 - Either very rare throughout its range or found locally in a restricted range, or having factors making it vulnerable
G4 - Apparently secure globally, though it may be rare in parts of its range
G5 - Demonstrably secure globally, though it may be rare in parts of its range
GH - Of historical occurrence throughout its range, with possibility of rediscovery
GX - Extinct throughout its range
G? - Status unknown
T# - Status of infraspecific taxa (subspecies or varieties). Rankings similar to G#.

S RANK: The Nature Conservancy rating of degree of state endangerment:
S1 - Critically imperiled state-wide because of extreme rarity or because of some factor(s) making it especially vulnerable to extirpation
S2 - Imperiled state-wide because of rarity or factor(s) making it vulnerable
S3 - Rare or uncommon in state, found only in a restricted range, or factors making it vulnerable
S4 - Apparently secure in state: Uncommon but not rare, and usually widespread
S5 - Secure: Common, widespread, and abundant
SA - Accidental in state (usually birds or butterflies that are far outside normal range)
SE - Exotic established in state
SH - Of historical occurrence in state, with possibility of rediscovery
SN - Regularly occurring in state, but in a migratory, non-breeding form
SR - Reported in state, but without good documentation
SX - Extirpated from state
S? - Rank not yet assessed.
Other Qualifiers:
B - Breeding
N - Non-breeding
? - Denotes inexact or uncertain numeric rank

LEGAL STATUS:
FE - Federal Endangered
FT - Federal Threatened
NC - Of Concern, National (unofficial - plants only)
RC - Of Concern, Regional (unofficial - plants only)
SE - State Endangered (official state list - animals only)
ST - State Threatened (official state list - animals only)
SC - Of Concern, State
SX - State Extirpated
DM - Delisted Taxon, Recovered, Being Monitored First Five Years
PE/PT/C- Proposed or candidate for federal listing

4.10 Cultural Resources

Cultural resources consist of prehistoric and historic districts, sites, structures, artifacts, objects, or any other physical evidence of human activity considered important to a culture, subculture, or community for scientific, traditional, religious, or other reasons. Cultural resources can be divided into two major categories: Prehistoric and Historic resources, and American Indian resources. Prehistoric and Historic resources include archaeological resources (prehistoric and historic) and architectural resources. American Indian resources are also known as traditional cultural properties.

Under the National Historic Preservation Act (NHPA), as amended, only cultural resources included in or eligible for inclusion on the National Register of Historic Places (NRHP), defined as 'historic properties', warrant consideration with regard to adverse impacts from a proposed action. Historic properties generally must be more than 50 years old to be considered for protection under the NHPA. To be considered eligible for the NRHP, cultural resources must meet one or more criteria as defined in 36 CFR 60.4 for inclusion on the NRHP. These criteria include association with an important event, association with a famous person, embodiment of the characteristics of a type, period or method of construction, or the ability to contribute to scientific research. Resources must also possess integrity (i.e., important historic features must be present and recognizable). Historic properties may be sites, buildings, structures, historic districts, or objects.

The Savannah area, including Savannah Harbor, is a culturally rich area, with respect to both archaeological and architectural resources. Some of the most abundantly found prehistoric sites in the Savannah area date to the Archaic Period which spans from 8000 B.C. to 1000 B.C. These sites are usually represented by shell middens or shell rings. The region also contains evidence of habitation from other prehistoric periods, namely the Woodland Period (1000 B.C. to A.D. 1150) and Mississippian Period (A.D. 1150 to European Contact).

The seaport has been a vital component of the city since settlement by General James Oglethorpe in 1733. As a result, extensive maritime facilities have been constructed along the shoreline, and vast quantities of cargo have moved through the port for over 250 years. In addition, the Savannah Harbor and vicinity was the site of many war-time activities during the Civil War. Fortifications were built along the river, some of which remain today.

