Final Fish and Wildlife Coordination Act Report

CHARLESTON HARBOR POST 45 PROJECT

Berkeley and Charleston Counties, South Carolina

SEPTEMBER 2014

Prepared by

US Fish and Wildlife Service *South Carolina Ecological Services Field Office*

for

US Army Corps of Engineers *Charleston District South Atlantic Division*

EXECUTIVE SUMMARY

Charleston Harbor is a tidal estuary on the Atlantic coast, located at Charleston, South Carolina (Berkeley and Charleston Counties). The Federal channel at Charleston Harbor was initially dredged in 1852. U.S. Army Corps of Engineers (USACE) currently proposes to dredge and modify harbor channels and the entrance channel to accommodate larger vessels, increase efficiencies and increase safety while abiding by USACE environmental principles.

The U.S. Fish and Wildlife Service (USFWS) prepared this Fish and Wildlife Coordination Act Report (CAR) with funds transferred from the USACE under the National Letter of Agreement between the agencies for funding of Fish and Wildlife Coordination Act (FWCA) activities. The Report is authorized by the Fish and Wildlife Coordination Act (16 U.S. Code Sections 661 through 667e; the Act of March 10, 1934; Ch. 55; 48 Stat. 401). FWCA provided the basic authority for the USFWS's involvement in evaluating impacts to fish and wildlife from proposed water resource development projects.

USACE's proposed action, i.e., "Alternative 52-48," comprises a design depth of 54 feet MLLW in the entrance channel, 52 feet MLLW from Mt Pleasant range to Wando River up to Wando terminal (including the turning basin) and to Cooper River at the proposed Navy Base terminal (including the turning basin). The design depth is 48 feet MLLW from Daniel Island bend to Ordnance reach (including the turning basin). Material will be deposited at the Charleston Ocean Dredged Material Site (ODMDS), Clouter Creek Disposal Area, or Yellow House Creek Disposal Area.

Resources that may be affected by the proposed action include tidal freshwater and brackish wetlands; Essential Fish Habitats including the estuarine water column, hardbottom, and subtidal softbottom; fishes including species managed under the Magnuson–Stevens Fishery Conservation and Management Act; species protected by state jurisdictions and/or the Endangered Species Act of 1973 ("ESA"); and migratory birds.

USACE proposes to mitigate for the partial functional losses (but not destruction) of approximately 114 acres of tidally influenced forested wetlands and approximately 167 acres of tidal freshwater marsh (located in the Ashley and Cooper River basins). Functional assessments to determine the appropriate mitigation using the Uniform Mitigation Assessment Method (UMAM) have been completed and indicate that 831 acres of mitigation through preservation may be necessary to compensate for functional losses. USACE also proposes to provide 33 acres of created hardbottom habitat to compensate for 28.6 acres of hardbottom impacts. Finally, USACE is proposing to beneficially use dredged material where possible to improve shoreline habitats.

USFWS has concerns that the project may be dredged more deeply than is absolutely necessary, and that opportunities to avoid and minimize impacts are being overlooked by not selecting a dredge depth that is shallower. Increasing harbor and channel depths and widths more than necessary increases not only impacts (in acres) to hardbottom and unconsolidated subtidal habitats, but also increases indirect impacts to tidal freshwater and oligohaline wetlands due to upstream salinity intrusion and decreased dissolved oxygen (DO) levels in surface waters, particularly during periods of drought and high seasonal water temperatures. Tidally influenced freshwater wetlands would be adversely affected by increases in salinity, which may result in the gradual replacement of freshwater and oligohaline plant species with more salt-tolerant plant species, possibly causing a commensurate shift in fish and macroinvertebrate populations upstream.

Although USACE contractors will utilize best management practices (BMPs) during project construction, direct and indirect impacts to valuable fish and wildlife populations and habitats are likely to occur. USFWS requests that USACE allow dredging to occur only during seasonal windows that would decrease the risk of death and injury to marine mammals, fishes, and shellfish (eggs, larvae, and adults), as well as sea turtles, and also not interfere with recreational fishing opportunities near the inlet and bridges used by gamefish. Protected species monitoring protocols on dredge vessels will also be required under Section 7 of the ESA.

Finally, USFWS requests further coordination with federal and state natural resource agencies regarding which mitigation option(s) for direct and indirect impacts to tidally influenced freshwater wetlands will be selected and how they will be implemented as the large number of acres necessary to offset impacts will incur considerable costs and require careful planning, implementation, as well as comprehensive monitoring.

Additional recommendations to USACE for this project’s potential effects on species protected under the ESA will be detailed during Section 7 consultation, although a Biological Opinion (BO) may not be issued by USFWS.

TABLE OF CONTENTS

Page

LIST OF FIGURES

Page

CHARLESTON HARBOR
NAVIGATION IMPROVEMENT (POST 45) PROJECT
CHARLESTON, SOUTH CAROLINA

INTRODUCTION

Authority

The Charleston Harbor Federal Navigation project, as authorized by Section 27 of the 1996 Water Resources Development Act (WRDA), provides for deepening the 800-foot entrance channel to a depth of 47 feet below mean lower low water (MLLW) for a distance of about 16.3 miles, increasing the depth of existing interior channels and turning basins to a depth of 45 feet below MLLW, and deepening the Shipyard Creek entrance/lower channel and lower turning basin to 45 feet below MLLW. Shipyard Creek was originally a separate authorization (River and Harbor Act of July 25, 1912), but was incorporated into the overall Charleston Harbor Federal Navigation channel in WRDA 1986. The navigation channel behind Crab Bank was originally authorized in 1940 by House Document 259, 76th Congress, 1st Session. Additional authorization to modify the channel to its present dimensions was provided in 1960 by House Document 35, 86th Congress, 1st Session.

The U.S. Fish and Wildlife Service (USFWS) prepared this Fish and Wildlife Coordination Act Report (CAR) with funds transferred from the U.S. Army Corps of Engineers (USACE) under the National Letter of Agreement between the agencies for funding of Fish and Wildlife Coordination Act (FWCA) activities. The CAR is authorized by the Fish and Wildlife Coordination Act (16 U.S. Code Sections 661 through 667e; the Act of March 10, 1934; Ch. 55; 48 Stat. 401). FWCA provides the basic authority for the Fish and Wildlife Service's involvement in evaluating impacts to fish and wildlife from proposed water resource development projects.

Purpose and scope

This CAR evaluates existing and future fish and wildlife resources within the Charleston Harbor project area and affected areas, provides the USFWS analysis of project impacts and mitigation plans and provides the USFWS position and mitigation recommendations. The CAR is based on the information currently available. However, because USACE has not identified a recommended plan, USFWS may provide additional comments and recommendations after the recommended plan is identified.

Prior studies and reports (Project history)

The Rivers and Harbor Act of 1852 initially authorized navigation improvements to Charleston Harbor. The passage of the Rivers and Harbor Act of 1878 authorized the deepening of a channel through the ocean bar to a depth of 21 feet MLW, as well as the construction of a pair of jetties as a means of stabilizing the new channel. In 1898 and 1904, additional dredging occurred in Charleston Harbor to secure channel depths of 26 and 30 feet deep, respectively. In October 1940, a 35-foot project was authorized, which provided for a channel from the 35-foot ocean contour up the Cooper River to the North Charleston Terminal area.

An October 1974 Interim Feasibility Report, as supplemented by a 1980 Phase I Advanced Engineering and Design Study of Charleston Harbor, recommended that Charleston Harbor and Shipyard Creek Entrance Channel be modified to provide for construction and maintenance of a 40-foot deep navigational channel 26.97 miles in length from the 42-foot ocean contour to the North Charleston Terminal on the Cooper River; a 38-foot deep channel in Shipyard Creek (a spur off the Cooper River to the west, just north of the confluence of the Cooper and Wando Rivers; see Figures 2 and 3) and 38-foot depths in both the upper and lower turning basins. USFWS provided a CAR on the formerly authorized deepening project (40-foot channel) in 1980 (USFWS 1980), and a supplemental CAR on mitigation alternatives for that project in 1986.

In 1982, USFWS provided a CAR on the Charleston Harbor Wando River extension project, which involved deepening the Wando River channel from 35 feet to 40 feet (construction completed in 1996), and then in 1991, USFWS provided a CAR on a proposal to deepen Shipyard Creek from 38 to 40 feet.

In March 1990 and August 1990, the Senate Committee on Environment and Public Works and the House Committee on Public Works and Transportation, respectively, adopted resolutions that authorized the study of improvements to be made to Charleston Harbor in the interest of navigation with a particular view toward deepening and/or widening. In 1996, USFWS submitted a CAR for the 1996 Feasibility Study (USFWS 1996). Based on the Study, authorization was given to further deepen the Federal channel to its present configuration which includes a 47-foot deep entrance channel and a 45-foot deep inner harbor channel.

Construction of the authorized project was initiated in 1998 with the removal of a contraction dike at the southern tip of Daniel Island. Since that time, the lower harbor (including Wando River), and the upper harbor (including Shipyard Creek) have been dredged to 45 feet, and the entrance channel has been dredged to 47 feet. All depths include an additional 2 feet of allowable overdepth dredging and 2 feet of advanced maintenance dredging. All of the authorized 1996 changes have been completed with the exception of the Daniel Island Turning Basin, as construction of the turning basin was contingent upon the construction of a new South Carolina State Port Authority (SCSPA) six-berth terminal on Daniel Island. Plans to build the terminal on Daniel Island have been canceled, and replaced with plans for a smaller, three-berth terminal (currently under construction) across the river at the former Charleston Naval Base.

In July 2010, a Section 905(b) (WRDA 86) analysis for a Charleston Harbor Navigation Improvement Project was completed recommending further assessment through a detailed Feasibility Report. On June 20, 2011, a Feasibility Cost Sharing Agreement was executed between USACE Charleston District (SAC) and the SCSPA. The Department of the Army released (on August 12, 2011) the Notice of Intent to prepare a Draft Environmental Impact Statement for a Study on the Feasibility of Deepening Charleston Harbor (Federal Register / Vol. 76, No. 156 / Friday, August 12, 2011 / Notices).

DESCRIPTION OF THE STUDY AREA

Study Area Overview and History

Charleston Harbor (Figure 1) is a natural tidal estuary on the Atlantic coast, located at Charleston, South Carolina (Berkeley and Charleston Counties) and approximately 100 miles southeast of Columbia, South Carolina, the state capital (Interstate Highway 26, or I-26, is the major artery between the two cities). The harbor is approximately 140 statute miles southwest of the entrance to North Carolina's Cape Fear River (which accesses the Port of Wilmington), North Carolina, and approximately 75 statute miles northeast of the entrance to the Savannah River (which accesses the Port of Savannah), which delineates part of the Georgia/South Carolina state line.

Charleston, originally founded as "Charles Towne" in 1670 on the west bank of what was to be eventually named the Ashley River. The city's historical significance and navigation industry have been entwined since Anthony Ashley-Cooper, one of the partners to whom the Carolina territory charter was granted by King Charles II of England, remarked that the settlement was to become a "great port towne." This became apparent by the middle of the 18^{th} century, when Charleston was the wealthiest town in the South and its port became the largest one south of Philadelphia, Pennsylvania.

Today, the city of Charleston has a population of approximately 123,000 (U.S. Census Bureau 2011) and is geographically distributed among six districts: the Peninsula/Downtown, West Ashley, Johns Island, James Island, Daniel Island, and the Cainhoy Peninsula. Surrounding cities include Mount Pleasant (to the east) and North Charleston, which are both serviced by Interstate Highway 526 (I-526). Including these areas, the population for the metro area is well over 600,000. Tourism, educational institutions (i.e., College of Charleston, the Citadel), and logistics (including navigation) comprise major portions of the economy of the area.

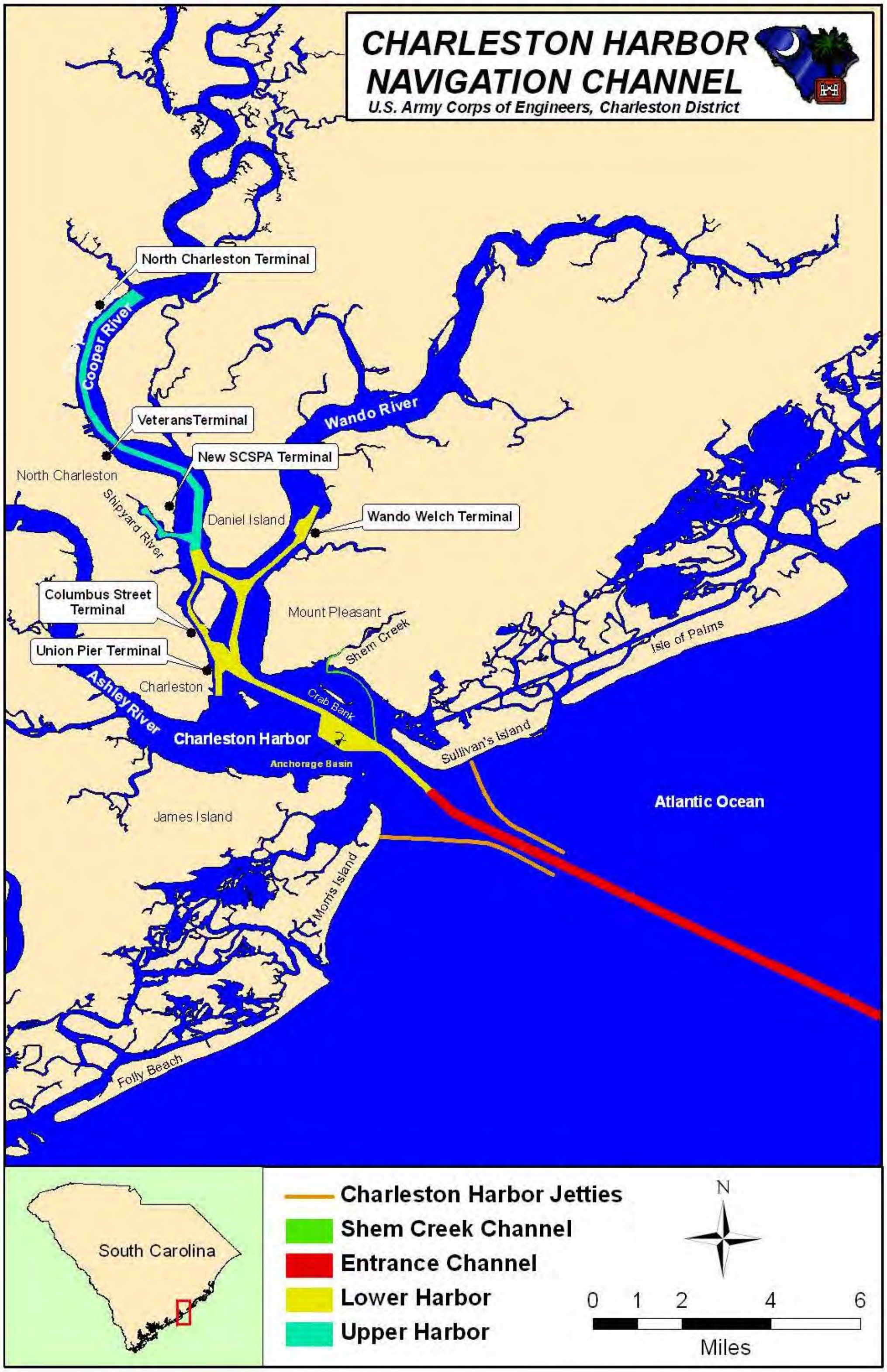


Figure 1 Charleston Harbor Location and Configuration

The South Carolina Ports Authority (SCSPA 2012) indicated that the top commodities handled at Charleston include agricultural products, consumer goods, machinery, metals, vehicles, chemicals, and clay products. It also noted that the Port of Charleston is one of the busiest container ports among all ports along the southeastern U.S. and Gulf coasts, and “is recognized as one of the nation’s most efficient and productive ports.”

Recreational opportunities and natural resources within and near Charleston are important features in the study area. In addition to the nearby Atlantic Ocean, rivers and creeks are ubiquitous in the area (see discussion below), and two major reservoirs are within 45 miles of the city (Lake Moultrie and Lake Marion). Francis Marion National Forest, northeast of Charleston, spans nearly 259,000 acres and encompasses vast tracts of recreational lands, aquatic habitats, and other valuable natural resources, including protected species.

Port and Harbor Layout/ Existing Federal Project

The harbor is formed by the confluence of the Ashley, Cooper, and Wando Rivers (Figure 2). Several state-operated port facilities are spread across approximately 14 square miles on the Cooper and Wando Rivers. Docking and maintenance facilities of the harbor are concentrated along the west shore of the Cooper River extending from Battery Point of the peninsular city to the mouth of Goose Creek. The entrance to the harbor is flanked by a dual weir-jetty system 2,900 feet apart. The jetties emerge from southern tip of Sullivan Island on the north side of the channel and from Morris Island on the south. Between the entrance channel and the inner harbor, the project crosses the Atlantic Intracoastal Waterway, which extends through the Ashley River (not part of the Charleston Harbor Federal Project; the juncture of the Federal Channel and the river comprises “Anchorage Basin 35”). The existing 45-foot Federal navigational channel extends from the 47-foot ocean contour through the jetties (which are 15,433 feet-long on the north and 19,104 feet-long on the south) to the North Charleston Terminal on the Cooper River, a distance of 27 miles. An additional 2.08-mile, 45-foot channel extends up the Wando River to the Wando Welch Terminal. The existing Federal channel varies in width from 400 feet in Town Creek and Wando River to a maximum, authorized width of 1000 feet in the entrance channel. The Charleston Harbor Federal navigation channel also includes Shipyard Creek. Shipyard Creek provides an entrance channel 300 feet wide and 45 feet deep from deep water in the Cooper River to a lower turning basin, and then a 200-foot wide by 30-foot deep channel to an upper turning basin. The lower turning basin and upper turning basin are 45 and 30 feet deep, respectively. This channel serves several private terminals. An additional, 110-foot-wide by 12-foot-deep navigational channel extends through the harbor, behind Crab Bank and through Shem Creek to Mount Pleasant, South Carolina.

USACE Charleston District
Charleston Harbor, South Carolina

Project Name: Charleston Harbor

Authorization: The project, as authorized by the 1996 Water Resources Development Act, provides for deepening the center 800 feet of the existing entrance channel to a depth of 47 feet below mean lower low water (MLLW) for a distance of about 16.3 miles, increasing the depth of existing interior channels and turning basins to a depth of 45 feet below MLLW, and deepening the Shipyard River entrance/lower channel and lower turning basin to 45 feet.

Project Description: Charleston Harbor (CWIS - 02980) is a natural tidal estuary located at Charleston, South Carolina. The harbor covers an area of approximately 14 square miles and is formed by the confluence of the Ashley, Cooper, and Wando Rivers. The entrance to Charleston Harbor is flanked by a dual weir-jetty system 2900 feet apart. Construction of the rubble mound jetties was completed in 1895. The south jetty, which springs from Morris Island, is 19,104 feet in length. The north jetty extends seaward from the southern tip of Sullivans Island and is 15,443 feet in length. The elevation of the jetties is approximately 12 feet above mean low water (MLW) with the ends extending from station 0+00 to station -112+00 of the federal navigational channel. The existing 45-foot Federal navigational channel extends from the 47-foot ocean contour through the jetties to the North Charleston Terminal on the Cooper River, a distance of 26.97 miles. An additional 2.08 mile 45-foot channel extends up the Wando River to the Wando Welch Terminal belonging to South Carolina States Ports Authority. The existing Federal channel varies in width from 400 feet in Town Creek and Wando River to 1000 feet wide in the entrance channel, Fort Sumter Range. A small 110-foot wide by 12-foot deep navigational channel also extends through the harbor, behind Crab Bank and up Shem Creek to Mount Pleasant.

Economics: Charleston Harbor is a vibrant modern intermodal harbor receiving and exporting goods throughout the world. The vessel fleet calling on Charleston Harbor and Shipyard River include containerships, bulk carriers, tankers, and to a lesser degree rollon-rolloffs and cruise ships. Charleston Harbor is located about midway along South Carolina's Atlantic coastline and is one of 17 US strategic ports. It is the 4th busiest container port on the east coast and the 8th in the nation. Provides over 50% of the equipment and material in support of reconstruction efforts in Iraq and Afghanistan. The harbor generates $45 billion annually for the regional economy, and supports the military as a major power projection platform. This project consists of maintenance of 44.6 miles of channel, three turning basins, and one anchorage basin.

Local Cooperation: The Project Cooperation Agreement (PCA) for the Charleston Harbor 45-foot Deepening/Widening project was signed on June 5, 1998. No project cooperation agreement is presently required for the upper portion of Shipyard River. Shipyard River is combined into this Charleston Harbor report as both projects use the same disposal areas and are combined into the same dredging contracts for convenience and efficient use of funds. The sponsor, South Carolina States Ports Authority, has furnished necessary funds and disposal areas in a timely manner.

Congressional Interest:
SC Graham, SC DeMint, Scott SC-1, Clyburn SC-6

Annual Dredge Material Removed:

In an average year, 2 million cubic yards of dredged material are removed from Charleston Harbor Federal Channel. This includes the Charleston Lower Harbor, Charleston Upper Harbor, and the Entrance Channel. The Joint Base Charleston averages around 700,000 cubic yards per year. Private dredging averages 500,000 cubic yards per year. Total dredge material removed is roughly 3.2 Million cubic yards per year.

Frequency of Dredging Events:

Entrance Channel is dredge once every 24 months (Dec-March). Lower Harbor is dredged every 12-15 Months. Upper Harbor (Including Shipyard River) is dredged every 18-21 Months. Joint Base Charleston is dredged every 15-18 Months. TC Dock is dredged in conjunction with Upper Harbor or Joint Base Charleston Dredging at least once per year.

Dredging Methods:

Upper Harbor, Shipyard River, and TC Dock are dredged by means of hydraulic pipeline dredges with the material being placed in the existing Clouter Creek Upland Disposal Area. The Entrance Channel is maintained by means of hopper dredges operating within the turtle dredging window (15 Dec to 31 March) and disposing of material in the EPA approved Ocean Dredged Material Disposal Site (ODMDS) located southwest of the Entrance Channel. Lower Harbor material is placed in the ODMDS by means of clamshell dredge and dump scows. With the Lower Harbor maintenance material going to the ODMDS, it is estimated that the ODMDS has a remaining capacity life of 21.3 years at a clearance elevation of -25 feet MLLW. Joint Base Charleston is dredged by means of hydraulic pipeline dredges with the material being placed in the existing Joint Base Charleston and Yellow House Disposal Areas.

Tidal Range:

The mean range of tide and spring range of tide above mean low water, respectively, in the entrance channel are 5.1 feet and 5.9 feet.

New Port Facility at the Old Navy Base:

In April 2007, the U.S. Army Corps of Engineers issued permits for a new three-berth, 280-acre container terminal on the former Charleston Naval Complex. The state permits were issued in late 2006. The $600-million project is supported by S.C. State Law and will boost capacity by 1.4 million TEU. Work to prepare the site for construction is well underway, and a 5,000-foot-long containment structure that will become the face of the dock has been constructed. The terminal's 171-acre first phase is slated to open in 2018 or as market demand requires.

SCSPA TERMINALS:

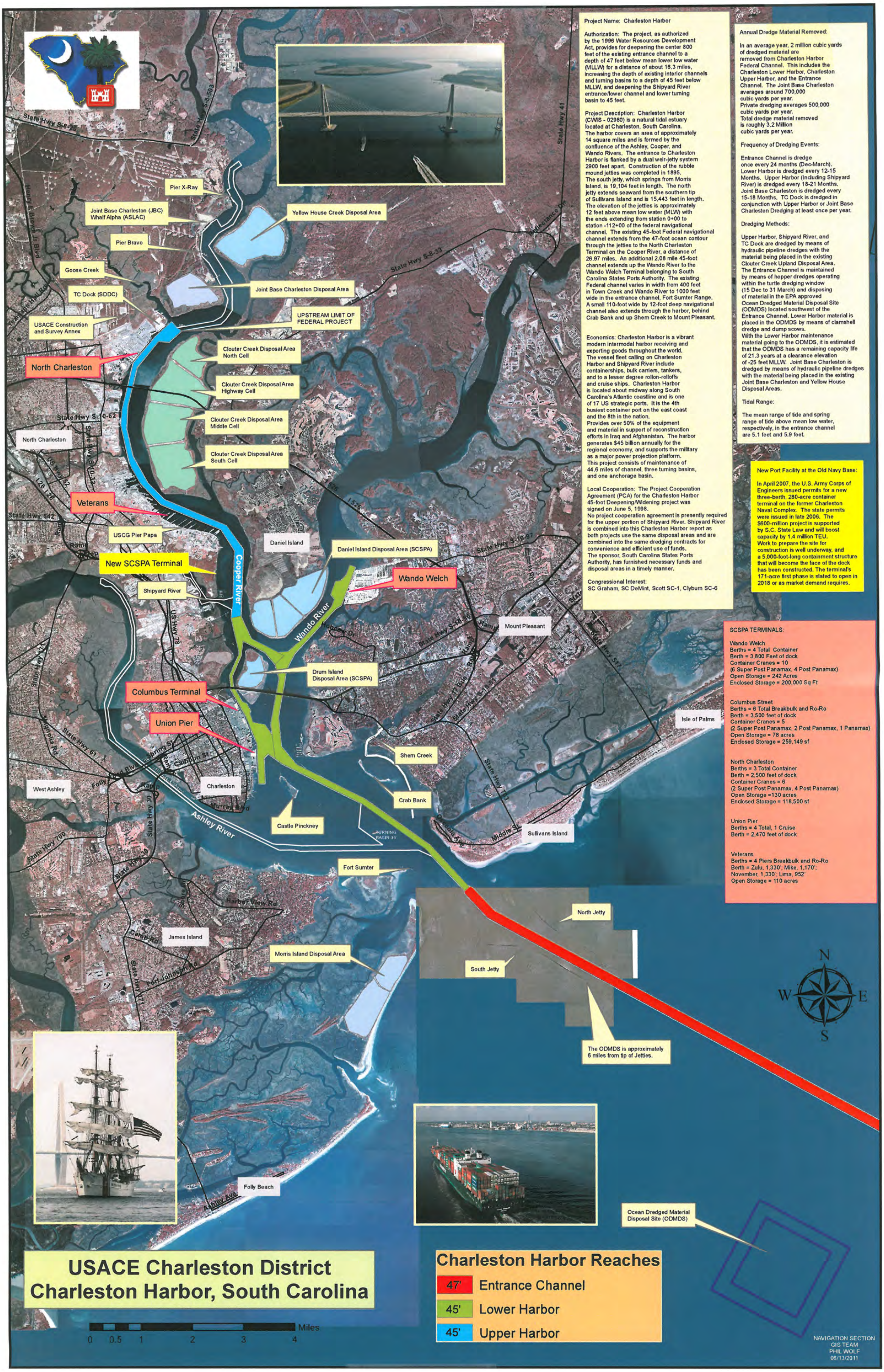
Wando Welch
Berths = 4 Total Container
Berth = 3,800 Feet of dock
Container Cranes = 10
(6 Super Post Panamax, 4 Post Panamax)
Open Storage = 242 Acres
Enclosed Storage = 200,000 Sq Ft

Columbus Street
Berths = 6 Total Breakbulk and Ro-Ro
Berth = 3,500 feet of dock
Container Cranes = 5
(2 Super Post Panamax, 2 Post Panamax, 1 Panamax)
Open Storage = 78 acres
Enclosed Storage = 259,149 sf

North Charleston
Berths = 3 Total Container
Berth = 2,500 feet of dock
Container Cranes = 6
(2 Super Post Panamax, 4 Post Panamax)
Open Storage =130 acres
Enclosed Storage = 118,500 sf

Union Pier
Berths = 4 Total, 1 Cruise
Berth = 2,470 feet of dock

Veterans
Berths = 4 Piers Breakbulk and Ro-Ro
Berth = Zulu, 1,330'; Mike, 1,170'; November, 1,330'; Lima, 952'
Open Storage = 110 acres



NAVIGATION SECTION
GIS TEAM
PHIL WOLF
06/13/2011

Local Tides and Constraints

The Charleston Harbor tide gauge (CHTS1) is located at the eastern end of Market Street/Cumberland Street ("Customhouse Wharf") in Charleston (32.781667° N, 79.925000° W). Flood stage is considered 7 feet (horizontal datum: NAD83), while the mean tidal range is 5.22 feet, the spring range is 6.15 feet, and the mean tide level is 2.8 feet.

Charleston has the deepest channels on the South Atlantic coast, capable of handling large ships and vessels drawing up to 48 feet of water (limited to a tide window of two hours per day). However, to receive 24-hour access in the Port of Charleston, ships have to be drafting 43 feet or less and will be constrained by tide if they require additional draft. Container ships are among the deepest drafting ships calling on Charleston Harbor, and their tight schedule and expensive delays causes them to avoid waiting on tidal advantage. A container ship calling at a greater-than-43-foot draft could be delayed on both the inbound and outbound voyages, compounding the problems.

Harbor Sediments and Dredged Material Management

Upland disposal for upper reaches of the project area has been proposed for the series of Clouter Creek disposal cells. However, upland disposal is not available or adequate for dredged materials resulting from required maintenance of Charleston Lower Harbor and Entrance Channel Reaches. Also, river (in-water) disposal is not feasible as it is strongly opposed by State and Federal environmental resource agencies. Accordingly, continued maintenance of Charleston Harbor depends on appropriate Ocean Disposal of dredged material. Use of ODMDSs is contingent on the quality of sediment to be deposited.

The grain size in the navigation channel for Charleston Harbor is mostly fine grain sediments (silt) with some sand in the entrance channel (USACE 2009). Prior to the 1999 deepening of harbor channels, sediment testing for physical, chemical, and biological parameters was conducted on maintenance material and new work material to obtain Clean Water Act Section 401 Water Quality Certification and Section 103 (of the Marine Protection Research and Sanctuaries Act) approval for ocean disposal of the material at the ODMDS. This included samples from or near all additional advanced maintenance areas. Sediments from Charleston Harbor were tested for Section 103 certification in 1994 in accordance with Environmental Protection Agency (EPA) requirements and in coordination with EPA (GEC 1994). A review of the information contained in the 1994 report showed that the sediments in the harbor were suitable for disposal at the Charleston ODMDS (depicted in Figure 2) with the exception of one site in Shipyard Creek. This decision was based on chemical analysis of sediments, elutriates of sediments, bioassays and studies for 17 stations within the Charleston Harbor project.

Sediments collected in 2004 near the Lower Town Creek additional advanced maintenance area and the Daniel Island Turning Basin (adjacent to the proposed Marine Container Terminal at the Charleston Naval Complex) have higher levels of silt and clay than the samples collected from the rest of the harbor in the 1994 effort (USACE 2006). However, there did not appear to have been a substantial change in the chemical composition of the dredged material (USACE 2005a).

