National Park Service
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Natural Resource Stewardship and Science

Natural Resource Condition Assessment

Fort Sumter National Monument and Charles Pinckney National Historic Site, South Carolina

Natural Resource Report NPS/NRSS/WRD/NRR—2012/517

ON THE COVER
A view of Fort Moultrie on top left, Fort Sumter on top right, NOAA C-CAP land cover of region on bottom.
Photographs by: Scott D. Klopfer, Conservation Management Institute, Virginia Tech

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Publisher's Note: Some or all of the work done for this project preceded the revised guidance issued for this project series in 2009/2010. See Prologue (p. xxvii) for more information.

Executive Summary

The goal of this assessment is to provide an overview of natural resource condition status to allow Fort Sumter National Monument (NM) and Charles Pinckney National Historic Site (NHS) to effectively manage National Park Service (NPS) trust resources through Resource Stewardship Strategies (RSS) and General Management Plans. An ancillary benefit is that it will aid the park in meeting government reporting requirements, such as the land health goals under the Government Performance Results Act (GPRA). This assessment is primarily based on existing data and information from the NPS Inventory & Monitoring Program, and from other Federal and State natural resource agencies.

A natural resource assessment should provide a concise, understandable, and accurate summary of the condition of the ecological system. Reporting on this ecological condition will provide for better decision-making (Young and Sanzone 2002). As such we found that collaborating with decision-makers was an important part of this project.

Precise measurements and objective analysis are preferred for assessing the condition of natural resources. Wherever possible, we used quantitative data and established thresholds, but in some cases only qualitative measures were available to rate important categories. Rather than remove these categories all together, we simply report on the type of data that was available and the methods used to compare these data to a desired condition. In all cases, straightforward tables, charts, maps, and geospatial data are provided to summarize findings.

The National Park Service (NPS) monitors the condition of their natural resources using an ecological monitoring framework that has been widely used among other agencies (Fancy et al. 2008). There are six basic level 1 categories: 1) air and climate; 2) geology and soils; 3) water; 4) biological integrity; 5) human use; and 6) ecosystem pattern and process. This framework is based on earlier work including the Environmental Protection Agency's ecological condition framework that uses similar essential ecological attributes as their upper-level categories (Young and Sanzone 2002). We found the NPS categories to be uncomplicated and intuitive. This framework is also familiar to NPS personnel and will allow the users to compare current vital sign monitoring plans to this assessment. We have, however, reorganized the NPS framework to go from small-scale (broad) to large-scale (detailed) analysis, beginning with a primary threat and stressor: ecosystem pattern and process (landscapes).

Throughout this assessment, several data under each natural resource category are given a condition status score. Some of these scores are based on predesigned systems, but all have been cross referenced to a good, fair, poor scoring system (Table 1).

Table 1. Condition status scoring system for the Fort Sumter National Monument and Charles Pinckney National Historic Site Natural Resource Condition Assessment.

Score	*Range*	*Midpoint*
Good	0.67 – 1.00	0.84
Fair	0.34 – 0.66	0.50
Poor	0.00 – 0.33	0.17

In addition, we provide a data quality rating based on three categories, *thematic*, *spatial*, and *temporal*. We gave *thematic* a 1 or 0 (yes or no) based on whether these data were from the best available source. *Spatial* received a 1 or 0 based on the spatial proximity of these data (in-park data or out-of-park data). We also gave *temporal* a 1 or 0 based on how recently these data were acquired. *Temporal* was somewhat dependent on data type, but generally, if the data were from the last 5 years they received a 1. A sample is shown in Table 2. These tables are combined and an overall condition status is reported in the conclusion of this document. The user can also access these scores in the provided spreadsheet to view calculations, update data, and modify importance ratings as management goals change.

Table 2. Example condition status table. Data quality was rated based on *thematic* (1 = best source; 0 = not the best source), s*patial* (1 = inside park boundary; 0 = outside park boundary), and *temporal* (1 = recent; 0 = older than 5 years). The colors green, yellow, and red refer to good, fair, and poor scores respectively (see Table 1).

Category	***Condition Status***	***Data Quality***		
		Thematic	*Spatial*	*Temporal*
Condition Group A		1	0	0
	Good	1 out of 3		
Condition Group B		1	1	0
	Fair	2 out of 3		
Condition Group C		1	1	1
	Poor	3 out of 3		

The overall condition status for Fort Sumter NM is in the fair range (0.47; Table 3); Charles Pinckney NHS is also in the fair range (0.59; Table 4). Midpoint scores were averaged for each NPS ecological monitoring framework level 2 category (Fancy et al. 2008) to come up with the overall condition status for the monument. The data quality scores were summed for each category.

At Fort Sumter NM, fire dynamics is the only category to score in the good range. Fire dynamics is a broad-scale assessment category upon which Fort Sumter NM has limited management influence. Consistent reporting and collaboration are essential for these categories.

Human effects, visitor use, climate, water quality, and soils are all in the fair range at Fort Sumter NM. Human effects are plentiful in this region and impervious surface coverage for Fort Sumter NM and within the subbasin study area are relatively high. Visitor and recreation use is rated fair because statistics indicated a sharp increase in visitors and it has been one of the most visited forts managed by the NPS. Climate and water quality are categories that will need coordination with other management organizations to improve. The limiting factors for water quality were fecal coliform and contaminants. Soils have remained relatively consistent, but flooding frequency and drainage class were poor.

Landscape dynamics, hydrology, and biological integrity for Fort Sumter NM were extremely limiting. This is more than likely due to the fact that this monument is within a highly urbanized area and the monument is focused on cultural resource management. Despite these findings,

improvements could be made. The landscape was rated within the monument and shows there is very little natural vegetation. Wetland functionality was rated poor in most cases. In addition, the species assemblages present at Fort Sumter NM do not appear to reflect the more complete biotic communities observed in the surrounding areas. Additionally, air quality at Fort Sumter NM received a poor rating. Despite a fair ozone exposure score, the poor rating was a result of high levels of estimated atmospheric deposition and poor visibility due to a high Haze Index score. Similar to landscape, fire, and human effects, air quality is a broad-scale assessment category upon which Fort Sumter NM has limited management influence.

For Charles Pinckney NHS, landscape dynamics, fire dynamics, visitor use, and soils scored in the good range. Landscape and fire are broad-scale assessment categories upon which Charles Pinckney NHS has limited management influence. Consistent reporting and collaboration are essential for these categories. Statistics do not indicate a sharp increase in visitors and there is no additional data to indicate a negative correlation between visitor use and natural resource condition. Soils have remained relatively consistent with the only limiting factor being the flooding frequency.

Categories that scored in the fair range included human effects, climate, hydrology, and water quality. Human effects are plentiful in this region and impervious surface coverage for Charles Pinckney NHS and within the subbasin study area are relatively high. Climate and water quality are categories that will need coordination with other management organizations to improve. The limiting factors for water quality were dissolved oxygen, fecal coliform, and contaminants. The wetland functionality was fair in most cases with nutrient transformation receiving a good rating.

Air quality and biological integrity received a poor rating at Charles Pinckney NHS. Despite a fair ozone exposure score, the poor air quality rating was a result of high levels of estimated atmospheric deposition and poor visibility due to a high Haze Index score. Similar to landscape, fire, human effects, and climate, air quality is a broad-scale assessment category upon which Charles Pinckney NHS has limited management influence. Pertaining to the poor biological integrity score, the species assemblages present at the historic site do not appear to reflect the more complete biotic communities observed in the surrounding areas. Relatively low similarity scores for most taxa may reflect the relatively low diversity at both Fort Sumter NM and Charles Pinckney NHS as a result. This is primarily due to the small size of the parks and the fact that the majority of the landcover surrounding and within the parks is developed.

For both parks, thematic (best-source) and spatial proximity, to a lesser degree, are the limiting factors in data quality. Thematic is often in the fair range for data quality mostly due to needing more local-scale data. These parks were established primarily to protect cultural resources, so a minimal amount of natural resource data has been collected on-site. There are plans to map vegetation communities and continue species and community inventory and monitoring. An observation that is present in several of the assessment categories is the importance of coordination with outside management organizations. It is also noted in several categories that additional local-scale data collection could improve assessment and management.

The good, fair, poor scoring system (Table 1) has its limitations. It is somewhat subjective, especially when pre-established thresholds and criteria are missing. However, in most cases we

were able to find thresholds from other agencies or peer-reviewed publications. We made note of the cases where established rating systems or thresholds were not available. With these caveats in mind, we effectively reported on the condition status of important natural resource management categories while providing further information on data quality.

Table 3. Overall condition status summary for Fort Sumter National Monument. Data quality was rated based on *thematic* (1 = best source; 0 = not the best source), s*patial* (1 = inside park boundary; 0 = outside park boundary), and *temporal* (1 = recent; 0 = older than 5 years). The colors green, yellow, and red refer to good, fair, and poor scores respectively (see Table 1).

Category	***Condition Status***	***Score***	***Data Quality***		
			Thematic	*Spatial*	*Temporal*
Landscape dynamics total			0	3	0
	Poor	0.28	3 out of 9		
Fire dynamics total			0	1	1
	Good	0.84	2 out of 3		
Human effects total			1	2	2
	Fair	0.50	5 out of 6		
Visitor use total			0	1	1
	Fair	0.50	2 out of 3		
Air quality total			3	1	3
	Poor	0.28	7 out of 9		
Climate total			5	1	5
	Fair	0.57	11 out of 15		
Hydrology total			0	6	6
	Poor	0.30	12 out of 18		
Water quality total			3	4	1
	Fair	0.59	8 out of 12		
Soil total			2	3	3
	Fair	0.62	8 out of 9		
Biotic total			5	0	5
	Poor	0.24	10 out of 15		
FOSU overall			19	22	25
	Fair	0.47	66 out of 99		

Table 4. Overall condition status summary for Charles Pinckney National Historic Site. Data quality was rated based on *thematic* (1 = best source; 0 = not the best source), s*patial* (1 = inside park boundary; 0 = outside park boundary), and *temporal* (1 = recent; 0 = older than 5 years). The colors green, yellow, and red refer to good, fair, and poor scores respectively (see Table 1).

Category	***Condition Status***	***Score***	***Data Quality***		
			Thematic	*Spatial*	*Temporal*
Landscape dynamics total			0	3	0
	Good	0.73	3 out of 9		
Fire dynamics total			0	1	1
	Good	0.84	2 out of 3		
Human effects total			1	2	2
	Fair	0.50	5 out of 6		
Visitor use total			0	1	1
	Good	0.84	2 out of 3		
Air quality total			3	1	3
	Poor	0.28	7 out of 9		
Climate total			5	1	5
	Fair	0.57	11 out of 15		
Hydrology total			0	6	6
	Fair	0.57	12 out of 18		
Water quality total			3	4	1
	Fair	0.54	8 out of 12		
Soil total			2	2	2
	Good	0.84	6 out of 9		
Biotic total			3	0	3
	Poor	0.17	6 out of 9		
CHPI overall			17	21	24
	Fair	0.59	62 out of 93		

This project provided a comprehensive amount of organized tabular data and many geospatial data layers and maps that will aid in the management of Fort Sumter NM and Charles Pinckney NHS. These data are provided on an accompanying disk and can be used to compare current status to future conditions. This is merely a first step to compiling data and reporting on current condition status, data gaps, and threats and stressors. A well established assessment protocol will include follow-up and future analysis.