4.10.1. Area of Potential Effects

Area of potential effects (APE) means the geographic area or areas within which an undertaking may directly or indirectly cause alterations in the character or use of historic properties, if any such properties exist. Savannah Harbor is an approximately 32.7 mile long Federal navigation project. For the proposed project the area of potential effects is defined as the following areas where ground disturbing activities and placement of dredged material will occur:

A. Channel bottom and side slopes of bar channel extension;

B. Channel bottom and side slopes of existing navigation channel;

C. Channel bottom and side slopes of bend wideners and channel side slopes where full-channel-width dredging will occur;

D. Channel bottom and side slopes of the Kings Island Turning Basin;

E. Channel bottom and side slopes in proposed passing lane areas;

F. Existing sediment placement sites; and

G. Environmental mitigation features.

4.10.2. Previously Disturbed Areas within the Area of Potential Effect

Due to previous dredging and other maintenance activities that have occurred within the Savannah Harbor, several areas within the APE have sustained considerable disturbance. The potential for cultural resources is extremely low in these areas and no initial or follow on investigations for historic properties will be conducted. These areas are as follows:

A. The existing navigation channel bottom between Stations 103+000 and -52+000B has been dredged to a depth well below historic harbor depths. Historically, the deepest place in the inner harbor was a 30-foot-deep hole located near Station 57+000 and the average channel depth was less than 15 feet. Any historic properties that were once located in the dredged channel bottom were removed by previous harbor deepening projects

B. That portion of the existing bar channel bottom located between Stations -52+000 and -60+000 was surveyed for the harbor deepening project conducted in the 1990s. No historic properties were located.

C. The side slopes and adjacent tops of slopes of the existing navigation channel between Stations +103+000 and -60+000B were surveyed for the harbor deepening project conducted in the 1990s. Historic properties that would be affected by construction of that project were identified and mitigated. Since much of the proposed project is to be constructed in a manner that will not alter existing channel side slopes and tops of slopes, these areas will not be investigated for historic properties, except in places where previous surveys have identified historic properties located immediately adjacent to the existing project.

D. Those portions of proposed bend wideners and the proposed passing lane that overlap existing harbor turning basins and channels that have been dredged to a depth of 38 or more feet, well below historic channel depths, will not be surveyed. Historic properties located in these areas would have been removed as part of previous dredging projects.

E. The bottom of the Kings Island Turning Basin has been dredged to a depth well below that which could have contained historic properties. This area will not be surveyed.

F. The existing Savannah Harbor dredged sediment placement sites have been used for a number of years. Original land surfaces that may contain historic properties are buried under 30

or more feet of dredged sediment. Existing offshore sediment placement sites were designed to avoid impacts to any sonar targets or magnetic anomalies identified during the planning process.

4.10.3. Management of Cultural Resources

Management of cultural resources in Savannah Harbor is an ongoing effort and will be accomplished via compliance with applicable cultural resource laws and regulations, and agreement documents prepared specifically for the Savannah Harbor Navigation Project. In 1992, Savannah District, the South Carolina and Georgia State Historic Preservation Offices, and the Advisory Council on Historic Preservation entered into a Programmatic Agreement to address impacts of the Savannah Harbor Navigation Project and the then proposed harbor deepening project. That deepening project was completed in 1994. All stipulations of the agreement have been carried out.

In 1992, Savannah District, the South Carolina and Georgia State Historic Preservation Offices, and the Advisory Council on Historic Preservation entered into a Programmatic Agreement to address impacts associated with the closing of New Cut and removing the Tidegate from operation in Savannah Harbor. Compliance with all stipulations in the Programmatic Agreement with the exception of Stipulation 12 has been carried out.

Stipulation 12 states: "In consultation with the Council, the GASHPO, and the SCSHPO, Savannah District will prepare a Memorandum of Agreement to outline procedures for identifying, evaluating, and mitigating and/or removing adverse effects of the Savannah Harbor Navigation Project upon the CSS *Georgia*, a property listed in the National Register of Historic Places." These studies and the results are discussed later in Section 5.12.

4.10.4. Status of Cultural Resources Investigations

Savannah District has conducted numerous cultural resources investigations within the Navigation Project since 1992 to identify and evaluate historic properties that may be impacted by undertakings in the Savannah Harbor. Areas that were investigated previously or those that are to be investigated for historic properties include: 1) Channel bottom and side slopes of bar channel extension; 2) Sides slopes of the existing navigation channel between Stations 103+000 and -98+600B in areas where the full channel width must be dredged to facilitate ship movements and in areas where historic properties abut the existing navigation channel; 3) Bottoms and side slopes of bend wideners where they do not overlap existing turning basins; 4) Sides slopes of the Kings Island Turning Basin; 5) Bottom and side slopes of proposed passing lanes; 6) Lands and water bottoms proposed for enhancement for project-related impacts to environmental resources; and 7) Proposed mitigation sites. Completed or in progress investigations include:

A. The portion of the existing Navigation Project that was deepened in 1994 (Stations 103+000 to –96+600B plus the Kings Island Turning Basin) was surveyed at that time and historic properties were investigated and mitigated.