USACE (2010) described testing of harbor sediments collected January 26 through February 2010. Eight sample stations were established in the Charleston Harbor Federal Navigation project, and 1 reference station in the Atlantic Ocean adjacent to the Charleston ODMDS. It was determined that, “The dredged material to be disposed of in the Charleston ODMDS does not exceed the limits set forth for the designated specific wastes or waste constituents listed in this section, such as: 1) liquid waste constituents immiscible with or slightly soluble in seawater, 2) radioactive materials, 3) wastes containing living organisms that may endanger human health or wildlife, and 4) wastes that are highly acidic or alkaline”, and, ” The test results indicate that the sediments are acceptable for ocean disposal under Section 103 of the Marine Protection, Research, and Sanctuaries Act of 1972, as amended.”

As part of the Post 45 study, sediment testing (chemical and bioassay) for not-previously-dredged materials was performed. Since maintenance and new work will likely be dredged together, the testing did not differentiate between the two.

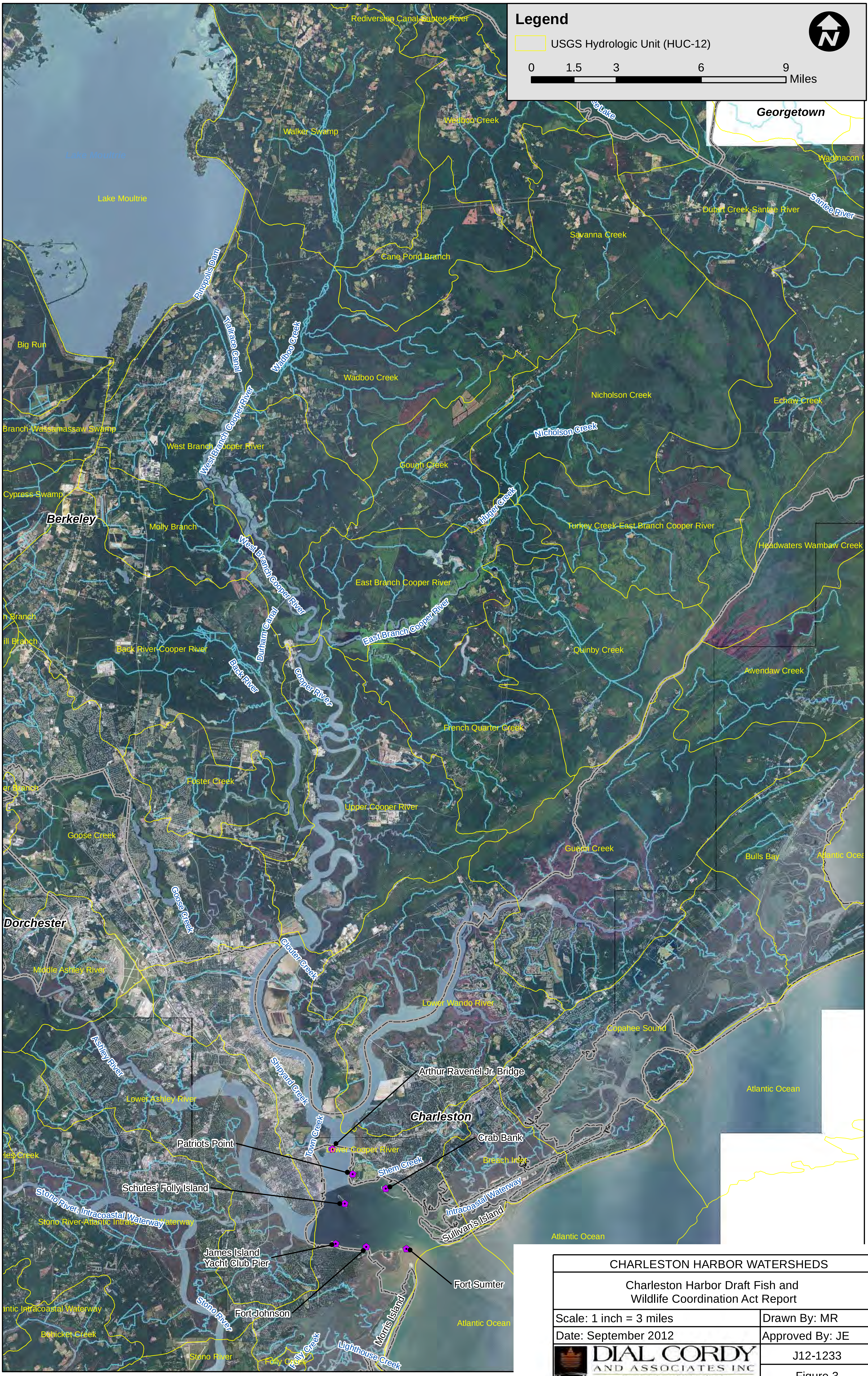
Water Quality

Water quality in the harbor depends greatly on the water quality of the rivers (and reservoirs) that feed the estuary (see Figure 3) as well as non-point effluent to the harbor. Characterizing these rivers is essential to assessing harbor water quality and the value of the rivers to environmental health and the area’s fish and wildlife resources.

Ashley River. The Ashley River originates in the coastal plain and flows into the western part of Charleston Harbor, generally from northwest of Charleston (Dorchester County). Areas of the river are bordered by historic plantations, but a large portion of the lower Ashley River Basin is now occupied by residential or commercial development. The river comprises approximately 30 miles of tidal slough, which, under low-flow conditions, contributes little to no freshwater input to the harbor system. Waters of this approximate 30-mile reach (from Bacon Bridge/ Road 165 to the harbor) are classified by the South Carolina Department of Health and Environmental Control (SCDHEC) as “SA,” (see Table 1). SCDHEC (2003) stated that, “Available information indicates the upper Ashley River does not meet the applicable water quality standard for dissolved oxygen (DO) for significant periods of time due to natural conditions.” These conditions were noted approximately 12 miles upstream of the US Highway 17 bridge at Charleston.

Table 1 South Carolina Tidal Saltwater Classification

Classification Code	Uses
SA	• Tidal saltwaters suitable for primary and secondary contact recreation, crabbing and fishing except for harvesting of clams, mussels, or oysters for market purposes or human consumption and uses listed in Class SB… • Also suitable for the survival and propagation of a balanced indigenous aquatic community of marine fauna and flora
SB	• Tidal saltwaters suitable for primary and secondary contact recreation, crabbing and fishing except for harvesting of clams, mussels or oysters for market purposes or human consumption. • Also suitable for the survival and propagation of a balanced indigenous aquatic community of marine fauna and flora
SFH	• Tidal saltwaters protected for shellfish harvesting and uses listed in Class SA and Class SB… • Suitable for primary and secondary contact recreation, crabbing and fishing... • Also suitable for the survival and propagation of a balanced indigenous aquatic community of marine fauna and flora



CHARLESTON HARBOR WATERSHEDS

Charleston Harbor Draft Fish and Wildlife Coordination Act Report

Scale: 1 inch = 3 miles	Drawn By: MR
Date: September 2012	Approved By: JE
DIAL CORDY AND ASSOCIATES INC Environmental Consultants	J12-1233
	Figure 3

Wando River. The Wando River originates in the coastal plain and flows into the eastern part of Charleston Harbor generally from the north and northeast (around Mount Pleasant, SC). Portions (approximately the lower 20 miles) of the Wando River are bordered by marsh which transitions to woodland in the upper reaches of the river. The drainage results in little freshwater input to the harbor, especially during low-flow periods and like the Ashley River, experiences depressed dissolved oxygen (DO) levels (SCDHEC 2003). Development along the Wando River has increased over the years with the completion of the interstate highway system, which crosses the river approximately 3.5 miles upstream from its confluence with the Cooper River. The South Carolina Ports Authority's Wando Terminal and a small commercial shipyard are found on the lower Wando River. However residential developments dominate the middle portion of the watershed. The Wando River is classified Shellfish Harvesting (i.e., "SFH," see Table 1) from its headwaters to a point approximately 2.5 miles above its confluence with the Cooper River. From this point to the Cooper River, it is classified as SA (see Table 1) (SCDHEC 2002).

Cooper River. The Cooper River has East and West Branches (whose juncture is locally termed "The Tee") from which it flows 32 miles southward to its outlet in Charleston Harbor. The East and West Branches of the Cooper River extend some 20 miles inland in a northward direction to their native origins as small ill-defined channels in a low-lying area of Berkeley County known as Ferguson Swamp. The Tail Race Canal, originating at Lake Moultrie's Pinopolis Dam and Lock, joins the West Branch of the Cooper River just south of the US Hwy 17A bridge. USACE discussed the history of the Cooper River's hydrology and DO issues in the Environmental Assessment for Charleston Harbor Additional Advanced Maintenance Dredging (2009). USACE stated that, "the progressive increase in the depth of the Federal navigation channel in the Cooper River over the past century has decreased the river bottom dissolved oxygen (DO) concentrations. Additionally, freshwater flow into the Cooper River from Lake Moultrie affects vertical mixing and DO in the Lower Cooper River. The diversion of freshwater into the Cooper River beginning in the 1940s caused the river to shift from a vertically well mixed to a more stratified condition, which decreased DO concentrations along the bottom of the river and increased sedimentation and maintenance requirements in the harbor. Following rediversion of flows and reduction of the freshwater flow into the Cooper River beginning in 1985 (see below section on managed impoundments), this stratification and sedimentation was greatly reduced. SCDHEC monitoring data in the Lower Cooper River (Station MD-045 at Daniel Island Bend) show a noteworthy decreasing trend in DO concentration prior to rediversion, but no substantial trend in DO concentration when only post-rediversion data (1986-1998) were considered (USACE 2006)." From just downstream of The Tee to its juncture with the Ashley River, the Cooper River is classified as SB (defined in Table 1). Upstream of The Tee, the river's waters are classified as "FW," or freshwater for multiple uses. The Cooper River is the only tributary to the harbor that carries significant freshwater, this coming from the diversion of water from the Santee River basin to the Cooper River via the diversion canal between Lakes Marion and Moultrie and the tailrace canal, which connects Lake Moultrie to the West Branch of the Cooper River (SCDHEC 2002).

Charleston Harbor. The central harbor area itself is an intertidal and subtidal estuarine system, characterized by highly variable salinity and dissolved oxygen concentrations. Available information on these systems shows that dissolved oxygen concentrations frequently fall below the criteria established for such waters. These excursions are usually observed during high temperature periods whether or not there are anthropogenic sources of oxygen demand to the system (SCDHEC 2002). Water quality In Charleston Harbor is classified as SB (see details in Table 1), and is considered water quality limited for the purposes of wasteload allocation (WLA) development (SCDHEC 2002). SCDHEC (2006) later added, "The Charleston Harbor system is not considered to be impaired under criteria of Section 303(d) of the Clean Water Act except for an area 0.5 miles southeast from the mouth of Shem Creek. The impairment is for copper related to potential impacts on aquatic life." More recently, SCDHEC (2012) has determined that, "Currently available data and modeling indicate that regulated and unregulated stormwater and nonpoint sources do not contribute to the allowable DO depression on the mainstem segments including Charleston Harbor and the Cooper, Ashley, and Wando Rivers at existing conditions." Based on SDHEC (2012), it appears that all areas in the project area are considered to "fully support" uses, albeit typical daily minimum DO averages are near 4 mg/L (vs. the desired 5 mg/L minimum used for other estuaries and upper reaches of rivers draining to Charleston Harbor).

Salt Intrusion. Salinity concentration in the river affects the estuarine habitat in many ways. Along with tidal inundation, salinity generally determines the marsh vegetation species; it directly affects the fish, crustacean and clam populations; and it influences DO concentrations. Salinity in the river is also of concern from a water usage perspective. Bushy Park is a freshwater reservoir located in the upper reaches of the Cooper River and used by local industry for water supply. Salinity intrusion to the estuary can cause periodic increases in chloride concentration above acceptable limits at the reservoir. These events typically occur during periods of drought, very high tides, sustained wind conditions or storm events. To counter salinity intrusion events, there are several U.S. Geological Survey (USGS) monitoring stations in the harbor and the freshwater release from Lake Moultrie can be increased during these events to lower salinity concentrations in the Cooper River (USACE 2006).

Dredge Disposal. A Section 401 Water Quality Certification was issued for disposal of dredged material associated with the project by the SCDHEC on May 2, 1995. A new 401 Water Quality Certification will be obtained for this project.

Hydraulics/Water Management

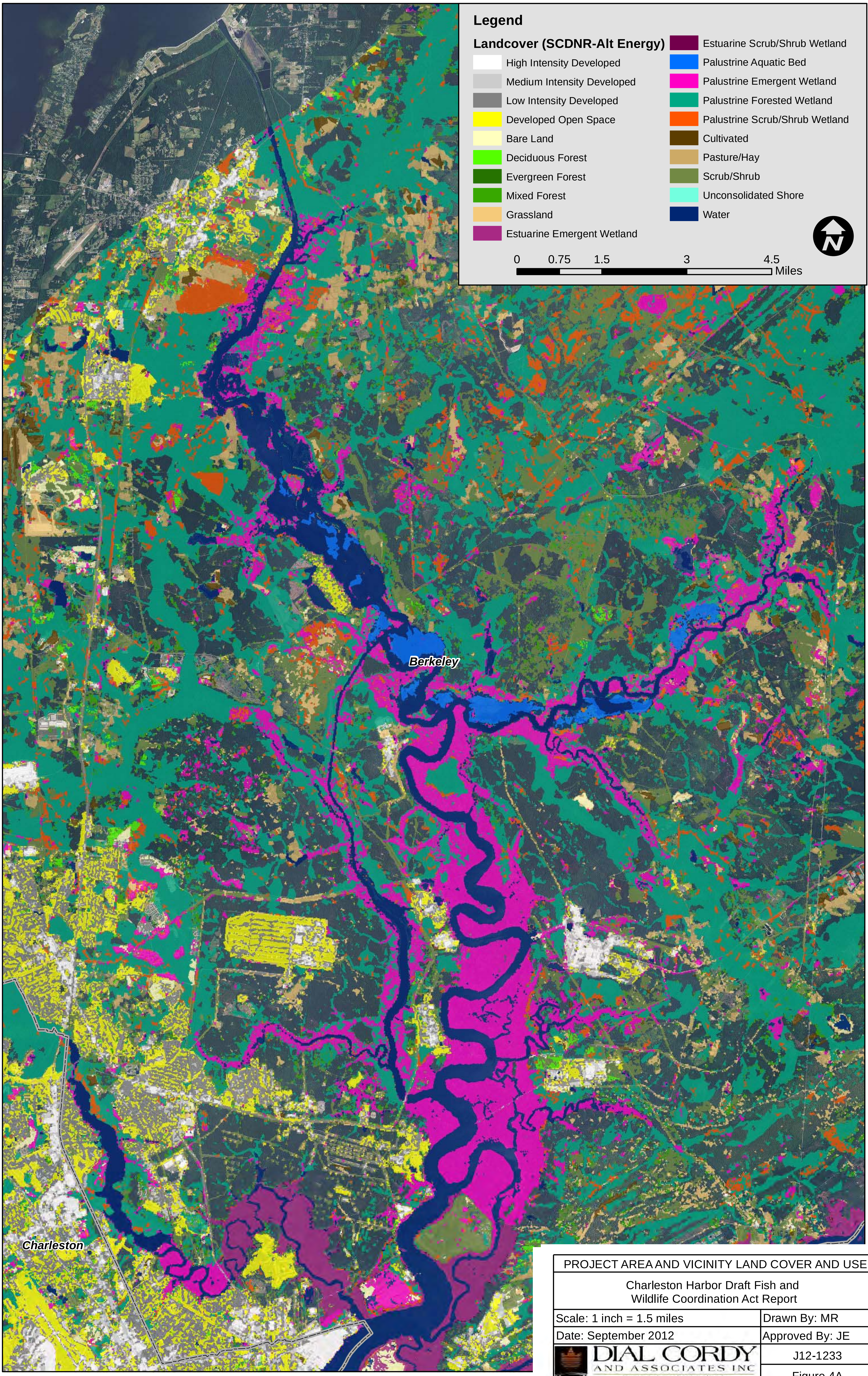
Flows to Charleston Harbor have been drastically manipulated, sometimes with unforeseen consequences. SCDHEC (2002) detailed the history of major alterations in the following text:

> "Prior to 1941, the Cooper River was a tidally-dominated stream, entirely confined to the coastal plain, with a net seaward discharge of approximately 70 ft^3/s [cubic feet per second]. In 1941, the Santee-Cooper Project was completed by the South Carolina Public Service Authority (SCPSA) in response to increased demands for hydroelectric power. Dams were built on the Santee and Cooper Rivers forming Lakes Marion and Moultrie, respectively. The elevation difference between Lake Moultrie and the Cooper River is approximately 55 feet greater than the difference between Lake Marion and the Santee River. To take advantage of this greater elevation difference, a diversion canal was constructed between Lake Marion and Lake Moultrie, diverting flow from the Santee River basin to the Cooper River. With diversion, the Cooper River annual mean discharge increased to approximately 15,000 ft^3/s. Due to severe shoaling in the harbor, the Army Corps of Engineers developed and executed plans to re-divert a portion of the Cooper River flow back to the Santee River. Since rediversion, which was fully implemented by August 1985, a flow agreement between the Corps of Engineers and SCPSA has established a goal of a weekly average discharge from Lake Moultrie to the Cooper River of 4,500 ft^3/s with an allowance for lower flows. Other changes to the system include significant port development with associated navigation channel dredging and the creation of a freshwater reservoir by diking the mouth of a tidal slough (Back River) and connecting the upper portion of the slough to the freshwater portion of the West Branch of the Cooper River by construction of Durham Canal…"

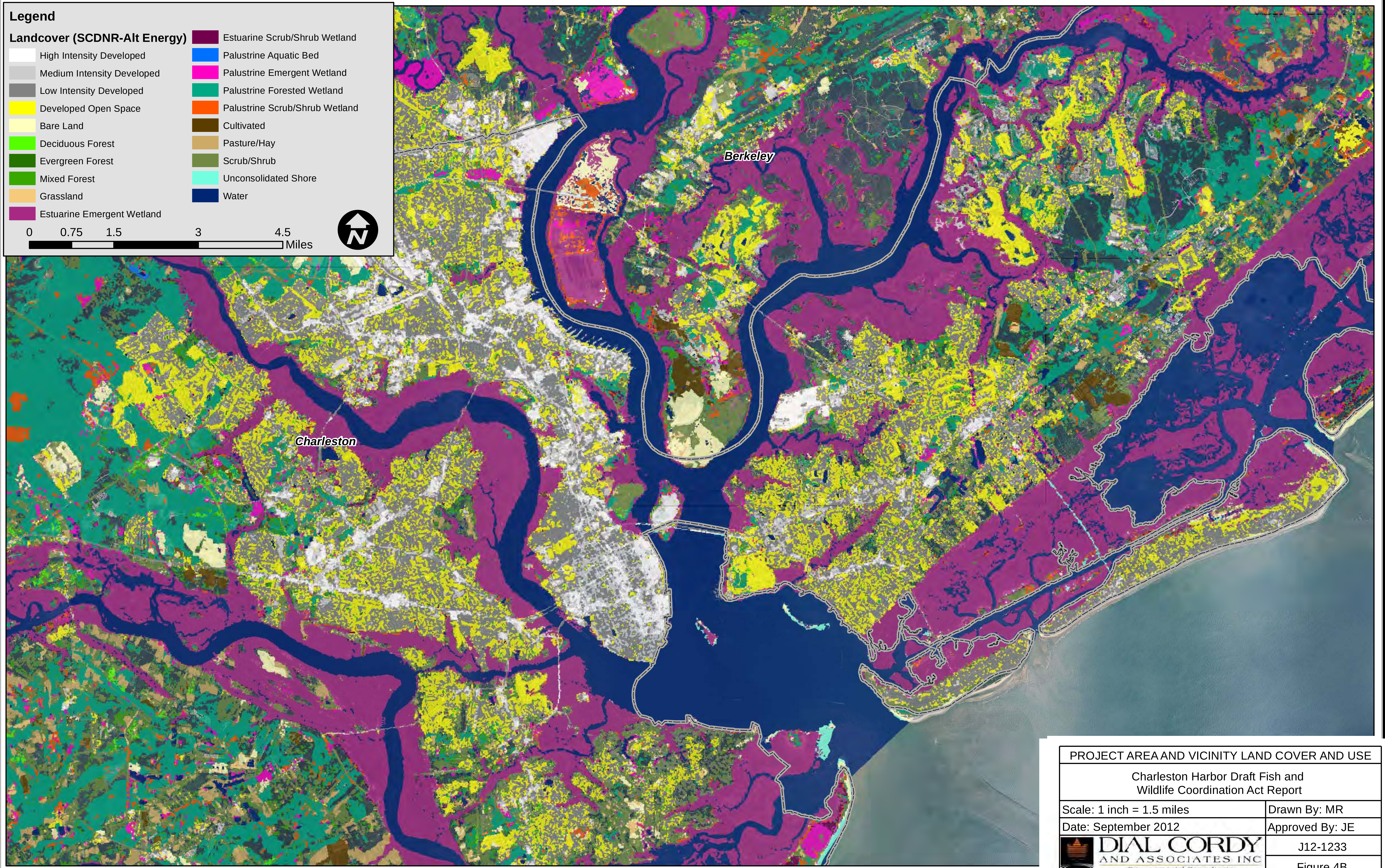
Releases of fresh water from the Santee Cooper Reservoir play a role in the water levels and salinity concentrations of riverine and tidally influenced areas downstream. These physical factors may influence the species composition and local biography of marine vertebrate species, invertebrate species, and riparian marsh plant species. The relative vertical positions of marine species within the water column may also be influenced due to the stratification of more saline waters in deeper portions of the estuary.

Land Use and General Cover Types

The project site and vicinity is situated in heavily urbanized/developed lands, but for interspersed salt marshes that surround tidal creeks draining to the major rivers or estuary (Figure 4). These lands and marshes reside in an ecoregion (see Griffith et al. 2002) classified as the *Sea Islands/Coastal Marsh* portion of the *Southern Coastal Plain*. Effects of the proposed project may also influence resources (waters and migratory species) upstream of the coastal marshes in aquatic and riparian habitats that reside in the *Carolina Flatwoods* portion of the *Middle Atlantic Coastal Plain* ecoregion. Griffith et al. 2002 described the marshes and flatwoods, respectively, in the following manner:



PROJECT AREA AND VICINITY LAND COVER AND USE	
Charleston Harbor Draft Fish and Wildlife Coordination Act Report	
Scale: 1 inch = 1.5 miles	Drawn By: MR
Date: September 2012	Approved By: JE
DIAL CORDY AND ASSOCIATES INC Environmental Consultants	J12-1233
	Figure 4A



PROJECT AREA AND VICINITY LAND COVER AND USE

Charleston Harbor Draft Fish and Wildlife Coordination Act Report

Scale: 1 inch = 1.5 miles	Drawn By: MR
Date: September 2012	Approved By: JE
DIAL CORDY AND ASSOCIATES INC Environmental Consultants	J12-1233
	Figure 4B

> “The *Sea Islands/Coastal Marsh* region contains the lowest elevations in South Carolina and is a highly dynamic environment affected by ocean wave, wind, and river action. Mostly sandy soils are found on the barrier islands, while organic and clayey soils often occur in the freshwater, brackish, and salt marshes. Maritime forests of live oak, red cedar, slash pine, and cabbage palmetto grow on parts of the sea islands, and various species of cordgrass, saltgrass, and rushes are dominant in the marshes. The coastal marshes are important nursery areas for fish, crabs, shrimp, and other marine species. During the colonial and antebellum periods in the 1700's and 1800's, a plantation agriculture economy dominated the region, producing rice, indigo, and Sea Island cotton.”
>
> “The nearly level coastal plain of the *Carolina Flatwoods* has less relief, wider upland surfaces, and larger areas of poorly drained soils than the adjacent, higher elevation Ecoregion 65l [the Atlantic southern loam plains, found to the north]. Covered by shallow coastal waters during the Pleistocene, the resultant terraces and shoreline-related landforms are covered typically by fine-loamy and coarse-loamy soils, with periodically high water tables. Other areas have clayey, sandy, or organic soils, contributing to the region’s plant diversity. Carolina bays and pocosins are abundant in some areas. The region is a significant center of endemic biota, with more biological diversity and rare species compared to 63e [code corresponds to mid-Atlantic flatwoods habitat, found farther to the north]. Pine flatwoods, pine savannas, freshwater marshes, pond pine woodlands, pocosins, and some sandhill communities were once common. Loblolly pine plantations are now widespread with an active forest industry. Artificial drainage for forestry and agriculture is common. North Carolina’s blueberry industry is concentrated on some of the sandy, acidic soils of the region.”

Apart from the obvious ocean and bay/estuary habitats, dominant land cover types in the immediate project area (Figure 4) include residential and commercial/services (including military facilities). “Nonforested wetlands” (i.e., marshes) abut most of the bay and open water cover types from harbor to headwaters. Farther upstream from the harbor (and away from the urban center), dominant land cover types in surrounding areas include planed pine (interspersed with forested wetlands) and upland mixed forests.

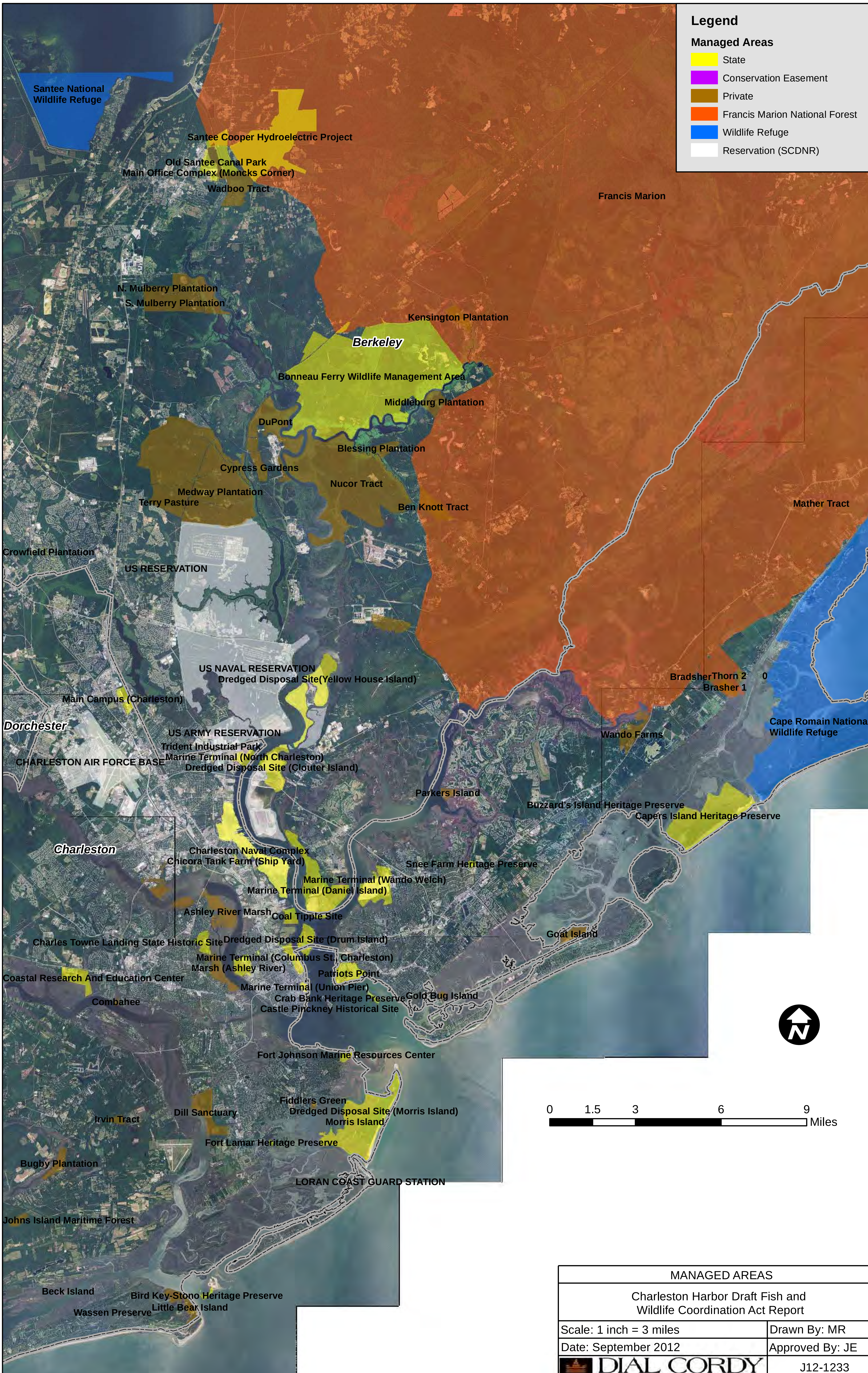
FISH AND WILDLIFE RESOURCES

Protected/Managed Lands and Impoundments

The southwestern corner of Francis Marion National Forest (FMNF) is only 10 miles upstream from Charleston Harbor on the Wando River (Figure 5). These lands are managed by the U.S. Department of Agriculture (USDA) Forest Service for multiple uses including watershed protection and improvement, timber and wood production, habitat for wildlife and fish species (including those that are threatened and endangered), wilderness area management, minerals leasing and recreation (USDA 2012). Two special geological features can be found throughout the forest: Carolina bays and limestone sinks. Limestone sinks are home for many rare plants such as the endangered pondberry. Carolina Bays have been a source of fascination for visitors to South Carolina’s lowcountry since the time of their discovery. They are fragile and unique ecosystems, wetland habitats that exhibit a variety of vegetative components. Only about 200 of South Carolina’s original 2,600 natural bays have remained in their pristine state. Many have fallen victim to drainage and clearing. There are about 25 well-defined Carolina Bays in the forest. All of the bays in the forest are protected, as are the forest’s four federally-designated wilderness areas (USDA 2012). FMNF is also home to a variety of wildlife, including the endangered red-cockaded woodpecker.

Cape Romain National Wildlife Refuge (NWR) surrounds Bulls Bay/Bull Harbor (Figure 5), just southeast of FMNF, and is bordered by the Atlantic Intracoastal Waterway (AIWW) on the northwest. Established in 1932 as a migratory bird refuge, Cape Romain NWR encompasses a 22-mile segment of the southeast Atlantic coast. The refuge consists of 66,287 acres which include an expanse of barrier islands, salt marshes, intricate coastal waterways, long sandy beaches, fresh and brackish water impoundments, and maritime forest. Points of interest include Bulls Island, Cape Island, and Lighthouse Island where two lighthouses, no longer operational, still stand. According to USFWS (2012a), the refuge's original objectives were to preserve in public ownership habitat for waterfowl, shorebirds and resident species. In recent years, objectives have expanded to include managing endangered species, protecting a 29,000-acre Class I (i.e., air quality-sensitive, see USFWS 2012b) Wilderness Area, and preserving the Bulls Island and Cape Island forests and their diverse plant communities. Currently, the refuge is actively working to aid the recovery of the threatened loggerhead sea turtle. Refuge beaches provide critical habitat for the threatened piping plover as it migrates along Atlantic coast beaches in the spring and fall. Wood stork also frequent the Cape Romain NWR area (USFWS 2009).