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This project would not have been possible without the help of personnel from Fort Sumter National Monument, NPS Southeast Region, Southeast Coast Network, and various departments at Virginia Tech. We would like to thank the following people for their contribution to this assessment effort:

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Prologue

Publisher's Note: This was one of several projects used to demonstrate a variety of study approaches and reporting products for a new series of natural resource condition assessments in national park units. Projects such as this one, undertaken during initial development phases for the new series, contributed to revised project standards and guidelines issued in 2009 and 2010 (applicable to projects started in 2009 or later years). Some or all of the work done for this project preceded those revisions. Consequently, aspects of this project's study approach and some report format and/or content details may not be consistent with the revised guidance, and may differ in comparison to what is found in more recently published reports from this series.

Abbreviations

AQI	Air Quality Index
BBS	Breeding Bird Survey
BOD	Biological Oxygen Demand
BMP	Best Management Practice
CHPI	Charles Pinckney National Historic Site
C-CAP	Coastal Change Analysis Program
CMI	Conservation Management Institute at Virginia Tech
CRD	Coastal Resources Division
DDT	Dichloro-Diphenyl-Trichloroethane
DEM	Digital Elevation Model
DIN	Dissolved Inorganic Nitrogen
DIP	Dissolved Inorganic Phosphorus
DNR	Department of Natural Resources
DO	Dissolved Oxygen
DRG	Digital Raster Graphic
EMAP	Environmental Monitoring and Assessment Program
EPA	Environmental Protection Agency
EPD	Environmental Protection Division
ERL	Effects Range Low
ESRI	Environmental Systems Research Institute
FDA	Food and Drug Administration
FEMA	Federal Emergency Management Agency
FOSU	Fort Sumter National Monument
GA	Georgia
GAP	Gap Analysis Program
GDD	Growing Degree Days
GeoMAC	Geospatial Multi-Agency Coordination Group
GFC	Georgia Forestry Commission
GIS	Geographic Information System
GMP	General Management Plan
GPRA	Government Performance Results Act
HUC	Hydrologic Unit Code
I&M	Inventory and Monitoring
LMER	Land Margin Ecosystem Research
LTER	Long-Term Ecological Research
MLRA	Major Land Resource Area
NB	National Battlefield
NCA	National Coastal Assessment
NCDC	National Climatic Data Center
NESDIS	National Environmental Satellite, Data, and Information Service
NHD	National Hydrologic Data
NHS	National Historic Site
NM	National Monument
NOAA	National Oceanic and Atmospheric Administration

NPS	National Park Service
NRCS	Natural Resources Conservation Service
NTCHS	National Technical Committee for Hydric Soils
NWI	National Wetlands Inventory
PAHs	Polycyclic Aromatic Hydrocarbons
PCBs	Polychlorinated Biphenyls
PDSI	Palmer Drought Severity Index
PPM	Parts per million
RSS	Resource Stewardship Strategies
SC	South Carolina
SCP	Southern Coastal Plain
SERCC	Southeast Regional Climate Center
SSURGO	Soil Survey Geographic
TD	Tropical Depression
TS	Tropical Storm
U.S.	United States
UGA	University of Georgia
USACE	United States Army Corps of Engineers
USDA	United States Department of Agriculture
USGS	United States Geological Survey

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1.0 Introduction

The goal of this assessment is to provide an overview of natural resource condition status to allow Fort Sumter National Monument (NM) and Charles Pinckney National Historic Site (NHS) to effectively manage National Park Service (NPS) trust resources through Resource Stewardship Strategies (RSS) and General Management Plans. An ancillary benefit is that it will aid the park in meeting government reporting requirements, such as the land health goals under the Government Performance Results Act (GPRA). This assessment is primarily based on existing data and information from the NPS Inventory & Monitoring Program, and from other Federal and State natural resource agencies.

A natural resource assessment should provide a concise, understandable, and accurate summary of the condition of the ecological system. Reporting on this ecological condition will provide for better decision-making (Young and Sanzone 2002). As such we found that collaborating with decision-makers was an important part of this project.

An iterative process was implemented to collect and synthesize data and meet with NPS staff. We collaborated on what was important for their particular assessment, park, and watershed. Additional data was then collected and the process repeated itself to further refine and identify additional natural resource issues and objectives for this assessment.

Precise measurements and objective analysis are preferred for assessing the condition of natural resources. Wherever possible, we used quantitative data and established thresholds, but in some cases only qualitative measures were available to rate important categories. Rather than remove these categories all together, we simply report on the type of data that was available and the methods used to compare these data to a desired condition. In all cases, straightforward tables, charts, maps, and geospatial data are provided to summarize findings.

2.0 Park and Resources

2.1 Bio-geographic and Physical Setting

2.1.1 Park Location and Size

Fort Sumter NM and Charles Pinckney NHS are located in the Coastal Plain of South Carolina in Charleston County (Figure 1). Fort Sumter NM is composed of four separate areas, totaling 232 acres (from geographic information system boundary, 2008). Fort Sumter itself is on an island at the entrance to Charleston Harbor. The ferry boat site, where visitors catch the boat to the island, is located within the city of Charleston. Fort Moultrie and the Historic Coast Guard Station are located on Sullivan's Island, to the northeast of Fort Sumter. Fort Moultrie serves as the park unit headquarters while the Coast Guard Station operates as the park maintenance and quarters facility (National Park Service 1998). Charles Pinckney NHS is a 33-acre park (from geographic information system boundary) that is managed jointly with Fort Sumter NM. This national historic site is within the corporate limits of Mount Pleasant, SC, historical Christ Church Parish, just NE of the city of Charleston (Figure 1) (National Park Service 1994).

2.1.2 Park Plans and Objectives

The purpose of Fort Sumter is to preserve the Civil War remnants of Fort Sumter and to commemorate and interpret the opening battle of the Civil War and Fort Sumter's role during the Civil War. The purpose of Fort Moultrie is to preserve existing historic military structures and artifacts, both above and below the ground, in order to illustrate the evolution of U.S. coastal defense; and to interpret the evolution of U.S. coastal defense with emphasis on the Battle of Sullivan's Island and the Fort's role during the Civil War (National Park Service 1998).

The monument's overall mission is to commemorate defining moments in American history within a military continuum spanning more than a century and a half. Two seacoast fortifications preserve and interpret these stories. At Fort Moultrie, the first American naval victory over the British in 1776 galvanized the patriot's cause for independence. Less than a century later, America's most tragic conflict ignited with the first shots of the Civil War at Fort Sumter (National Park Service 1998).

Charles Pinckney NHS was established to provide for the interpretation of the life of Charles Pinckney; preserve and interpret his home, Snee Farm; and present the history of the United States as a young nation (National Park Service 1994, 2004b).

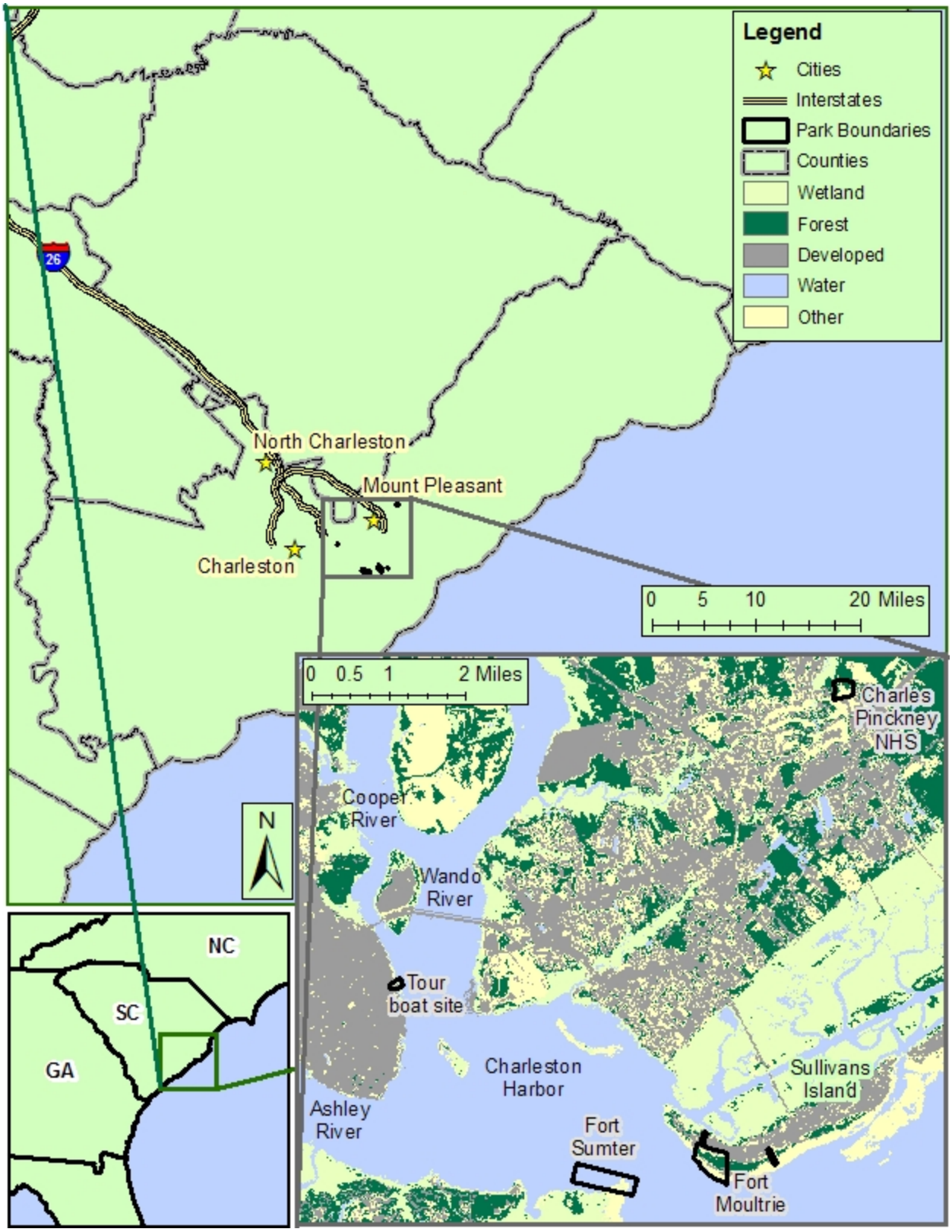

Figure 1. Fort Sumter National Monument and Charles Pinckney National Historic Site are located on the east coast of South Carolina, in the Charleston metropolitan area.

2.1.3 Climate

The climate of the Charleston region of the South Carolina Coastal Plain is temperate, semitropical with hot, humid summers and mild winters. The average annual temperature of the area is 66.0 degrees Fahrenheit (°F), with a mean maximum temperature of 74.5 °F and mean minimum temperature of 57.5 °F (The Southeast Regional Climate Center 2008). The coolest month on average is January, at 48.9 °F and the warmest month is July, at 81.6 °F. Lowest and highest recorded temperatures were 9°F in 1985 and 105 °F in 1952. The wettest month has historically been August, with an average of 6.18 inches (The Southeast Regional Climate Center 2008). Major storms are of concern, as this area is brushed or hit by a tropical system every 4.31 years with a direct hurricane hit every 11.5 years on average (Hurricane City 2008).