B. Remote sensing surveys were conducted of the Back River Sediment Basin area and portions on upper Back River were surveyed as part of the studies required under the terms of the 1992 Programmatic Agreement for the closing of New Cut and the removal of the Tidegate from operation. The survey area included the Back River, from shore to shore, from the mouth of the Sediment Basin at its juncture with the Savannah Harbor navigation channel to Hog Island.

C. Investigations of the *CSS Georgia* to identify past, present, and future impacts from the existing Navigation Project and the effects of the proposed Expansion Project have been conducted. The reports of these investigations have been coordinated with the Georgia and South Carolina State Historic Preservation Offices.

D. In 2003, Savannah District contractor Panamerican Consultants, Inc., completed a survey of the proposed channel design.

E. In 2005, Savannah District contractor Panamerican Consultants, Inc., conducted a survey of new design elements and conducted diver investigations of 10 magnetic anomalies and/or sonar targets located within the area of potential effect.

F. Savannah and Wilmington Districts conducted a study to determine the incremental effect of the proposed Expansion Project upon Ft. Pulaski National Monument.

G. In 1992, as part of the New Cut Closure Project studies, Savannah District contractor Tidewater Atlantic Resources, Inc., conducted low water shoreline and remote sensing surveys of the Back River from its mouth to the lower end of Hog Island in Little Back River. Thirty-one archaeological sites and 26 magnetic anomalies and/or sonar targets were recorded.

H. In 1993 and 1994, Savannah District archaeologists conducted archival research, archaeological survey, site documentation and monitoring, and diver investigations of the sites and anomalies/targets identified in Back River above the Tidegate during the 1992 survey. A number of the sites were determined eligible for inclusion in the National Register of Historic Places. The report concluded that the New Cut Closure Project had caused erosion at some of the resources, but, these sites had since stabilized and the detailed research and documentation conducted by Savannah District was adequate to mitigate this effect.

I. Savannah District recovered core samples from an area of a proposed off-shore bend widener, where analysis of sub-bottom profiler data indicated the presence of a Pleistocene stream channel. The cores were analyzed and the results reported by New South Associates in 2005.

As a result of the investigations conducted by Savannah District that are related to the Savannah Harbor Navigation Project and investigations conducted by others in the vicinity of the APE, several archaeological and architectural resources have formally been determined eligible for the NRHP, listed on the NRHP or have pending nominations for listing to the NRHP. The identified resources are described below, and their current statuses are summarized below in Table 4-16.

Fort Pulaski National Monument (GA): Station -2+000B to 8+000. Constructed during the 1830s and 1840s, Fort Pulaski is operated and maintained as an historic site by the National Park Service. It is included in the National Register of Historic Places at the national level of significance for its architecture, association with significant events, association with significant people, and archaeological research potential. Erosion is an on-going problem on the channel-ward side of monument property. While the fort itself is not endangered by the erosion, associated archaeological deposits may be. The shoreline is well outside the channel side slope and the erosion is unassociated with channel maintenance dredging.

The Monument has expressed concern about the incremental effect of wakes from deeper-draft ships that would transit a deeper navigation channel. Savannah and Wilmington Districts conducted an engineering study to determine the nature and scope of this incremental effect. This study concluded that the proposed expansion project would result in a negligible increase in erosion. No further studies are recommended.

Savannah National Historic Landmark District (GA): Stations +72+000 to +79+000. The Savannah National Historic Landmark District is located along the south shore of the Savannah Harbor navigation channel. The district is listed in the National Register of Historic Places at the national level for its architecture. All but one small area is protected by modern bulkheads, wharves, or rip rap. The exception is located near Station +75+500 where a brick-faced wharf constructed during the last quarter of the nineteenth century forms an alcove in the modern bulkhead. This area is used for small boat mooring. Proposed channel improvements will have no effect upon the landmark district.