The Santee Cooper Reservoir comprises a system of two lakes: Moultrie and Marion. Lake Moultrie is a 60,000-acre reservoir created in the early 1940s by the South Carolina Public Service Authority ("Santee Cooper") via construction of the Pinopolis Dam. The project was originally designed to route the Santee River flow down the Cooper River. However, since 1985 flow has been re-diverted to the Santee River through a USACE canal and hydroelectric dam located near the town of St. Stephen. The St. Stephen Dam is equipped with a fish lift that allows passage upstream for anadromous fish species like



MANAGED AREAS	
Charleston Harbor Draft Fish and Wildlife Coordination Act Report	
Scale: 1 inch = 3 miles	Drawn By: MR
Date: September 2012	Approved By: JE
DIAL CORDY AND ASSOCIATES INC Environmental Consultants	J12-1233
	Figure 5

American shad and blueback herring. The Pinopolis Dam has a boat lock that allows both boat traffic and anadromous fish passage (South Carolina Department of Natural Resources 2011c).

Lake Marion, South Carolina's largest lake, is an 110,000-acre reservoir that drains to both the Santee River and also (ultimately) the Cooper River via a diversion canal that feeds Lake Moultrie. The Santee Dam was erected to create the reservoir on the Santee River. The closure of Lake Marion Dam in 1941 trapped a founding population of striped bass and a thriving population developed in the reservoir. Investigations of this population first demonstrated that striped bass could complete its life cycle entirely in freshwater. The striped bass fishery has declined in recent years due to a variety of factors, but recent steps taken to rebuild the population have had positive results. Blue catfish and flathead catfish were introduced into the system in the mid-1960s. They have readily adapted to the Santee Cooper lakes system and today provide anglers with trophy catches. Largemouth bass and shellcracker fisheries also draw anglers each spring (South Carolina Department of Natural Resources 2011b). Field studies related to fishes using the reservoirs, flow levels, and water temperatures can be found by consulting Santee Cooper (2009a). Real-time level data for the reservoirs also can be found by consulting Santee Cooper (2009b).

Wetlands

Geography and History. The metro-Charleston area encompasses an area of 65 square miles, 40 of which are marsh and lowlands (see Appendix A for detailed wetland maps). With the confluence of the Ashley, Cooper, and Wando Rivers, the harbor's contributing watersheds drain approximately 1,200 square miles (SCDHEC 2002). Historically, the Ashley, Wando, and Cooper Rivers were all tidal sloughs with limited freshwater inflow and extensive tidal marshes. Alterations, principally the construction of upstream reservoirs and canals, have altered historic freshwater flows (which were historically weak), as discussed above in the Hydraulics/Water Management section. Also, in the 17^{th} and 18^{th} centuries, rice plantations were created in the upper Cooper and Ashley Rivers by extensive diking of intertidal wetlands. Remnants of these fields can be seen above the Tee where the Cooper River splits into the East and West Branches and along the upper Ashley River. Notwithstanding the above, large tracts of tidal marsh remain throughout the project area, and these are extremely important for both resident and migratory fish and wildlife.

Dominant Vegetation. Tidal meso- and polyhaline wetlands in Charleston Harbor include estuarine emergent marshes dominated by cordgrass species (*Spartina alterniflora*) and black needlerush (*Juncus roemerianus*). Higher emergent marsh areas contain sea oxeye (*Borrichia frutescens*), salt grass (*Distichlis spicata*) and salt meadow hay (*Spartina patens*). Estuarine scrub shrub wetlands are dominated by wax myrtle (*Myrica cerifera*), salt marsh elder (*Iva frutescens*), and groundsel tree (*Baccharis halimifolia*). No wetlands directly abut the Federal navigation channel (Figure 4b).

Tidal oligohaline wetlands are dominated by big cordgrass (*Spartina cynosuiroides*) and black needlerush. Other species include smooth cordgrass (*Spartina alterniflora)*, and salt-marsh bulrush (*Bolboschoenus robustus*). A number of freshwater species can occur within these marshes including including arrow-arum (*Peltandra virginica*), wild rice (*Zizania aquatica*), dotted smartweed (*Persicaria punctatum*), water primrose (*Ludwigia* sp.), bur-marigold (*Bidens* sp.), and salt-marsh aster (*Symphyotrichum* sp.).

Tidal freshwater wetlands include intertidal emergent species, floating leaf vegetation, and submerged aquatic vegetation. Typically tidal freshwater wetlands/marshes are more species rich than their brackish or saltwater counterparts, and include such species as white marsh/cutgrass (*Zizaniopsis miliacea*), wild rice, sawgrass (*Cladium sp.*) and bulrush (*Scirpus sp.*). Also present and often mixed in with these common freshwater plants are big cordgrass, black needlerush, and salt-marsh bulrush. These wetlands frequently have an understory of green arrow arum (*Peltandra virginica*), water-primrose (*Ludwigia sp.*), water hyacinth (*Eichhornia sp.*), pickerelweed (*Pontederia sp.*), sensitive fern (*Onoclea sensibilis*), arrowhead/duck potato (*Sagittaria sp.*), water hemlock (*Cicuta sp.*), lizard's tail (*Saururus cernuus*), alligator weed (*Alternanthera philoxeroides*), obedient plant (*Physostegia virginiana*), spider lily (*Lycoris radiata*), smartweed (*Polygonum sp.*), beard grass (*Andropogon sp.*), false indigo (*Amorpha sp.*), and groundnut (*Apios americana*). Submerged aquatic vegetation primarily includes hydrilla (*Hydrilla verticillata)*, Brazilan elodea *(Egeria densa), p*ondweed (*potamogeton sp.),* and Carolina fanwort (*Cabomba sp.).* While floating leaf vegetation primarily included species such as water-primrose, water hyacinth, pickerelweed, and smartweed.

Also present along the freshwater portion of these river systems are palustrine freshwater forested wetlands and occur at the interface of tidal aquatic and terrestrial ecosystems (James et al., 2012). They are deciduous forested wetlands, made up of different species of gum (*Nyssa* sp.) and oak (*Quercus* sp.) and bald cypress (*Taxodium distichum*), as well as tupelo, red maple, eastern red cedar, Atlantic white cedar, wax myrtle, sweet bay, red bay, pine, magnolias, etc.

Associated Species. Estuarine emergent/shrub wetlands are the most dominant wetland type in the project area. They are ecologically sensitive and important habitats. In addition to providing refuge for terrestrial wildlife, they are extremely important for certain anadromous fish species. In addition, they function to filter nutrients and sediments from upland sources, thereby improving downstream water quality. Also, these habitats buffer the adverse physical effects of stormwater flows. Another important function of these wetlands is to contribute detritus, which forms the basis of downstream (including tidal marsh) food chains (South Atlantic Fishery Management Council 1998).

Estuarine emergent wetlands are important for many wildlife species, including, but not limited to certain species managed under Essential Fish Habitat (EFH) provisions (see EFH section below). For example, the majority of estuarine shrimp are found in close proximity to such shallow wetland systems. These wetlands are also important for many species of snapper, grouper, flounder, and certain migratory pelagic species as nursery and foraging areas. However, most juvenile managed fish found in the riparian salt/brackish marsh nurseries are spawned offshore and transported into the estuary through tidal inlets. Many commercial and managed species such as shrimp and summer flounder (*Paralichthys* *dentatus*) inhabit the tidal salt marsh edge, while adult spotted seatrout (*Cynoscion nebulosus*), flounder, and red drum (*Sciaenops ocellatus*) forage the grass line for shrimp and other prey. Although the red drum is commercially important it is not a federally managed species. Nursery areas, for species such as black drum (*Pogonias cromis*), red drum, and spotted seatrout, can include soft bottom areas surrounded by salt/brackish marsh as well. Hence, the estuarine marshes are essential habitat to many managed species and serve multiple functions to various fish life-stages (Street et al. 2005).

Some of the most ubiquitous residents (permanent or transitory) of wetlands comprise migratory birds (see Migratory Birds section below). Bitterns, oystercatchers, rail, herons, pelicans, terns, ibises, egrets, and gulls are a small sampling of typical coastal wetland avian species. Of course, wetlands comprise important habitat for many protected species or those of special concern as well, including the red knot, a bird species that is a candidate for listing under the Endangered Species Act.

Other typical inhabitants of estuarine wetlands include blue crab (*Callinectes sapidus* Rathburn) and eastern oyster (*Crassostrea virginica*). These species, along with shrimp and various life stages of the bird and fish species noted above form part of a broad food-web that is necessary for supporting populations of consumers, such as bald eagles, ospreys, alligators, snakes, minks/weasels, bobcats, and other vertebrates, including humans.

Essential Fish Habitats and Managed Species

The 1996 Congressional amendments to the Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA) (PL 94-265) 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 EFH and a requirement for interagency coordination to further the conservation of federally managed fisheries. Essential Fish Habitat is defined in the act as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity." The definition for EFH may include habitat for an individual species or an assemblage of species, whichever is appropriate within each Fisheries Management Plan (FMP). Habitat Areas of Particular Concern (HAPC) are also considered EFH.

The National Marine Fisheries Service (NMFS) provided USACE with a National Environmental Policy Act (NEPA) Scoping letter on November 2, 2011. In this letter NMFS indicated that "Essential Fish Habitat (EFH) within the project area includes estuarine and marine emergent vegetation, tidal freshwater wetlands, tidal creeks, oyster reefs, water column, intertidal and subtidal mudflats (unconsolidated bottom), coastal inlets, coral and artificial reefs, and hardbottom." Many of these habitats foster growth and provide food and protection from predators and are integral to producing healthy populations of commercially and recreationally important species.

Estuarine and marine and brackish emergent vegetation. NOAA defines estuarine emergent wetlands as "Deepwater tidal habitats and adjacent tidal wetlands that are usually semi-enclosed by land but have open, partly obstructed, or sporadic access to the ocean, with ocean-derived water at least occasionally diluted by freshwater runoff from the land. The upstream and landward limit is where ocean-derived salts measure less than .5 ppt during the period of average annual low flow. The seaward limit is (1) an imaginary line closing the mouth of a river, bay, or sound; and (2) the seaward limit of wetland emergents, shrubs, or trees when not included in (1)." These wetlands would be considered brackish and saltmarsh areas. Tidal wetlands in Charleston Harbor include emergent tidal marshes dominated by cordgrass species (*Spartina alterniflora*) and black rush (*Juncus roemerianus).* High marsh areas contain sea oxeye (*Borrichia frutescens)*, salt grass (*Distichlis spicata)* and salt meadow hay (*Spartina patens*), and scrub shrub wetlands dominated by wax myrtle (*Myrica cerifera)*, salt marsh elder (*Iva frutescens)*, and groundsel tree (*Baccharis halimifolia)*. Common reed (*Phragmites australis)* is also found along the fringe of the high marsh. Tidal oligohaline (brackish) marsh systems provide important habitat for numerous species of fish and crustacea.

Tidal Freshwater emergent vegetation. Extensive studies have been conducted in salt marsh systems, while tidal freshwater and oligohaline marshes have been the focus of far fewer investigations. However, the existing studies that focus on tidal freshwater and oligohaline areas have concluded that they also provide important habitat that is utilized by fish and crustacea (McIvor et al 1989, Odum et al 1988). The Cooper and Ashley Rivers both have these wetlands that were analyzed by the Corps in a wetland impact assessment.

Palustrine Wetlands. Freshwater wetlands, also known as palustrine forested wetlands, are by definition, “All nontidal wetlands dominated by trees, shrubs, persistent emergents, emergent mosses, or lichens, and all such tidal wetlands where ocean-derived salinities are below 0.5 ppt [parts per thousand]” (Cowardin et al., 1979). James et al., (2012) indicated that palustrine freshwater forested wetlands exist at the landward extent of the head of tide and above the saltwater-freshwater interface, which theoretically occurs at the 0.5 ppt salinity boundary. Field et al., (1991) conservatively estimated that there are 40,000 hectares of tidal freshwater forested wetlands in South Carolina. They are deciduous forested wetlands, made up of different species of gum (*Nyssa* sp.) and oak (*Quercus* sp.) and bald cypress (*Taxodium distichum*), which have the ability to survive in areas that are either seasonally flooded or covered with water much of the year. The Cooper, Ashley, and Wando Rivers all have palustrine wetlands (tidal and non-tidal) within their watersheds that were analyzed by the Corps in a wetland impact assessment.

Tidal Creeks. Variable in size and water depth, coastal tidal creeks are nursery grounds for larvae and juvenile fish species. As an interface between estuarine habitats and the freshwater confluence of upstream flow, tidal creeks are characterized by their oyster bars, mud flats, and intertidal rivulets. At high tide when predators can access these creeks, juvenile fishes take advantage of the protection afforded by the marsh. As the tide ebbs and predators are forced to leave the shallow creeks, juveniles move off the marsh surface and concentrate in the creeks where their abundances can be quite high.

Oyster Reefs. The term oyster reef often is interchanged loosely with other terms for local estuarine areas inhabited by oysters, including oyster bar, oyster bed, oyster rock, and oyster ground. Typically, oyster reefs are defined as natural bivalve structures found between the tide lines which can be composed of oyster shell, live oysters, and other organisms that form contiguous from scattered oysters in marshes and mud flats. Figure 6 shows live oyster and washed oyster habitats near the project area, as determined by SCDNR in 2011.

Water Column. Relevant primarily to pelagic species the estuarine water column is classified as essential fish habitat. It is located between the sediment-water interface and the surface of the water. The EFH estuarine water column provides both migrating and residential species of varying life stages the opportunity to survive in a productive, active, unpredictable, and at times strenuous environment. As the transport medium for nutrients and organisms between the ocean and inland freshwater systems, the estuarine water column is as essential a habitat as any marsh, seagrass bed, or reef (South Atlantic Fishery Management Council 1998a). Section 5 of this document details the potential short term and long term impacts the project would have on the water column.

Intertidal and subtidal mudflats (unconsolidated bottom). Intertidal flats are the unvegetated bottoms of estuaries and sounds that lie between the high and low tide lines. These flats occur along mainland or barrier island shorelines or can emerge in areas unconnected to dry land. Intertidal flats are most extensive where tidal range is greatest, such as near inlets and in the southern portion of the coast. Because the influence of lunar tides is minimal in the large sounds, true intertidal flats are not extensive, except for the area immediately adjacent to inlets (Peterson and Peterson 1979).

Coastal Inlets. Sand spits, jetties, islets, tidal flats, shoals and sandbars are often associated with coastal inlets (considered an HAPC for shrimp) which themselves are restricted areas of intense ebb and flow tidal changes. Inlets are bottlenecked areas where ocean currents, driven by tides, meet slightly lower salinity estuarine waters (resulting from upland runoff, streams, and rivers) Coastal inlets are areas of intense changes in energy caused by the daily tidal changes. Inlet habitats in the southeastern United States are frequently affected by waterway and beach nourishment projects.

OYSTER COMMUNITIES

Charleston Harbor Draft Fish and Wildlife Coordination Act Report

Scale: 1 inch = 1.5 miles	Drawn By: MR
Date: September 2012	Approved By: JE
DIAL CORDY AND ASSOCIATES INC Environmental Consultants	J12-1233
	Figure 6

Hardbottom. Hardbottom refers to a classification of coral communities that occur in temperate, subtropical, and tropical regions that lack the coral diversity, density, and reef development of other types of coral communities (South Atlantic Fishery Management Council 1998a). The South Carolina Department of Natural Resources (SCDNR) defines hardbottom habitat as "exposed areas of rock or consolidated sediments, distinguished from surrounding unconsolidated sediments, which may or may not be characterized by a thin veneer of live or dead biota, generally located in the ocean rather than in the estuarine system."

Man-made structures, such as artificial reefs, wrecks, and jetties, provide additional suitable substrate for development of hardbottom communities. Artificial reefs are structures constructed or placed in waters for the purpose of enhancing fishery resources and providing opportunities for commercial and recreational fisheries. Although the purpose of artificial reef placement is primarily fishery enhancement, colonization of the structures by marine life results in establishment of hard bottom habitat. Vessels that have run aground or sunk and remain on the seafloor can also provide a base for hardbottom communities.

Federally Managed Fisheries

Species that may occur in these project-area habitats are noted in Table 1, if managed by either South Atlantic Fishery Management Council (SAFMC) or NMFS or if either entity has developed fishery management plan for that species. The following paragraphs discuss these species' potential to occur in EFH within the project area (adapted from USACE 2006), and a map indicating the presence and position of various EFH as well as HAPC, are shown in Figure 7.

Shrimp. In the southeastern United States, the shrimp industry is based on the white shrimp (*Litopenaeus setiferus*), brown shrimp (*Farfantepenaeus aztecus*), pink shrimp (*Farfantepenaeus duorarum*), and the deeper water rock shrimp (*Sicyonia brevirostris*). The royal red shrimp (*Pleoticus robustus*) also occurs in deeper water and sustains a limited harvest. For the above species, HAPC within the project area include estuarine and marine water columns within the inlet, which includes the navigation channel (Figure 8A). These areas are the connecting water bodies between inshore estuarine nursery areas, offshore marine habitats used for spawning and growth to maturity. EFH for rock shrimp and royal red shrimp occurs in deeper offshore waters.

Snapper Grouper Complex. This complex of ten families of fishes containing 73 species are managed by the SAFMC. There is variation in specific life history patterns and habitat use among the snapper grouper complex species. For specific life stages of estuarine dependent and nearshore snapper grouper species, EFH includes areas inshore of the 100-foot-deep ocean contour, such as the salt and brackish marshes, tidal creeks, soft sediments found in Charleston Harbor, and unconsolidated bottom occurring in the navigation channel. EFH-HAPC for species of the complex is shown in Figure 8A, including some notable offshore areas, which show an affiliation with the hardbottom/artificial reef areas depicted in Figure 7. As for other species, estuarine and marine water columns are connecting water bodies between inshore estuarine nursery areas and offshore waters used for maturation and spawning.

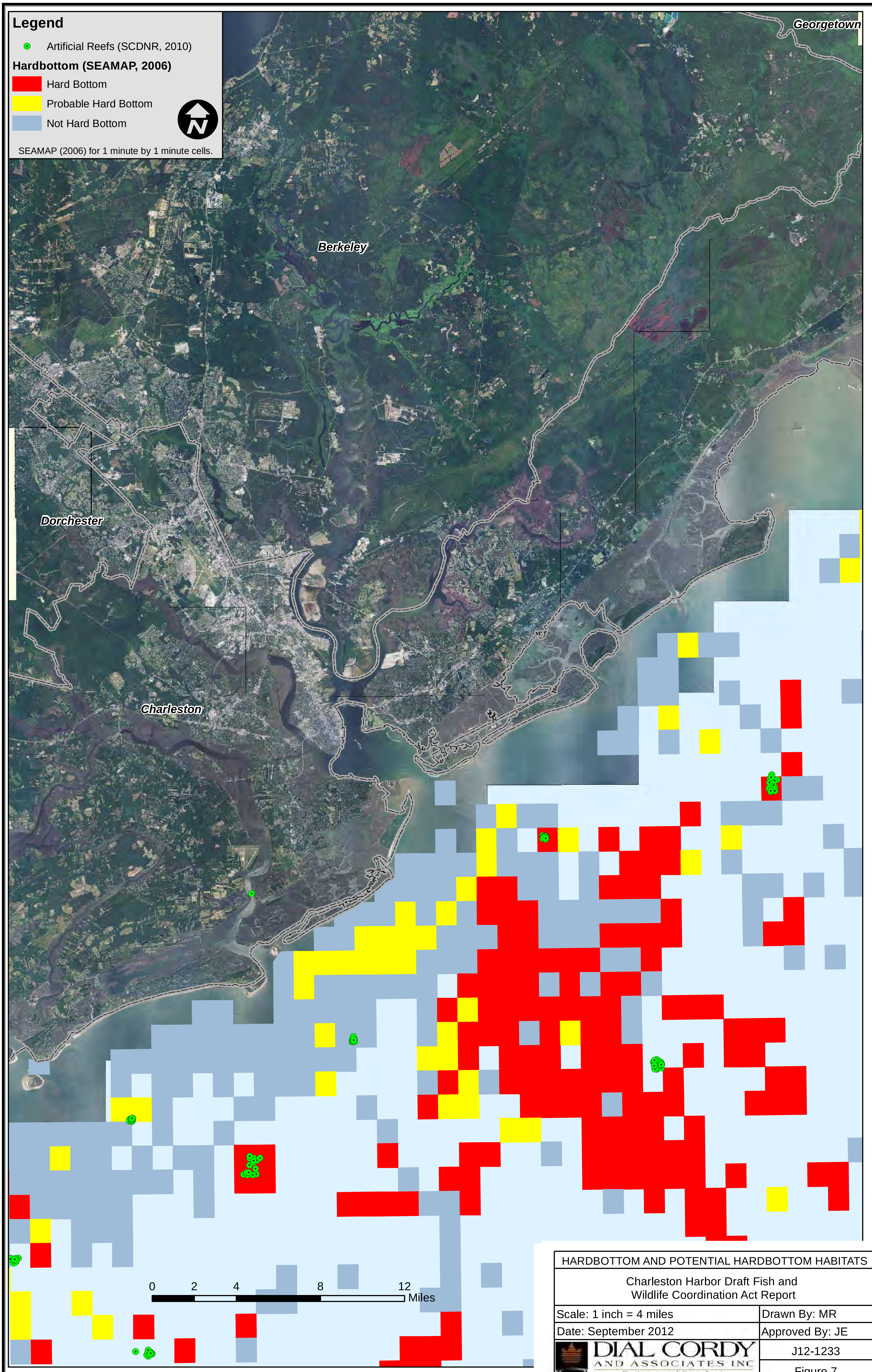
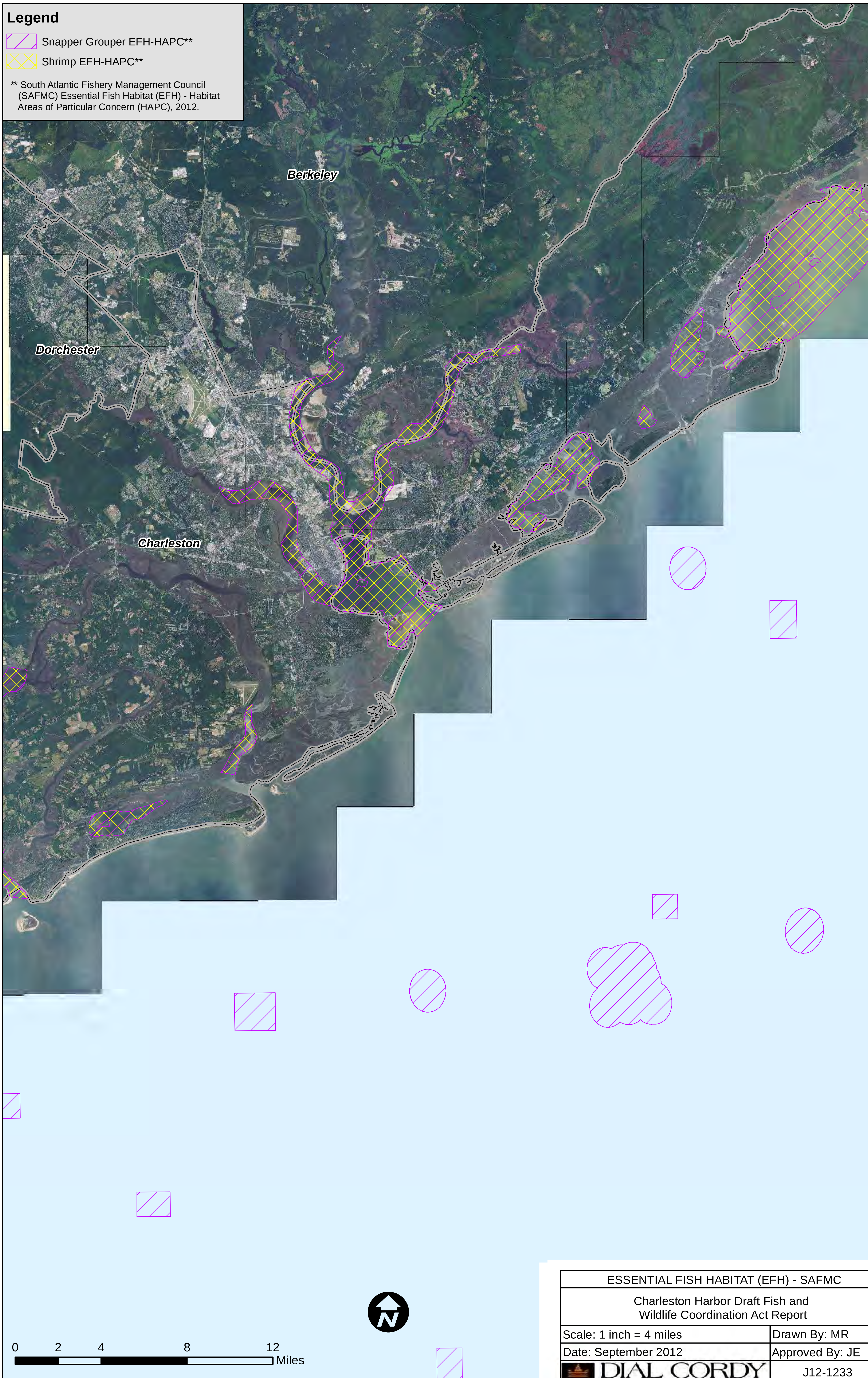
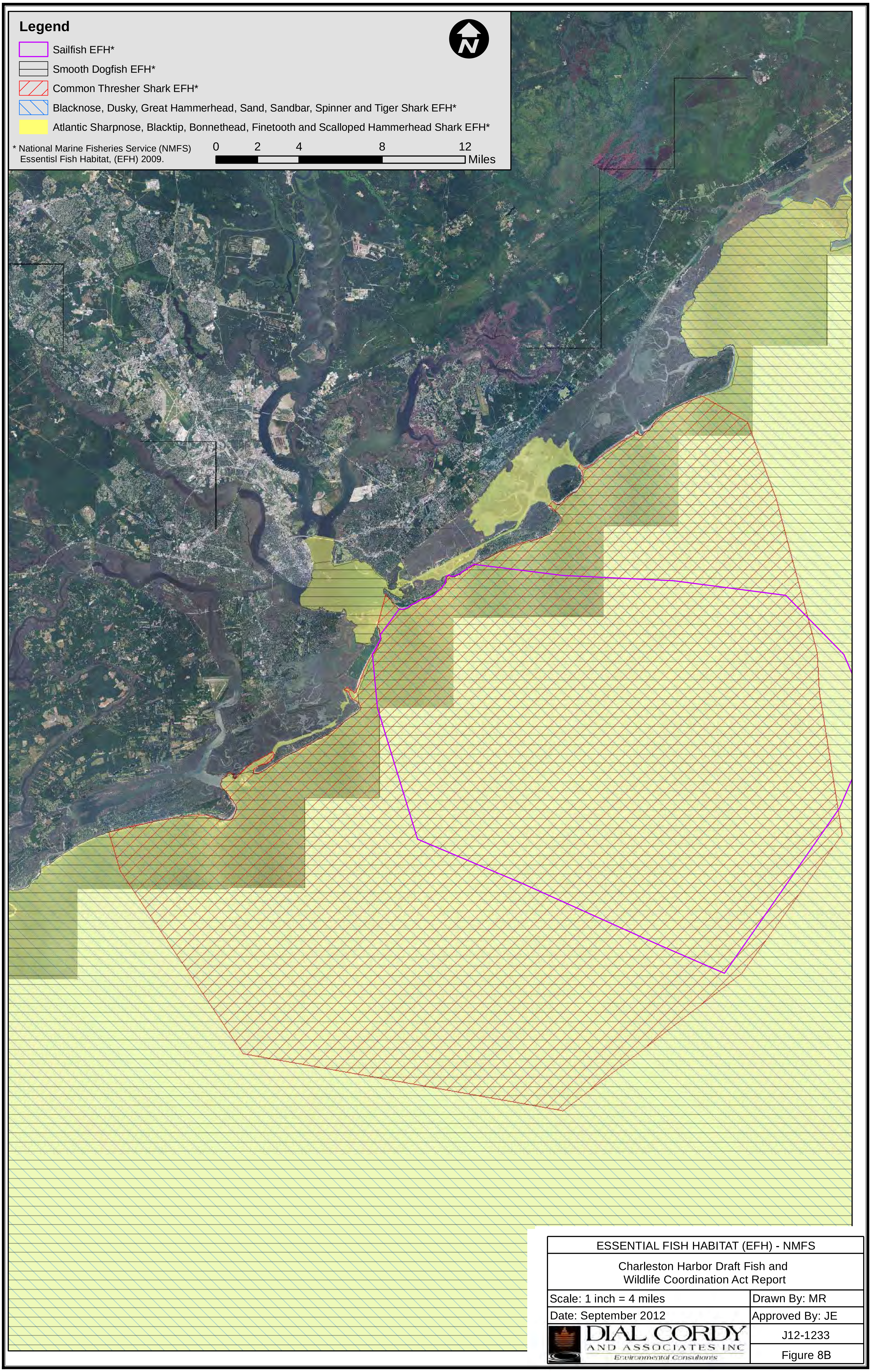

Legend
Artificial Reefs (SCDNR, 2010)
Hardbottom (SEAMAP, 2006)
Hard Bottom
Probable Hard Bottom
Not Hard Bottom
N
SEAMAP (2006) for 1 minute by 1 minute cells.
Georgetown
Berkeley
Dorchester
Charleston
0
2
4
8
12
Miles
HARDBOTTOM AND POTENTIAL HARDBOTTOM HABITATS
Charleston Harbor Draft Fish and
Wildlife Coordination Act Report
Scale: 1 inch = 4 miles
Drawn By: MR
Date: September 2012
Approved By: JE
DIAL CORDY
AND ASSOCIATES INC
Environmental Consultants
J12-1233
Figure 7

Table 1 Fishery Management Plans (FMPs) and Managed Species for the South Atlantic that May Occur in the Project Area

Common Name	Species
Shrimp FMP	
brown shrimp	*Farfantepenaeus aztecus*
pink shrimp	*Farfantepenaeus duorarum*
rock shrimp	*Sicyonia brevirostris*
royal red shrimp	*Pleoticus robustus*
white shrimp	*Litopenaeus setiferus*
Snapper Grouper Complex FMP	
jack crevalle	*Caranx hippos*
gag grouper	*Mycteroperca microlepis*
black sea bass	*Centropristis striata*
mutton snapper	*Lutjanus analis*
red snapper	*Lutjanus campechanus*
lane snapper	*Lutjanus synagris*
gray snapper	*Lutjanus griseus*
yellowtail snapper	*Ocyurus chrysurus*
spadefish	*Chaetodipterus faber*
white grunt	*Haemulon plumier*
sheepshead	*Archosargus probatocephalus*
hogfish	*Lachnolaimus maximus*
Coastal Migratory Pelagics FMP	
king mackerel	*Scomberomorus cavalla*
Spanish mackerel	*Scomberomorus maculatus*
cobia	*Rachycentron canadum*
Mid-Atlantic FMP species in South Atlantic Region	
bluefish	*Pomatomus saltatrix*
summer flounder	*Paralichthys dentatus*
Highly Migratory Species (Under Federal FMP)	
lemon shark	*Negaprion brevirostris*
bull shark	*Carcharhinus leucas*
blacknose shark	*Carcharhinus acronotus*
finetooth shark	*Aprionodon isodon*
dusky shark	*Carcharhinus obscurus*
bonnethead shark	*Sphyrna tiburo*
Atlantic sharpnose shark	*Rhizoprionodon terraenovae*



ESSENTIAL FISH HABITAT (EFH) - SAFMC	
Charleston Harbor Draft Fish and Wildlife Coordination Act Report	
Scale: 1 inch = 4 miles	Drawn By: MR
Date: September 2012	Approved By: JE
DIAL CORDY AND ASSOCIATES INC Environmental Consultants	J12-1233
	Figure 8A



Legend
Sailfish EFH*
Smooth Dogfish EFH*
Common Thresher Shark EFH*
Blacknose, Dusky, Great Hammerhead, Sand, Sandbar, Spinner and Tiger Shark EFH*
Atlantic Sharpnose, Blacktip, Bonnethead, Finetooth and Scalloped Hammerhead Shark EFH*
* National Marine Fisheries Service (NMFS) Essentisl Fish Habitat, (EFH) 2009.
0 2 4 8 12 Miles
N
ESSENTIAL FISH HABITAT (EFH) - NMFS
Charleston Harbor Draft Fish and Wildlife Coordination Act Report
Scale: 1 inch = 4 miles
Drawn By: MR
Date: September 2012
Approved By: JE
DIAL CORDY AND ASSOCIATES INC
Environmental Consultants
J12-1233
Figure 8B

Coastal Migratory Pelagics. King and Spanish mackerel and cobia are coastal migratory pelagic species managed by the SAFMC. EFH for these species include the inlet and, in a more general sense, any high-salinity bays which may occur in the project vicinity. Many coastal pelagic prey species are estuarine-dependant in that they spend all or a portion of their lives in estuaries. Accordingly, the coastal pelagic species, by virtue of their food source, are to some degree also dependent on estuaries and, therefore, can be expected to be detrimentally affected if the productive capabilities of estuaries are greatly degraded.