2.1.4 Geology, Landforms, and Soils

The Coastal Plain region is composed of undeformed sedimentary rock layers whose ages range from the Late Cretaceous to the present Holocene sediments of the coast. Beneath Coastal Plain sediments are harder igneous and metamorphic rocks, such as those found in the Piedmont. Usually referred to as the "basement rocks," these hard rocks occur at greater and greater depths toward the south and east, reaching depths of up to 10,000 feet or more beneath the modern Georgia coast (Frazier 2007). Sediment from the upper Piedmont region eroded into the Coastal Plain over the past 100 million years. In addition to recent alluvium, organic and marine deposits make up some of the sediment found in the Coastal Plain (UGA Department of Geology 2008). Human-dredged and deposited sediments are abundant along the coastlines. Specifically, the region near Fort Sumter NM is a mix of Pleistocene-aged marine deposits, Holocene-aged alluvium and human-modified material. The region near Charles Pinckney NHS is a Pleistocene-aged deposit of marine origin.

Some areas of Fort Sumter NM are highly developed, but generally the sites are composed of flat terrain, salt water marshes, and some dune, salt marsh, and maritime forest plant communities (National Park Service 1998). Nearby Charles Pinckney NHS is also surrounded by highly developed areas. The 33-acre historic site has flat terrain, upland habitat, as well as a small portion of wetlands. Some of the property is in the 100-year floodplain (National Park Service 1994).

According to Soil Survey Geographic (SSURGO), compiled by the National Park Service (2006), Fort Sumter NM is composed of *Water* (61%); *Coastal Beaches and Dune Land* (23.4%); *Made Land* (13%); *Urban Land-Yuahannah-Yemassee-Ogeechee Association* (2.2%); and *Capers Silty Clay Loam* (0.4%). Charles Pinckney NHS is composed of *Chipley Loamy Fine Sand* (80.6%); *Scranton Loamy Fine Sand* (7.7%); *Yonges Loamy Fine Sand* (7.1%); and *Charleston Loamy Fine Sand* (4.6%). Additional information on these soils can be found in 3.5.1 Geology and Soils section.

2.1.5 Surface Water and Wetlands

Fort Sumter NM and Charles Pinckney NHS are part of South Carolina's Cooper River/Ashley River basin. Fort Sumter NM is in the Ashley River (SC Coastal) subbasin. This subbasin spans 895 square miles with 377 stream miles, 4,232 acres of lake cover, and 32,700 acres of estuarine areas (SCDHEC - South Carolina Department of Health and Environmental Control 2005). Fort

Sumter is located on an island in the Charleston Harbor, and Fort Moultrie, a unit of Fort Sumter NM, is on the opposite side of the harbor on Sullivan's Island (Figure 2). Charles Pinckney NHS is in the Cooper River subbasin. This subbasin is 845 square miles, and made up of eight different watersheds. There are 587 stream miles, 60,192 acres of lake water, and 13,060 acres of estuarine areas in this subbasin (SCDHEC 2005). Charles Pinckney NHS is located in the coastal plain in the Wando River watershed (HUC 0305020108) not far from Boone Hall Creek which connects to the Wando River and flows into the Charleston Harbor (Figure 3).

Figure 2. Water resources and hydrologic unit boundaries at Fort Sumter National Monument.

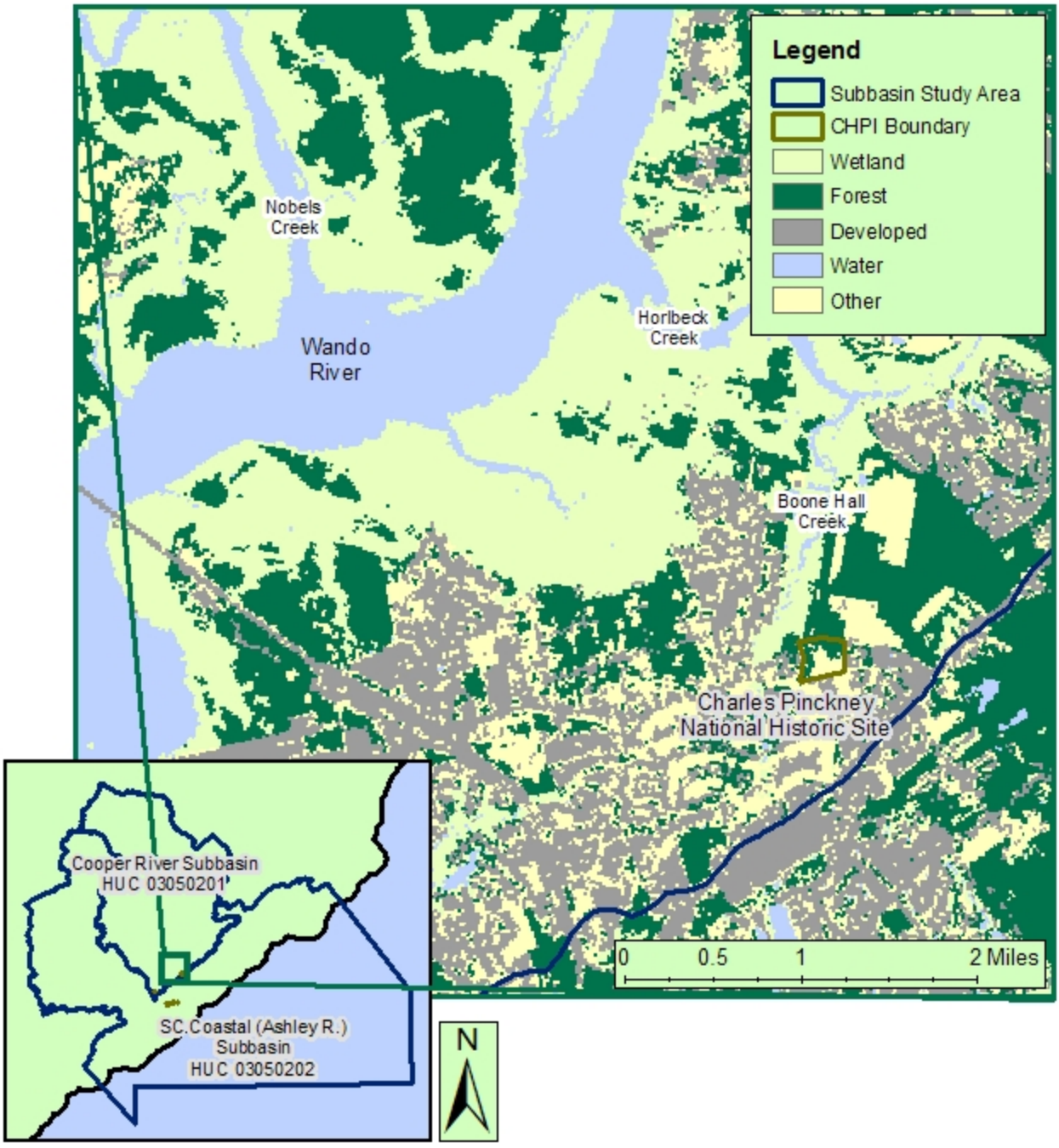

Figure 3. Water resources and hydrologic unit boundaries at Charles Pinckney National Historic Site.

According to the U.S. Fish and Wildlife Service, National Wetlands Inventory (NWI), there are 156 acres of wetlands at Fort Sumter NM and 3 acres of wetlands at Charles Pinckney NHS. Based on a classification that is explained further in 3.1.1 Landscape Dynamics section, we found 149.3 acres of wetlands within the Fort Sumter NM boundary. This includes open water (117.3 acres) and unconsolidated shore (28.6 acres). According to our classification, there were 2.9 acres of wetlands at Charles Pinckney NHS. These wetlands are important globally and support a myriad of aquatic plants and animals. As development along the coast and threats of

rising sea level from climate change continues, importance will be placed on maintaining wetlands.

2.2 Regional and Historic Context

2.2.1 Regional History and Land Use

The region surrounding Fort Sumter NM and Charles Pinckney NHS has a rich history stretching back to Native American occupation and early European colonization. Charleston, originally Charles Town, was established in 1670 by English settlers. It was one of the most important and largest settlements of the original thirteen colonies. To defend against the French, Spanish, and pirates, a signal gun was manned on Sullivan's Island. Immigration of European settlers and skilled craftsman was encouraged by the British government. Slaves and indentured servants later arrived in large number through Charles Town. The major crops of the time were rice and indigo, supported by good growing conditions and the colonial plantation system (National Park Service).

The cities of Charleston and Mount Pleasant are both situated within Charleston County, South Carolina. The city of Charleston serves as the county seat for Charleston County, which is part of the Charleston-North Charleston, South Carolina Metropolitan Statistical Area (MSA). The 2007 population estimate for the Charleston-North Charleston MSA was 630,100 people, ranking 81st out of 363 MSAs nationwide (U.S. Census Bureau 2009b). Moderate population increases from U.S. Census Bureau (2009a) data were evident in this region. The fastest growing county in the region is Dorchester County, which grew from 83,060 to 123,505 individuals between 1990 and 2007, a 49% increase. Georgetown County grew from 46,302 to 60,499 individuals between 1990 and 2007, a 31% increase. Berkeley and Charleston counties experienced respective population increases of 27% and 16% from 1990 to 2007. Berkeley grew from 128,776 to 163,622 individuals and Charleston grew from 295,039 to 342,973 individuals.

Charleston County is a highly urbanized area of South Carolina. Transportation, trade, government-associated industries, military, tourism, and fish and shellfish industries are the area's major employers. The Port of Charleston is first among container cargo ports in the Southeast and gulf coast regions (National Park Service 1994).

2.2.2 Site History

The first engagement of the American Civil War took place at Fort Sumter on April 12, 1861. Although begun in 1829, the fort was still under construction in 1861. Union forces did not retake Fort Sumter until February 1865 after General Sherman secured Columbia, South Carolina for the north. Fort Sumter was rebuilt and modernized in the late 1800's, but aircraft made coastal defenses unnecessary, so Fort Sumter was transferred to the National Park Service on April 28, 1948 (National Park Service 1998).

Nearby Fort Moultrie, on Sullivan's Island, was the sight of the first major American victory against the British during the American Revolution. Fort Moultrie was rebuilt twice throughout its history. The current fort was completed in 1809 and, like Fort Sumter, was modified and

renovated in the late 1800's. It was later transferred the National Park Service in 1960 (National Park Service 1998).

Charles Pinckney made major contributions to and signed the United States Constitution. His original Snee Farm was purchased by his father in 1754 and occupied 715 acres. Charles Pinckney owned and operated the plantation from 1782 to 1816. He owned other farms in the region, but presumably Snee Farm would have been a regular retreat for Pinckney from Charleston by an easy boat ride. The Pinckneys were a prominent Charleston family. Rice and indigo plantations, supported by slavery, upheld the southern social structure that the Pinckneys were a part of. Snee Farm also played prominently in Pinckney's political ambition, since he was elected to the South Carolina House of Representatives in 1778 from Christ Church Parish (Blythe et al. 2000).