Fort James Jackson National Historic Landmark (GA): Station +58+000 and +59+000. Fort Jackson is located at the top of the channel side slope on the south shore of the Savannah Harbor navigation channel. It is owned by the State of Georgia and is operated and maintained as a historic site by the Coastal Heritage Society. It is listed in the National Register at the national level of significance for its architecture and association with significant events and historic figures. In 2003, in accordance with a Memorandum of Agreement between Savannah District and the Georgia State Historic Preservation Office, the District completed a bank stabilization project to protect this property from harbor operation and maintenance activities. The potential for future harbor deepening was considered in the design process. No further protection is required for this property.

CSS *Georgia* (SC & GA waters): Station 58+500 to 59+000. The wreck of CSS *Georgia* is included in the National Register of Historic Places at the national level of significance for architecture, association with significant events, association with significant people, and archaeological research potential. The National Register boundary includes the channel side slope, the top of slope, and an area extending 50 feet into the authorized navigation channel. The boundary between South Carolina and Georgia runs through the wreck site. Since 1984, Savannah District has had an agreement with both states to avoid the site area during dredging by 50 horizontal feet for a distance of 1,000 feet along the channel. No dredging has been conducted of any portion of the existing navigation channel located between Stations 58+000 and 59+000 since 1992.

A 1992 Programmatic Agreement required Savannah District to determine past, present, and future effects of the existing Savannah Harbor Navigation Project upon this resource and to identify and evaluate alternatives to mitigate these effects. The Corps conducted the study in 2003 in conjunction with studies to determine the incremental effect of the proposed Expansion Project. The studies demonstrated that past, present, and future operation and maintenance activities have, and will continue to have, an adverse effect upon the wreck site. In addition, the proposed meeting area that would be constructed as part of the Expansion Project would adversely affect the site. The report of these investigations has been coordinated with the Georgia and South Carolina State Historic Preservation Offices. The Savannah District will conduct archaeological data recovery prior to new work dredging near the CSS *Georgia*. The SHEP will be responsible for final clearance of explosive ordnance prior to deepening the channel and constructing the meeting area.

The Savannah and Ogeechee Canal (GA): Station 79+000. The river lock and northern terminus of the Savannah and Ogeechee Canal is located on the south shore adjacent to the Highway 17 Bridge. The canal was constructed during the 1830s. It is listed in the National Register of Historic Places at the state level for architecture and archaeological research potential. The proposed project will have no effect upon the canal.

Pennyworth Island (Back River, GA). During 1993 and 1994, Savannah District archaeologists conducted archival research, shoreline inspection, and documentation of sites along the shoreline of Pennyworth Island in support of the New Cut Closure Project. As a result of these investigations, Savannah District recommended that Pennyworth Island was eligible for inclusion in the National Register of Historic Places at the local level for its ability to provide information on 19th century rice culture along the Savannah River. The island had a diverse history spanning the period from 1825 to the early 20th century and was one of the last active rice plantations on the river. The investigations documented all historic shoreline features, noted that shoreline erosion had been on-going for many years, and recommended that no further work be conducted for the New Cut Closure Project.

The island was in private ownership at the time of the fieldwork. Recently, it was purchased by Chatham County. The County used the 1993/1994 research to prepare a nomination to the National Register of Historic Places. The nomination is pending approval. The island may be affected by the proposed environmental mitigation measures included in the Savannah Harbor Expansion Project. Potential effects may include increased shoreline erosion or accretion and will be addressed in accordance with the Programmatic Agreement.

Fig Island Channel Site (GA): Station 72+000 to 73+500. The Fig Island Channel Site is located on the north side slope and shore of the existing navigation channel. The site has been determined eligible for inclusion in the National Register of Historic Places at the state level for its archaeological research potential. The site area was once a channel between Fig and Hutchinson Islands. The channel was used for disposal of wrecked and derelict vessels during the eighteenth and nineteenth centuries.
The eastern third of the site has been bulkheaded and lies beneath the US Army Corps of Engineers' Depot. The western two-thirds of the site has been the subject of a number of archaeological investigations. The District excavated and documented three vessels as

mitigation for the effects of a 1980s channel widening project. During the 1993/94 deepening project, the District excavated and documented parts of 20 vessels. The vessels spanned the period ca. 1770 to 1900 and were located within the area of potential effect for that deepening project.