Mid-Atlantic Species in South Atlantic Region. Bluefish and summer flounder are two species listed in the Mid-Atlantic Fisheries Management Plan that occur in the South Atlantic. Bluefish juveniles and adults are listed as using estuaries from North Carolina to Florida and are common in Charleston Harbor including the vicinity of the navigation channel.

Highly Migratory Species. The sharks listed in Table 1 are included in the Highly Migratory Species (Federal) Fishery Management Plan, and are relatively common in the Charleston Harbor. EFH for these shark species include the inlet and estuarine and shallow coastal waters all of which include the navigation channel. EFH for sharks in the project area is shown in Figure 8B.

Other Fish and Shellfish

Common forage and gamefish. A study of the Charleston Harbor by Van Dolah et al. (1990) identified many important finfish species within the lower Cooper River, including high numbers of Atlantic menhaden (*Brevoortia tyrannus*), bay anchovy (*Anchoa mitchilli*), silver perch (*Bairdiella chrysoura*), weakfish (*Cynoscion regalis*), spot (*Leiostomus xanthurus*), Atlantic croaker (*Micropogonias undulatus*), and star drum (*Stellifer lanceolatus*). Summer flounder (*Paralichtys dentatus*) and southern flounder (*P. lethostigma*), two important recreational species, were caught in low numbers throughout the year.

Sharks (as noted above), skates, and rays can all potentially be found in the project area. Schwartz (2003) reported that six species of sharks can pup their young in South Carolina waters during warm summer months: smooth dogfish, spiny dogfish, blacknose, Atlantic sharpnose, tiger, and dusky sharks. Although none are commercially harvested within the estuary, many are recreationally important.

The harbor system also supports large populations of white shrimp, brown shrimp, and blue crab, which are harvested both commercially and recreationally. Penaeid shrimp and blue crab are the most common large invertebrates in the creeks of Charleston Harbor (e.g., Shem Creek, Clouter Creek, Beresford Creek and Shipyard Creek). Dominant finfish species in these areas included spot, Atlantic menhaden, Atlantic croaker, southern flounder, and bay anchovy (Wenner 1997), which supported the findings of Van Dolah et al. (1990).

Many of the species listed above are recreationally important, such as flounder, spot, and Atlantic croaker. Other sciaenids, such as red drum (*Sciaenops ocellatus*) and spotted sea trout (*Cynoscion nebulosus*) are likewise sought, and therefore require management. The habitat and spawning tendencies of these, and other species, are further discussed below. Sharks will be separately discussed under EFH coordination. The following data were transcribed from SCDNR (2011a):

Spot (*Leiostomus xanthurus*)

- Adults inhabit estuaries, tidal creeks, and shallow coastal waters; generally over muddy or sand-mud bottoms; also over oyster reefs and along beaches.
- Juveniles utilize lower salinity tidal creeks; yearlings progress to deeper water of lower estuaries and inlets; most common over mud or detritus-laden bottoms and seagrass beds.
- Spawn October through March over outer continental shelf. Adults congregate near inlets and beaches during fall prior to offshore and southerly spawning migrations.
- Larval develop offshore, utilizing currents to reach nearshore waters where they metamorphose into bottom dwellers near estuarine inlets; enter estuaries December through April.

Atlantic Croaker (*Micropogonias undulatus*)

- Adults are common over mud and sandy bottom; also over oyster reefs and live bottoms. Tolerate a range of salinities, but prefer moderate salinity.
- Juveniles utilize low salinity upper reaches of estuaries, primarily associated with muddy bottoms or detritus-laden habitats; progress to higher salinity with age; overwinter in deeper channels and tidal rivers within estuaries.
- Spawning occurs over continental shelf during fall and winter.
- Larvae use tidal currents to reach nursery grounds in low salinity tidal creeks at the upper reaches of estuaries; inshore larval migration peaks late fall through spring.

Black Drum (*Pogonias cromis*)

- Adults are common over sandy and soft live bottoms in salt and brackish water including: estuaries, coastal rivers, shallow coastal bays, and along beaches. Spatial distribution closely tied to natural and artificial hard structures, including: reefs, rock piles, jetties, docks, pier pilings, and bridges.
- Juveniles are common over muddy bottoms in shallow tidal creeks and salt marsh. Subadults progress to deeper creeks, river mouths, and bays and into nearshore coastal waters.
- Spawning occurs during spring and early summer in high salinity inlets, estuaries, bays, sounds, and coastal rivers. Adults may form schools for migration to spawning grounds.
- Larvae use tidal currents to enter estuaries where they settle in shallow tidal creeks. Older juveniles leave deeper inshore waters during fall, migrate offshore to overwinter, and return inshore in the spring.

Red Drum (*Sciaenops ocellatus*)

- Adults utilize nearshore and inshore bottom habitats, such as tidal creeks, oyster reefs, and beaches, typically over sandy or sandy-mud bottoms; may also congregate in nearshore groups.
- Juveniles inhabit estuaries near shallow tidal creeks and salt marshes, commonly at marsh grass edges or in the vicinity of oyster reefs; reside in deeper river channels during winter. Subadults inhabit larger tidal creeks, rivers, and the front beaches of barrier islands.
- Spawn during late summer and fall. Spawning aggregations occur near estuary inlets and passes along barrier island beaches.
- Larval red drum use vertical migrations to ride high salinity tidal currents into tidal creeks and shallow salt marsh nursery habitats

Spotted Seatrout (*Cynoscion nebulosus*)

- Adults are common near salt marsh edges and over grass beds, in the vicinity of tidal creek mouths and channels, and over oyster reefs.
- Juveniles utilize shallow tidal creeks and salt marsh as nursery habitats, often over submerged vegetation. Subadults inhabit larger tidal creeks and main portions of estuaries.
- Spawning aggregations occur at night, often in habitat associated with piers, pilings, bridges, points of land, and holes.
- Larvae utilize shallow tidal creeks as nurseries from June through November. Older juveniles progress to larger creeks and deeper reaches of estuaries in fall, often forming schools of similar sized fish.

Weakfish (*Cynoscion regalis*)

- Adults inhabit estuaries as well as bays, sounds, and nearshore coastal waters. Prefer sandy bottoms and at the edges of grass beds where their prey are concentrated.
- Juveniles can tolerate wide salinity ranges. Utilize estuaries as nursery grounds, especially over sandy or sand-grass bottoms in moderate salinity water. Move to deeper channels, rivers, bays and sounds with age.
- Spawning occurs in deeper reaches of estuaries and nearshore bays and sounds from March through October (peak April through June). Males form spawning aggregations and attract females by using muscle contractions to vibrate the swim bladder.
- Larvae become demersal (occupying the sea floor) shortly after hatching and utilize tidal currents to reach low salinity nursery habitats in upper reaches of estuaries. Juveniles leave estuaries and migrate to coastal waters during fall.

Southern Flounder (*Paralichthys lethostigma*)

- Adults inhabit estuaries, rivers, and shallow coastal water including front beach; most abundant in shallow, muddy bottom tidal creeks and at tidal creek mouths; also utilize flooded salt marshes at high tides and occasionally near estuarine inlets; overwinter offshore.
- Juveniles reside in shallow, soft bottom tidal creeks at upper reaches of estuaries; may occasionally reach freshwater; may utilize submerged vegetation either as cover or for foraging purposes.
- Adults migrate to unknown locations offshore during late fall; spawning occurs in these areas throughout the winter; return to inshore habitats during spring.
- Larvae undergo a 30- to 60-day pelagic phase then use ocean currents to enter estuaries during late winter and early spring. Metamorphosis is partially completed prior to settling inshore; once inside the estuary larvae finish metamorphosis and settle to the bottom in the flat juvenile body form. Juveniles remain in estuaries through winter and first migrate offshore just prior to spawning.

Blue Crab (*Callinectes sapidus* Rathburn)

- Occupy a range of estuarine habitats as well as coastal bays, sounds and nearshore waters; often in association with submerged vegetation or oyster reefs.
- Adult males utilize soft bottom tidal creeks and middle to upper reaches of estuaries, generally moving further upstream than females. Females utilize similar but higher salinity habitats until moving to estuary mouths to spawn; thereafter, females remain near inlets or in coastal ocean waters.
- Juveniles reside in shallow, soft bottom habitats in upper estuaries, tidal creeks, salt marshes, and rivers.
- Mating occurs in low salinity upper estuary waters following terminal molting of females. Mating occurs February through November. Adult females mate only once in life, store sperm internally, and spawn (April through August) multiple times over the next one to two years.
- Early larval development (zoeal stages) occurs in oceanic waters. Larvae use tidal currents to recruit to estuaries as megalopae (i.e. postlarvae) and move into upper estuaries as juveniles.

White Shrimp (*Litopenaeus setiferus*)

- Adults inhabit estuarine waters, typically over muddy bottoms and in habitats with high detritus loads; move to offshore mud bottom habitats during and following spawning.
- Juveniles utilize tidal creeks, oyster reefs and estuaries, typically over muddy bottoms; move closer to estuary mouths as growth continues.
- Migrate to nearshore coastal areas with muddy bottoms for summer spawning.
- Post-larvae believed to use nearshore tidal and wind-driven currents to move into estuaries during spring and summer. Utilize shallow, muddy tidal creeks with low to moderate salinity as nursery grounds; migrate to deeper reaches of estuaries as juveniles.

Eastern oyster (*Crassostrea virginica*)

- Estuaries, salt marsh, mudflats, tidal bays and sounds; typically form intertidal reefs extending from just below mean low water to approximately three feet higher than mean low water (Figure 6). Once settled, they are sessile throughout life.
- Mature within months of setting and reproduce by the end of first year. They are protandrous hermaphrodites, beginning life as male and switching to female later in life.
- Spawn intermittently May – November when water reaches at least 68°F.
- Fertilization external, producing planktonic larvae. After approximately two to three weeks larvae metamorphose and "set" on hard substrates to become "spat"; oyster shells/reef preferred substrate. Peak recruitment occurs June through September.

Sciaenids (sea trouts) are some of the most commonly fished species in the harbor and estuary. Given recreational fishing pressures, proper management of important areas just before and during spawning are crucial to maintain healthy stocks. The list below summarizes approximate spawning times and localities in the Charleston area.

Sciaenid Spawning in the Charleston Harbor Estuarine System

Red drum:	Early August through the end of September (Charleston Harbor Inlet)
Black drum:	Late March through early May (Ravenel Bridge/ Chas Harbor Inlet)
Spotted seatrout:	Late April through early September (Ravenel Bridge/ Harbor Inlet/Ft. Johnson/JI Yacht Club Pier)
Weakfish:	Late March through October (Coastal waters)
Silver perch:	Late March through early May (Harbor Inlet/ smaller creeks throughout the estuary)
Star drum:	Early May through June (Deep water near the Chas Harbor Inlet)

In addition to the above notable spawning locations, certain other areas in the harbor provide habitat for recreational and other species. "The Grillage" and "Dynamite Hole" are popular fishing locales near the mouth of Charleston Harbor. The Grillage, where "the rock juts from the sand bottom like a ledge along a river, crumbling into boulders like a glacier calving (Peterson 2012)," is located off the tip of Sullivan's Island on the north side of the harbor's mouth. Dynamite Hole is closer to the south jetty. These locations are known for populations of redfish and such sharks as bonnetheads, sharpnose and blacktips (Kibler 2008). Recently students have created 3D representations of The Grillage (see Peterson 2012), which indicates its importance to the local fishery.

A substantial fishery exists outside the harbor as well. The most popular species fished offshore include Atlantic croaker, bluefish, Atlantic sharpnose shark, southern kingfish, spot, weakfish, brown shrimp and white shrimp.

Diadromous species

Diadromous (freshwater and saltwater life stages) fish that use the Cooper River include the American shad (*Alosa sapidissima*), hickory shad (*Alosa mediocris*), blueback herring (*Alosa aestivalis*), American eel (*Anguilla rostrata*), Atlantic sturgeon (*Acipenser oxyrhynchus*), and shortnose sturgeon (*Acipenser brevirostrum*). Because these species require multiple habitats and must have certain environmental parameters to complete migration and their life cycles, there are more potential disturbances that could adversely affect spawning and recruitment. Sturgeons will be discussed below in the Protected Species section.

The following species accounts, focusing on habitat affiliations and spawning tendencies, has been transcribed from Green et al.(2009), which may be consulted for many additional biological and ecological details relating to these and other Atlantic coast diadromous species.

American shad. American shad spend most of their lives in marine waters. Adults migrate into coastal rivers and tributaries to spawn. Rivers, bays, and estuaries associated with spawning reaches are used as nursery areas (ASMFC 1999). South Carolina has “stabilized or increasing numbers” of individuals (ASMFC 1988, Cooke and Leach 2003). Spawning of American shad in South Carolina begins in mid-January (Walburg and Nichols 1967; Leggett and Whitney 1972). Spawning runs typically last two to three months, but may vary depending on weather conditions (Limburg et al. 2003). There does not seem to be a minimum distance from brackish waters at which spawning occurs (Leim 1924, Massmann 1952), but upstream and mid-river segments appear to be favored (Massmann 1952, Bilkovic et al. 2002). It is not unusual for American shad to travel 25 to 100 miles upstream to spawn; some populations historically migrated over 300 miles upstream (Stevenson 1899; Walburg and Nichols 1967).

Areas with high water flows provide a cue for spawning American shad (Orth and White 1993). In 1985, a rediversion canal and hydroelectric dam constructed between the Cooper River and Santee River, South Carolina, increased the average flow of the Santee River from 63 m^3/s to 295 m^3/s. (Cooke and Leach 2003). The increased river flow and access to spawning grounds through the fish passage facility have contributed to increases in American shad populations.

Adults appear to be quite tolerant of turbid water conditions. In the Shuebenacadie River, Nova Scotia, suspended solid concentrations as high as 1000 mg/L did not deter migrating adults (Leim 1924). Furthermore, Auld and Schubel (1978) found that suspended solid concentrations of 1000 mg/L did not significantly affect hatching success of eggs.

In South Carolina, juvenile American shad were found predominantly in deeper, channel habitats of estuarine systems, during fall and winter. Small crustaceans preyed upon by American shad are generally abundant near the bottom in these areas (McCord 2003).

Hickory shad. Hickory shad spend most of their adult lives at sea, entering brackish and freshwater only to spawn (Colette and Klein-MacPhee 2002). Little is known about the life history and specific habitat requirements of this species. However, coastal migrations and habitat requirements are thought to be similar to that of other alosine species, particularly American shad (Klauda et al. 1991). Adult hickory shad are highly sought after by sport fishermen when they ascend rivers and tributaries during their spawning run (Mansueti 1962, Pate 1972). Therefore, they are most likely to be sought in the Santee and Cooper between early March and mid-May as that corresponds with the South Carolina spawning window (Bulak and Curtis 1979).

Some environmental tolerances/preferences have been determined for various life stages of hickory shad. Adults have been found spawning in Maryland waters where the dissolved oxygen level was between 5.7 and 11.8 mg/L (B. M. Richardson, Maryland Department of Natural Resources, personal communication). Juveniles in Maryland waters were captured where dissolved oxygen ranged from 4.1 to 10.9 mg/L [B. M. Richardson, Maryland Department of Natural Resources, personal communication with Green et al (2009)]. Juveniles were found during the summer in estuarine waters of the Altamaha River, Georgia, when salinities reached 10 ppt, and during the winter, when salinities ranged from 10 to 20 ppt (Street 1970). As noted above, juveniles may forego the oligohaline portion of the estuary in favor of a more saline nursery environment (Pate 1972). Eggs were collected in the Roanoke River at dissolved oxygen levels ranging from 6.76 to 11.27 mg/L (Harris and Hightower 2007).

In South Carolina, juvenile hickory shad are more predominant in shallow expanses of sounds and bays, compared to deeper, channel habitats occupied by juvenile American shad and blueback herring. The variation in distribution is likely the result of differences in food preferences. Small fishes preferred by hickory shad are likely more numerous in shallower habitats adjacent to marshlands (McCord 2003).

Blueback herring. Blueback herring are an anadromous, highly migratory, euryhaline, pelagic, schooling species that spend most of their lives at sea, returning to freshwater only to spawn (Colette and Klein-MacPhee 2002), ascending freshwater far upstream (Massman 1953; Davis and Cheek 1966; Perlmutter et al. 1967; Crecco 1982) to do so. They are an ESA species of concern. Their distribution is a function of habitat suitability and hydrological conditions, such as swift flowing water (Loesch and Lund 1977).

Blueback herring select a great variety of spawning habitat types (Street 1970; Frankensteen 1976; Christie 1978), including small tributaries upstream from the tidal zone (ASMFC 1999), seasonally flooded rice fields, small densely vegetated streams, cypress swamps, and oxbows, where the substrate is soft and detritus is present (Adams and Street 1969; Godwin and Adams 1969; Adams 1970; Street 1970; Curtis et al. 1982; Meador et al. 1984). Loesch (1987) has reported that individuals can adapt their spawning behavior under certain environmental conditions and disperse to new areas if the conditions are suitable. This behavior was demonstrated in the Santee-Cooper System, South Carolina, where hydrological alterations resulting from the creation of a rediversion canal led to changes in spawning site selection in both rivers. In the Cooper River, blueback herring lost access to formerly impounded rice fields along the river, which were important spawning areas. Following the construction of the rediversion canal, there was an increase in the number and length of tributaries along the river that were used as spawning habitat. In the adjacent Santee River, adults dispersed into the rediversion canal itself in favor of their former habitat, which was further upstream (Eversole et al. 1994). In the Santee, herring arrive in February (Bulak and Christie 1981), but spawning begins in early March (Christie 1978; Meador 1982).

Individuals generally spawn in freshwater above the head of tide; brackish and tidal areas are rarely used for spawning by this species (Nichols and Breder 1927; Hildebrand 1963; Fay et al. 1983; Murdy et al. 1997). Adults, eggs, larvae, and juveniles can tolerate a wide range of salinities, but seem to prefer a more narrow range, depending on life history stage. For example, while spawning may occur in salinities ranging from 0 to 6 ppt, it typically takes place in waters that are less than 1 ppt (Klauda et al. 1991). Boger (2002) presented a modified salinity range for Virginia rivers, suggesting that a suitable salinity range for spawning adults is 0 to 5 ppt (parts per thousand). Although spawning often occurs in freshwater, blueback herring eggs and larvae can survive in salinities as high as 18 to 22 ppt (Johnston and Cheverie 1988). Larvae require a minimum of 5.0 mg/L (milligrams per liter) of dissolved oxygen for survival (Jones et al. 1978).

Adult blueback herring require a minimum of 5.0 mg/L of dissolved oxygen (Jones et al. 1978). For example, adults caught in the Cooper and Santee Rivers, South Carolina, were always captured in areas that had a dissolved oxygen concentration of 6 mg/L or higher (Christie et al. 1981). Juvenile blueback herring have been collected in waters of the Cape Fear River, North Carolina, where dissolved oxygen concentrations ranged from 2.4 to 10.0 mg/L (Davis and Cheek 1966). In the laboratory, juveniles that were exposed to dissolved oxygen concentrations of 2.0 to 3.0 mg/L for 16 hours experienced a 33% mortality rate. Researchers determined that the juveniles were unable to detect and avoid waters with low dissolved oxygen (Dorfman and Westman 1970).

The rediversion canal (mentioned above) and hydroelectric dam with a fish passage facility were constructed between the Cooper River and Santee River, which increased the average flow of the Santee River from 63 m^3/s to 295 m^3/s (Cooke and Leach 2003). Following the rediversion, blueback herring did not concentrate below the dam and few were attracted into the fish lock during periods of zero discharge. Too much water flow also posed a problem, as adults were found concentrating below the dam during periods of discharge, but were unable to locate the entrance to the fish lock due to high turbulence (Chappelear and Cooke 1994). As a result, blueback herring changed migration patterns by abandoning the Santee River, and following the dredged canal to the higher flow of the St. Stephen Dam. Subsequently, access to spawning grounds was increased, which contributed to increases in blueback herring populations (Cooke and Leach 2003). Although the importance of instream flow requirements has been previously recognized (Crecco and Savoy 1984; ASMFC 1985; Crecco et al. 1986; Ross et al. 1993), it has usually been with regard to spawning habitat requirements or recruitment potential (Moser and Ross 1994).

American eel. American eel are a catadromous species that reproduces in salt water, and after an oceanic larval stage, migrates to brackish or fresh water for growth to maturity. Upon reaching maturity, they migrate back to the ocean to spawn. Ocean-dwelling young emerge from eggs as leptocephalus larvae, and later transform into the “glass eel” stage. Glass eels enter estuaries by drifting on flood tides and holding position near the bottom of ebb tides

(McCleave and Wippelhauser 1987), and by actively swimming along shore in estuaries above tidal influence (Barbin and Krueger 1994). Glass eels move back up into the water column on flood tides and return to the bottom during ebb tides (Pacheco and Grant 1973; McCleave and Kleckner 1985; McCleave and Wippelhauser 1987). As the translucent glass eels develop pigment, many begin to migrate from estuaries into freshwater. These young pigmented individuals are termed “elvers.”

Some elvers remain in coastal rivers and estuaries, while others may continue movements upstream in the winter and the spring (Facey and Van den Avyle 1987). Upstream migration may comprise up to three to five years of an individual’s yellow-phase (Haro and Krueger 1991). Some yellow-phase American eel continue migrating upstream until they reach maturity, while others remain in the lower portions of coastal estuaries and rivers (Morrison et al. 2003; Cairns et al. 2004; Lamson et al. 2006). Eel migrations upstream occur from March through October, and peak in May and July depending on location (Richkus and Whalen 1999). The yellow-phase is the primary growth stage where individuals spend most of their lives, is characterized by a lack of sexual maturity, and may last many years.

Yellow eels gradually metamorphose into silver eels before migrating out to sea. During this maturation, American eel migrate downriver to marine waters. Silver eel migration begins at different times of year depending on location, but occurs primarily in the fall, although winter migrations have been documented (Facey and Helfman 1985; Euston et al. 1997, 1998). The age and size at which downstream migration begins varies geographically. Hansen and Eversole (1984) found that in the Cooper River, South Carolina, American eel older than 7 years old and greater than 65 cm in length were sparse, suggesting that adults migrate at a younger age and smaller size than in the northern part of their range.

Little is known about the salinity requirements of juvenile American eel. Sheldon and McCleave (1985) documented glass eels in Penobscot, Maine, in salinities ranging from 0 to 25.2 ppt. Salinity is not likely a limiting habitat parameter for American eel, as they are found in a wide range of salinities (Morrison et al. 2003). However, Rulifson et al. (2004) found that catch of American eel was affected by dissolved oxygen rates, and determined that dissolved oxygen was a strong predictor of the distribution of American eel in North Carolina. High catches of American eel were almost always in waters with dissolved oxygen levels above 4 mg/L (Rulifson et al. 2004).

Threats and vulnerabilities. Green et al. (2009) provided a detailed assessment of challenges for the continued success of Atlantic diadromous species, including those utilizing the project area. They noted that dams and fish passage were fairly universal issues that need to be considered when managing populations of these fishes. However, it was stated that both the Pinopolis navigational lock and St. Stephen fish passage facility provide passage for blueback herring and American shad. They then cautioned, “these facilities do not effectively pass sturgeons, nor do they incorporate efficient outmigration technologies, even for alosines [shads and herrings]. Effective passage designs for sturgeons have not yet been determined. In fact, poorly designed fish passage facilities may negatively impact sturgeon populations by increasing mortality.” (Fish passage at St. Steven is currently being addressed in another USACE study.) Among other threats to American Shad, Hickory Shad, and Blueback Herring in the project area was water withdrawal. Green et al. (2009) explained that, "…tidal freshwater marshes along the Cooper River (many of which are relic rice impoundments with breached or eroded dikes), which were used extensively as spawning habitat by blueback herring prior to rediversion of flows into the Santee River, are less extensive under reduced flows, and many are now partly dewatered or influenced by brackish water. The flow regimens in both the Cooper and Santee Rivers are typically in highs and lows (with more abrupt changes from peaked power generation and flood releases) than are characteristic of more gradual river flow changes that occur in open rivers where waters expand into, and withdraw from, floodplains."

Protected Species

The Charleston Harbor study area supports a number of endangered and threatened species listed under the Endangered Species Act (ESA) of 1973 and the Marine Mammal Protection Act (MMPA) of 1972. Species protected under ESA and known to occur in the project area are listed in Table 2. Below is a cursory treatment of major groups of protected species; for most species below, separate consultation involving greater detail of life history and important habitat parameters will be provided

Whales. Whales listed in Table 2 are protected under both the ESA as well as the MMPA. North Atlantic right whale observational data is shown in Figure 9. Right whales are highly migratory and summer in New England and the Canadian Maritime Provinces. The breeding and calving grounds for the right whale occur off of the coast of southern Georgia and north Florida. Additional data and will be provided during ESA consultation with NMFS. Right whales migrate off South Carolina waters from November through March.

Dolphins. The Charleston Estuarine System (CES) stock of bottlenose dolphin (*Tursiops truncatus*) is centered near Charleston, South Carolina. Dolphins are not protected under ESA, but they are protected under MMPA. Dolphins are active in the estuary as well as in nearshore coastal waters. In fact, the group of dolphins that uses the harbor most exclusively is distinct from those residing in coastal areas or just using coastal areas for migrations. Moreover, the number of observed dolphins in the harbor is relatively high compared to other estuaries in South Carolina (Speakman et al. 2006, as cited in NOAA 2009).

Manatees. West Indian manatees are protected under ESA as well as the MMPA. They are occasionally observed in Charleston Harbor during warmer months. However, the frequency of observation is typically low. Murphy and Griffin (undated SCDNR pamphlet) gave particular attention to foraging in South Carolina estuaries:

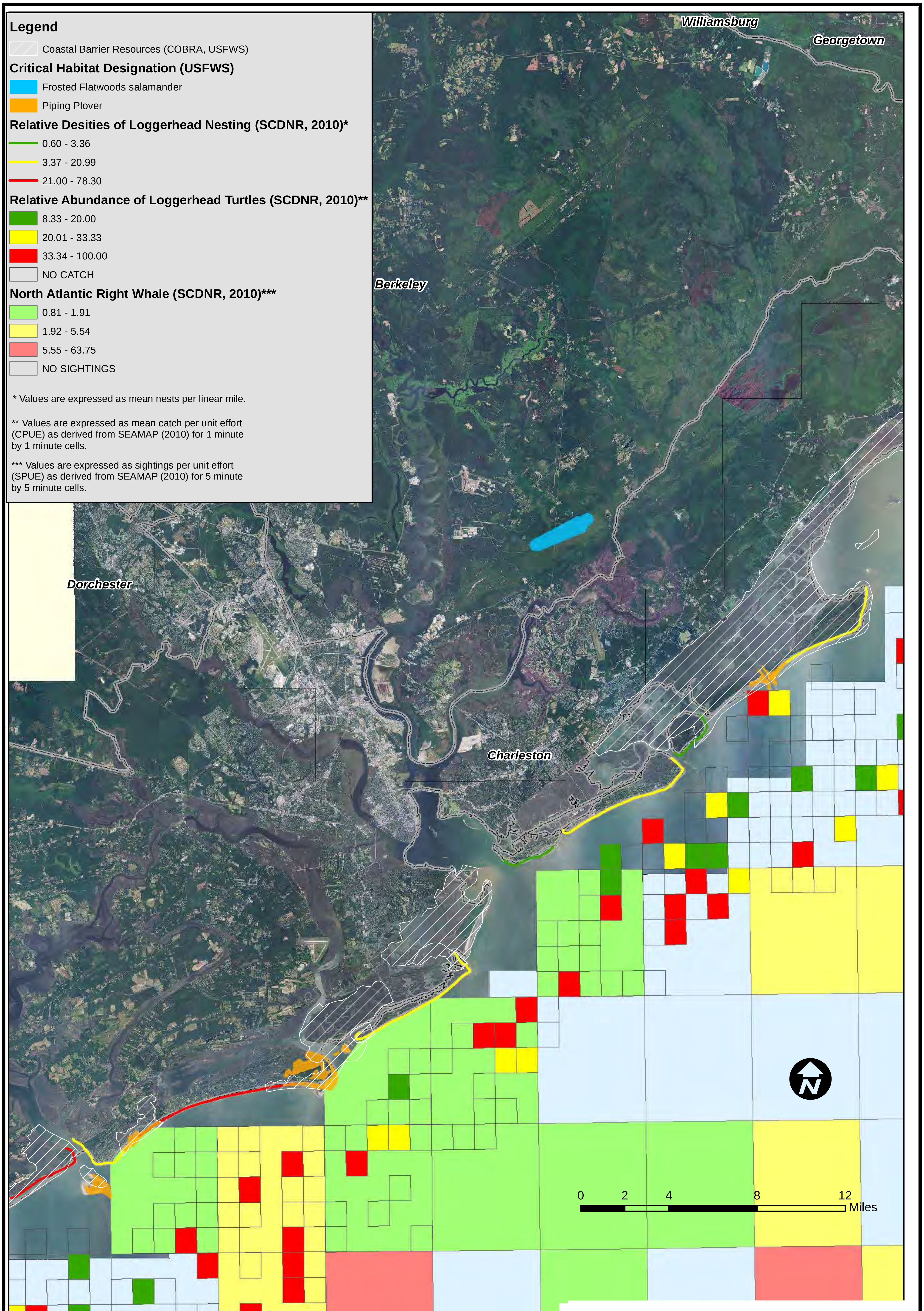
> "In South Carolina, manatees occupy fresh, brackish and marine habitats and move freely between salinity extremes. Because of our high tidal amplitude, manatees feed on abundant *Spartina alterniflora* grasses at high tide and frequently move to submerged *Ulva* sp. beds at low tide. Manatees will move up rivers until the water is too shallow for passage or is blocked by a dam. There is no evidence that manatees

concentrate on the upper Cooper River, which is the only site with extensive stands of the introduced exotic plant *Hydrilla verticillata* accessible to manatees in the state."