2.3 Unique and Significant Park Resources and Designations

2.3.1 Unique Resources

There are several significant historical park resources at Fort Sumter NM. The forts and associated military structures are important historical resources. There is a museum collection of over 40,000 items, mainly excavated artifacts. These include glass, pottery, metal fragments, large projectile and artillery collection (National Park Service 1998). There are no unique resources of natural resource significance present at Fort Sumter NM. However, the 122 acres below the water in Charleston Harbor could hold additional unique cultural resources as well as important natural resources in this estuarine environment.

There are also some significant historical park resources at Charles Pinckney NHS. These were examined in the General Management Plan (National Park Service 1994) and include:

- The house at Snee Farm, built in the early 1800s by either Francis Gottier Deliesseline or William Mathews, later owners of the farm. The original, middle portion of the house is a rare example of nineteenth century low country coastal cottage (Blythe et al. 2000). Wings were added to the house in the 1930s.
- The caretaker's house, barn, and corn crib that were built between 1936 and 1945.
- The likely foundation of the Pinckney house, artifacts from that era, and slave dwellings.

2.3.2 Special Designations

Fort Sumter NM and Charles Pinckney NHS have no special natural resource designations, however several of the sites under management by Fort Sumter NM are listed on the National Register of Historic Places (National Park Service 1998, Blythe et al. 2000). These include:

- Fort Sumter,
- Battery Huger,
- Fort Moultrie (all historic structures within the Fort Moultrie unit),
- Coast Guard Station structures (adjacent to Fort Moultrie),
- Snee Farm main house (in 1973), and
- the entire Charles Pinckney NHS property (in 1988).

3.0 Condition Assessment (Interdisciplinary Synthesis)

The National Park Service (NPS) monitors the condition of their natural resources using an ecological monitoring framework that has been widely used among other agencies (Fancy et al. 2008). There are six basic level 1 categories: 1) air and climate; 2) geology and soils; 3) water; 4) biological integrity; 5) human use; and 6) ecosystem pattern and process. This framework is based on earlier work including the Environmental Protection Agency's ecological condition framework that uses similar essential ecological attributes as their upper-level categories (Young and Sanzone 2002). We found the NPS categories to be uncomplicated and intuitive. This framework is also familiar to NPS personnel and will allow the users to compare current vital sign monitoring plans to this assessment. We have, however, reorganized the NPS framework to go from small-scale (broad) to large-scale (detailed) analysis, beginning with a primary threat and stressor, ecosystem pattern and process (landscapes).

Throughout this assessment, several data under each natural resource category are given a condition status score. Some of these scores are based on predesigned systems, but all have been cross referenced to a good, fair, poor scoring system (Table 1).

Table 1. Condition status scoring system for Fort Sumter National Monument and Charles Pinckney National Historic Site Natural Resource Assessment.

Score	*Range*	*Midpoint*
Good	0.67 – 1.00	0.84
Fair	0.34 – 0.66	0.5
Poor	0.00 – 0.33	0.17

In addition, we provide a data quality rating based on three categories, *thematic*, *spatial*, and *temporal*. We gave *thematic* a 1 or 0 (yes or no) based on whether these data were from the best available source. *Spatial* received a 1 or 0 based on the spatial proximity of these data (park data or out of park data). We also gave *temporal* a 1 or 0 based on how recent these data were acquired. *Temporal* was somewhat dependent on data type, but generally, if the data were from the last 5 years, they received a 1. A sample is shown in Table 2. These tables are combined and an overall condition status is reported in the conclusion of this document. The user can also access these scores in the provided spreadsheet to view calculations, update data, and modify importance ratings as management goals change.

Table 2. Example condition status table. Data quality was rated based on *thematic* (1 = best source; 0 = not the best source), s*patial* (1 = inside park boundary; 0 = outside park boundary), and *temporal* (1 = recent; 0 = older than 5 years). The colors green, yellow, and red refer to good, fair, and poor scores respectively (see Table 1).

Category	***Condition Status***	***Data Quality***		
		Thematic	*Spatial*	*Temporal*
Condition Group A		1	0	0
	Good	1 out of 3		
Condition Group B		1	1	0
	Fair	2 out of 3		
Condition Group C		1	1	1
	Poor	3 out of 3		

3.1 Ecosystem Pattern and Process

3.1.1 Landscape Dynamics

Managing the entire landscape as opposed to individual species or community types is a recommended step to maintain ecosystem health. With that in mind, the landscape as a whole was considered at Fort Sumter NM and Charles Pinckney NHS. Ecosystems do not often function within the small political boundaries in which regulating bodies are constrained. Fort Sumter NM and Charles Pinckney NHS are relatively small parks, so we chose to first look at each of them within their watershed context and then examine the finer-scale park properties.

3.1.1.a Current condition:

Study area:

The broad study area that we chose was based on the National Hydrologic Data (NHD) and includes the Copper, South Carolina subbasin, hydrologic unit code (HUC) 03050201, and the South Carolina Coastal subbasin, HUC 03050202. The NHD geospatial layers further delineate the Copper subbasin into eight specific watersheds. This study area covers portions of Charleston, Dorchester, Berkeley, and Georgetown counties, South Carolina (Figure 4).

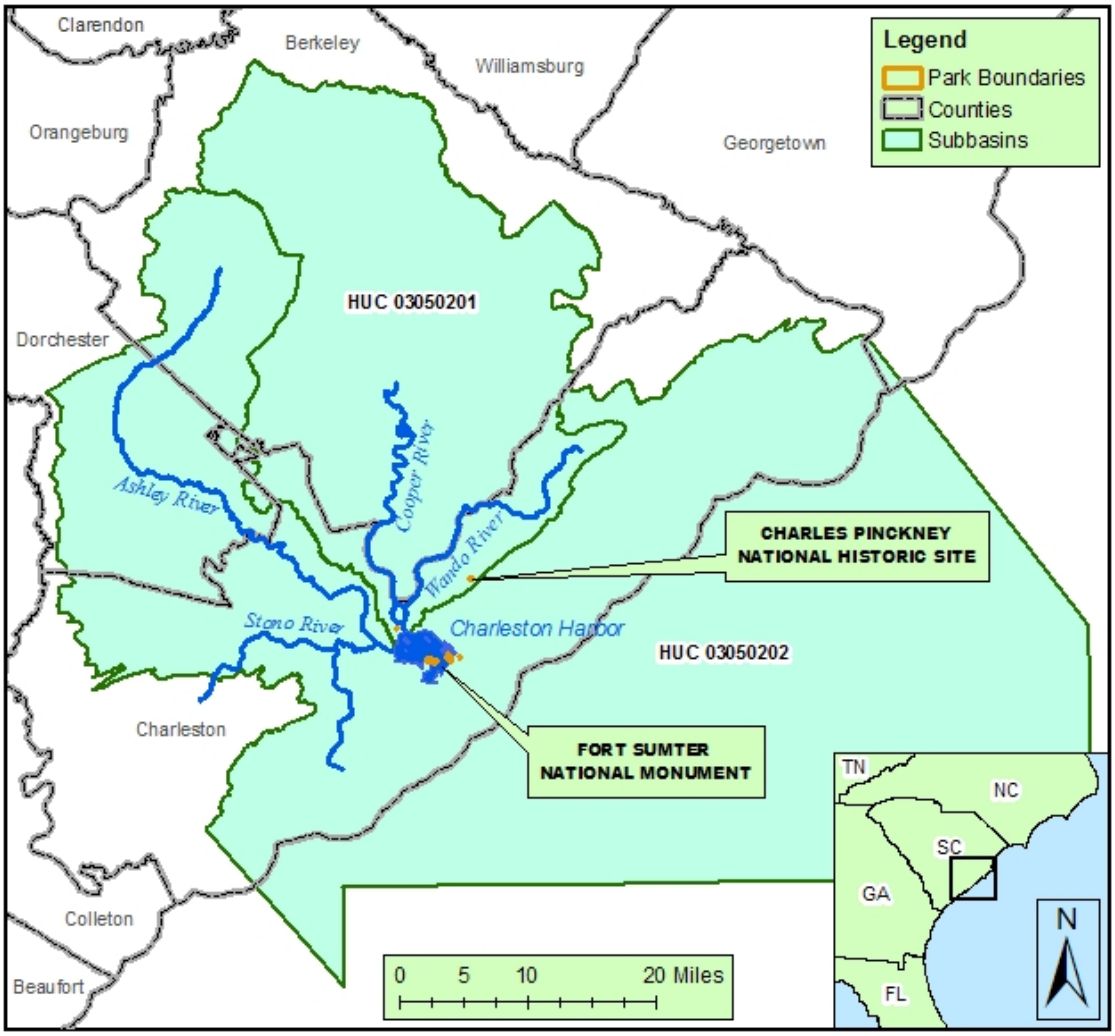

Figure 4. The subbasin study area examined for the Fort Sumter National Monument and Charles Pinckney National Historic Site Natural Resource Assessment.

Land cover:

When looking at land cover, there are several possible data sources that could be used. We chose the newest, most complete and detailed classification from the National Oceanic and Atmospheric Administration (NOAA) Coastal Change Analysis Program (C-CAP). These data are part of the overall National Land Cover Dataset, but are more detailed around the coastal regions (National Oceanic and Atmospheric Administration 2008a). We examined these data in the overall subbasin study area outlined above and within the Fort Sumter NM and Charles Pinckney NHS boundaries. Because the parks contain a relatively small area, the spatial resolution of C-CAP for analysis within the park boundaries was questionable. Consequently, we (Conservation Management Institute at Virginia Tech, CMI) also performed a more detailed classification using heads-up digitizing over 2006 digital orthophotos from USGS and SC Department of Natural Resources (2006). This delineation was performed at a minimum 1:10,000 scale and polygons were attributed using photointerpretation and the C-CAP classification schema. More detailed spatial data preparation methods can be found in Appendix A: Land cover calculation methods.

The total land area within the subbasin study area is approximately 1,414,775 acres. Of this total acreage, 20.0% or 282,669 acres is Evergreen Forest. This is the highest represented class (after water) for the subbasin study area (Table 3, Figure 5). At Fort Sumter NM, Unconsolidated Shore is the highest represented class after water (at 12.3% or 28.6 acres in the CMI classification, Table 3, Figure 6). The highest land cover class at Charles Pinckney NHS is Grassland, representing 13.4 acres or 40.8% of the detailed CMI classification (Table 4, Figure 6). The highest natural vegetation class at Fort Sumter NM is Evergreen Forest at 13.9 acres or 6.0%.

Table 3. Land cover (from CMI classification and 2001 NOAA C-CAP) totals and percent of total within Fort Sumter National Monument (FOSU) boundary and in the subbasin study area containing FOSU. "FOSU Acres (CMI)" are the number of acres of each cover type within FOSU as delineated by the Conservation Management Institute at Virginia Tech (CMI). "FOSU Acres (NOAA)" are the number of acres of each cover type within FOSU as classified by the National Oceanic and Atmospheric Administration (NOAA 2008a) Coastal Change Analysis Program (C-CAP). "Study Area Acres" are the number of acres of each cover type within the subbasin study area as classified by the NOAA. In each case, "%" refers to the percent of the total acreage of FOSU or the subbasin study area.