In 2000, portions of the site's 1854 pile dam wall were illegally removed. In 2003, the extreme western portion of the site was investigated as part of planning for a Chatham County project that included bulk heading the adjacent slip. One eighteenth century hull was located within the project's potential area of effect. This project requires a Department of the Army Permit that would be issued under the authority of Section 10 of the Rivers and Harbors Act of 1899 and Section 404 of the Clean Water Act of 1972. Federal permitting and consultation under Section 106 is proceeding as part of that project. A Memorandum of Agreement has been completed identifying mitigation procedures for effects to this resource.

The remaining non-bulkheaded portions of the site have been purchased by a developer who intends to bulkhead the shoreline and construct residential and commercial buildings on the site. The bulkhead would require a Department of the Army permit.

The Fig Island Channel Site area will not be affected by bend widener construction or full-channel-width dredging, however, since the channel side slope has been determined eligible for inclusion in the National Register of Places, the District has conducted a slope stability analysis study to determine if incremental erosion would occur at the site. The analysis indicated that there would be no impact to the side slope.

Mansfield/Shaftsbury Plantation—09CH685 (Back River, GA). Savannah District archaeologists conducted archival research and field documentation for this plantation as part of the 1993/1994 New Cut Closure Project studies. The plantation was recommended eligible for inclusion in the National Register of Historic Places at the local level of significance for its ability to provide information on historic rice culture along the Savannah River. No further investigations were recommended for this resource as part of the New Cut Closure Project. The site may be affected by increased shoreline erosion or accretion as part of the Savannah Harbor Expansion Project. Impacts to the site will be identified and addressed in accordance with the Programmatic Agreement.

Poplar Grove Plantation—38JA203 (Back River, SC). Savannah District archaeologists conducted archival research and field documentation for this plantation as part of the 1993/1994 New Cut Closure Project studies. The plantation was recommended eligible for inclusion in the National Register of Historic Places at the local level of significance for its ability to provide information on historic rice culture along the Savannah River. No further investigations were recommended for this resource as part of the New Cut Closure Project. The site may be affected by increased shoreline erosion or accretion as part of the Savannah Harbor Expansion Project. Impacts to the site will be identified and addressed in accordance with the Programmatic Agreement.

Shubra Plantation—38JA204 (Back River, SC). Savannah District archaeologists conducted archival research and field documentation for this plantation as part of the 1993/1994 New Cut

Closure Project studies. The plantation was recommended eligible for inclusion in the National Register of Historic Places at the local level of significance for its ability to provide information on historic rice culture along the Savannah River. No further investigations were recommended for this resource as part of the New Cut Closure Project. The site may be affected by increased shoreline erosion or accretion as part of the Savannah Harbor Expansion Project. Impacts to the site will be identified and addressed in accordance with the Programmatic Agreement.

Table 4-16. Location and Status of Known Cultural Resources in the APE

Resource Name/Site Number	Location	NRHP Status
Fort Pulaski National Monument (GA)	Station -2+000B to 8+000	Listed as National Monument
Savannah National Historic Landmark District (GA)	Stations +72+000 to +79+000	Listed as National Historic Landmark
Fort James Jackson National Historic Landmark (GA)	Station +58+000 and +59+000	Listed as National Historic Landmark
CSS *Georgia* (SC & GA waters)	Station 58+500 to 59+000	Listed
The Savannah and Ogeechee Canal (GA)	Station 79+000	Listed
Pennyworth Island	Back River, GA	Nomination Pending Approval
Fig Island Channel Site	Station 72+000 to 73+500	Determined Eligible
Mansfield/Shaftsbury Plantation—09CH685	Back River, GA	Recommended Eligible
Poplar Grove Plantation—38JA203	Back River, GA	Recommended Eligible
Shubra Plantation – 38JA204	Back River, SC	Recommended Eligible

4.11 Aesthetic and Recreational

Broad expanses of salt marsh exist between developed high ground areas and the barrier islands. This broad vista is one of the highly enjoyed features of living in coastal Georgia. The tidal creeks which wind through those marshes also provide avenues for recreational users for the coastal area. Kayaking in those creeks has grown into an activity that is enjoyed by many residents and coastal visitors. Large live oaks are common throughout the area and with their draping Spanish moss they provide stunning visual views no matter where they are found.