Table 2 Endangered and threatened species in Charleston (SC) area

Common Name	Species	Federal Status	State Status
Mammals			
Blue whale	*Balaenoptera musculus*	E	E
Finback whale	*Balaenoptera physalus*	E	E
Humpback whale	*Megaptera novaeangliae*	E	E
North Atlantic right whale	*Eubalaena glacialis*	E	E
Sei whale	*Balaenoptera borealis*	E	E
Sperm whale	*Physeter macrocephalus*	E	E
West Indian manatee	*Trichechus manatus*	E	E
Rafinesque's big-eared bat	*Corynorhinus rafinesquii*	N/A	E
Birds			
Bald eagle	*Haliaeetus leucocephalus*	BGEPA	T
Wood stork	*Mycteria americana*	E	E
Red-cockaded woodpecker	*Picoides borealis*	E	E
Piping plover	*Charadrius melodus*	T	E
Wilson's plover	*Charadrius wilsonia*	N/A	T
American swallow-tailed kite	*Elanoides forficatus*	SSC	E
Least tern	*Sterna antillarum*	N/A	T
Bachman's warbler	*Vermivora bachmanii*	E (D/E)	E
Kirtland's warbler	*Dendroica kirtlandii*	E	E
Red knot	*Calidris canutus rufa*	C	N/A
Reptiles			
Kemp's Ridley sea turtle	*Lepidochelys kempii*	E	E
Hawksbill sea turtle	*Eretmochelys imbracata*	E	E
Leatherback sea turtle	*Dermochelys coriacea*	E	E
Loggerhead sea turtle	*Caretta caretta*	T	T
Green sea turtle	*Chelonia mydas*	T	T
Spotted turtle	*Chlemmys guttata*	N/A	T
Gopher tortoise	*Gopherus polyphemus*	C	E
Amphibians			
Flatwoods salamander	*Ambystoma cingulatum*	T	E
Dwarf siren	*Pseudobranchus striatus*	N/A	T
Gopher frog	*Rana capito*	N/A	E
Fishes			
Shortnose sturgeon	*Acipenser brevirostrum*	E	E
Atlantic sturgeon	*Acipenser oxyrinchus oxyrinchus*	E	E
Plants			
Sea-beach amaranth	*Amaranthus pumilus*	T	N/A
Canby's dropwort	*Oxypolis canbyi*	E	N/A
Pondberry	*Lindera melissifolia*	E	N/A
American chaffseed	*Schwalbea americana*	E	N/A
T = Threatened; E = Endangered; S/A = Similarity of Appearance to a Threatened Taxon SSP = Species of Special Concern; BGEPA = Bald and Golden Eagle Protection Act C = Candidate for Listing; D/E = May be delisted due to extinction			

Sources: Websites: http://www.dnr.sc.gov/species/index.html, http://www.nmfs.noaa.gov/pr/species/fish/, http://ecos.fws.gov/tess_public/countySearch!speciesByCountyReport.action?fips=45019; and J. Holling, SCDNR Heritage Trust Program, September 2012, pers com.



PROTECTED SPECIES

Charleston Harbor Draft Fish and Wildlife Coordination Act Report

Scale: 1 inch = 4 miles	Drawn By: MR
Date: September 2012	Approved By: JE
DIAL CORDY AND ASSOCIATES INC Environmental Consultants	J12-1233
	Figure 9

Additional habitat parameters and conservation challenges will be addressed during Section 7 consultation, to be provided under separate cover.

Birds. Several protected birds use the project area and adjacent habitat resources. Within Charleston County, there is USFWS-listed Critical Habitat (in Cape Romain NWR) for the piping plover (*Charadrius melodus*; see Figure 9), which is protected as threatened under ESA. This habitat within the NWR includes beach, non-forested wetland, and some bay/estuarine areas utilized for foraging; the species does not nest in South Carolina. The red knot (*Calidrus canutus rufa*) is a migratory shorebird that is currently proposed for listing under ESA. It does not nest in South Carolina, but may use habitats in the project area for foraging. Wood storks (*Mycteria americana*), which were down-listed in June 2014 from endangered to threatened status, are common during the summer and fall months at the Cape Romain National Wildlife Refuge. The majority of wood storks in the NWR are seen on Bulls Island where they use the ponds as feeding areas (USFWS 2009).

The nearby Francis Marion National Forest (FMNF) is home to endangered red-cockaded woodpecker (*Picoides borealis)*. In 1989, Hurricane Hugo devastated what was then the second largest population of the birds in existence, uprooting or snapping most of the trees in which they made their nest cavities. Management efforts to restore the population included the creation of artificial nesting cavities for the woodpeckers, and, by the mid-1990s, the population had rebounded to approximately 75% of its previous level. Today, the forest has exceeded its original recovery plan for the birds with 395 active clusters. Because the effort has been so successful, FMNF now functions as a donor population when birds are needed to establish populations elsewhere (USDA 2012).

*Sea Turtles. S*ea turtles that may be found in the project are listed in Table 2. Figure 9 shows both the relative density of the nests on beaches near the project area, as well as the percent-occurrence observations of swimming turtles offshore of the harbor inlet. Nesting beaches include Sullivan's Island, which is closest to the project site but has a relatively low nesting density, Folly Beach (a barrier island southwest of Morris Island Disposal Area), Isle of Palms (northeast of Sullivan's Island), and the NWR northeast of the Isle of Palms (discussed below). The refuge conducts an intensive nest protection and relocation program for the loggerhead sea turtle. The turtles nesting on Cape Roman National Wildlife Refuge are part of the northern sub-population of loggerhead sea turtle which encompasses the nesting area north of Amelia Island, Florida. Cape Island, the northern most barrier island of the refuge, receives the majority of nests laid, an average of 1000 nests annually (USFWS 2009).

In South Carolina, nesting (occurring mid-May to mid-August) is most likely to be carried out by loggerhead sea turtles, as their largest nesting concentrations are found in Florida, Georgia, South Carolina, and North Carolina. However, 80% of their nesting occurs in six coastal Florida counties (USFWS 2012d). Green sea turtles may, though not frequently, nest in South Carolina, as they nest in small numbers in the U.S. Virgin Islands, Puerto Rico, Georgia, South Carolina, and North Carolina, but in larger numbers in Florida and Hawaii (USFWS 2012c). They nest from June through September. Leatherback nesting in South Carolina is rare. NMFS has jurisdiction over sea turtles in water and USFWS has jurisdiction of the turtles on land (nesting and hatchling).

South Carolina “juvenile sea turtle guild” comprises Kemp’s Ridley sea turtle, green turtles, and hawksbill sea turtles. Individuals of these species may forage in both inshore and nearshore areas, including habitats in and near the proposed project area. These species, along with loggerhead sea turtles, are the species most affected by dredging operations in/near Charleston Harbor.

According to the USACE (2012) Sea Turtle Data Warehouse, over 20 years of sea turtle take data have been recorded for the Federal project area/Charleston Harbor Entrance Channel. Since 1991, 19 takes have been known to occur (Table 3) there; these affecting green sea turtles, loggerhead turtles, and Kemp’s Ridley sea turtles.

Table 3: Sea Turtle Take due to Dredging at Charleston Harbor Entrance Channel (Federal Project)

Year	New (N) or Maintenance (M) dredging	Dredged quantity (cy)	Number of takes (sp)	Number relocated
2012*	M	1,745,000	1(G)**	N/A
2004	M	1,449,234	3(L)***	7(L)
2000	N & M	5,627,386	5(L) 1(G)	2(L) 3(K)
1999	M	1,562,690	1(L)	N/A
1997	M	775,418	5(L)	2(L)
1991	N & M	376,425	3(L)	16(L) 1(K)

Key: G = green sea turtle; L = loggerhead sea turtle; K = Kemp’s Ridley sea turtle
*unverified, potentially incomplete project records; **one Atlantic sturgeon taken also; ***two Atlantic sturgeon relocated; Source: USACE (2012)

Amphibians. The frosted flatwoods salamander (*Ambystoma cingulatum*) is listed as threatened under the ESA and as endangered by the State of South Carolina. Figure 9 shows designated Critical Habitat north of Mount Pleasant, SC. That habitat comprises upland pine forest and grassland interspersed with forested and non-forested wetland.

Sturgeons. Both sturgeon species noted above are listed as endangered under ESA. Sturgeon typically feed in the slow-moving waters of large rivers in their lower estuaries (on benthic organisms) and spawn upstream in fresh water, usually on coarse substrates in more swift waters. NMFS (2012) noted that less than 300 adults are spawning in the Atlantic sturgeon Carolina District Population Segment (DPS). SCDNR (2010) stated that there appears to be one shortnose sturgeon populations in the Cooper River, another in the Santee River, and “there may also be a landlocked ("damlocked") population in the Santee-Cooper Lake System (Lakes Marion and Moultrie and tributary rivers).” The risk factors relating to sturgeon are briefly discussed above in the Diadromous Fish section of this report. Incidental take of Atlantic sturgeon is possible during dredging projects (see Table 3 notes above). Details pertaining to its life history and habitat requirements of these two species will be more fully addressed during ESA Section 7 consultation.

Migratory Birds

Although the seabird sanctuaries are known to provide necessary habitats for migratory bird species discussed above, many other species frequent the sanctuaries and other areas/habitats within and near the project area. Such birds roost and forage in surrounding coastal environments such as tidal flats, mud flats, and beaches during the winter months. Species likely to occur are listed in Table 4, along with their associated habitats. Some of the notable areas providing various habitat functions are detailed below. Many of these sites are not only used by bird species, but also by other vertebrate species that are associated with birds (in many cases preying on eggs, chicks, and fledglings).

Migratory bird species using sand/beach and mudflat habitats for nesting adjacent to navigational channels and waterways may be particularly sensitive to human disturbance. During such times, disturbance could cause unsuccessful nesting and/or death to chicks. Terns, pelicans, willet, and skimmers typically nest from April through July. Wood storks and plovers may use habitats adjacent to the harbor for feeding and roosting, and could be disturbed by vessels, construction, or other human activities.

Deveaux Bank, Bird Key Stono, and Crab Bank Seabird Sanctuaries. Several localities within and near Charleston Harbor are notable for their importance for local biota. In fact, some sites are so significant for nesting migratory birds, the state of South Carolina has closed them to human access for all or part of the year for the protection of nesting adults and their young. Deveaux Bank Seabird Sanctuary (located approximately 15 miles to the southwest of the harbor's entrance channel) is closed year-round (above the high tide line), while the Bird Key Stono Sanctuary (located approximately 10 miles to the southwest of the entrance channel) and Crab Bank Seabird Sanctuary (inside the harbor) are completely closed to boat landings (above the low tide line) from March 15 to October 15. The rest of the year, Crab Bank and Bird Key are closed above the high tide line but the intertidal zone is open. Typical bird species using these sites include black skimmers, brown pelicans, willet, Wilson's plover, and various tern species (Sandwich, least, royal, common, Forester's, and gull-billed). The sites are preferred due to both the availability of grounds for nest creation as well as forage, (e.g., supplying chicks with small fish).

SCDNR provided a nesting update for the above Charleston County sites (see Sanders 2012). For the 2012 nesting season, biologists observed 3,451 brown pelican, 4,198 royal tern, and 2,139 Sandwich tern, and 203 black skimmer nests across the three sanctuaries. SCDNR also noted that least terns (listed as "threatened" by the DNR) "attempted to nest on a few DNR properties [i.e., Botany Bay Plantation, approximately 17-18 miles to the southwest of the project area], but many nests were not successful this year due to a variety of reasons including flooding, predation and human disturbance." Of these species, black skimmers tend to nest later in the season and tend nests and fledgling chicks to at least the end of August.

Table 4: Migratory birds likely to occur in the project area

Common Name	Scientific Name	Sand/ Beach	Mud-flat	Pond	Salt Marsh	Open Water
American bittern	*Botaurus lentiginosus*				X	
American coot	*Fulica americana*			X		
American oystercatcher	*Haematopus palliatus*		X	X	X	
Bald eagle	*Haliaeetus leucoephalus*			X		X
Belted kingfisher	*Ceryle alcyon*			X		X
Black rail	*Laterallus jamaicensis*				X	
Black skimmer	*Rynchops niger*	X		X		X
Black-backed gull	*Larus marinus*	X	X	X		X
Black-bellied plover	*Pluvialis squatarola*	X	X			
Black-crowned night heron	*Nyticorax nycticorax*			X	X	
Black-necked stilt	*Himantopus mexicanus*	X	X	X		
Brown pelican	*Pelecanus occidentalis*				X	X
Clapper rail	*Fallus longirostris*				X	
Common moorhen	*Gallinula chloropus*			X		X
Common tern	*Sterna hirundo*	X		X	X	X
Double-crested cormorant	*Phalacrocorax auritus*			X		X
Dunlin	*Calidris alpina*	X	X			
Foresters tern	*Sterna forsteri*	X		X	X	X
Glossy ibis	*Plegadis falcinellus*		X	X	X	
Great blue heron	*Ardea herodias*			X	X	
Great egret	*Ardea alba*			X	X	
Greater yellowlegs	*Tringa melamoleuca*		X	X	X	
Gull-billed tern	*Sterna nilotica*	X		X		X
King rail	*Rallus elegans*				X	
Laughing gull	*Larus atricilla*	X	X	X		X
Least tern	*Sterna antillarum*	X		X		X
Little blue heron	*Egretta caerulea*		X	X		
Short-billed dowitcher	*Limnodromus griseus*		X	X		
Osprey	*Pandion haliateus*			X		X
Piping plover	*Charadrius melodus*	X	X			
Red knot	*Calidris canutus*	X	X		X	
Ring-billed gull	*Larus delawarensis*	X	X	X	X	X
Royal tern	*Sterna maxima*	X		X		X
Ruddy turnstone	*Arenaria interpres*	X	X			
Sanderling	*Calidris alba*	X	X			
Sandwich tern	*Sterna sandvicensis*	X		X		X
Semipalmated plover	*Charadrius semipalmatus*	X	X			
Snowy egret	*Egretta thula*		X	X		
Sora	*Porzana carolina*				X	
Spotted sandpiper	*Actitis macularia*	X	X			

Table 4: Migratory birds likely to occur in the project area (continued)*

Common Name	Scientific Name	Sand/ Beach	Mud-flat	Pond	Salt Marsh	Open Water
Tricolored heron	*Egretta tricolor*			X	X	
Virginia rail	*Rallus limicola*				X	
Whimbrel	*Numenius phaeopus*	X	X		X	
White ibis	*Eudocimus albus*		X	X		
Willet	*Catoptrophorus semipalmatus*	X	X			
Wilson's plover	*Charadrius wilsonia*	X	X			
Wood stork	*Mycteria americana*			X		X
Yellow rail	*Coturnicops noveboracensis*				X	
Yellow-crowned night heron	*Nyctanassa violacea*			X		X

*list is not exhaustive

Crab Bank. Crab bank is a 22-acre island that separates the main harbor from a small navigation channel (12-feet-deep) that enters Shem Creek (Figure 3). The island, which, at its nearest approach is 0.5 miles from the Federal channel, comprises Crab Bank Seabird Sanctuary, managed by the SCDNR (see Martin 2008 for a recent article on bird management at the site). SCDNR (2007) described Crab Bank in the following text:

> “This area has been designated as an "Important Bird Area" in South Carolina. The purpose of the Important Bird Area (IBA) program is to identify sites that provide vital habitat for birds using a scientific set of criteria. The Seabird Sanctuaries are sandspit islands formed by deposits from their associated river systems. The islands are dynamic and shift in position and structure due to erosion and deposition of sand. Two plant communities exist on the preserves: intertidal beach and maritime grasslands. The intertidal beach community consists of shifting sand beaches and regularly-flooded mud flats. If present, vegetation is sparse and consists of smooth cord grass, glasswort, marsh hay and sea purslane. Although all species may not nest on the island each year, examples of species that have used the island include: brown pelican, least tern, royal tern, black skimmer, gull-billed tern, sandwich tern, common tern, laughing gull, Wilson's plover, American oystercatcher, willet, great egret, snowy egret, tricolored heron and ibis. Besides providing nesting habitat, the sanctuary provides winter loafing and feeding areas for numerous species. The colonial nesting behavior of these birds makes them very susceptible to disturbance. Birds are densely packed into breeding sites during the nesting season, rendering the entire colony susceptible to disruption or destruction. Therefore, the sanctuary is closed to public use from March 15 thru October 15. The area may be viewed from boats during these months and is accessible to the public below the high water tidal line from October 16 thru March 14.”

Shutes Folly Island. Shutes Folly Island (seen in Figure 3, bottom of sheet) is in the central part of the harbor is one mile east of Charleston and nearly 0.25 mile from the Federal channel. Castle Pinckney, a historic structure originally constructed in 1810 (now privately owned). The island has beach and bay habitats that are used by various birds as well as managed fish species. In 2010, the island provided nesting sites for many snowy egret, tricolored heron, black skimmer, eastern brown pelican, gull-billed tern, and great egret (listed in decreasing dominance). There were also a dozen American oystercatchers nesting on the shell rakes at Castle Pinckney. Habitat types are the castle structure and washed oyster shell mounds around the edge. Recently, the property's ownership changed and the structure was cleared of vegetation. The structure supported no nesting in 2012 due to the lack of vegetation, but the shell rakes comprised typical skimmer, gull- billed tern, and oystercatcher nesting.

Cape Romain National Wildlife Refuge. Cape Romain National Wildlife Refuge (NWR) surrounds Bull Bay/Bull Harbor (Figure 5), just south of Francis Marion National Forest, and is bordered by the Atlantic Intracoastal Waterway (AIWW) on the north. Over 277 species of birds can be found on the NWR (USFWS 2009), with concentrations of shorebirds, wading birds, waterfowl and raptors. The refuge includes one of the largest nesting rookeries for brown pelicans, terns, and gulls on the South Carolina coast, and harbors one of the largest wintering populations of American oystercatchers on the east coast. Other common species on the refuge include bald eagles, endangered wood storks and, during the summer season, migratory songbirds such as the painted bunting (USFWS 2009).

Francis Marion National Forest. The southwestern corner of Francis Marion National Forest (FMNF) is only 10 miles upstream from Charleston Harbor (just past Mount Pleasant, SC) on the Wando River (Figure 5). Two special geological features can be found throughout the forest: Carolina bays and limestone sinks. There are about 25 well-defined Carolina Bays on the forest. All of the bays in the forest are protected, as are the forest's four federally-designated wilderness areas (USDA 2012). FMNF is also home to a variety of wildlife, including the endangered red-cockaded woodpecker (for details, see Protected Species section above).

Patriot's Point. Patriots Point (across the Cooper River from Charleston in Figure 3) houses a Naval and Maritime Museum, active recreational features, and scenic, natural areas. The tidal areas, nearby Shem's Creek, and open spaces (including a golf course) make the area attractive to various bird and other wildlife species.

Sullivan's Island. Sullivan's Island, shown in Figure 3 along the coast is an important habitat for both migratory birds and nesting sea turtles (see Protected Species discussion above).

Edisto Island Botany Bay Plantation/Edisto Beach State Park. Edisto Island Botany Bay Plantation/ Edisto Beach State Park is located approximately 17 or18 miles away from the project site, but is among the habitat resources available to migratory birds in the area. Least terns are known to nest there.

Confined Disposal Facilities. Confined Disposal Facilities (CDFs) areas are managed by federal, state and local entities for the purpose of depositing excess material collected during dredging events. These are scattered along the rivers, estuary, and coastal areas in the project area (Figure 5). Because dredged material may be deposited in CDFs as slurry that eventually "dewaters" or as sand, these areas may appear to have physical characteristics of ponds, mudflats, or sandy areas at various times during their use (or disuse). Birds (many listed in Table 4) seeking habitats of these types may be attracted to these areas, and some attempt nesting (even successfully so) in them as well.

Other Environmental Considerations

Upland disposal sites/ spoil islands. Spoil sites used for dredging have recently involved the Clouter Creek upland diked disposal areas (four cells). Morris Island (near the inlet), Drum Island (SCSPA site at the juncture of the Cooper and Wando Rivers) and the Daniel Island Disposal Area (another SCSPA site, north of Drum Island) have also been used in the past.

Hazardous, Toxic, and Radioactive Wastes. Previous maintenance dredging has been located in the existing navigation channel where dredging occurs on a twelve- to eighteen-month rotation. Because of the frequent dredging activity, hazardous or toxic wastes were not expected to be encountered. Sediments dredged from the harbor were tested in 2009 for the purposes of ocean disposal (USACE 2010). Sediments were tested most recently in 2012 for the proposed deepening project (USACE, 2013). The analysis confirmed that hazardous and toxic materials are not present in the sediments above levels of concern (see below "Offshore Dredged Material Disposal Sites" section and above discussion in "Harbor Sediments and Spoil Management" section).

Air Quality. The U.S. Environmental Protection Agency (EPA) Region 4 and the South Carolina Department of Health and Environmental Control, Bureau of Air Quality regulate air quality in South Carolina.

The project is located within the jurisdiction for air quality of the South Carolina Department of Health and Environmental Control (SCDHEC), Bureau of Air Quality. The air quality in Charleston and surrounding counties, South Carolina, are designated by SCDHEC as an attainment area for all six criteria pollutants. The ambient air quality for Charleston County, South Carolina has been determined to be in compliance with the National Ambient Air Quality Standards (Barnes 2009).

The Clean Air Act (42 U.S.C. 7401–7671q), as amended, gives EPA the responsibility for establishing the primary and secondary National Ambient Air Quality Standards (NAAQS) (40 CFR Part 50) that set acceptable concentration levels for six criteria pollutants: fine particulate matter (PM10), very fine particulate matter (PM2.5), sulfur dioxide, carbon monoxide, nitrous oxides (NO_x), ozone (O_3), and lead. Short-term standards (1-, 8-, and 24-hour periods) have been established for pollutants that contribute to acute health effects, while long-term standards (annual averages) have been established for pollutants that contribute to chronic health effects. On the basis of the severity of the pollution problem, areas that do not attain the standards are categorized as marginal, moderate, serious, severe, or extreme. Each state has the authority to adopt standards stricter than those established under the federal program; however, South Carolina accepts the federal standards (USEPA 2009).

EPA has defined Class I areas as those areas designated as pristine or wilderness areas and require more rigorous safeguard to prevent deterioration of the natural pristine air quality. Class III areas are planning areas set aside for industrial growth, and EPA sets higher increments in these areas. There are no Class III designations approved for South Carolina and specifically in the project area. Class II areas are all other areas of the state that are not either Class I or III.

The Cape Romain Wildlife Refuge (NWR) is the only Class I area located within 200 km of the proposed project. The NWR is located approximately 20 miles northeast of Charleston. Under the Clean Air Act, Class I areas are afforded extra protection from deterioration of air quality from permitted stationary sources. Stationary sources include facilities such as power plants and industrial processing plants. As a participant in the Federal Interagency Monitoring of Protected Visual Environments (IMPROVE) project, monitoring of particulate matter (PM-10 and PM-2.5) has been conducted at Cape Romain since September 1994. The U.S. Fish and Wildlife Service, which manages the National Wildlife Refuge system, is part of this cooperative monitoring program, along with the National Park system, the U.S. Forest Service, and the Bureau of Land Management. IMPROVE was established to ascertain visibility in Class I areas, identify sources of anthropogenic impairments to visibility, and determine trends in order to gauge progress toward fulfilling the long-term goal of no anthropogenic impairment of visibility or air quality in protected areas. The ambient concentrations within the Cape Romain Wildlife Refuge are well below the NAAQS of 150 g/m3 and 65 g/m3 for 24-hour average PM-10 and PM-2.5, respectively.

Offshore Dredged Material Disposal Sites. A site monitoring and management plan (SMMP) was completed for the Charleston Harbor ODMDS in 2005 (USACE 2005b). Monitoring of the sediments indicates that the levels of sediment contaminants within the disposal area and surrounding areas were low (Jutte 2005). EPA concurred with ocean disposal of sediments from Charleston Harbor in the ODMDS, most recently in 2010. (See also above discussion in “Harbor Sediments and Spoil Management” section).

PROBLEMS AND OPPORTUNITIES

The identification of problems and opportunities initiates the first step in the six-step planning process that Federal water resource agencies must use as described in the Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies, commonly called the “P&G.” A “problem” represents an existing undesirable condition to be considered for change. An “opportunity” provides a chance to create a future desirable condition. Meetings and coordination with the Sponsor (South Carolina State Ports Authority), terminal operators, the Charleston Branch (Harbor) Pilots’ Association, the U.S. Coast Guard, the Charleston Harbor Navigation Safety Committee, maritime interests, environmental resource agencies, and interested individuals attending a public workshop held on December 13, 2011, provided valuable information related to existing problems and concerns which provide opportunities for navigation improvements.

Navigation concerns include three main problems; insufficient Federal channel depths, difficult currents, and restrictive channel widths and turning basins. Larger ships currently experience transportation delays due to insufficient Federal channel depths. To reach port terminals, these larger ships must either be light loaded, anchor offshore to await favorable tide conditions, or both. These approaches require the vessel operator to forego potential transportation cost savings available from the economies of scale associated with larger ships. Ships drafting greater than 43 feet will be constrained by existing channel depths. Furthermore, restrictive channel widths limit ship passage to one-way traffic in many reaches and larger container ships require expanded turning basins. Finally, there have been allisions, collisions and groundings in the harbor concentrated in four areas. Strong and unpredictable ebb tide crosscurrents at the confluence of the Wando and Cooper Rivers make turns difficult in the channel reaches immediately north of the Ravenel Bridge.

PLANNING OBJECTIVES AND CONSTRAINTS

Planning objectives are statements that describe the desired results of the planning process by solving or alleviating the above problems and taking advantage of or realizing the opportunities. The following planning objectives were determined:

1) Reduce navigation transportation costs to and from Charleston Harbor to the extent possible over the period of analysis.

2) Develop an alternative that is environmentally sustainable for the period of analysis.

The optimal plan must also be acceptable from the NED perspective, as directed by the *Planning Guidance Notebook*, as well as from Environmental Quality (EQ) and Regional Economic Development (RED) perspectives, and to account for Other Social Effects (OSE). Plans will be formulated to be complete, effective, efficient and acceptable, and to reasonably maximize net benefits. In summary, these specific objectives to achieve these comprise the following:

1) Reduce the transportation cost of import and export trade through Charleston Harbor and contribute to increases in national economic development (NED)

2) Reduce navigation constraints facing harbor pilots and their operating practices including limited one-way traffic in certain reaches

Constraints are restrictions that limit the planning process. Constraints could include resources, legal, or policy constraints. Plan formulation involves meeting the study objectives while not violating constraints. Specific Post 45 study constraints include:

- Bridge (Ravenel Fixed and Don Holt) horizontal clearances and air draft restrictions. A full description of the bridge constraints can be found in the Existing Conditions section of the EIS.

- Underkeel Clearance: According to the US Coast Pilot, Chapter 6, page 276, the Charleston Harbor Pilots generally require a four foot margin for underkeel clearance, between the lowest point on the vessel's hull and the harbor bottom, for vessels transiting Charleston's waterways at normal harbor speeds. Evaluation of the pilot's data will provide the average minimum underkeel clearance observed throughout the entire trip. The need to include this extra depth could limit the overall design or project depth needed to achieve project objectives.

- Various federal and state regulations, including federal law, USACE regulations, executive orders and South Carolina state statutes.

- Maritime safety requirements

- Avoiding and minimizing impacts to any shallow water aquifers

- Avoiding and minimizing impacts to cultural resources

- Avoiding and minimizing impacts to any landside infrastructure

- Avoiding and minimizing impacts to any marine mammals, threatened or endangered species, and migratory birds

- Avoiding and minimizing impacts to dissolved oxygen

- Avoiding and minimizing impacts to special aquatic resources, specifically freshwater wetlands

ALTERNATIVES/ SELECTED PLAN

In addition to the future-without-project (FWOP) alternative (synonymous with NEPA No Action Alternative), USACE studied the degree to which six potential construction alternatives met project objectives. Differences among alternatives are primarily due to varying project depths. The alternatives, named according to the depths of the (1) Wando/Cooper River to Navy base reach and (2) Navy based to Ordnance Reach, analyzed include the following:

- Alternative 48-47: Channel widths are maximum widenings, transitions, bend easings and turning basin enlargements. Design depth is 50 feet MLLW in the entrance channel, 48 feet MLLW from Mt Pleasant range to Wando River up to Wando terminal (includes turning basin) and to Cooper River at proposed Navy Base terminal (includes turning basin). This includes the widener area in Customs House Reach, but the remainder of Customs House Reach, as well as Tidewater Reach, Town Creek Turning Basin and Lower Town Creek Reach remain at the Existing Condition design depths. Design depth is 47 feet MLLW from Daniel Island bend to Ordnance reach (includes turning basin). Assume SLR is 0.57 feet above existing level.