Land Cover Classification	*FOSU Acres (CMI)*	*FOSU % (CMI)*	*FOSU Acres (NOAA)*	*FOSU % (NOAA)*	*Study Area Acres*	*Study Area %*
Water	117.3	50.5	117.6	50.6	406035	28.7
Unconsolidated Shore	28.6	12.3	21.3	9.2	9438	0.7
Low Intensity Developed	27.6	11.9	24.0	10.3	53527	3.8
Developed Open Space	18.8	8.1	8.2	3.5	41099	2.9
Evergreen Forest	13.9	6.0	6.7	2.9	282669	20.0
Grassland	9.6	4.2	9.8	4.2	23800	1.7
Medium Intensity Developed	7.9	3.4	4.0	1.7	12749	0.9
Scrub/Shrub	4.4	1.9	16.7	7.2	88523	6.3
Palustrine Forested Wetland	2.0	0.9	4.2	1.8	246854	17.4
Estuarine Emergent Wetland	1.4	0.6	3.1	1.3	101576	7.2
Bare Land	0.6	0.3	15.3	6.6	4953	0.4
Palustrine Emergent Wetland	0.0	0.0	0.7	0.3	32571	2.3
Palustrine Scrub/Shrub Wetland	0.0	0.0	0.4	0.2	30908	2.2
High Intensity Developed	0.0	0.0	0.2	0.1	7466	0.5
Estuarine Scrub/Shrub Wetland	0.0	0.0	0.2	0.1	1662	0.1
Pasture/Hay	0.0	0.0	0.0	0.0	36582	2.6
Mixed Forest	0.0	0.0	0.0	0.0	16505	1.2
Cultivated	0.0	0.0	0.0	0.0	11612	0.8
Deciduous Forest	0.0	0.0	0.0	0.0	5190	0.4
Palustrine Aquatic Beds	0.0	0.0	0.0	0.0	1054	0.1

Table 4. Land cover (from CMI classification and 2001 NOAA C-CAP) totals and percent of total within Charles Pinckney National Historic Site (CHPI) boundary and in the subbasin study area containing CHPI. "CHPI Acres (CMI)" are the number of acres of each cover type within CHPI as delineated by the Conservation Management Institute at Virginia Tech (CMI). "CHPI Acres (NOAA)" are the number of acres of each cover type within CHPI as classified by the National Oceanic and Atmospheric Administration (NOAA 2008a) Coastal Change Analysis Program (C-CAP). "Study Area Acres" are the number of acres of each cover type within the subbasin study area as classified by the NOAA. In each case, "%" refers to the percent of the total acreage of CHPI or the subbasin study area.

Land Cover Classification	*CHPI Acres (CMI)*	*CHPI % (CMI)*	*CHPI Acres (NOAA)*	*CHPI % (NOAA)*	*Study Area Acres*	*Study Area %*
Grassland	13.4	40.8	0.4	1.4	23800	1.7
Evergreen Forest	10.7	32.7	9.1	27.7	282669	20.0
Mixed Forest	4.0	12.2	0.2	0.7	16505	1.2
Palustrine Forested Wetland	1.6	5.0	1.1	3.4	246854	17.4
Scrub/Shrub	1.3	4.0	4.2	12.8	88523	6.3
Palustrine Emergent Wetland	1.0	2.9	0.9	2.7	32571	2.3
Low Intensity Developed	0.5	1.4	0.9	2.7	53527	3.8
Estuarine Emergent Wetland	0.3	1.0	0.0	0.0	101576	7.2
Developed Open Space	0.0	0.0	15.3	46.6	41099	2.9
Deciduous Forest	0.0	0.0	0.4	1.4	5190	0.4
Estuarine Scrub/Shrub Wetland	0.0	0.0	0.2	0.7	1662	0.1
Water	0.0	0.0	0.0	0.0	406035	28.7
Pasture/Hay	0.0	0.0	0.0	0.0	36582	2.6
Palustrine Scrub/Shrub Wetland	0.0	0.0	0.0	0.0	30908	2.2
Medium Intensity Developed	0.0	0.0	0.0	0.0	12749	0.9
Cultivated	0.0	0.0	0.0	0.0	11612	0.8
Unconsolidated Shore	0.0	0.0	0.0	0.0	9438	0.7
High Intensity Developed	0.0	0.0	0.0	0.0	7466	0.5
Bare Land	0.0	0.0	0.0	0.0	4953	0.4
Palustrine Aquatic Beds	0.0	0.0	0.0	0.0	1054	0.1

We also compared the cover type percentages with other protected areas in the subbasin study area (Table 5, Table 6). These acreages and percentages show that Fort Sumter NM is protecting a minor amount of the Evergreen Forest within the protected areas in the subbasin; and a smaller percentage (6.0%) or relative make-up compared to the other protected areas (11.3%, Table 5). Fort Sumter NM is also protecting considerably less relative area of wetlands to other protected areas (FOSU = 1.5%, other = 66.1%). Charles Pinckney NHS is protecting a minor amount of the Evergreen Forest within the protected areas, but a comparable relative make-up of Evergreen Forest (32.7%) to other protected land in the study area (36.4%). In addition, this historic site is protecting wetlands at a considerably lower relative make-up (8.9%) as compared to the subbasin protected lands (57.4%, Table 6).

Table 5. Comparison of cover types (from CMI classification and 2001 NOAA C-CAP) within Fort Sumter National Monument boundary, coastal subbasin study area, and other protected areas within the coastal subbasin study area. "FOSU Acres (CMI)" are the number of acres of each cover type within FOSU as delineated by the Conservation Management Institute at Virginia Tech (CMI). "Study Area Acres" are the number of acres of each cover type within the subbasin study area as classified by the National Oceanic and Atmospheric Administration (NOAA 2008a) Coastal Change Analysis Program (C-CAP). "Conservation Acres (NOAA)" are the number of acres of each cover type within conservation areas in the study area as classified by the NOAA. In each case, "%" refers to the percent of the total acreage of either FOSU, study area, or conservation areas.

Land Cover Classification	*FOSU Acres (CMI)*	*FOSU % (CMI)*	*Study Area Acres*	*Study Area %*	*Conservation Acres (NOAA)*	*Conservation % (NOAA)*
Water	117.3	50.5	406035	28.7	9942.2	14.8
Unconsolidated Shore	28.6	12.3	9438	0.7	1464.4	2.2
Low Intensity Developed	27.6	11.9	53527	3.8	111.0	0.2
Developed Open Space	18.8	8.1	41099	2.9	20.9	0.0
Evergreen Forest	13.9	6.0	282669	20.0	7597.1	11.3
Grassland	9.6	4.2	23800	1.7	678.3	1.0
Medium Intensity Developed	7.9	3.4	12749	0.9	8.0	0.0
Scrub/Shrub	4.4	1.9	88523	6.3	1736.2	2.6
Palustrine Forested Wetland	2.0	0.9	246854	17.4	6753.8	10.1
Estuarine Emergent Wetland	1.4	0.6	101576	7.2	32482.5	48.5
Bare Land	0.6	0.3	4953	0.4	589.1	0.9
Pasture/Hay	0.0	0.0	36582	2.6	97.4	0.1
Palustrine Emergent Wetland	0.0	0.0	32571	2.3	3476.6	5.2
Palustrine Scrub/Shrub Wetland	0.0	0.0	30908	2.2	1148.2	1.7
Mixed Forest	0.0	0.0	16505	1.2	424.5	0.6
Cultivated	0.0	0.0	11612	0.8	19.8	0.0
High Intensity Developed	0.0	0.0	7466	0.5	0.2	0.0
Deciduous Forest	0.0	0.0	5190	0.4	32.2	0.0
Estuarine Scrub/Shrub Wetland	0.0	0.0	1662	0.1	390.1	0.6
Palustrine Aquatic Beds	0.0	0.0	1054	0.1	0.0	0.0
Estuarine Forested Wetland	0.0	0.0	0	0.0	0.0	0.0
Total	232.1	100	1414775	100.0	66972.5	100.0

Table 6. Comparison of cover types (from CMI classification and 2001 NOAA C-CAP) within Charles Pinckney National Historic Site boundary, watershed study area, and other protected areas within the watershed. "CHPI Acres (CMI)" are the number of acres of each cover type within CHPI as delineated by the Conservation Management Institute at Virginia Tech (CMI). "Study Area Acres" are the number of acres of each cover type within the subbasin study area as classified by the National Oceanic and Atmospheric Administration (NOAA 2008a) Coastal Change Analysis Program (C-CAP). "Conservation Acres (NOAA)" are the number of acres of each cover type within conservation areas in the study area as classified by the NOAA. In each case, "%" refers to the percent of the total acreage of either CHPI, study area, or conservation areas.

Land Cover Classification	*CHPI Acres (CMI)*	*CHPI % (CMI)*	*Study Area Acres*	*Study Area %*	*Conservation Acres (NOAA)*	*Conservation % (NOAA)*
Grassland	13.4	40.8	23800	1.7	185.5	1.3
Evergreen Forest	10.7	32.7	282669	20.0	5035.8	36.4
Mixed Forest	4.0	12.2	16505	1.2	145.0	1.0
Palustrine Forested Wetland	1.6	5.0	246854	17.4	6443.3	46.6
Scrub/Shrub	1.3	4.0	88523	6.3	321.1	2.3
Palustrine Emergent Wetland	1.0	2.9	32571	2.3	201.0	1.5
Low Intensity Developed	0.5	1.4	53527	3.8	64.9	0.5
Estuarine Emergent Wetland	0.3	1.0	101576	7.2	646.3	4.7
Water	0.0	0.0	406035	28.7	40.0	0.3
Developed Open Space	0.0	0.0	41099	2.9	24.0	0.2
Pasture/Hay	0.0	0.0	36582	2.6	57.6	0.4
Palustrine Scrub/Shrub Wetland	0.0	0.0	30908	2.2	624.9	4.5
Medium Intensity Developed	0.0	0.0	12749	0.9	10.0	0.1
Cultivated	0.0	0.0	11612	0.8	4.9	0.0
Unconsolidated Shore	0.0	0.0	9438	0.7	0.0	0.0
High Intensity Developed	0.0	0.0	7466	0.5	0.4	0.0
Deciduous Forest	0.0	0.0	5190	0.4	0.9	0.0
Bare Land	0.0	0.0	4953	0.4	0.0	0.0
Estuarine Scrub/Shrub Wetland	0.0	0.0	1662	0.1	16.2	0.1
Palustrine Aquatic Beds	0.0	0.0	1054	0.1	0.0	0.0
Estuarine Forested Wetland	0.0	0.0	0	0.0	0.0	0.0
Total	32.7	100.0	1414775	100.0	13822.0	100.0

Table 7. Protected areas surrounding Fort Sumter National Monument and Charles Pinckney National Historic Site, within the subbasin study area.