As a historic city, Savannah attracts numerous tourists, many of which visit the harbor area. A significant portion of the riverfront has been restored. It is known as River Street and is a

popular tourist destination, with hotels, restaurants and small shops. A lengthy promenade, approximately 1/2 mile, has been established and is well used by both tourists and residents. Events are regularly held which draw thousands of attendees. Therefore, extensive recreational use does occur along portions of the harbor. These uses stem from the historic and cultural aspects of the city, whose origin was directly tied to the harbor. Those uses have expanded to widespread commercial operations which serve both tourists and local residents. In 1733, General Oglethorpe laid out the city in a series of grids that allowed for open streets and shady public squares. In the 1990's, more than 50 million people came to visit Savannah, drawn by its architecture, fountains and green squares.

The City of Tybee Island is an urbanized beach community characterized by single-family dwellings, condominiums, and small hotels. The aesthetic values of this beach community are evidenced by the popularity of the area for family-oriented use and tourism. The total environment of ocean, estuaries, and inlets attract many residents and visitors to the area to enjoy the sights, sounds, winds, and marine environment.

4.12 Recreational and Commercial Fishing

Recreational and commercial fishing are important industries in coastal Georgia. Commercial shrimp trawling is common in the immediate vicinity of the dredged entrance channel, since this is a natural corridor for emigrating shrimp. The GA DNR Coastal Resources Division (Personal Communication, 26 February 2007, Mr. Spud Woodward, Assistant Director for Marine Fisheries) indicates that Georgia's territorial waters south of the channel are open to food shrimp trawling during the established season, which is typically mid-June through December. Trawling occurs off the beach at Tybee Island, but is limited because of water depth.

The GA DNR Coastal Resources Division (Personal Communication, 26 February 2007, Mr. Spud Woodward, Assistant Director for Marine Fisheries) stated there is limited commercial fishing for blue crabs in the lower Savannah River. The Division knows of one commercial crabber who works that area. There may be other fishermen in the spring when female crabs are moving toward the ocean to release their eggs. The Division prohibits deployment of traps in marked navigation channels, which obviously limits the area of the lower Savannah that is open to commercial blue crab fishing. The Division has never known commercial blue crab fishing to occur in the area outside the river entrance and in the nearshore area off Tybee Island. In Georgia, commercial fishing for blue crabs occurs throughout the year with the least activity during the winter.

The following table provides a summary of fish and shellfish landings in Georgia. This table was developed by the GA DNR, Coastal Resources Division and used by permission.