- Alternative 48-48: Channel widths are maximum widenings, transitions, bend easings and turning basin enlargements. Design depth is 50 feet MLLW in the entrance channel, 48 feet MLLW from Mt Pleasant range to Wando River up to Wando terminal (includes turning basin) and to Cooper River at proposed Navy Base terminal (includes turning basin). Design depth is 48 feet MLLW from Daniel Island bend to Ordnance reach (includes turning basin). Assume SLR is 0.57 feet above existing level.

- Alternative 50-47: Channel widths are maximum widenings, transitions, bend easings and turning basin enlargements. Design depth is 52 feet MLLW in the entrance channel, 50 feet MLLW from Mt Pleasant range to Wando River up to Wando terminal (includes turning basin) and to Cooper River at proposed Navy Base terminal (includes turning basin). Design depth is 47 feet MLLW from Daniel Island bend to Ordnance reach (includes turning basin). Assume SLR is 0.57 feet above existing level.

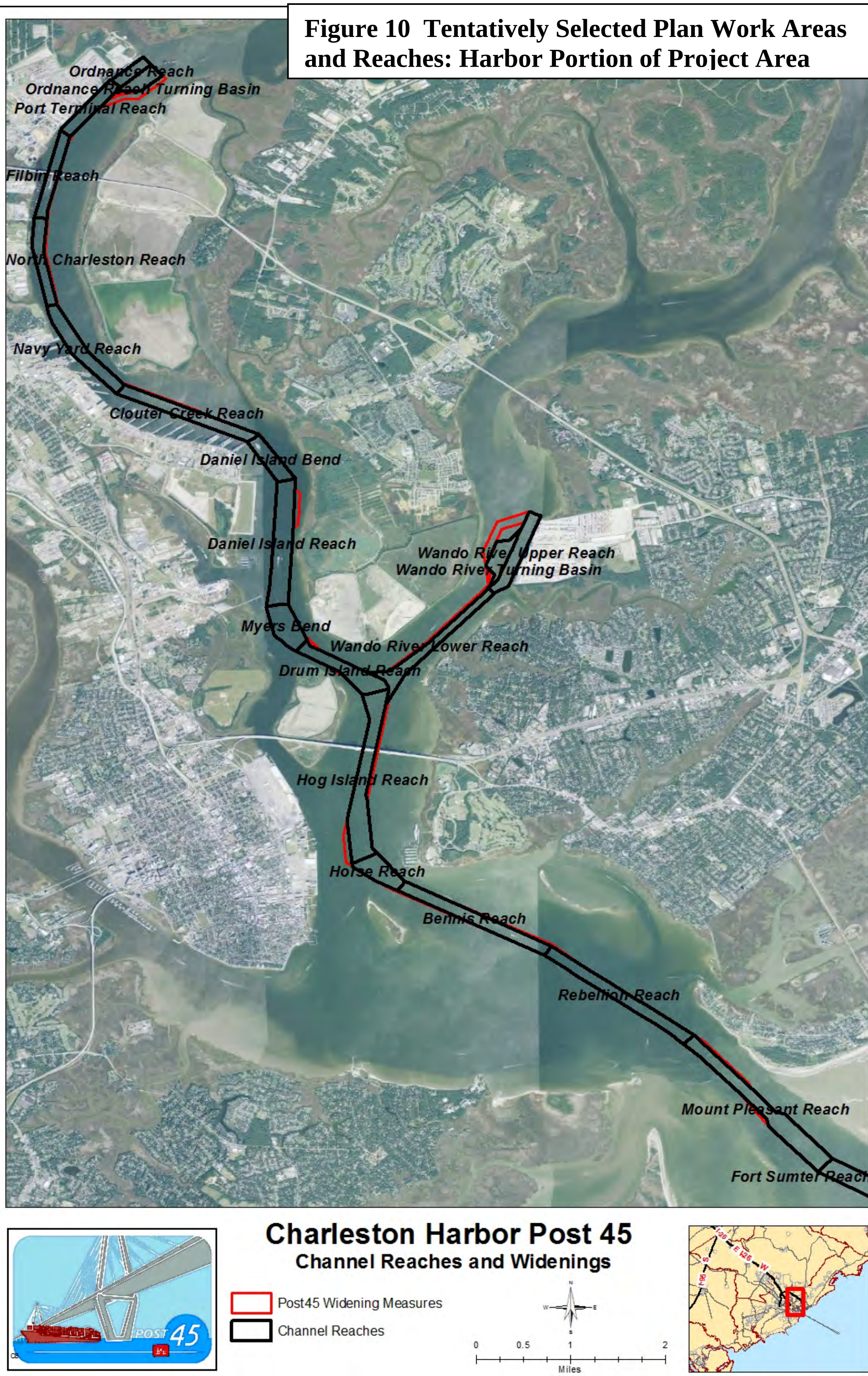
- Alternative 50-48: Channel widths are maximum widenings, transitions, bend easings and turning basin enlargements. Design depth is 52 feet MLLW in the entrance channel, 50 feet MLLW from Mt Pleasant range to Wando River up to Wando terminal (includes turning basin) and to Cooper River at proposed Navy Base terminal (includes turning basin). Design depth is 48 feet MLLW from Daniel Island bend to Ordnance reach (includes turning basin). Assume SLR is 0.57 feet above existing level. [This is the tentatively selected plan.]

- Alternative 52-47: Channel widths are maximum widenings, transitions, bend easings and turning basin enlargements. Design depth is 54 feet MLLW in the entrance channel, 52 feet MLLW from Mt Pleasant range to Wando River up to Wando terminal (includes turning basin) and to Cooper River at proposed Navy Base terminal (includes turning basin). Design depth is 47 feet MLLW from Daniel Island bend to Ordnance reach (includes turning basin). Assume SLR is 0.57 feet above existing level.

- <u>Alternative 52-48: Channel widths are maximum widenings, transitions, bend easings and turning basin enlargements. Design depth is 54 feet MLLW in the entrance channel, 52 feet MLLW from Mt Pleasant range to Wando River up to Wando terminal (includes turning basin) and to Cooper River at proposed Navy Base terminal (includes turning basin). Design depth is 48 feet MLLW from Daniel Island bend to Ordnance reach (includes turning basin). Assume SLR is 0.57 feet above existing level.</u>

For each alternative, two or three contraction dikes may be constructed near the Wando Welch Terminal and the Wando Reach of the Navigation Channel in order to minimize shoaling and reduce maintenance costs. The dikes would be extended shore perpendicular from the west bank of the river and would range from 350 ft to 840 ft in length. The proposed project is underlined above; it is Alternative 52-48*, shown in plan view in Figures 10 and11. The remainder of this CAR will focus on evaluating the effects of that alternative, and recommending measures to avoid and minimize such impacts, and recommend mitigation for unavoidable impacts.

Figure 10 Tentatively Selected Plan Work Areas and Reaches: Harbor Portion of Project Area



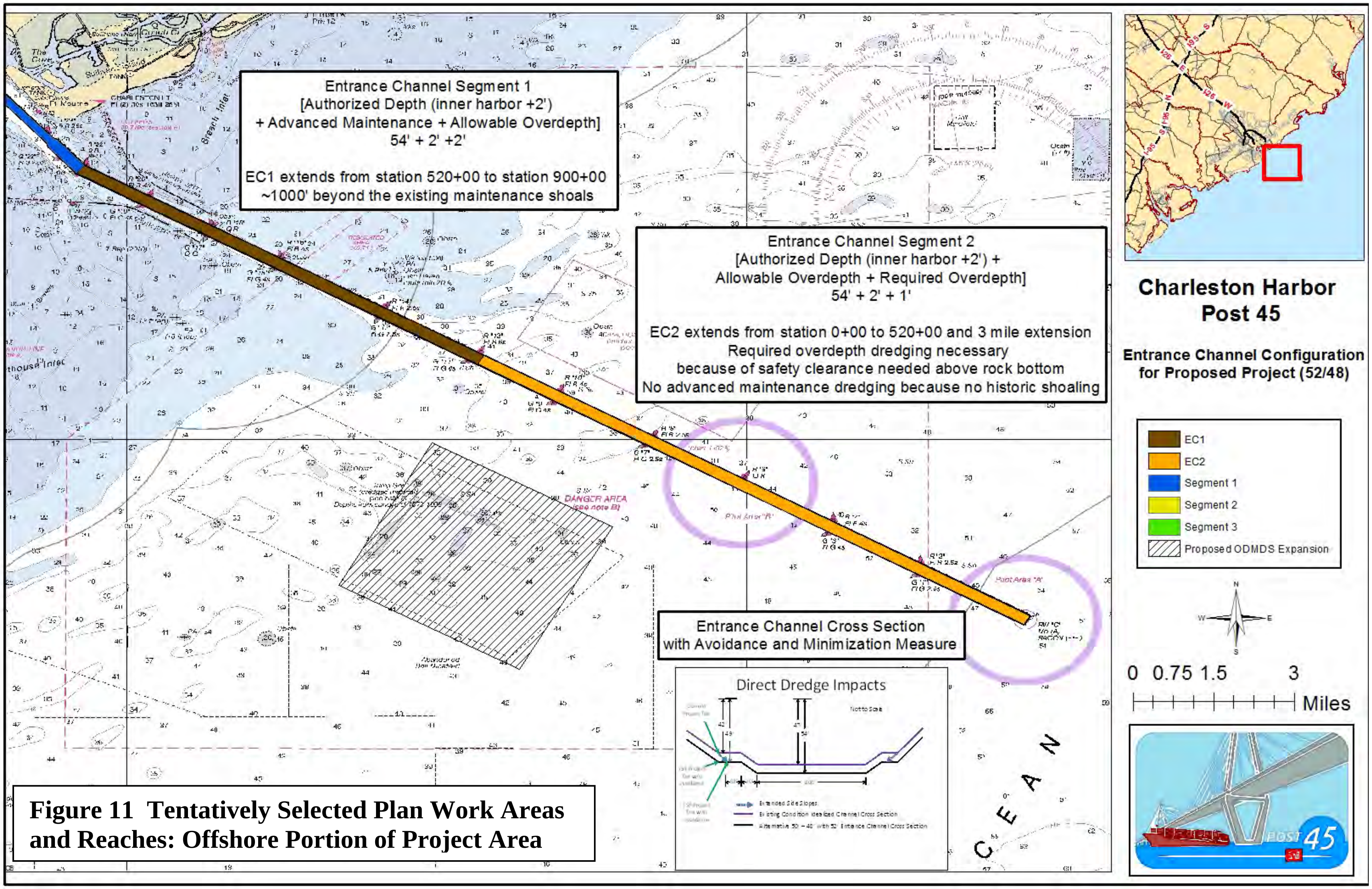


Figure 11 Tentatively Selected Plan Work Areas and Reaches: Offshore Portion of Project Area

USACE proposes to use as much dredged material as practicable for beneficial uses. Potential opportunities for beneficial use of dredged material include shorebird and/or colonial waterfowl habitat creation (e.g., Crab Bank, Shutes Folly, etc.), marsh creation, nearshore placement off of Morris Island, and marine hardbottom creation. Charleston District will evaluate all possible beneficial uses of dredged material during the feasibility study and will coordinate this evaluation with SCDHEC, SCDNR, USFWS, and NMFS. Details of any beneficial use concept will be explored during the Preconstruction Engineering and Design (PED) phase of the study. USACE stated that a thorough monitoring plan at any and all dredged material use sites, whether considered "beneficial" or not (at upland or offshore sites) will ensure that no adverse cumulative impacts to fish and wildlife occur.

PROJECT IMPACTS

Impacts due to the proposed action include direct and indirect impacts. From among the project area resources outline above, specific impacts to the following resources were identified by USACE: water quality, fisheries, hardbottom, estuarine and tidal freshwater wetlands, tidal palustrine forests, and other Essential Fish Habitats. USACE identified cumulative impacts in one of the appendices to the EIS.

Wetlands

USACE has determined that dredging operations for the proposed action would not directly affect existing wetlands; however the construction of two or three contraction dikes would directly affect a relatively small acreage of tidal saltmarsh and potentially oyster habitat. The exact acreage of these impacts is not yet determined because the exact locations of the dikes are uncertain. Indirect effects are predicted as a result of the deepening and widening of the channel. Specifically, slight changes in the vegetation assemblages may occur due to marginal increases in salinity of the Cooper and Ashley Rivers.

Changes in the salinity level of a wetland can alter the vegetative composition, soils, and habitat function of the system. Most of these effects would occur within tidal freshwater systems, as these systems are not typically adapted to experience high salinity concentrations for increased frequencies or durations. Plants that are not adapted to tolerate higher salinities will generally succumb and be replaced by those with higher tolerances. Higher salinities can increase the mineralization of nitrogen and phosphorous in soils, leading to "tree stress and senescence" as well as conversion to oligohaline marsh (Noe 2013). Increases in sulfate reduction can decrease organic matter content in the soil, reducing elevations and increasing flooding. Following deepening of the Cape Fear River channel, Hackney (2013) monitored wetland vegetation, salinity, pore water sulfate, and other parameters at riverine and estuarine sampling stations. Monitoring occurred over a ten-year period at a series of sites influenced by a variety of salinity and flooding regimes. The monitoring data suggested that wetland transition from tidal swamp to tidal marsh was caused by increasing sulfate in the soil as a result of inundation with sulfate-laden saline water.

With coordination from the Interagency Coordination Team, USACE developed a method to determine indirect impacts to tidally influenced freshwater marshes in the system (Wetland Impact Assessment Appendix, Main Report). The method involved the following rough steps: 1. Wetland delineation and classification, 2. Determining assessment reaches, 3. Determining length of river in assessment reaches, 4. Determining wetlands per river foot ratios, 5. Determining habitat coverage associated with assessment reaches, 5. Interpolating isopleths, and 7. Assessing wetland areas affected by the alternatives. Alternatives were evaluated based on the future without project condition, which assumes 50 years of historic sea level rise. Modeling efforts indicated that if the proposed project is constructed (the 52/48' Alternative), approximately 7.21 and 17.3 acres of palustrine forested wetlands and tidal freshwater marshes, respectively, along the Ashley River would be affected, and approximately 193.52 and 275.38 acres of palustrine forested wetlands and tidal freshwater marshes, respectively, along the Cooper River would be affected. In affected areas, some plant species intolerant of salinities ranging from 0.5 ppt to 5.0 ppt may decrease in percent coverage while others with tolerance would increase. Population densities and diversity of fish and wildlife are not anticipated to be adversely affected, as the areas will remain vegetated and provide expected wetland functions (bank stability, water storage, nutrient cycling, refuge and forage, etc.).

Table 5: Size (in acres) of Indirect Wetland Impacts by Project Alternative

Wetland Location/ Type	Alternative					
	48/47	48/48	50/47	50/48	52/47	52/48 (TSP)
Ashley River/ Forested	4.88	5.00	5.46	5.50	6.80	7.21
Ashley River/ Herbaceous	11.71	11.99	13.12	13.20	16.33	17.30
Cooper River/ Forested	89.59	97.46	104.48	111.28	189.47	193.52
Cooper River/ Herbaceous	127.49	138.70	148.69	158.36	269.62	275.38
Total	233.67	253.15	271.75	288.34	482.22	493.41

Interagency meetings resulted in a desire to understand what the impacts would be at the time of construction. For this analysis, USACE used the year 2022 to be the year the project would be completed. The 2022 impacts factored in 10 years of sea level rise (from 2012 baseline) and the following alternatives, 48/48, 50/48, and 52/48. Table 6 summarizes the wetland impacts on the Ashley and Cooper Rivers for each alternative. The results of this analysis found that the impacts were slightly smaller after only 10 years of sea level rise than with 50 years of sea level rise. Since the impacts will occur closer to this time frame, these numbers were ultimately used to determine compensatory mitigation requirements.

Table 6: Incremental wetland impacts for each alternative compared to the condition at the time of construction completion in 2022

Alternatives: Impacts at Time of Construction (Year 2022)			
Wetland Impacts	**48/48**	**50/48**	**52/48**
Ashley River forested wetlands	3.35 acres	4.88 acres	6.13 acres
Ashley River marsh wetlands	8.05 acres	11.71 acres	14.73 acres
Cooper River forested wetlands	45.09 acres	76.59 acres	107.34 acres
Cooper River marsh wetlands	64.17 acres	108.99 acres	152.76 acres
Total	**120.66 acres**	**201.77 acres**	**280.96 acres**

Essential Fish Habitats and Managed Fish Species

USACE identified the following potential effects of the proposed action on EFH and species managed under the Magnuson–Stevens Fishery Conservation and Management Act:

1. Direct mortality or injury of individual fishes (adults, subadults, juveniles, larvae, and/or eggs, depending on species, time of year, location, etc.) due to dredge equipment during construction and maintenance dredging (an effect temporary in duration).

2. Indirectly affecting foraging behavior of individuals through production of turbidity (specifically suspended solids) at construction/maintenance dredging sites (an effect temporary in duration)

3. Indirectly affecting movements of individuals around/away from dredging sites due to construction equipment and related disturbed benthic habitats (an effect temporary in duration).

4. Indirectly affecting foraging and refuge habitats by removal of benthic habitat (i.e., hardbottom) (an effect predicted to be temporary in duration); mitigation areas will compensate for functional losses, and new hardbottom may be exposed due to dredging.

5. Directly, but slightly, affecting water column DO and salinity in certain parts of the estuary (a permanent effect).

6. Indirectly affecting some fishes and invertebrates (not currently identified), which may move a short distance upstream if they are intolerant of slight increases in

salinity, or to other positions/microhabitats in the estuary if they are intolerant of slight shifts in DO (a permanent effect).

7. Indirectly affecting plant species composition and/or relative percent coverage in certain palustrine forested and emergent wetlands due to slight shifts in pore water salinity (a permanent effect). Wetland mitigation will be provided to compensate for functional losses of palustrine forested and emergent wetlands.

USACE stated that, individually or in sum, the majority of impacts described above are not anticipated to significantly adversely affect managed species or EFHs. Significant impacts to EFH will occur due to conversion of approximately 281 acres of freshwater wetlands to more saline conditions, and to approximately 29 acres of hardbottom habitat in the existing Entrance Channel. USACE indicates that, where possible, the above effects have been minimized via project design. USACE indicates that efforts to further minimize project impacts will occur, where practicable, during the Planning Engineering and Design Phase. Where necessary impacts remain, USACE will provide compensatory mitigation for habitats.

Other Fish and Shellfish

Direct Impacts

Direct impacts due to construction are anticipated to be minimal by USACE. Motile species can avoid the dredge equipment. However, there will be some entrainment of slow-moving benthic individuals as well as larvae and eggs (for both fishes and shellfishes) suspended in the water column. When practicable, seasonal "windows" for dredging will be observed by USACE contractors in order to ensure the availability of critical spawning and foraging locations and periods. For this project and for future O&M dredging, USACE indicated that they will adhere to a seasonal window at two SCDNR identified sciaenid fish species spawning hot spots. These two areas are at "the Grillage" and the base of the Ravenel Bridge.

- The Grillage: From April through September, dredging will not occur within Mt. Pleasant, Rebellion Reach or in Ft Sumter Reach between the jetties.
- Ravenel Bridge: From April through September, dredging will not occur within Hog Island Reach within a distance of 1000 ft on either side of the Bridge.

Indirect Impacts

In addition to fish species managed under the Magnuson–Stevens Act considered in the above section, USACE investigated potential impacts to several fish species based on habitat suitability index (HSI) model outputs and SCDNR fishery data. Species used in analyses included two sturgeon species (see "Protected Species" section below), red drum (*Sciaenops ocellatus*), striped bass (*Morone saxatilis*), blueback herring (*Alosa aestivalis*), and southern flounder (*Paralichthys lethostigma*). These species are representative of important families of fishes in the project area, and their respective life-history phases and behaviors require/use various niches within the inshore ecosystem. Impacts determined for these “indicator” species (by modeling future habitat suitability based on anticipated physical habitat change in salinity, water depth, DO, etc. and comparing to existing actual use by species) may also occur to other similar species in the estuary. USACE concluded the following in relation to potential impacts to these fishes from the proposed action:

1. For larval and juvenile red drum, there are many areas where habitat may *benefit* due to the proposed action. Many of these locations involve sites without species presence data. However, some of these habitats are located at or near locations where the species has been previously captured. See Appendix K of the Main Report/EIS for details.

2. Due to the proposed action, habitat suitability was predicted to *increase* for adult and juvenile striped bass at one location (comprising approximately a dozen model cells). The site/area did not correspond to a known capture site. Future-with-project conditions in approximately two-dozen model cells indicated decreases in striped bass spawning habitat suitability. No adult or juvenile bass were captured in the vicinity of those cells during two SCDNR sampling programs. See Appendix K of the Main Report/EIS for details.

3. Inconsequential amounts of habitat critical for juvenile blueback herring would be adversely affected by the proposed action. See Appendix K of the Main Report/EIS for details.

4. The proposed action may result in extremely slight adverse changes in southern flounder habitat for several areas, including some areas where the species was captured. However, there are no anticipated habitat changes for most/numerous locations where the species was captured. See Appendix K of the Main Report/EIS for details.

Many of the above conclusions were in part based on USACE predictions that future with-project conditions will involve very small changes to various water quality parameters when compared to future-without-project conditions. These minor changes may result in positive and/or negative alterations to water temperature, salinity, DO, and/or velocity (or no alterations in some cases). Subsequently, changes in these parameters affect modeled habitat suitability for various life-history phases and behaviors of studied fishes according to dredge depth (i.e., alternative). The modeled changes are likely smaller than the year-to-year variation in salinity zones, DO, temperature, etc. No habitats were anticipated to be adversely affected on a widespread basis throughout the project area due to the proposed action. Typically, the proposed action was predicted to affect habitat suitability in isolated model cells or in a small cluster of adjacent cells (resulting in the findings noted in the bullet list above).

Fishes and invertebrates utilizing hardbottom and wetland habitats are noted by USACE as being of particular importance. Indirect effects to fishes due to impacts to hardbottom resources are predicted. However, USACE anticipated that substrates will re-colonize and mitigation will ultimately increase the overall acreage of these habitats in the project area that are available for use by fishes and invertebrates (and foraging sea turtles as well). USACE also stated that there may be some minor alterations in the vegetative species composition of riparian wetlands (due to slight shifts in river salinity in the Cooper River, less so in the Ashley River), but subsequent indirect effects to fish and wildlife are not anticipated to result.

In addition to the above impacts, the potential construction of up to three contraction dikes along the west bank of the Wando River could impact an undetermined but small acreage of oyster reef habitat. Any impacts resulting from construction of these contraction dikes will be assessed and mitigated for after consultation with resource agencies.

Protected Species

USACE has indicated that effects to species protected under the Endangered Species Act of 1973 are not likely to be significant if the proposed project is constructed. However, USACE does indicate some potential effects to Atlantic sturgeon (*Acipencer oxyrinchus*) habitat and shortnose sturgeon (*Acipenser brevirostrum*) habitat.

Specifically, the HSI/fisheries analysis (the same series of analyses that produced other fish impacts noted above; it is an appendix to the EIS) stated that the proposed action may decrease adult Atlantic sturgeon habitat suitability in some areas of the harbor that appear to be affiliated with use by the species. Inconsequential amounts of habitat potentially used by Atlantic sturgeon for spawning would be adversely affected by the proposed action. The proposed action may decrease juvenile Atlantic sturgeon habitat suitability in several dozen model cells. Some of the areas/cells are near stations where the species was detected, but most are not near stations where the tags of individuals were detected. Areas important for Atlantic sturgeon egg and larvae habitat do *not* appear to be associated with cells predicted to decrease in suitability. These conclusions were based on water quality model results in conjunction with published water quality thresholds for the species (HSI was not used as no HSI model exists for the species). Note that USACE does not necessarily predict adverse effects to the *species*, but only effects to some potential habitat *areas*.

USACE also concluded in the HSI/Fisheries analysis that inconsequential amounts of habitat that may be useful for shortnose sturgeon during spawning and foraging behaviors would be adversely affected by the proposed action. HSI data were used to inform this conclusion.

Effects to the above and other protected species are discussed by USACE in the Post 45 Biological Assessment (included in the appendices of the EIS).

Migratory Birds

USACE does not anticipate that migratory birds will be adversely (directly or indirectly) affected by the proposed action. Neither will Critical Habitat for federally protected birds be affected (i.e., in the Cape Romain NWR, Francis Marion National Forest). Dredging operations will be conducted so as to not interfere with birds nesting on beaches adjacent to Federal channels within the harbor. USACE studies indicated that shorelines used by birds within the harbor will not be eroded any more in the future-with-project condition than in the without-project-condition. Moreover, USACE plans on discussing with agencies beneficial uses to mitigate inshore shoreline losses and increase available nesting areas for beach-nesting species. USACE will continue to operate its agreement with the Town of Folly Beach regarding any losses of coastal (i.e. on the ocean-side of the barrier islands) material due to downdrift sand shortages (due to interference from the jetties and entrance channel) in cooperation with the local sponsor. Both harbor and coastal beaches are important nesting, foraging, and loafing/roosting habitats for migratory birds.

Other Environmental Considerations

Air Quality

USACE evaluated air impacts resulting from Criteria Pollutants, hazardous air pollutants (HABs), and greenhouse gases. The US Environmental Protection Agency's (EPA's) "Current Methodologies in Preparing Mobile Source Port-Related Emission Inventories, Final Report, dated April 2009 provided the framework to determine all air emissions at the Port of Charleston and the analysis is documented within the Air Quality Appendix of the EIS. USACE noted that any impacts to air quality resulting from construction activities would be temporary and that the total increases in temporary air pollutants would be relatively minor to the existing point- and mobile-source emissions in the tri-county area. Following construction, the shift in vessel traffic will likely result in fewer ships (albeit larger ones) making calls to the port, which, in combination with more efficient fuels has been determined to actually decrease the total amount of air pollution resulting from vessels and cargo handling equipment when compared to the future without project (no action) alternative. No increase in emissions over the no action alternative is expected at any of the terminals within Charleston Harbor.

Water Quality

Dissolved Oxygen

USACE performed an evaluation of DO throughout the project area. The 2013 dissolved oxygen (DO) total maximum daily load (TMDL) revises and combines the existing 2002 Cooper River-Wando River-Charleston Harbor TMDL ("Cooper TMDL") and the 2003 Ashley River TMDL ("Ashley TMDL"). The revised TMDL is for Charleston Harbor, Cooper, Ashley and Wando Rivers DO TMDL ("Charleston Harbor TMDL"). The basis for this revision is a new 3-Dimensional Environmental Fluid Dynamics Code model (EFDC) model covering the entire system completed in 2008, a revised DO standard as amended in the South Carolina Pollution Control Act in 2010 (adopted in South Carolina Regulation 61-68), and subsequent reallocation of the TMDLs led by the Berkeley-Charleston-Dorchester Council of Governments (BCDCOG, see http://www.bcdcog.com/).

Many of the waters in the Charleston Harbor area are known to experience naturally low DO levels that do not attain established numeric criteria. Inclusion of these sites not supporting the aquatic life use has been based on the reasonable potential that anti-degradation requirements under South Carolina Regulation 61-68 (S.C. R.61-68), Section D.4.a, are not maintained due to impacts from point sources or other activities causing more than 0.1 mg/L DO depression.

The revised TMDL allows additional loading compared to the previous TMDLs due in part to a more accurate model. The new model more accurately represents estuarine circulation in Charleston Harbor and the Cooper River and freshwater flow to the upper Ashley River resulting in higher predicted dilution and allowable effluent loading throughout the system.

This TMDL includes final limits for continuous NPDES permitted dischargers in the system; however, the revised Charleston Harbor TMDL is not a fixed number. The total waste load allocation (WLA) may vary depending on the locations of the individual loads in relation to the critical segments. A “TMDL calculator” spreadsheet tool was developed based on the EFDC model. The TMDL calculator computes the DO depression at the critical locations in the estuary in response to various combinations of individual NPDES wastewater loads. The BCDCOG used the calculator to facilitate the wasteload allocation process. The BCDCOG approved allocation included in this TMDL is one possible combination of individual WLAs shown by modeling to achieve the TMDL target of 0.1 mg/L allowable DO depression. Future reallocations, and changes in the total WLA, are possible without further revision of the TMDL provided the TMDL target is maintained as shown by the EFDC model and/or TMDL calculator.

Recent model runs of the EFDC model for the proposed action (Post-45) indicate the maximum depth alternative of 52 feet in Wando and Lower Cooper River and 48 feet in the Cooper River above the new Navy Base terminal would not have significant effect on the TMDL WLA. Plots compare the WLA impacts before the project and after the project. The DO impacts from point-source discharges estimated by the TMDL (Cantrell 2013) are not used for this cumulative impacts analysis. The TMDL is conservative because it was calculated based on the assumption that all of the discharges are constantly and simultaneously discharging at the maximum permitted load. This assumption does not recognize the time-varying nature of the individual point-source discharge loading rates, which is particularly important for a system with multiple point-source dischargers. USACE coordinated with the EPA and SCDHEC a more realistic evaluation of cumulative impacts of the project and dischargers. A description of the analysis can be found within the EIS and Appendix A of the Main Report/EIS.

The results of the time-varying discharge modeling provide an estimate of DO impacts that are smaller than those estimated by the 2013 TMDL. The analysis of measured daily point-source discharge monitoring data presented in this study show that the average ultimate oxygen demand (UOD) loading rate into the estuary is about 33,000 lbs/day, including increases in average point-source discharge flow rates to account for 5 years of future growth. In contrast, the 2013 TMDL allocates a UOD loading rate of almost 145,000 lbs/day to the point-source discharges, which is assumed to be discharged into the estuary constantly at the maximum permitted limits. Therefore, the 2013 TMDL study that used constant point-source loading rates predicts greater DO impacts in the estuary than the results shown by this evaluation. The more accurate characterization of the point-source loads used for this study allows for a more accurate assessment of the cumulative impacts caused by the proposed Post 45 project and NPDES dischargers.

The results indicate that the cumulative DO impacts resulting from both the point-source pollution discharges into the estuary and the proposed Post 45 Project navigation channel expansion will not cause cumulative DO impacts greater than the 0.1 mg/L allowed by DHEC's anti-degradation rule. As a result, DO impact mitigation should not be required to offset Post 45 project impacts in order to comply with the anti-degradation rule. Because of this and the HSI models showing that DO does not significantly affect various fish species, USACE anticipates that long term impacts from reductions in DO will not significantly adversely affect aquatic species.

Turbidity

USACE stated that water quality impacts due to turbidity from construction activities in the harbor and channels would be temporary due to implementation of construction best management plans (BMPs) including dredge shut-down protocols. USACE also stated that water quality impacts due to turbidity from dredged material deposition at the Charleston ODMDS would also be temporary, but to ensure protection of nearby sensitive marine benthic habitats (notably, hardbottom), a rigorous and detailed monitoring plan will be implemented. Turbidity from the effluent from dewatering of material at confined upland disposal sites could be a concern for regulatory agencies. USACE indicated they would comply with water quality certification requirements issued by SCDHEC.