Protected Area	*Managed Area*	*Primary Owner*	*Acres*
Ardea	Local Land Trust Preserve/Easement	Private	6
Ashley River Marsh	Local Land Trust Preserve/Easement	Lowcountry Open Land Trust	1644
Beck Island	Local Land Trust Preserve/Easement	Private	321
Bird Key-Stono Heritage Preserve	State Natural Heritage Preserve	South Carolina Department of Natural Resources	12
Bradsher	TNC Easement	Private	5528
Brasher 1	TNC Preserve	The Nature Conservancy	151
Buzzard's Island Heritage Preserve	State Natural Heritage Preserve	South Carolina Department of Natural Resources	37
Cape Romain National Wildlife Refuge	National Wildlife Refuge (NWR)	United States Fish & Wildlife Service	380
Capers Island Heritage Preserve	State Natural Heritage Preserve	South Carolina Department of Natural Resources	2263
Castle Pinckney Historical Site	State Lands	Ports Authority	6046
Crab Bank Heritage Preserve	State Natural Heritage Preserve	South Carolina Department of Natural Resources	41
Dill Sanctuary	Private Institution – Managed for Biodiversity	Charleston Museum	144
FMNF Botanical and Zoological Area	Botanical Reserve	United States Forest Service	134
FMNF Wilderness Area	Wilderness Area	United States Forest Service	3199
Fiddlers Green	TNC Easement	Private	2649
Fort Lamar Heritage Preserve	State Natural Heritage Preserve	South Carolina Department of Natural Resources	6
Francis Marion National Forest	Forest Service (USFS)	United States Forest Service	9815
Goat Island	Local Land Trust Preserve/Easement	Private	64487
Gold Bug Island	Local Land Trust Preserve/Easement	Private	65
Irvin Tract	Local Land Trust Preserve/Easement	Private	20
Johns Island Maritime Forest	TNC Preserve	The Nature Conservancy	14
Kiawah R. Marsh	Local Land Trust Preserve/Easement	Lowcountry Open Land Trust	191
Little Bear Island	Ducks Unlimited Easement	Private	55
Lofton's L 0ng'	TNC Easement	Private	12286
Mather Tract	Local Land Trust Preserve/Easement	Private	1
Parkers Island	Local Land Trust Preserve/Easement	Private	23

Protected Area	*Managed Area*	*Primary Owner*	*Acres*
Santee Coastal Reserve	State Wildlife Reserves	South Carolina Department of Natural Resources	4700
Thorn 2 0	TNC Easement	Private	7
Wando Farms	Ducks Unlimited Easement	Private	2173
Wassen Preserve	Local Land Trust Preserve/Easement	Kiawah Island Natural Habitat Conservancy	17

Vegetation:

In addition, we reclassified and examined the land cover data to quantify "natural vegetation," "semi-natural vegetation," and "unnatural vegetation" within the subbasin study area and within the monument boundaries (Appendix A). Fort Sumter NM is composed of 22.0% "semi-natural vegetation," 41.4% "unnatural vegetation," and 31.4% "natural vegetation" (Table 8, Figure 8). This is in stark contrast to the subbasin study area, where "natural vegetation" dominates the landscape at 83.6% (Table 8, Figure 7). In contrast to Fort Sumter NM, "natural vegetation" dominates the relative land area of Charles Pinckney NHS (Table 8, Figure 7). Only 1.4% of this site is in "unnatural vegetation," while its subbasin study area is composed of 7.4% "unnatural vegetation."

Table 8. Comparison of natural, semi-natural, and unnatural vegetation (reclassified from CMI classification and 2001 NOAA C-CAP) at Fort Sumter National Monument, Charles Pinckney National Historic Site, and in the subbasin study area. "FOSU Acres" and "CHPI Acres" are the number of acres of each vegetation type within FOSU or CHPI as delineated by the Conservation Management Institute at Virginia Tech (CMI). "Study Area Acres" are the number of acres of each vegetation type within the subbasin study area as classified by the NOAA. In each case, "%" refers to the percent of the total acreage of either FOSU, CHPI, or the subbasin study area.

Vegetation Classification	*FOSU Acres*	*FOSU %*	*CHPI Acres*	*CHPI %*	*Study Area Acres*	*Study Area %*
Natural Vegetation	31.4	36.6	32.3	98.6	831313.6	83.6
Semi-natural Vegetation	18.8	22.0	0.0	0.0	89293.8	9.0
Unnatural Vegetation	35.5	41.4	0.5	1.4	73742.5	7.4

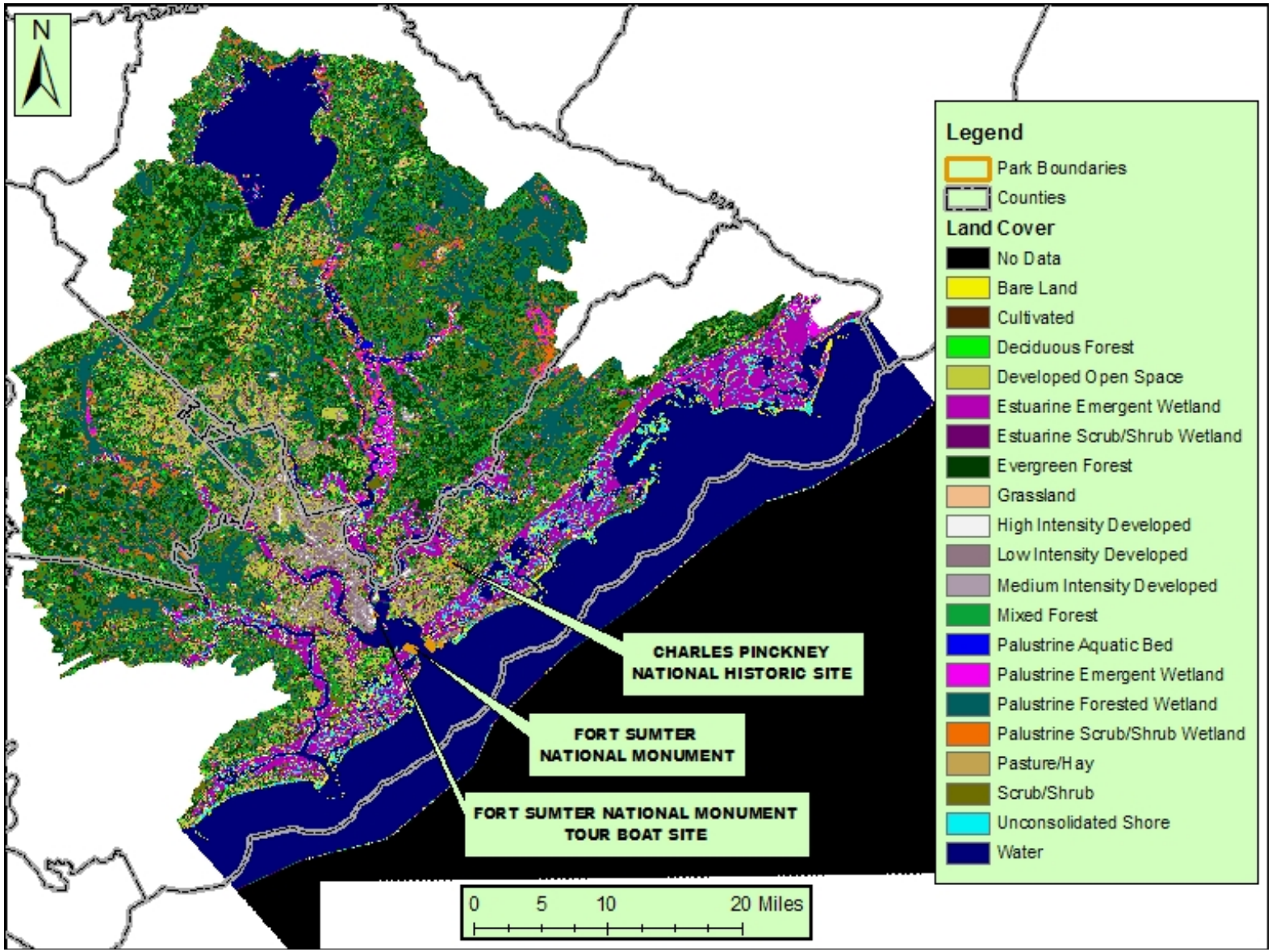

Figure 5. Land cover (from 2001 NOAA C-CAP) in the Fort Sumter National Monument and Charles Pinckney National Historic Site subbasin study area.

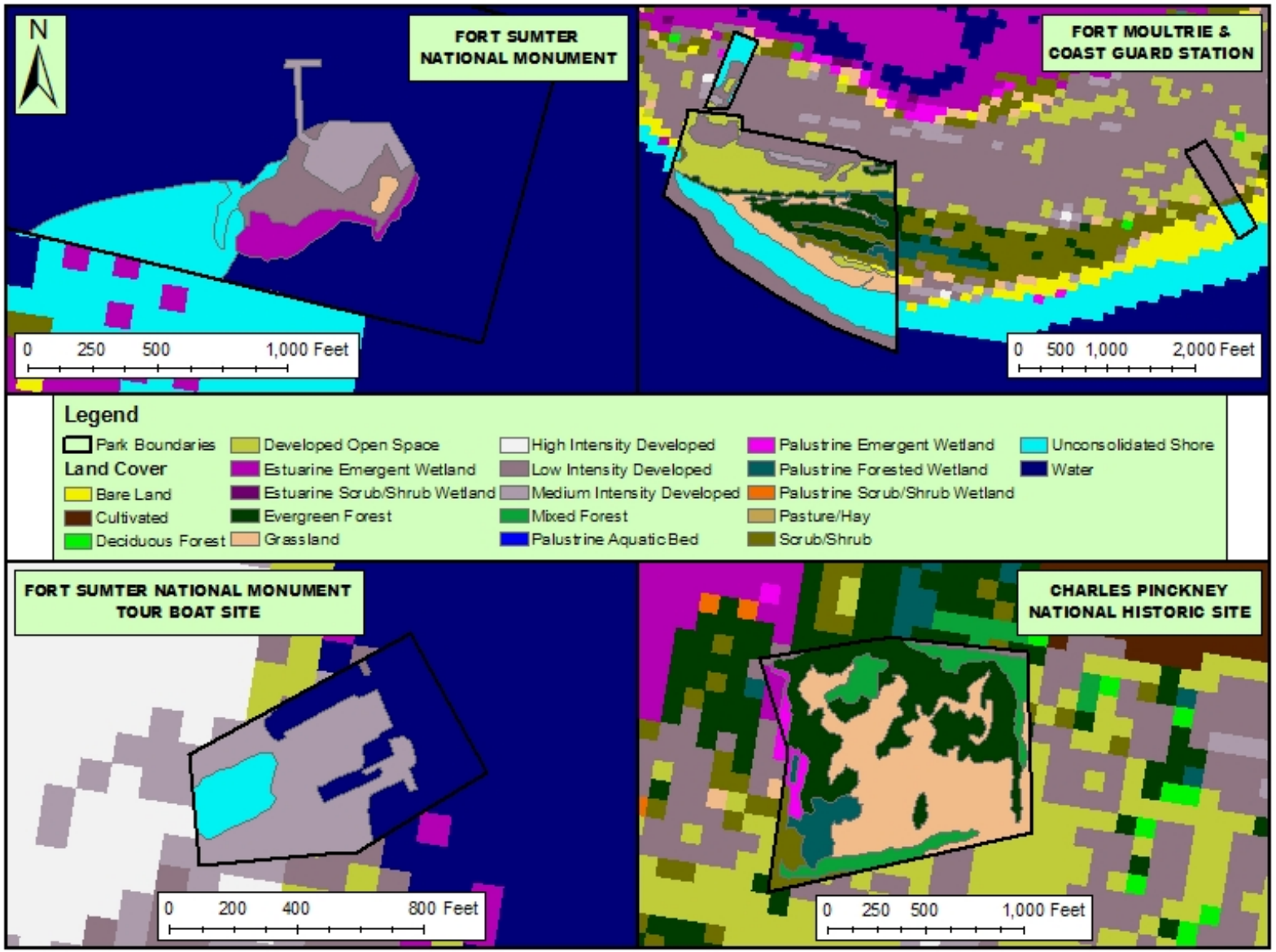

Figure 6. Land cover (from CMI classification within park boundaries and 2001 NOAA C-CAP) at Fort Sumter National Monument and Charles Pinckney National Historic Site.