Table 4-17. Summary of Georgia Fish and Shellfish Landings by Broad Category

Year		Food Shrimp	Hard Blue Crabs	Bait Shrimp	Hard Clams	Pelagics	Offshore Demersals	Shad	Other Finfish	Misc. Crustacean & Mollusks	Whelks	Oysters	Total
1994	lbs	4,581,070	8,853,564	60,833	10,824	180,057	417,159	75,785	196,631	65,782	672,617	13,624	15,127,946
	value	19,783,714	4,510,691	562,552	73,158	122,826	655,338	80,945	163,725	211,057	377,323	29,764	26,571,093
1995	lbs	7,255,073	9,298,860	59,753	9,763	96,548	398,103	172,525	170,141	83,673	557,129	6,340	18,107,908
	value	27,002,973	5,020,608	572,736	64,974	78,981	698,915	131,350	163,436	257,288	336,654	15,571	34,343,486
1996	lbs	4,132,607	5,791,688	53,798	31,647	69,187	339,553	152,241	161,044	108,745	425,534	4,269	11,270,313
	value	16,335,208	3,018,151	519,561	194,409	35,166	576,617	109,285	152,500	368,962	254,717	9,227	21,573,803
1997	lbs	4,543,631	6,808,290	58,376	16,281	35,386	262,831	125,872	184,650	179,622	621,230	7,480	12,843,649
	value	22,254,286	3,835,798	590,563	114,521	32,290	443,529	93,540	174,552	532,564	389,437	18,428	28,479,507
1998	lbs	4,370,638	5,037,747	59,887	17,416	19,354	276,170	136,881	95,645	140,892	582,515	6,956	10,744,101
	value	19,080,321	2,604,625	634,375	122,891	18,189	502,850	86,370	88,690	490,948	406,942	17,212	24,053,412
1999	lbs	4,380,827	3,901,226	59,918	24,912	120,017	306,670	45,905	106,779	239,458	591,161	6,608	9,783,481
	value	18,364,973	2,045,493	665,633	153,074	71,328	606,778	45,496	103,670	469,301	414,997	17,325	22,958,068
2000	lbs	3,534,630	3,202,634	52,363	25,352	40,681	385,481	58,051	72,448	94,610	421,248	3,800	7,891,298
	value	17,309,053	2,077,587	565,352	212,821	40,738	779,277	33,457	72,298	399,445	277,485	9,733	21,777,246
2001	lbs	2,761,313	2,702,493	62,759	24,872	52,946	425,927	34,611	32,280	1,225,170	325,761	8,528	7,656,660
	value	10,459,975	2,500,657	576,654	186,644	40,280	849,034	27,729	32,853	496,320	245,330	22,254	15,437,730
2002	lbs	3,397,290	2,027,491	76,016	48,611	100,986	424,841	27,699	42,112	1,553,296	63,585	7,996	7,769,923
	value	11,140,950	1,967,968	688,185	319,413	64,948	830,321	22,682	42,519	440,057	49,621	19,997	15,586,661
2003	lbs	3,519,644	1,855,396	79,219	74,983	62,471	285,688	36,076	25,306	1,591,403	90,169	10,976	7,631,331
	value	9,815,906	1,901,797	723,316	520,515	41,318	552,420	27,024	28,852	401,035	69,393	31,019	14,112,595
2004	lbs	3,223,113	3,066,234	69,833	69,826	44,791	304,817	42,582	30,491	1,160,738	3,581	5,108	8,021,114
	value	10,023,570	2,272,500	634,951	426,048	37,414	645,037	34,418	33,448	429,375	3,941	14,859	14,555,561
2005	lbs	2,882,969	4,386,837	60,844	112,483	34,761	292,511	45,556	28,623	325,250	2,688	5,268	8,176,566
	value	8,539,787	3,019,314	564,190	658,175	32,017	621,393	44,083	31,491	206,917	2,768	20,473	13,739,648
2006	lbs	2,457,065	4,076,881	67,441	46,086	18,745	177,890	65,288	27,136	72,551	4,709	14,480	7,028,272
	value	7,089,816	2,881,119	634,732	299,292	19,158	461,343	67,961	31,027	120,449	5,729	55,231	11,665,859
2007	lbs	1,777,112	4,399,402	43,234	59,360	32,188	207,417	44,639	18,477	376,649	1,074	15,976	6,975,528
	value	6,024,147	3,536,939	404,991	405,746	32,710	519,332	45,060	26,348	297,300	1,315	65,250	11,359,138
2008	lbs	1,947,419	4,180,334	54,064	67,113	22,171	191,291	33,976	24,545	1,281,953	4,488	13,168	7,820,522
	value	7,330,941	3,666,172	467,390	523,449	20,217	550,296	36,827	31,225	416,931	5,878	55,321	13,104,647
2009	lbs	2,146,048	3,604,146	61,862	90,277	26,935	221,768	34,807	21,797	572,950	16,365	19,016	6,815,971
	value	6,335,710	3,418,446	551,619	603,283	25,692	535,973	35,340	27,366	682,619	17,380	81,265	12,314,693
2010	lbs	180,813	176,201	1,138	12,050				7,572	2,080,243	15,699	6,496	2,480,212
	value	314,484	227,800	9,847	65,460				8,839	195,138	18,844	28,125	868,537
Average 1992-2010	lbs	3,358,310	4,315,848	57,726	43,639	59,827	307,382	70,781	73,275	656,058	258,797	9,182	9,184,988
	value	12,776,813	2,853,274	550,979	290,816	44,580	614,278	57,598	71,343	377,394	169,280	30,062	17,794,217

Values are ex-vessel
Shrimp weights are pounds of tails
Crab and fish are pounds of whole animals

updated 12/15/2011
2009 and 2010 data are incomplete and subject to change
Adapted from GA DNR-CRD

Commercial and sport fishing within Savannah Harbor is low due to heavy vessel traffic levels and high shoaling rates which limit benthic communities and required recurring maintenance dredging. Marine finfish taken around the mouth of the harbor include spotted sea trout, spot, croaker and other bottom species. Cobia and tripletail provide for a limited amount of sport fishing in the outer channel.