Hazardous, Toxic, and Radioactive Substances

No effects from hazardous, toxic, and radioactive (HTRW) substances on waters in the project area are anticipated by USACE. Protocols for protecting waters from oil, grease and other construction-equipment-related contaminants will be required of contractors.

USACE stated that it collected samples and conducted physical/chemical, toxicological, and bioaccumulation evaluations on sediment samples for the purpose of determining where and how sediment dredged during potential deepening can be disposed. Laboratory results indicated that dredged material meets requirements for disposal of sediments offshore at the Charleston ODMDS. Results of the testing was documented by USACE in an MPRSA Section 103 evaluation, which was subsequently approved by the EPA.

Offshore Dredged Material Disposal Sites

Use of the ODMDS will be regulated by the conditions of its governing documents. USACE does not predict any adverse impacts to habitats adjacent to the ODMDS. USACE is currently working with the EPA on a Section 102 (MPRSA) modification of the existing

ODMDS. The SCDNR has recommended that at least some of the rock material dredged from the navigation channel be used to extend the existing berm along portions of the southern and western boundaries of the ODMDS, in order to contain any fine-grained dredged material within the ODMDS and prevent its migration onto nearby hardbottom habitat.

Upland disposal sites/ spoil islands

No additional upland disposal sites are anticipated. USACE will ensure that no adverse conditions result from construction in these managed areas. Dredged material will be tested for HTRW levels prior to disposal, and runoff will be monitored to ensure that downstream habitats are not adversely affected by turbidity or any other pollutants.

USACE-PROPOSED MITIGATION

Wetlands

USACE proposes to mitigate for the lost functions of tidally influenced, freshwater wetlands resulting from indirect water-quality effects. The wetland impact assessment method determined that up to 280.96 acres of wetlands may be affected in the Cooper and Ashley Rivers. Indirect impacts are expected to occur through a shift from very low salinity wetlands to slightly higher salinity brackish marsh. Changes in the salinity level of a wetland can alter the vegetative composition, soils, and habitat function of the system. Most of these effects would occur within oligohaline and tidal freshwater systems, as these systems are not typically adapted to high salinity concentrations at increased frequencies or durations. Plants that cannot tolerate higher salinities will generally be replaced by those that can. USACE anticipates that due to the wide salinity tolerance of many vegetation species along the rivers, only a portion of the community will undergo replacement.

Determination of appropriate mitigation for wetland impacts resulting from the Post 45 project is necessarily unconventional, as is that the nature of predicted impacts are different than those typically mitigated for under Section 404 of the Clean Water Act, those being filling, clearing, draining or converting from one wetland type to another, e.g., forested to emergent. USACE models indicate that Post 45 impacts will result in a gradual transition of some freshwater and oligohaline plant communities to a less diverse, more salt-tolerant plant community. USACE performed a functional analyses to determine the appropriate type and acreage of mitigation using the Uniform Mitigation Assessment Method (UMAM), which is used in Florida projects but is not geographically restrictive due to model inputs or conclusions. A discussion of the use of UMAM can be found within the EIS and associated Appendices. UMAM results and a contingency factor indicate that the TSP could require approximately 831 acres of mitigation by purchasing wetlands for preservation.

Mitigation options included the use of mitigation banks, restoration/enhancement, or purchase of conservation easements or properties for preservation/enhancement. Property acquisition of lands within the FMNF proclamation boundary is considered by USACE to be a feasible alternative. Any acquired lands would be conveyed to the U.S. Forest Service for incorporation into the FNMF. Potentially suitable lands consist of complex mosaics of upland

and wetland communities, with extensive ecotones (providing habitat variability) running northeast to southwest. Wetlands include both flowing and isolated palustrine habitats. Other tracts comprise current and former wetlands that were converted to inland ricefields at the time of European settlement, but which have since succeeded to forest stands dominated by pond cypress, red maple, laurel oak, and sweetgum. Uplands are primarily longleaf pine woodland or savannah, historical longleaf areas converted to loblolly pine plantation, and southern maritime forest. These tracts lie in proximity to one of the largest remaining expanses of longleaf pine forest, a reservoir for rare, threatened and endangered species. The surrounding FMNF was recently identified as a Significant Geographic Area for the maintenance and restoration of longleaf pine. The tracts are also proximal to the extensive marshes and estuaries of the Cape Romain NWR, a Class I Wilderness area.

In addition to the indirect impacts noted above, the project may involve some direct impacts to saltwater tidal wetlands (acreage unknown at this time, as plan is conceptual) due to the construction of up to three contraction dikes along the Wando River. If determined to be necessary during PED, these impacts will be assessed using UMAM and mitigated for by restoration of tidally impounded wetlands within Charleston Harbor. A recent NMFS study of potential tidal creek/wetland restoration sites can be used to identify appropriate mitigation sites.

Oyster Reefs

Oyster reefs impacted from the potential construction of contraction dikes will be mitigated by creation of oyster reefs within the Charleston Harbor area. The site determination of these reefs will be determined through coordination with the SCDNR oyster program.

Hardbottom

USACE is attempting to avoid all direct impacts to known and probable hardbottom habitat along the edge of the channel by refining channel design such that the cross-section indicates continuation of the same side slope from the existing channel down to the new proposed depth (rather than pushing the side slopes back farther to accommodate additional depth. Nevertheless, there are previously un-dredged areas in the navigation channel that currently support hardbottom habitat. These areas are within the area authorized to be maintained at 47’+2’+2’, but due to existing deep water and lack of shoaling in some areas, some of these areas of the channel have not been dredged (as either post-authorization new work material or as maintenance dredging since the last deepening project). USACE determined that the proposed project may impact up to 28.6 acres of known and potential hardbottom within these previously un-dredged areas in the authorized channel. While existing hardbottom habitats will be dredged to project depth, those same areas will uncover deeper hardbottom substrates, which will be available for potential colonization, albeit subject to periodic (but infrequent) maintenance dredging.

USACE-performed habitat equivalency analyses (HEA) indicated that the proposed action would require 29.7 acres of mitigation. The selected alternative involves using dredged limestone rock from the entrance channel and depositing it in a designated mitigation area adjacent to the Charleston Post 45 entrance channel, between the Charleston ODMDS and the entrance channel. The proposed mitigation involves use of dredged material (limestone rock) transported to a designated area to construct a marine patch reef feature. Each placement will be surrounded by a halo of sand or native material, because interspersed sand patches near the hardbottom habitat are thought to be important in ecological function. An excavator or clamshell dredge would permit the largest diameter material to comprise the reef. However, use of a cutterhead suction dredge could minimize costs.

The designated mitigation area will be adjacent to the Charleston entrance channel, between the Charleston ODMDS and the channel. Water depths in the mitigation area are between 35 and 50 feet. The new reef feature will consist of individual low relief mounds separated by existing bottom service area (sand substrate). The reef feature is designed to provide bathymetric anomalies, hard bottom surfaces material, habitat diversity, and stability.

Construction of the mitigation area will take place during the construction of the project, such that suitable rock material excavated from the channel can be used for reef building and to minimize any temporal lag in providing functional habitat substrates.

USFWS EVALUATION OF PLAN AND MITIGATION

The focus of this evaluation includes the proposed action (the plan most likely to be executed) intended to expand and deepen the Federal channels at Charleston Harbor. This USFWS evaluation does not consider the use of an existing, permitted ODMDS, or the use of an ODMDS that may be modified and separately permitted (and hence, reviewed via National Environmental Protection Act (NEPA) and ESA regulations) in the future.

USFWS has concerns that the project may be dredged more deeply than is absolutely necessary, and that opportunities to avoid and minimize impacts are being overlooked. If the vast majority of vessels can still call at the port with selection of a shallower additional depth plan, USFWS prefers that plan is selected. If the proposed plan only allows a few additional ships than would be allowed to call with a new, shallower depth, dredging more deeply may be unwarranted. Increasing harbor and channel depths more than necessary increases not only impacts (in acres) to hardbottom and unconsolidated subtidal habitats, but also increases indirect impacts to water quality due to increased salinity and decreased DO. Riparian freshwater wetlands would be adversely affected by increases in salinity, which may destroy existing vegetation and cause a shift in fish and macroinvertebrate populations upstream. The estuarine water column would be adversely affected by both increases in salinity and decreases in DO particularly during periods of drought and seasonally high water temperatures.

Although USACE contractors will utilize BMPs during project construction, direct and indirect impacts to valuable fish and wildlife populations and habitats are likely to occur. USFWS requests that USACE allow dredging to occur only during seasonal windows that would decrease the risk of death and injury to fishes and shellfish (eggs, larvae, and adults), as well as sea turtles. Protected species monitoring protocols on dredge vessels will also be required under Section 7 of the Endangered Species Act. Plans should include measures to minimize the effects of lighting and noise on the movements of wildlife, particularly species protected under ESA and the Migratory Bird Treaty Act. If upland disposal sites are used and dewatered portions of the sites are used for nesting by birds, young must be fledged prior to pumping spoil onto the sites.

Finally, USFWS requests further coordination with all state and federal natural resource agencies regarding which mitigation options for direct and indirect impacts to wetlands will be selected and how they will be implemented, as the large number of acres necessary to offset impacts will incur considerable cost and require careful planning and implementation as well as comprehensive monitoring and adaptive management.

USFWS concurs with USACE's efforts to incorporate beneficial use of dredge material (e.g., at Crab Bank and/or Shutes Folly, etc) and will assist in coordinating a plan that will have net beneficial effects on fish and wildlife.

Additional recommendations to USACE for this project's potential effects on species protected under the Endangered Species Act of 1973 will be detailed during Section 7 consultation.

UNCERTAINTY AND RISK

The U.S. EPA considers "risk" to be the chance of harmful effects to human health or to ecological systems resulting from exposure to an environmental stressor. "Uncertainty" refers to our inability to determine an outcome with certainty…(USEPA 2012). For the proposed project, risks include death and injuries to fish and wildlife as well as habitats. Habitats that may be affected beyond our certainty to predict impacts include wetlands, hardbottom, and estuarine and marine waters. For example, USACE risks unforeseen impacts to hardbottom if dredge material leaks from scows and covers the habitat. Larger areas of tidal freshwater and brackish wetlands could be adversely affected if salinity increases exceed model predictions for the Cooper and Ashley Rivers. Turbidity plumes from dredging could exceed permitted levels prior to their being observed and abated. Sensitive life-history phases, such as eggs and larvae of fishes and invertebrates could be adversely affected more than predicted if spawning occurs slightly outside the predicted time-frame and overlaps with allowable dredging windows. Estimates of indirect impacts, particularly due to changes in salinity and dissolved oxygen could be inaccurate. Finally, mitigation efforts could fail due to a number of unforeseen circumstances.

MONITORING AND ADAPTIVE MANAGEMENT

Details below indicate the minimum standards required for monitoring both project impacts as well as compensatory mitigation. If monitoring indicates that impacts exceed those that were expected, or if mitigation success is lacking, corrective action must be proposed and executed such that the size and extent of mitigation is commensurate with habitat losses. Furthermore, if additional avoidance and minimization can be achieved during the

Preliminary Engineering Design (PED) phase or during construction, less mitigation may be required, and coordination with relevant agencies should be engaged to that end.

Monitoring for effects on water quality and protected species should be part of the proposed project, as well as for success of proposed wetland and hardbottom mitigation (see below). Consultations with the USFWS and the Biological Opinion from NOAA will detail necessary monitoring for protected species. Monitoring for water quality associated with dredge and ODMDS areas must conform to permit conditions. Standard water quality monitoring of receiving waterbodies near any effluents from upland confined disposal facilities (CDFs) should be conducted at least twice daily during the deposition of materials and as materials are being dewatered (if applicable). Monitoring positions should be downstream of any discharges from spoil sites. If no detectable flow is apparent, the monitoring stations should be downstream of the tidal current. A reference station should be established upstream from any effluent discharges or tidal currents for comparison to project-area samples. If dissolved oxygen levels are significantly lower, or temperatures or turbidity are significantly higher than the background/control site, deposition rates should be attenuated or the operation should be halted until water quality parameters return to ambient levels. Failure to do so may result in unnecessary adverse effects to eggs and larvae of certain fish and invertebrate species, and interfere with fish spawning and foraging activities in nearby areas.

Monitoring of hardbottom areas should include PED phase, construction, and post-construction components for both impact areas, impact-adjacent areas, potential mitigation areas, and comparable reference sites. Each biological monitoring survey must include underwater documentation surveys of the mitigation area, including both in situ data collection and video documentation to record conditions observed during the survey. The monitoring plan should be designed to allow the habitat and faunal community at the mitigation area to be compared to the impact and reference areas, as well as document that hardbottom areas adjacent to the impact area have not been adversely affected.

Monitoring of wetland impact and mitigation areas should include both baseline surveys as well as post-construction surveys. Establishing survey transects (in areas of anticipated habitat change and in comparable reference areas) for monitoring vegetation type and health in addition to pore-water salinity is an important component. These should also be established beyond the area of anticipated change in the event that modeled projections underestimated the extent of salinity intrusion or other indirect impacts. Results should be corrected for the effects of relative sea level rise. Baseline and post-preservation/enhancement monitoring of mitigation areas should also be conducted in accordance with mitigation policies governing implementation of South Carolina’s Section 401 program and USACE’s 404 program. Success criteria should be based on outputs from UMAM analyses.

RECOMMENDATIONS AND USFWS POSITION

Recommendations

To date, USACE has not requested section 7 consultation with USFWS or NMFS. In preface to Section 7 consultation, the USFWS provides the following suggestions regarding protected species for USACE use, analysis, and implementation, as undertaking these measures will also afford benefits to fish and wildlife species associated with protected species, and using the same habitats:

1. USACE must make all practicable efforts to avoid collisions between dredging equipment (and support vessels) and West Indian manatee, particularly during construction activities occurring during summer months, and engage measures to minimize the risks of collisions. Measures may include the use of task-dedicated marine mammal observers/spotters on all vessels who alert vessel operators of the presence of the species. Any collision with and/or injury to a manatee shall be reported immediately to Jim Valade of the U.S. Fish and Wildlife Service, North Florida Field Office, at (904) 731-3116.

2. USACE must make all practicable efforts to avoid collisions, entrainment in dredging equipment, and other disturbances affecting loggerhead, green, leatherback, and Kemp's Ridley sea turtles. In the event that a turtle is injured or killed, USACE must contact the SCDNR stranding hotline in Charleston at 1-843-633-1639.

3. USACE must make all practicable efforts to avoid collisions, entrainment in dredging equipment, and other disturbances affecting the shortnose sturgeon and Atlantic sturgeon, and adopt measures to minimize the risk of such disturbances and any resulting casualties.

4. USACE must make all practicable efforts to avoid noise and other disturbances affecting wood stork, particularly during its nesting season (March through August), and adopt measures to minimize the risk of such disturbances.

5. USACE must make all practicable efforts to avoid effects to piping plover due to dredging and disposal activities (noise and other disturbances, as well as habitat alteration) within or near potential wintering areas, and adopt measures to minimize the risk of such effects.

6. USACE must make all practicable efforts to avoid effects to the red knot, as it is proposed for listing under the ESA and may gain full federal protection prior to construction of the proposed project.

7. USACE reconsider the option to construct contraction dikes, as these may result in barriers for sturgeon and manatee movement.

Furthermore, USFWS recommends the following for implementation throughout the project area:

8. USACE should coordinate with local, state, and federal resource agencies to investigate opportunities for reusing non-contaminated, dredged material to restore coastal habitats such as Crab Bank, Castle Pinckney (Shutes Folly), and Morris Island.

9. USACE should continue to use the Unified Mitigation Assessment Method (UMAM) in order to determine functional value of wetlands to be affected by brackish water intrusion and to calculate compensation for the anticipated functional loss of wetlands. Adaptive management techniques for use following construction should be in part based on the UMAM effort to ensure adequate compensation and long-term consistency in determining both impacts and mitigation success.

10. To minimize effects on migratory birds during nighttime dredging activities, all lighting for dredge equipment, barges, and support vessels must be directed downward toward the work area. No omnidirectional or skyward pointed lights may be utilized.

11. USACE should reconsider the option to construct contraction dikes, as these may result in navigation safety issues, unpredictable sedimentation and erosion effects, and oyster and wetland impacts.

Pursuant to the Magnuson-Stevens Act, USFWS recommends the following:

12. USACE will seek consultation with NMFS Habitat Conservation Division if EFH is adversely affected in order to develop EFH avoidance and minimization measures. Where avoidance and minimization is not feasible, restoration for lost EFH or improvements to existing EFH should be considered and implemented.

Pursuant to coordination with the state of South Carolina, USFWS recommends the following:

13. USACE must provide assurances that the deposition of sediments in spoil areas will not exceed the boundaries of the spoil areas either directly or via subsequent overflow/repose of material.

14. USACE must provide that it will use best available technology to confine any fine material to designated Confined Upland Disposal Facilities (CDFs) if upland disposal is determined to be necessary for the project.

15. USACE must never use any unconfined areas for spoil disposal (except for renourishment at such areas as Crab Bank, Castle Pinckney, or Morris Island (using dredged material comparable to the native sediments in grain-size, mineralogy, and organic carbon content. Only beach compatible sand should be used for Morris Island).

16. USACE should limit dredging in sensitive areas (i.e. The Grillage) to the cooler months of the year to protect juvenile shrimp, crabs and finfish, as well as to avoid periods of peak recreational fishing activity near the inlet, the Grillage and other congregating areas.

USFWS Position

In conclusion, implementation of the Tentatively Selected Plan may impact fish and wildlife resources directly and indirectly as a result of dredging. The fish and wildlife resources likely to be directly and indirectly affected include the estuarine water column, freshwater tidal wetlands, low-relief hardbottom, and unconsolidated bottom habitat. USACE has proposed that the USACE avoid and minimize potential adverse effects through dredging (if that activity proves necessary) to a shallower depth, vacating plans for in-stream contraction dikes, and the implementation of listed species protection plans during construction activities. USFWS also encourages USACE to develop measures for improving DO conditions in Charleston Harbor, although it is acknowledged that many methods may be outside their jurisdiction. Protection of recreational opportunities (i.e., fishing) is another priority for USFWS, and avoiding dredging near sportfish congregating and spawning areas during critical periods is strongly encouraged. Finally, USFWS recommends the development of a comprehensive (pre-, during, and post-project) environmental monitoring program to verify that project impacts do not exceed model predictions and to ensure that the mitigation areas are performing to a level where habitat replacement values are maintained. We encourage USACE to continue to work with resource agencies to develop several suitable alternative mitigation plans and look forward to our ongoing cooperation in determining suitable impact minimization actions.

COORDINATION WITH STATE AND FEDERAL WILDLIFE AGENCIES

To date, the following coordination with state and Federal resource agencies has occurred:

- Oct 4, 2011: Interagency Coordination Team kickoff meeting/scoping meeting
- November 22, 2011: Sediment testing ICT meeting
- December 11, 2011: Environmental Fluid Dynamics Code (EFDC) ICT meeting
- December 2011 – January 2012: multiple commenting mechanisms for EFDC data collection plan
- July 25, 2012: CAR kickoff meeting
- December 5, 2012: ICT study progress report (ICT update)
- February 19, 2013: ICT distribution of cultural resources and hardbottom resources report
- February 25, 2013: EFDC calibration meeting
- April 29, 2013: Beneficial use of dredged material ICT meeting
- May 23, 2013: ICT study progress report (ICT update)
- June 12, 2013: ICT distribution of minutes from DHEC/USACE meeting on DO and TMDL analysis

- July 26, 2013: ICT distribution of wetlands characterization report
- August 6, 2013: ICT distribution of sediment contaminants report
- September 20, 2013: ICT study progress report (ICT update)
- September 20, 2013: ICT distribution of diving report on 3 potential cultural resource anomalies
- November 20, 2013: ICT meeting on hardbottom habitat and wetland impact methodology
- December 11, 2013: ICT meeting on dissolved oxygen impacts and Habitat Suitability Index results
- February 13, 2014: Hardbottom habitat impact determination meeting
- April 16-17, 2014: ICT meeting on wetlands mitigation determination using UMAM – field work on the Cooper River
- April 23, 2014: ICT distribution of UMAM scoring for Cooper River wetlands
- June 6, 2014: ICT distribution of hardbottom habitat impact assessment, HEA findings, mitigation concept, and monitoring/adaptive management plan
- June – July 2014: Informal consultation with NMFS and USFWS on Draft Biological Assessment findings
- June – July 2014: Informal coordination with NOAA on Essential Fish Habitat assessment

LITERATURE CITED

Adams, J. G. 1970. Clupeids in the Altamaha River. Georgia. Georgia Game and Fish Commission, Coastal Fisheries Division, Contribution Series No. 20, Brunswick, Georgia.

Adams, J. G., and M. W. Street. 1969. Notes on the spawning and embryological development of blueback herring, *Alosa aestivalis* (Mitchill), in the Altamaha River, Georgia. Georgia Game and Fish Commission, Coastal Fisheries Division, Contribution Series No. 16, Brunswick, Georgia.

ASMFC (Atlantic States Marine Fisheries Commission). 1985. Fishery management plan for the anadromous alosid stocks of the Eastern United States: American shad, hickory shad, alewife, and blueback herring. ASMFC Fishery Management Report No. 6, Washington, D.C.

ASMFC (Atlantic States Marine Fisheries Commission). 1988. Supplement to the fishery management plan for the anadromous alosid stocks of the eastern United States: American shad, hickory shad, alewife, and blueback herring. ASMFC Fishery Management Report No. 12, Washington, D.C.

ASMFC (Atlantic States Marine Fisheries Commission). 1999. Amendment 1 to the interstate fishery management plan for shad and river herring. ASMFC Fishery Management Report No. 35, Washington, D.C.

ASMFC (Atlantic States Marine Fisheries Commission). 1999. Amendment 1 to the interstate fishery management plan for shad and Adams and Street 1969.

Auld, A. H., and J. R. Schubel. 1978. Effects of suspended sediments on fish eggs and larvae: A laboratory assessment. Estuarine and Coastal Marine Science 6: 153-164.

Barbin, G. P., and W. H. Krueger. 1994. Behavior and swimming performance of elvers of the American eel, *Anguilla rostrata*, in an experimental flume. Journal of Fish Biology 45: 111-121.

Bilkovic, D. M., C. H. Hershner, and J. E. Olney. 2002. Macroscale assessment of American shad spawning and nursery habitat in the Mattaponi and Pamunkey Rivers, Virginia. North American Journal of Fisheries Management 22: 1176-1192.

Boger, R. A. 2002. Development of a watershed and stream-reach spawning habitat model for river herring (*Alosa pseudoharengus* and *A. aestivalis*). Doctoral dissertation. The College of William and Mary, Williamsburg, Virginia.

Bulak, J. S., and R. W. Christie. 1981. Santee-Cooper blueback herring studies. South Carolina Wildlife and Marine Resources Department, Annual Progress Report No. SCR 1-5, Columbia, South Carolina.

Bulak, J. S., J. S. Tuten, and T. A. Curtis. 1979. Santee-Cooper blueback herring studies. Annual Progress Report Project No. SCR 1-3: 1 Jan. 1979 to 30 Sept. 1979. South Carolina

Wildlife and Marine Resources Department, Division of Wildlife and Freshwater Fisheries, Barnwell, South Carolina.

Cairns, D. K., J. C. Shiao, Y. Iizuka, W. -N Tzeng, and C. D. MacPherson. 2004. Movement patterns of American eels in an impounded watercourse, as indicated by otoliths microchemistry. North American Journal of Fisheries Management 24: 452-458.

Chappelear, S. J., and D. W. Cooke. 1994. Blueback herring behavior in the tailrace of the St. Stephen dam and fishlock. Pages 108-112 in J. E. Cooper, R. T. Eades, R. J. Klauda, and J. G. Loesch, editors. Anadromous Alosa Symposium, Tidewater Chapter, American Fisheries Society, Bethesda, Maryland.

Christie, R. W. 1978. Spawning distributing of blueback herring, *Alosa aestivalis* (Mitchill) in abandoned rice fields and tributaries of the west branch of the Cooper River, South Carolina. Masters thesis. Clemson University, Clemson, South Carolina.

Christie, R. W., P. T. Walker, A. G. Eversole, and T. A. Curtis. 1981. Distribution of spawning blueback herring on the West Branch of Cooper River and the Santee River, South Carolina. Proceedings of the Annual Conference of the Southeastern Association of Fish and Wildlife Agencies 35: 632-640.

Collette, B., and G. Klein-MacPhee, editors. 2002. Bigelow and Schroeder's fishes of the Gulf of Maine, 3rd edition. Smithsonian Institution Press, Washington, D.C.

Collette, B., and G. Klein-MacPhee, editors. 2002. Bigelow and Schroeder's fishes of the Gulf of Maine, 3rd edition. Smithsonian Institution Press, Washington, D.C.

Cooke, D. W., and S. D. Leach. 2003. Beneficial effects of increased river flow and upstream fish passage on anadromous alosine stocks. Pages 331-338 in K. E. Limburg, and J. R. Waldeman, editors. Biodiversity, status, and conservation of the world's shads. American Fisheries Society Symposium 35, Bethesda, Maryland.

Cooke, D. W., and S. D. Leach. 2003. Beneficial effects of increased river flow and upstream fish passage on anadromous alosine stocks. Pages 331-338 in K. E. Limburg, and J. R. Waldeman, editors. Biodiversity, status, and conservation of the world's shads. American Fisheries Society Symposium 35, Bethesda, Maryland.

Crecco, V. A. 1982. Overview of alewife and blueback herring runs in Connecticut. Report to Atlantic States Marine Fisheries Commission, Alosid Scientific and Statistical Committee, Washington, D.C.

Crecco, V. A., and T. Savoy. 1984. Effects of fluctuations in hydrographic conditions on yearclass strength of American shad (*Alosa sapidissima*) in the Connecticut River. Canadian Journal of Fisheries and Aquatic Sciences 41: 1216-1223.

Crecco, V. A., T. Savoy, and W. Whitworth. 1986. Effects of density-dependent and climatic factors on American shad, *Alosa sapidissima*, recruitment: A predictive approach. Canadian Journal of Fisheries and Aquatic Sciences 43: 457-463.

Curtis, T. A., R. W. Christie, and J. S. Bulak. 1982. Santee-Cooper blueback herring studies. South Carolina Wildlife and Marine Resources Department, Annual Progress Report No. SCR-1-6, Columbia, South Carolina.

Davis, J. R., and R. P. Cheek. 1966. Distribution, food habits, and growth of young clupeids, Cape Fear river system, North Carolina. Proceedings of the Annual Conference of the Southeastern Association of Game and Fish Commissioners 20: 250-260.

Dorfman, D., and J. Westman. 1970. Responses of some anadromous fishes to varied oxygen concentrations and increased temperatures. Rutgers University OWRR Project No. B- 012-NJ, New Brunswick, New Jersey.

Euston, E. T., D. D. Royer, and C. L. Simmons. 1997. Relationship of emigration of silver American eels (*Anguilla rostrata*) to environmental variables at a low hydro station. Pages 549-558 *in* D. J. Mahoney, editor. Proceedings of the International Conference of Hydropower, August 5-8, 1997, Atlanta, Georgia. American Society of Civil Engineers, New York.

Euston, E. T., D. D. Royer, and C. L. Simmons. 1998. American eels and hydro plants: Clues to eel passage. Hydro Review August: 94-103.

Eversole, A. G., C. J. Kempton, C. S. Thomason, and R. S. Slack. 1994. Blueback herring distribution and relative abundance in the Santee-Cooper system: Before and after rediversion. Pages 64-71 *in* J. E. Cooper, R. T. Eades, R. J. Klauda, and J. G. Loesch, editors. Anadromous Alosa Symposium, Tidewater Chapter, American Fisheries Society, Bethesda, Maryland.

Facey, D. E., and G. S. Helfman. 1985. Reproductive migrations of American eels in Georgia. Proceedings of the 39th Annual Conference of the Southeastern Association of Fish and Wildlife Agencies 39: 132-138.

Facey, D. E., and M. J. Van den Avyle. 1987. Species profiles: Life histories and environmental requirements of coastal fishes and invertebrates (North Atlantic) –American eel. U.S. Fish and Wildlife Service Biological Report No. 82(11.74), and U.S. Army Corps of Engineers Report No. TR EL-82-4, Washington, DC.

Fay, C. W., R. J. Neves, and G. B. Pardue. 1983. Species profiles: Life histories and environmental requirements of coastal fishes and invertebrates (mid-Atlantic) – alewife/blueback herring. U.S. Fish and Wildlife Service, Division of Biological Services Report No. FWS/OBS-82/11.9, and U.S. Army Corps of Engineers Report No. TR EL- 82-4, Washington, D.C.

Frankensteen, E. D. 1976. Genus Alosa in a channelized and an unchannelized creek of the Tar River basin, North Carolina. Masters thesis. East Carolina University, Greenville, North Carolina.

Godwin, W. F., and J. G. Adams. 1969. Young clupeids of the Altamaha River, Georgia. Georgia Game and Fish Commission, Marine Fisheries Division Contribution Series No. 15, Atlanta, Georgia.

Green, K. E., J. L. Zimmerman, R. W. Laney and J. C. Thomas-Blate. 2009. Atlantic Coast Diadromous Fish Habitat: A Review of Utilization, Threats, Recommendations for Conservation, and Research Needs. Atlantic States Marine Fisheries Commission Habitat Management Series #9. Washington, D.C. 465 pp.

Griffith, G.E., Omernik, J.M., Comstock, J.A., Schafale, M.P., McNab, W.H., Lenat, D.R., MacPherson, T.F., Glover, J.B., and Shelburne, V.B. 2002. Ecoregions of North Carolina and South Carolina, (color poster with map, descriptive text, summary tables, and photographs): Reston, Virginia, U.S. Geological Survey (map scale 1:1,500,000).

Gulf Engineers and Consultants (GEC). 1994. Sediment Boring and Charleston Harbor, Cooper River South Carolina. Baton Rouge, LA.

Hansen, R. A., and A. G. Eversole. 1984. Age, growth, and sex ratio of American eels in brackish water portions of a South Carolina River. Transactions of the American Fisheries Society 113: 744-749.

Haro, A. J., and W. H. Krueger. 1991. Pigmentation, otolith rings, and upstream migration of juvenile American eels (*Anguilla rostrata*) in a coastal Rhode Island stream. Canadian Journal of Zoology 69: 812-814.

Harris, J. E., and J. E. Hightower. 2007. Relative abundance of migratory fishes within a restored braided-channel habitat below the Roanoke Rapids Dam. Annual Report to Dominion. North Carolina Cooperative Fish and Wildlife Research Unit, North Carolina State University, Raleigh, North Carolina.

Hildebrand, S. F. 1963. Family Clupeidae. Pages 257-454 in H. B. Bigelow, editor. Fishes of the Western North Atlantic, part 3. Sears Foundation for Marine Research, Yale University, New Haven, Connecticut.