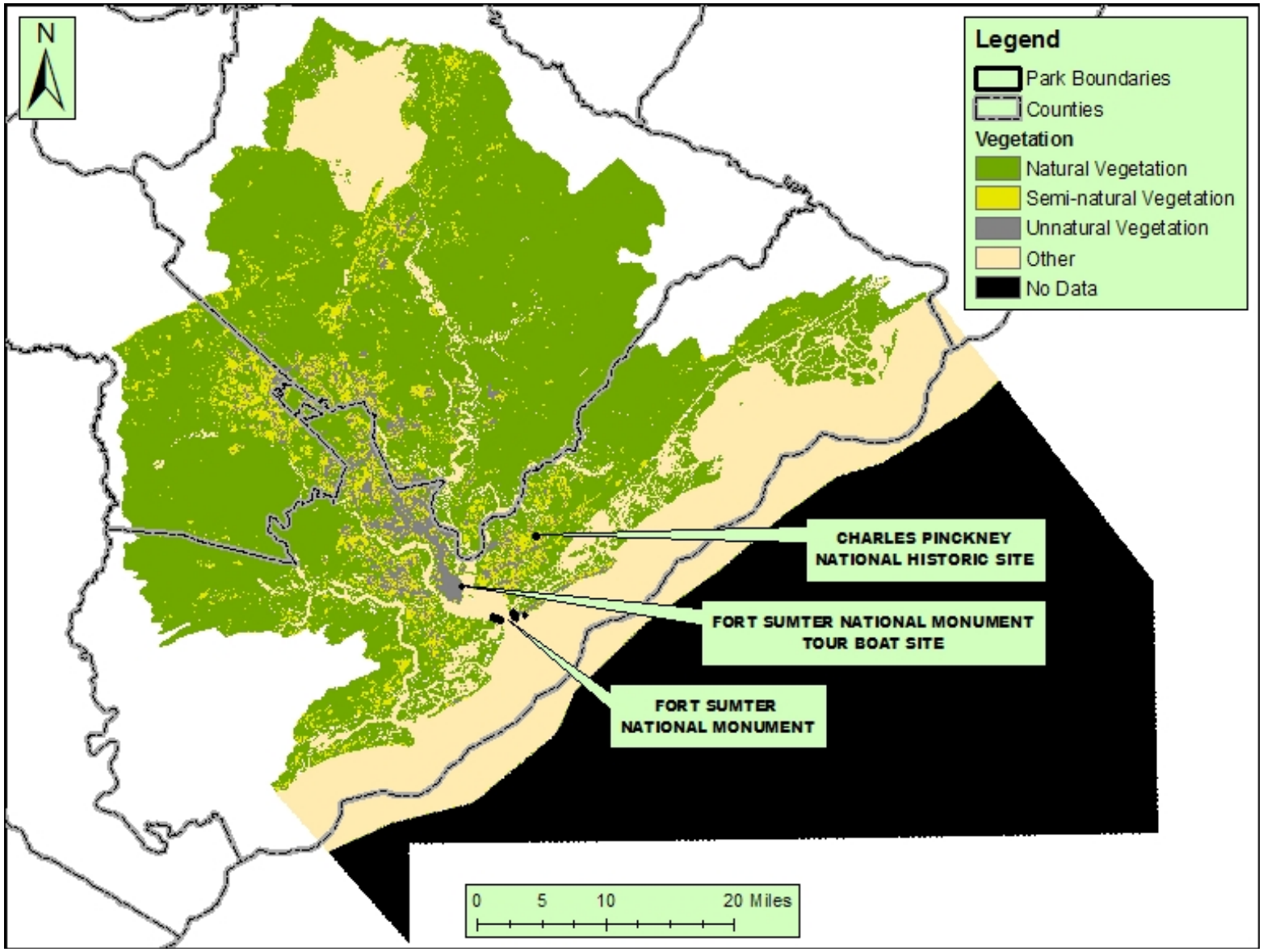

Figure 7. Vegetation reclass (from 2001 NOAA C-CAP) for the Fort Sumter National Monument and Charles Pinckney National Historic Site subbasin study area.

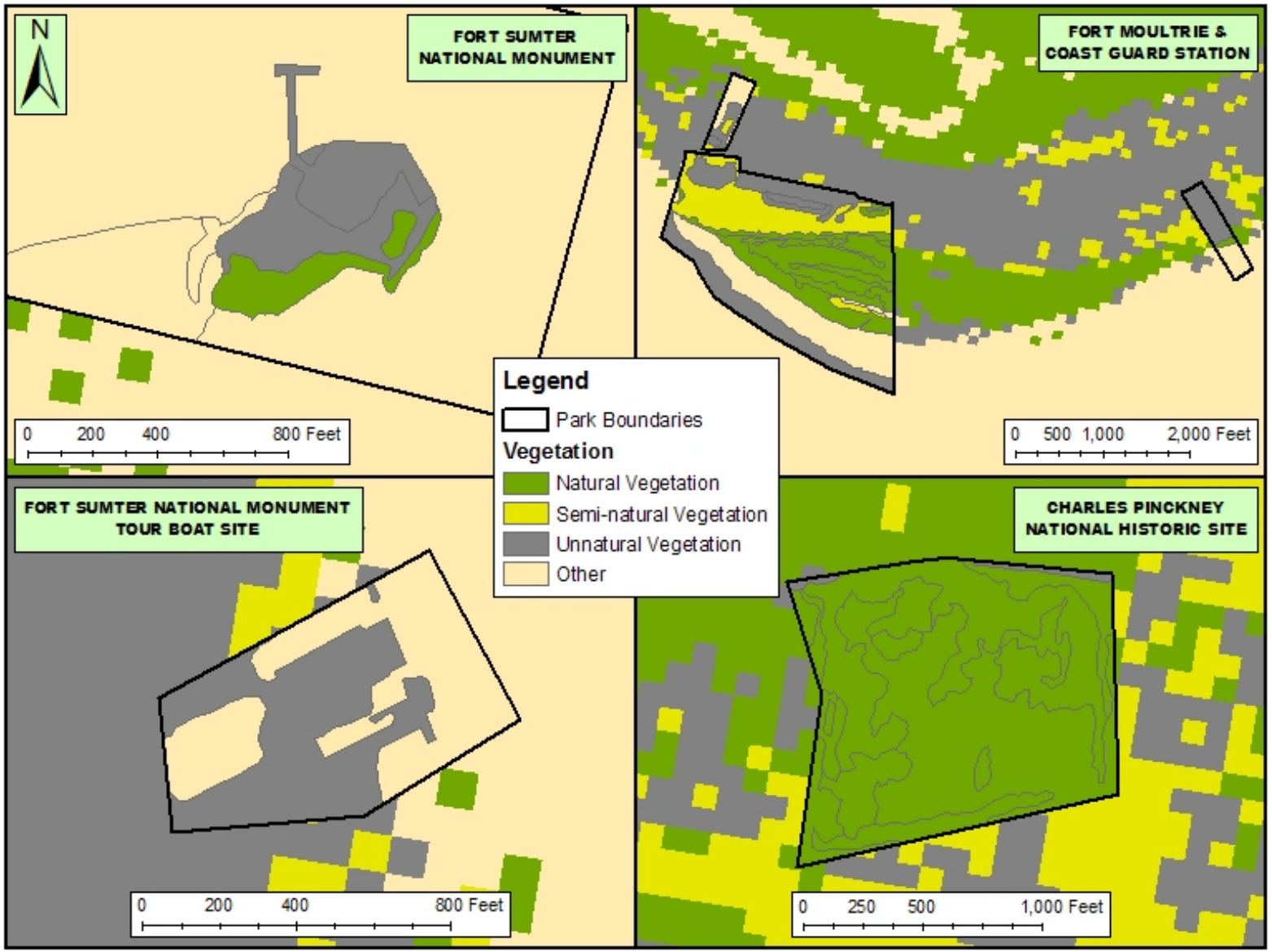

Figure 8. Vegetation reclass (from CMI classification within park boundaries and 2001 NOAA C-CAP) for Fort Sumter National Monument and Charles Pinckney National Historic Site.

3.1.1.b Resource threats and stressors:
Threats and stressors to landscape dynamics are plentiful and often serve as primary threats to other natural resource categories examined in this assessment. Several were mentioned in the previous condition status and all are related. They include human population growth, unstructured development, and overutilization of natural resources, all of which often lead to habitat fragmentation and wetland loss.

Land cover changes have been evident throughout the subbasin study area (Table 9). There was a 9% increase from 1996 to 2001 in developed areas within the study area. These changes will directly impact Fort Sumter NM and Charles Pinckney NHS as even relatively small protected natural areas fall under increased pressure to accommodate much of their region's natural processes and biodiversity.

Table 9. Land cover change (from 1996 and 2001 C-CAP) in the subbasin study area containing Fort Sumter National Monument and Charles Pinckney National Historic Site.