GA DNR, Coastal Resources Division indicates the area of the navigation channel commonly known as Tybee Roads and eastward is a popular location for recreational fishing for king and Spanish mackerel during the late spring and summer. One ocean fishing pier is located on Tybee Island (Tybee Pavilion Ocean Pier off 16th Street) and is considered an important recreational facility. The ocean pier, private recreational vessels, charter boats, and head boats that use the nearshore waters also contribute to the local economy. Recreational surf fishing is not extensive on Tybee Island since the natural water depth is shallow near the beach and very gradually deepens offshore.

4.13 Socio-Economic Resources

4.13.1 Land Use

The City of Savannah dominates the mainland on the south side of the harbor. The city's historic downtown area is located on a bluff approximately 18 miles upstream from the river's mouth. Heavy industry and shipping facilities are located along the south side of the harbor upstream from the city's historic area to the upper limits of the authorized deep-draft navigation channel. Additional heavy industries and a few shipping facilities line the harbor downstream from the city historic area to the Atlantic Intracoastal Waterway. The Savannah National Wildlife Refuge, Tybee National Wildlife Refuge, Fort Jackson Historic Site, and Fort Pulaski National Monument are located within the project area. From the Atlantic Intracoastal Waterway to the river's mouth, both sides of the harbor are predominately undeveloped areas consisting of islands, marshes, upland confined dredged sediment placement facilities, and other undeveloped sites.

Land use on the South Carolina side of the Savannah River is basically agricultural, silvicultural, with some recreation. Substantial growth in residential development is occurring in Jasper County, South Carolina. The rate of that growth has slowed as a result of the recent economic downturn, but continued growth is expected in the future. Wetland habitat types found along Savannah Harbor include saltwater aquatic, saltwater coastal flats, saltwater marshes, freshwater aquatic, freshwater flats, and freshwater marsh.

4.13.2 Population

4.13.2.1 Georgia. Georgia had a population of 9,687,653 based on 2010 US Census data. This was an increase of 18.3% from the 2000 census population of 89,186,453, which was an increase of 26.4% since the 1990 census. Chatham County, Georgia had a population of 265,128 in 2010, an increase of 14.3% from the 232,048 in 2000. The City of Savannah, located in Chatham County, had a 2009 estimated population of 134,699, also growing 2.4% since 2000.

4.13.2.2 South Carolina. South Carolina had a population of 4,625,364 in 2010, increasing by 15.3% from 4,012,012 in 2000. The 2000 population also grew 13.1% since the 1990 census. Jasper County, South Carolina, that borders Savannah, had a population of 24,777 in 2010. This is an increase of 19.8% from the 20,678 according to the 2000 Census.

4.13.3 Income and Employment

4.13.3.1 Georgia. Economic data from the Bureau of Labor Statistics indicates that in November of 2011 Georgia had a labor force of 4,748,200. The unemployment rate in Georgia was 9.9% which is 0.5% drop from November 2010. Chatham County's labor force in November 2011 was 130,625 with an unemployment rate of 8.7%, a 0.5% decrease from November 2010. In 2010, the City of Savannah had a labor force of 175,700 and an unemployment of 9% which was an increase of 0.7% from the 2009 rate. The US Census Bureau reports that the personal per capita income of Georgia in 2009 was $25,098 and $25,240 per capita in Chatham County. According to the US Department of Commerce, the personal per capita income in Savannah for 2010 was $38,899.

4.13.3.2 South Carolina. Using the same data sources listed above, South Carolina's labor force in November 2011 was 2,165,000. South Carolina's unemployment rate dropped 1.0% from 10.9% to 9.9% in from November 2010 to November 2011. Jasper County had a labor force of 10,399 and 8.3% unemployment rate in November 2011, a drop of 1.7% in unemployment from November 2010. The US Department of Commerce Bureau of Economic Analysis data shows that the personal per capita income in 2009 was $31,646 in South Carolina and $26,625 in Jasper County.