Johnston, C. E., and J. C. Cheverie. 1988. Observations on the diel and seasonal drift of eggs and larvae of anadromous rainbow smelt, *Osmerus mordax*, and blueback herring, *Alosa aestivalis*, in a coastal stream on Prince Edward Island. Canadian Field Naturalist 102: 508-514.

Jones, P. W., F. D. Martin, and J. D. Hardy, Jr. 1978. Development of fishes of the mid-Atlantic Bight: An atlas of egg, larval and juvenile stages, volume I, Acipenseridae through Ictaluridae. U.S. Fish and Wildlife Service Report No. FWS/OBS-78/12, Washington, D.C.

Jutte, P.C. et al. 2005. An Environmental Assessment of the Charleston Ocean Dredged Material Disposal Site and Surrounding Areas: Physical and Biological Conditions of the Charleston Harbor Deepening Project. South Carolina Department of Natural Resources, Marine Resources Research Institute.

Kibler, D. 2008. Sharks, bull redfish make Charleston Harbor hot spots come alive. South Carolina Sportsman. Website: http://www.southcarolinasportsman.com/details.php?id=647.

Klauda, R. J., S. A. Fischer, L. W. Hall, Jr., and J. A. Sullivan. 1991. American shad and hickory shad. Pages 9.1-9.27 *in* S. L. Funderburk, J. A. Mihursky, S. J. Jordan, and D. Riley, editors. Habitat requirements for Chesapeake Bay living resources, 2nd edition. Chesapeake Bay Program, Living Resources Subcommittee, Annapolis, Maryland.

Klauda, R. J., S. A. Fischer, L. W. Hall, Jr., and J. A. Sullivan. 1991. Alewife and blueback herring; *Alosa pseudoharengus* and *Alosa aestivalis*. Pages 10.1-10.29 in S. L. Funderburk, J. A. Mihursky, S. J. Jordan, and D. Riley, editors. Habitat requirements for Chesapeake Bay living resources, 2nd Edition. Chesapeake Bay Program, Living Resources Subcommittee, Annapolis, Maryland.

Lamson, H. M., J. -C. Shiao, Y. Lizuka, W. -N. Tzeng, and D. H. Cairns. 2006. Movement patterns of American eels *(Anguilla rostrata*) between salt and fresh water in a coastal watershed, based on otolith microchemistry. Marine Biology 149: 1567-1576.

Leggett, W. C., and R. R. Whitney. 1972. Water temperature and the migrations of American shad. Fisheries Bulletin 70: 659-670.

Leim, A. H. 1924. The life-history of the shad (*Alosa sapidissima* (Wilson)) with special reference to the factors limiting its abundance. Contributions To Canadian Biology, New Series 2: 161-284.

Limburg, K. E., K. A. Hattala, and A. Kahnle. 2003. American shad in its native range. Pages 125-140 *in* K. E. Limburg, and J. R. Waldman, editors. Biodiversity, status, and conservation of the world's shads. American Fisheries Society Symposium 35, Bethesda, Maryland.

Loesch, J. G. 1987. Overview of life history aspects of anadromous alewife and blueback herring in freshwater habitats. Pages 89-103 in M. J. Dadswell, R. J. Klauda, C. M. Moffitt, and R. L. Saunders, editors. Common strategies of anadromous and catadromous fishes. American Fisheries Society Symposium 1, Bethesda, Maryland.

Loesch, J. G., and W. A. Lund, Jr. 1977. A contribution to the life history of the blueback herring, *Alosa aestivalis*. Transactions of the American Fisheries Society 106: 583-589.

Mansueti, R. J. 1962. Eggs, larvae, and young of the hickory shad, *Alosa mediocris*, with comments on its ecology in the estuary. Chesapeake Science 3: 173-205.

Martin, A. 2008. For the Birds. South Carolina Wildlife. Website: http://www.dnr.sc.gov/magazine/pubs/mayjune2008/forthebirds.html.

Massman, W. H. 1953. Relative abundance of young fishes in Virginia estuaries. Transactions of the North America Wildlife Conference 18: 439-449.

Massmann, W. H. 1952. Characteristics of spawning areas of shad, *Alosa sapidissima* (Wilson), in some Virginia streams. Transactions of the American Fisheries Society 81: 78-93.

McCleave, J. D., and G. S. Wippelhauser. 1987. Behavioral aspects of selective tidal stream transport in juvenile American eels. Pages 138-150 *in* M. J. Dadswell, R. J. Klauda, C. M. Moffitt, and R. L. Saunders, editors. Common strategies of anadromous and catadromous fishes. American Fisheries Society Symposium 1, Bethesda, Maryland.

McCleave, J. D., and R. C. Kleckner. 1985. Oceanic migrations of Atlantic eels (*Anguilla* spp.): Adults and their offspring. Contributions in Marine Science 27: 316-337.

McCord, J. W. 2003. Alosid habitats for South Carolina watersheds. South Carolina Department of Natural Resources, Office of Fisheries Management, Diadromous Fisheries Program, Charleston, South Carolina.

McCord, J. W. 2003. Alosid habitats for South Carolina watersheds. South Carolina Department of Natural Resources, Office of Fisheries Management, Diadromous Fisheries Program, Charleston, South Carolina.

McCord, J. W. 2003. Investigation of fisheries parameters for anadromous fishes in South Carolina. Completion Report to NMFS, 1 Mar. 1998 – 28 Feb. 2001, Project No. AFC- 53. South Carolina Department of Natural Resources, Charleston, South Carolina.

Meador, M. R. 1982. Occurrence and distribution of larval fish in the Santee River system. Masters thesis. Clemson University, Clemson, South Carolina.

Meador, M. R., A. G. Eversole, and J. S. Bulak. 1984. Utilization of portions of the Santee River system by spawning blueback herring. North American Journal of Fisheries Management 4: 155-163.

Morrison, W. E., D. H. Secor, and P. M. Piccoli. 2003. Estuarine habitat use by Hudson River American eels as determined by otolith strontium: calcium ratios. Pages 87-99 *in* D. A. Dixon, editor. Biology, management, and protection of catadromous eels. American Fisheries Society, Symposium 33, Bethesda, Maryland.

Moser, M. L., and S. W. Ross. 1994. Effects of changing current regime and river discharge on the estuarine phase of anadromous fish migration. Pages 343-347 in K. R. Dyer, and R. J. Orth, editors. Changes in fluxes in estuaries: Implications from science to management. Olsen and Olsen, Fredensborg, Denmark.

Murdy, E. O., R. S. Birdsong, and J. A. Musick. 1997. Fishes of Chesapeake Bay. Smithsonian Institution Press, Washington, D.C.

Murphy, T.M., and D.B. Griffin. (Undated). Florida Manatee. SC Department of Natural Resources. Website: http://www.dnr.sc.gov/cwcs/pdf/FloridaManatee.pdf.

National Marine Fisheries Service (NMFS). 2012. Atlantic Sturgeon Carolina Distinct Population Segment: Endangered (brochure). Website: http://www.nmfs.noaa.gov/pr/pdfs/species/atlanticsturgeon_carolina_dps.pdf.

National Oceanic and Atmospheric Administration (NOAA). 2009. Bottlenose dolphin (*Tursiops truncatus*) Charleston Estuarine System Stock. NEFSC. 7 pp.

Nichols, J. T., and C. M Breder, Jr. 1927. The marine fishes of New York and southern New England. Zoologica (New York) 9: 1-192.

Orth, D. J., and R. J. White. 1993. Stream habitat management. Pages 205-230 *in* C. C. Kohler, and W. A. Hubert, editors. Inland fisheries management in North America. American Fisheries Society, Bethesda, Maryland.

Pacheco, A. L., and G. C. Grant. 1973. Immature fishes associated with larval Atlantic menhaden at Indian River Inlet, Delaware, 1958-1961. Pages 78-117 *in* A. L. Pacheco, editor. Proceedings of a workshop on egg, larval, and juvenile stages of fish in Atlantic coast estuaries. Sandy Hook Laboratory Technical Series Report No. 1, Sandy Hook, New Jersey.

Pate, P. P. 1972. Life history aspects of the hickory shad, *Alosa mediocris* (Mitchill), in the Neuse River, North Carolina. Masters thesis. North Carolina State University, Raleigh, North Carolina.

Perlmutter, A., E. E. Schmidt, and E. Leff. 1967. Distribution and abundance of fish along the shores of the lower Hudson River during the summer of 1965. New York Fish and Game Journal 14: 46-75.

Peterson, B. 2012. Students help make 3-D images of the Grillage. The Post and Courier. Website: http://www.postandcourier.com/article/20120319/PC1602/303199925.

Richkus, W. A., and K. G. Whalen. 1999. American eel (*Anguilla rostrata*) scoping study report. Final Report, March 1999 by Versar, Inc., prepared for Electric Power Research Institute, Palo Alto, California.

Ross, R. M., R. M Bennett, and T. W. H. Backman. 1993. Habitat use and spawning adult, egg, and larval American Shad in the Delaware River. Rivers 4: 227-238.

Rulifson, R. A., C. Cahoon, and J. L. Cudney. 2004. Critical habitat assessment and population demographics of the American eel fishery in Northwestern Pamlico Sound, North Carolina. Final Report for the North Carolina Sea Grant Fishery Resource Grant Program, Project No. 02-EP-13.

Sanders, F. 2012. Highlights from the seabird nesting season at DNR bird sanctuaries. DNR News. SC Department of Natural Resources. Website: http://dnr.sc.gov/news/yr2012/aug30/aug30_bird.html.

Santee Cooper. 2009a. Field Studies and Reports. Website: https://www.santeecooper.com/portal/page/portal/santeecooper/environment/fercrelicensing/fercfieldstudies.

Santee Cooper. 2009b. Lake Information. Website: https://www.santeecooper.com/portal/page/portal/santeecooper/environment/vacationingthelakes/lake%20and%20stream%20data.

Schwartz, F. 2003. Sharks, Skates, and Rays of the Carolinas. University of North Carolina Press.

Sheldon, W. W., and J. D. McCleave. 1985. Abundance of glass eels of the American eel, *Anguilla rostrata*, in mid-channel and near shore during estuarine migration. Naturaliste Canadien 112: 425-430.

South Atlantic Fishery Management Council (SAFMC).1998. Final Habitat Plan for the South Atlantic region: Essential Fish Habitat Requirements for Fishery Management Plans of the South Atlantic Fishery Management Council. SAFMC. Charleston, SC. 457 pp.

South Carolina Department of Health and Environmental Control (SCDHEC). 2002. Total Maximum Daily Load (TMDL), Cooper River, Wando River, Charleston Harbor System, South Carolina. SCDHEC Bureau of Water. 22 pp.

South Carolina Department of Health and Environmental Control (SCDHEC). 2003. Total Maximum Daily Load (TMDL), Ashley River, South Carolina. SCDHEC Bureau of Water. 14 pp.

South Carolina Department of Health and Environmental Control. 2006. State of South Carolina Integrated Report for 2006. Part I: Listing of Impaired waters. Website: http://www.scdhec.gov/environment/water/docs/06_303d.pdf.

South Carolina Department of Natural Resources (SCDNR). 2007. Crab Bank Seabird Sanctuary. Website:. https://www.dnr.sc.gov/mlands/managedland?p_id=215.

South Carolina Department of Natural Resources (SCDNR). 2010. Shortnose Sturgeon *Acipenser brevirostrum,* Website: http://www.dnr.sc.gov/marine/mrri/diadrofish/shortnosesturg.html.

South Carolina Department of Natural Resources (SCDNR). 2011a. Marine – Species. Website: http://www.dnr.sc.gov/marine/species/index.html.

South Carolina Department of Natural Resources (SCDNR). 2011b. Lake Marion. Website: http://www.dnr.sc.gov/lakes/marion/description.html.

South Carolina Department of Natural Resources (SCDNR). 2011c. Lake Moultrie. Website: http://www.dnr.sc.gov/lakes/moultrie/description.html.

South Carolina Ports Authority (SCSPA). 2012. South Carolina Ports Fact Sheet. SCSPA. Charleston, SC. 1 p.

Stevenson, C. H. 1899. The shad fisheries of the Atlantic coast of the United States. Pages 101-269 *in* Report of the Commission for 1898, part 24. U.S. Commission of Fish and Fisheries.

Street, M. W. 1970. Some aspects of the life histories of hickory shad, *Alosa mediocris* (Mitchill), and blueback herring, *Alosa aestivalis* (Mitchill), in the Altamaha River, Georgia. Masters thesis. University of Georgia, Athens, Georgia.

Street, M. W. 1970. Some aspects of the life histories of hickory shad, *Alosa mediocris* (Mitchill), and blueback herring, *Alosa aestivalis* (Mitchill), in the Altamaha River, Georgia. Masters thesis. University of Georgia, Athens, Georgia.

Street, M.W., A.S. Deaton, W.S. Chappell, and P.D. Mooreside. 2005. North Carolina Coastal Habitat Protection Plan. North Carolina Department of Environment and Natural Resources, Division of Marine Fisheries, Morehead City, NC. Accessed March 2009. Available online at http://www.ncfisheries.net/habitat/chppdocs /F_Wetlands.pdf.

U.S. Army Corps of Engineers (USACE). 2005a. MPRSA Evaluation: Charleston Harbor, Lower Town Creek/Cooper River Maintenance Dredging New Testing. USACE Charleston District.

U.S. Army Corps of Engineers (USACE). 2005b. Charleston Ocean Dredged Material Disposal Site, Site Management and Monitoring Plan. USACE Charleston District.

U.S. Army Corps of Engineers (USACE). 2006. Final Environmental Impact Statement, Proposed Marine Container Terminal at the Charleston Naval Complex, North Charleston, South Carolina. Charleston District USACE, Charleston, SC. Available at http://www.porteis.com/project/documents.htm.

U.S. Army Corps of Engineers (USACE). 2009. Final Environmental Assessment, Charleston Harbor Additional Advanced Maintenance Dredging, Charleston Harbor, South Carolina. Charleston District USACE, Charleston, SC. 33 pp.

U.S. Army Corps of Engineers (USACE). 2010. Section 103 Evaluation of Dredged Material Proposed for Ocean Disposal, Charleston Lower Harbor and Entrance Channel, Charleston, South Carolina. Charleston District USACE.

U.S. Army Corps of Engineers (USACE). 2012. USACE Sea Turtle Data Warehouse. Engineer Research and Development Center. Website: http://el.erdc.usace.army.mil/seaturtles/list.cfm?Code=Project&Step=2&Type=SAC.

U.S. Army Corps of Engineers (USACE). 2013. Draft Charleston Harbor Navigation Improvement Project (Post 45) Dredging MPRSA Section 103 Sediment Testing and Analysis Report.

U.S. Census Bureau. 2011. State and County QuickFacts. Charleston, South Carolina. http://quickfacts.census.gov/qfd/states/45/4513330.html.

U.S. Department of Agriculture (USDA). 2012. Discover the Francis Marion and Sumter National Forests. Website: http://www.fs.usda.gov/scnfs.

U.S. Environmental Protection Agency (USEPA). 2012. Risk Assessment Basic Information. Website last updated on 7/31/12: http://www.epa.gov/risk_assessment/basicinformation.htm.

U.S. Fish and Wildlife Service (USFWS). 1980. Fish and Wildlife Coordination Act Report for Charleston Harbor Deepening. Charleston, SC. 23 pp.

U.S. Fish and Wildlife Service (USFWS). 1996. Fish and Wildlife Coordination Act Report on Charleston Harbor Deepening Study. Charleston, SC. 25 pp.

U.S. Fish and Wildlife Service (USFWS). 2009. Wildlife and Habitat Management. Website: http://www.fws.gov/caperomain/wildlifehabitatmanagement.html.

U.S. Fish and Wildlife Service (USFWS). 2012a. Welcome to Cape Romain National Wildlife Refuge. Website: http://www.fws.gov/caperomain/wildlifehabitatmanagement.html.

U.S. Fish and Wildlife Service (USFWS). 2012b. Digest of Federal Resource Laws of Interest to the U.S. Fish and Wildlife Service. Website: http://www.fws.gov/laws/lawsdigest/CLENAIR.html.

U.S. Fish and Wildlife Service (USFWS). 2012c. Green Sea Turtle (*Chelonia mydas*). Website: http://www.fws.gov/northflorida/SeaTurtles/Turtle%20Factsheets/green-sea-turtle.htm.

U.S. Fish and Wildlife Service (USFWS). 2012d. Loggerhead Sea Turtle (*Caretta caretta*). Website: http://www.fws.gov/northflorida/SeaTurtles/Turtle%20Factsheets/loggerhead-sea-turtle.htm.

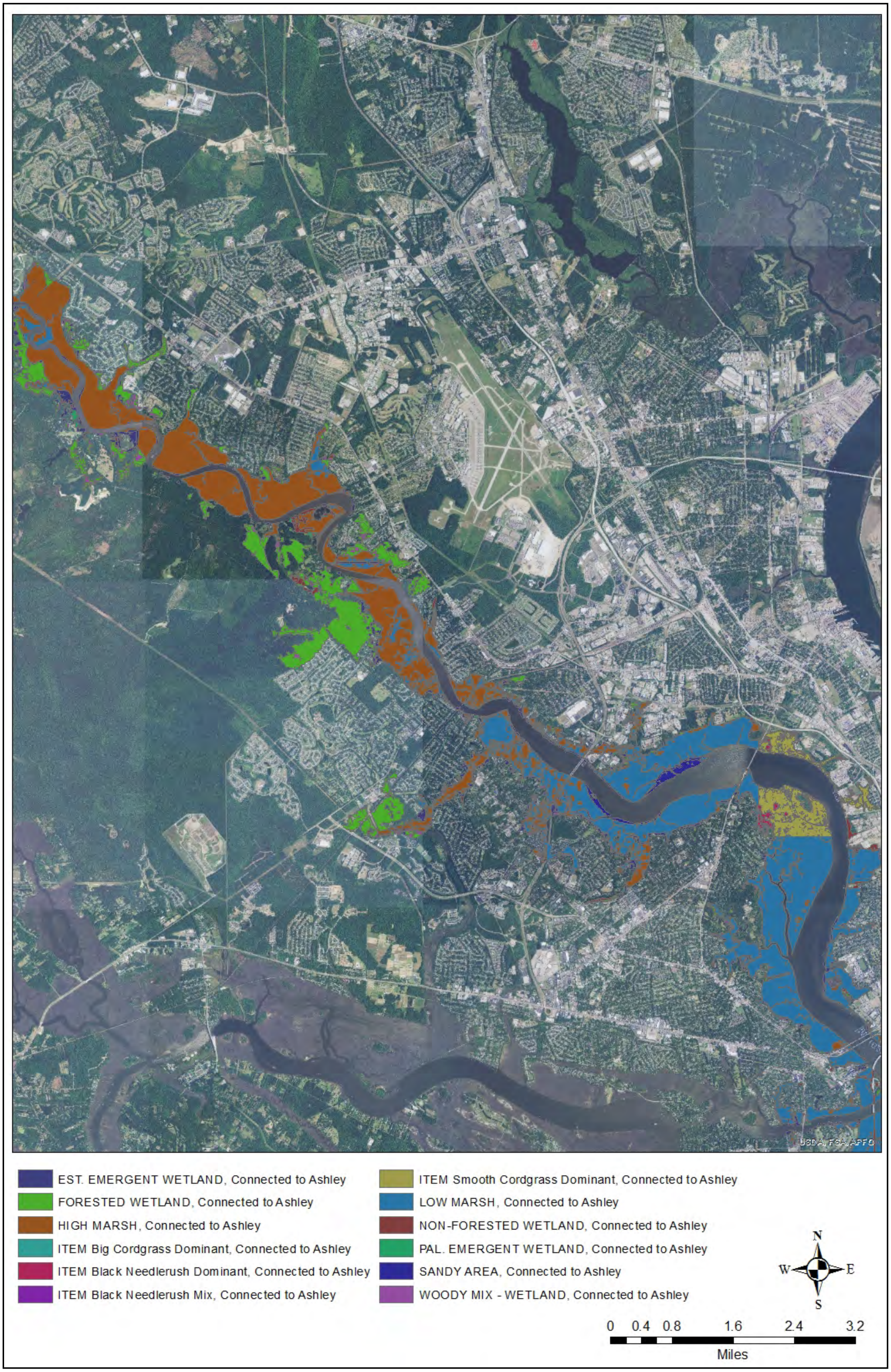
Van Dolah, R. F., P.H. Wendt, and E.L. Wenner, eds. 1990. A Physical and Ecological Characterization of the Charleston Harbor Estuarine System. Marine Resources Division, S. Carolina Wildlife and Marine Resources Dept.

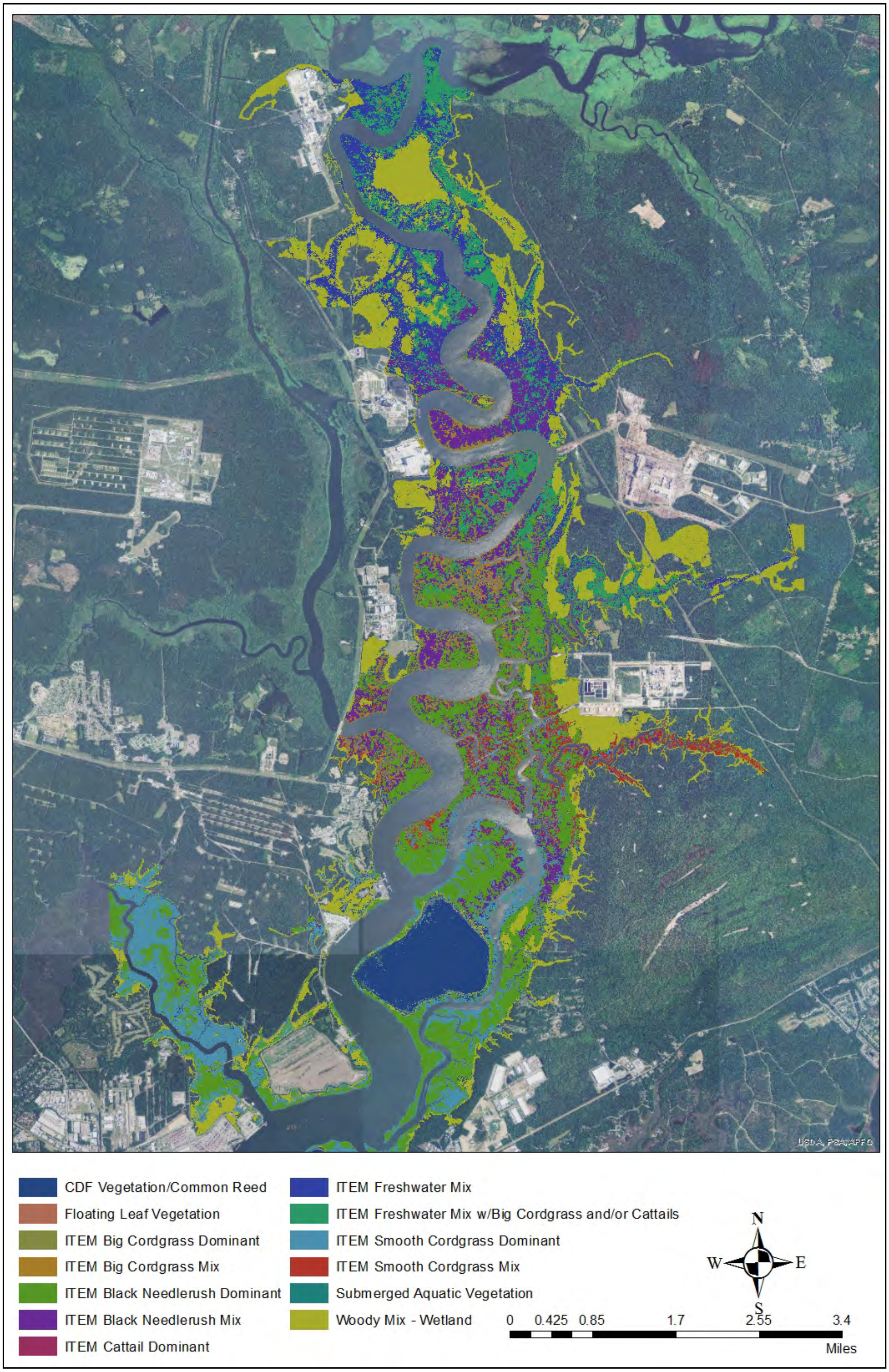
Walburg, C. H., and P. R. Nichols. 1967. Biology and management of the American shad and status of the fisheries, Atlantic coast of the United States, 1960. U.S. Fish and Wildlife Service Special Science Report for Fisheries 550.

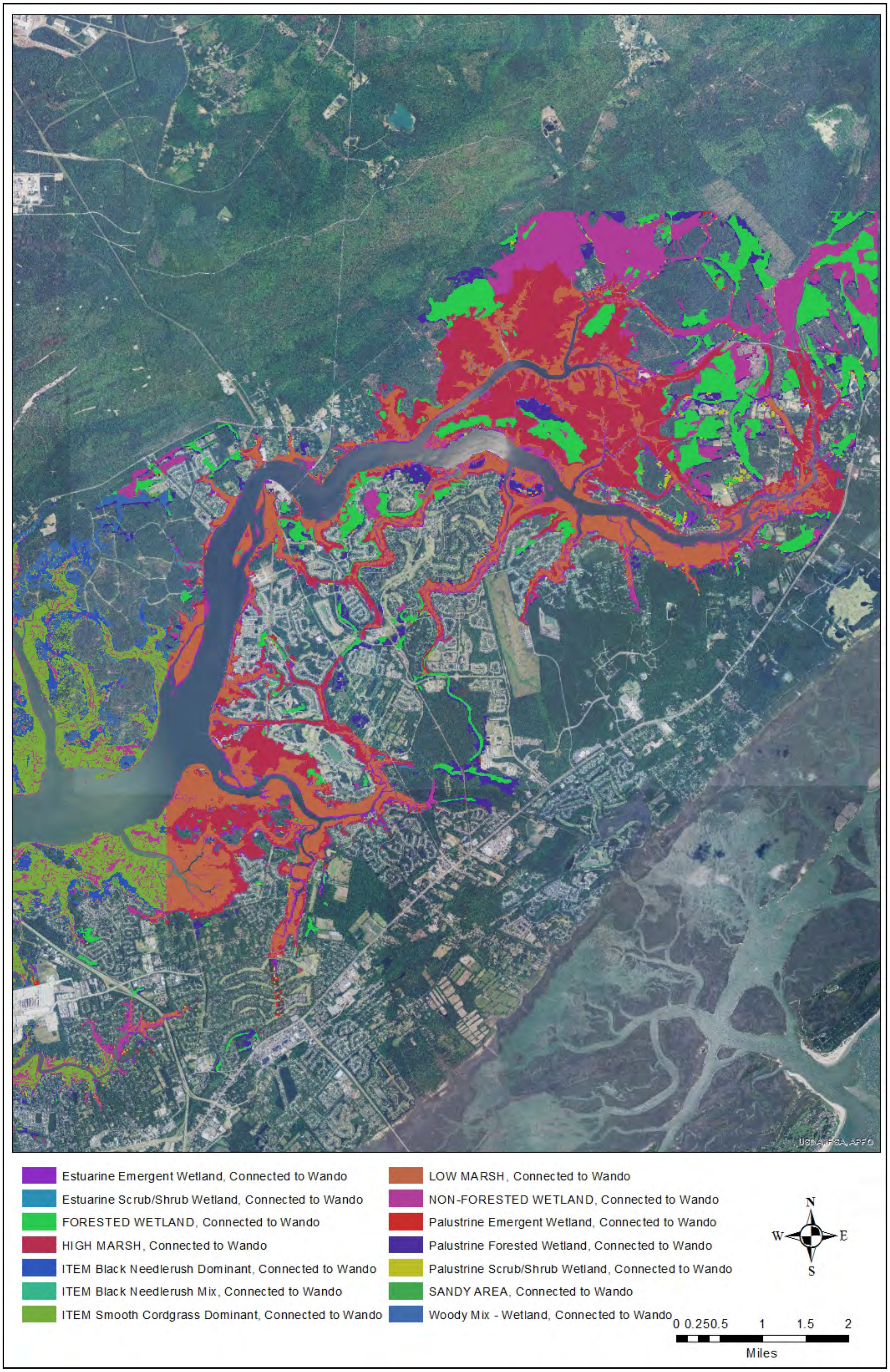
Wenner, C.A. 1997. Seasonal Species Composition and Abundance of Larval and Juvenile Fishes from Surface and Bottom Plankton Collections. SCDNR.

APPENDIX A


USDA, FSA, APFO
High Marsh (Juncus)
Low Marsh (Spartina)
N
W
E
S
0 0.5 1 2 3 4
Miles


USDA, FSA, APFO
EST. EMERGENT WETLAND, Connected to Ashley
FORESTED WETLAND, Connected to Ashley
HIGH MARSH, Connected to Ashley
ITEM Big Cordgrass Dominant, Connected to Ashley
ITEM Black Needlerush Dominant, Connected to Ashley
ITEM Black Needlerush Mix, Connected to Ashley
ITEM Smooth Cordgrass Dominant, Connected to Ashley
LOW MARSH, Connected to Ashley
NON-FORESTED WETLAND, Connected to Ashley
PAL. EMERGENT WETLAND, Connected to Ashley
SANDY AREA, Connected to Ashley
WOODY MIX - WETLAND, Connected to Ashley
N
W
E
S
0 0.4 0.8 1.6 2.4 3.2
Miles


USDA, FSA, APFO
CDF Vegetation/Common Reed
Floating Leaf Vegetation
ITEM Big Cordgrass Dominant
ITEM Big Cordgrass Mix
ITEM Black Needlerush Dominant
ITEM Black Needlerush Mix
ITEM Cattail Dominant
ITEM Freshwater Mix
ITEM Freshwater Mix w/Big Cordgrass and/or Cattails
ITEM Smooth Cordgrass Dominant
ITEM Smooth Cordgrass Mix
Submerged Aquatic Vegetation
Woody Mix - Wetland
N
W
E
S
0 0.425 0.85 1.7 2.55 3.4
Miles


USDA FSA, APFO
Estuarine Emergent Wetland, Connected to Wando
Estuarine Scrub/Shrub Wetland, Connected to Wando
FORESTED WETLAND, Connected to Wando
HIGH MARSH, Connected to Wando
ITEM Black Needlerush Dominant, Connected to Wando
ITEM Black Needlerush Mix, Connected to Wando
ITEM Smooth Cordgrass Dominant, Connected to Wando
LOW MARSH, Connected to Wando
NON-FORESTED WETLAND, Connected to Wando
Palustrine Emergent Wetland, Connected to Wando
Palustrine Forested Wetland, Connected to Wando
Palustrine Scrub/Shrub Wetland, Connected to Wando
SANDY AREA, Connected to Wando
Woody Mix - Wetland, Connected to Wando
N
W
E
S
0 0.250.5 1 1.5 2
Miles