Land Cover Classification	*Study Area Acres 1996*	*Study Area % 1996*	*Study Area Acres 2001*	*Study Area % 2001*	*Percent Change 1996 - 2001*
Palustrine Scrub/Shrub Wetland	22064	1.6	30908	2.2	40.09
Grassland	18893	1.3	23800	1.7	25.98
Deciduous Forest	4147	0.3	5190	0.4	25.16
Palustrine Emergent Wetland	26775	1.9	32571	2.3	21.64
Developed Open Space	34541	2.4	41099	2.9	18.99
Scrub/Shrub	75554	5.3	88523	6.3	17.17
Estuarine Scrub/Shrub Wetland	1479	0.1	1662	0.1	12.38
Bare Land	4428	0.3	4953	0.4	11.84
Low Intensity Developed	49812	3.5	53527	3.8	7.46
Mixed Forest	15490	1.1	16505	1.2	6.55
Medium Intensity Developed	12005	0.8	12749	0.9	6.20
Cultivated	11158	0.8	11612	0.8	4.07
Pasture/Hay	35192	2.5	36582	2.6	3.95
High Intensity Developed	7334	0.5	7466	0.5	1.80
Water	404187	28.6	406035	28.7	0.46
Estuarine Emergent Wetland	101400	7.2	101576	7.2	0.17
Estuarine Forested Wetland	0	0.0	0	0.0	0.00
Palustrine Forested Wetland	269253	19.0	246854	17.4	-8.32
Evergreen Forest	308837	21.8	282669	20.0	-8.47
Unconsolidated Shore	10766	0.8	9438	0.7	-12.34
Palustrine Aquatic Beds	1461	0.1	1054	0.1	-27.86

3.1.1.c Critical knowledge or data gaps:
To assess in-park landscapes, a more comprehensive, detailed-scale map of vegetation communities would be an ideal addition to the broader-scale land cover on which this analysis was primarily based. The National Park Service has a service-wide vegetation mapping initiative (National Park Service 2008b) and current plans will have final maps available for Fort Sumter

NM and Charles Pinckney NHS in 2012 (Curtis 2008). We could also draw more thorough conclusions with more recently acquired data (Table 10). The detailed classification we performed used dated imagery, and was done relatively fast, with no fieldwork, verification, or accuracy assessment. With that said, it was much more accurate than the NOAA C-CAP classification (30 by 30 meter pixel resolution) at the more detailed park scale.

3.1.1.d Condition status summary

The land cover comparison to coastal study area condition status for Fort Sumter NM is fair because this monument is protecting a smaller percentage of forest cover types than the subbasin study area (Table 10). Water and unconsolidated shore compose the largest land cover class at Fort Sumter NM. The water, shore, and other semi-natural land cover classes offer some benefits. Charles Pinckney NHS is good for comparison to the subbasin because the site is protecting a larger relative area of grassland, evergreen forest, and mixed forest than the subbasin study area (Table 11). Compared to other conservation areas, Fort Sumter NM is protecting a smaller relative area of evergreen forest and wetlands, so this monument received a poor status for this category (Table 10). Charles Pinckney NHS is in the fair range compared to other conservation areas because it is protecting a comparable relative make-up of evergreen forest but a considerably lower make-up of wetlands (Table 11). Fort Sumter NM is protecting a low percentage (31.4%) of natural vegetation, so it is rated poor for comparison to the subbasin study area (Table 10). Natural vegetation makes up most of the relative land area of Charles Pinckney NHS, so vegetation comparison to subbasin study area received a good condition status (Table 11).

Table 10. Landscape dynamics condition status summary within Fort Sumter National Monument. Data quality was rated based on *thematic* (1 = best source; 0 = not the best source), s*patial* (1 = inside park boundary; 0 = outside park boundary), and *temporal* (1 = recent; 0 = older than 5 years). The colors green, yellow, and red refer to good, fair, and poor scores respectively (see Table 1).

Category	***Condition Status***	***Midpoint***	***Data Quality***		
			Thematic	*Spatial*	*Temporal*
Land cover comparison to subbasin study area			0	1	0
	Fair	0.5	1 out of 3		
Land cover comparison to conservation areas			0	1	0
	Poor	0.17	1 out of 3		
Vegetation comparison to subbasin study area			0	1	0
	Poor	0.17	1 out of 3		
Landscape dynamics total			0	3	0
	Poor	0.28	3 out of 9		

Table 11. Landscape dynamics condition status summary within Charles Pinckney National Historic Site. Data quality was rated based on *thematic* (1 = best source; 0 = not the best source), s*patial* (1 = inside park boundary; 0 = outside park boundary), and *temporal* (1 = recent; 0 = older than 5 years). The colors green, yellow, and red refer to good, fair, and poor scores respectively (see Table 1).

Category	***Condition Status***	***Midpoint***	***Data Quality***		
			Thematic	*Spatial*	*Temporal*
Land cover comparison to subbasin study area			0	1	0
	Good	0.84	1 out of 3		
Land cover comparison to conservation areas			0	1	0
	Fair	0.5	1 out of 3		
Vegetation comparison to subbasin study area			0	1	0
	Good	0.84	1 out of 3		
Landscape dynamics total			0	3	0
	Good	0.73	3 out of 9		

3.1.1.e Recommendations to park managers:
Landscape scale initiatives take collaboration from all parties involved. Continuing to build on partnerships with other conservation organizations and land managers (Table 12) will promote broad-scale collaboration efforts.

Table 12. List of protected areas, organizations, and contact information.

Protected Area	***Primary Owner***	***Website***
Ardea	Private	N/A
Ashley River Marsh	Lowcountry Open Land Trust	http://www.lolt.org/
Beck Island	Private	N/A
Bird Key-Stono Heritage Preserve	South Carolina Department of Natural Resources	http://www.dnr.sc.gov/
Bradsher	Private	N/A
Brasher 1	The Nature Conservancy	http://www.nature.org/
Buzzard's Island Heritage Preserve	South Carolina Department of Natural Resources	http://www.dnr.sc.gov/
Cape Romain National Wildlife Refuge	United States Fish & Wildlife Service	http://www.fws.gov/
Capers Island Heritage Preserve	South Carolina Department of Natural Resources	http://www.dnr.sc.gov/
Castle Pinckney Historical Site	Ports Authority	http://www.port-of-charleston.com/
Crab Bank Heritage Preserve	South Carolina Department of Natural Resources	http://www.dnr.sc.gov/
Dill Sanctuary	Charleston Museum	http://www.charlestonmuseum.org/
FMNF Botanical and Zoological Area	United States Forest Service	http://www.fs.fed.us/
FMNF Wilderness Area	United States Forest Service	http://www.fs.fed.us/
Fiddlers Green	Private	N/A
Fort Lamar Heritage Preserve	South Carolina Department of Natural Resources	http://www.dnr.sc.gov/
Francis Marion National Forest	United States Forest Service	http://www.fs.fed.us/

Protected Area	*Primary Owner*	*Website*
Goat Island	Private	N/A
Gold Bug Island	Private	N/A
Irvin Tract	Private	N/A
Johns Island Maritime Forest	The Nature Conservancy	http://www.nature.org/
Kiawah R. Marsh	Lowcountry Open Land Trust	http://www.lolt.org/
Little Bear Island	Private	N/A
Lofton's L 0ng'	Private	N/A
Mather Tract	Private	N/A
Parkers Island	Private	N/A
Santee Coastal Reserve	South Carolina Department of Natural Resources	http://www.dnr.sc.gov/
Thorn 2 0	Private	N/A
Wando Farms	Private	N/A
Wassen Preserve	Kiawah Island Natural Habitat Conservancy	http://www.kiawahconservancy.org/

3.1.2 Fire and Fuel Dynamics

Fire exclusion practices have drastically changed the natural fire processes that took place in many ecosystems across the United States (U.S. Geological Survey 2000). Fire is now being used more actively in managing natural landscapes such as historical prairies and pine savannahs in the Coastal Plain of the Southeastern U.S. (Waldrop et al. 1992, U.S. Geological Survey 2000). Chinese tallow and other Southeastern invasive exotic species may also be controlled with appropriately timed controlled burns (Zouhar et al. 2008).

3.1.2.a Current condition:

Despite the Southeastern Coastal Plain having an active fire regime and history, fire has not been a major concern at Fort Sumter NM or Charles Pinckney NHS. There have been two fires recorded at Fort Sumter NM since 1972; there have been no fires recorded at Charles Pinckney NHS (Table 13). The size, scope, or location of these fires is unknown due to insufficient data. There have been five fires within 20 miles of Fort Sumter NM and Charles Pinckney NHS reported by the Geospatial Multi-Agency Coordination Group (GeoMAC 2008) since 2000 (Figure 9).

Table 13. Wildfires reported at Fort Sumter National Monument from 1/1/1972 to 12/31/2007, at the National Fire and Aviation Management Web Application (National Wildfire Coordinating Group 2008).

WFMI ID	Fire Name	NPS ID	Protection Type	Date	Acres	Cause	Owner
226882	Support	1	Support actions by NPS resources	8/8/1990	N/A	N/A	USFS
226883	Foothills	1	Support actions by NPS resources	8/5/1992	N/A	N/A	USFS

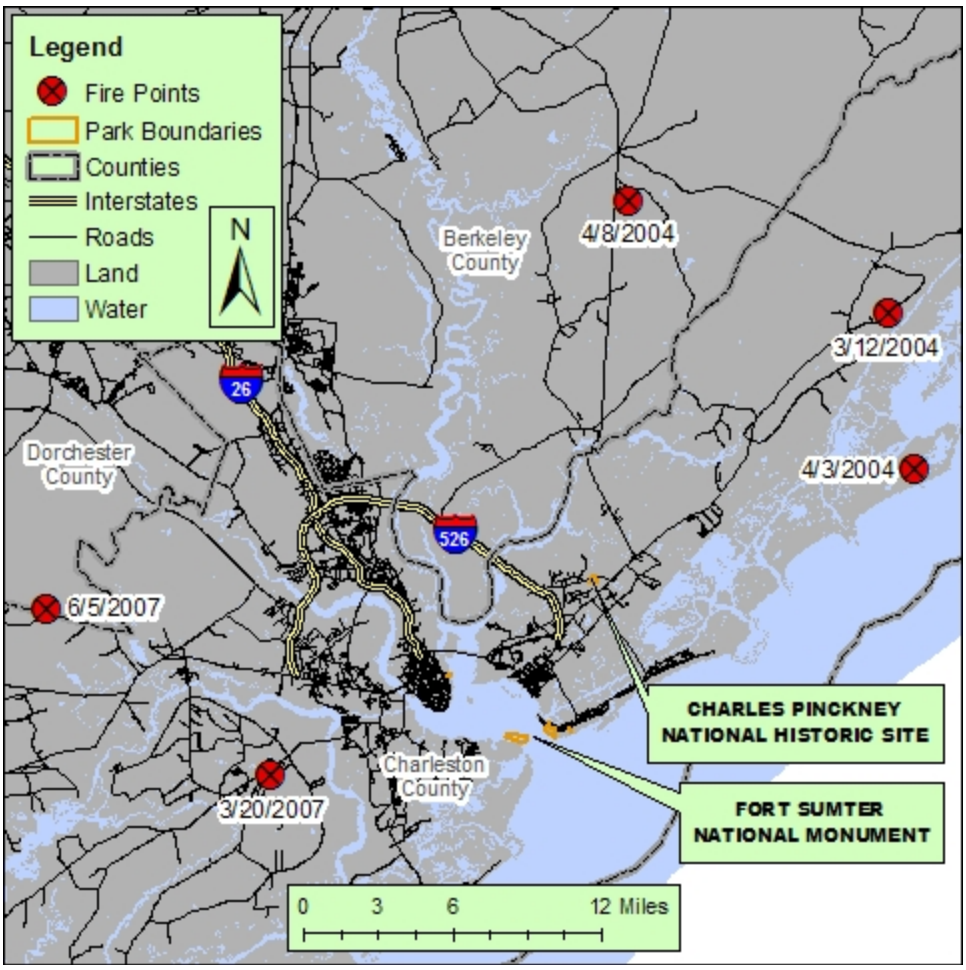

Figure 9. Wildfire sites and the dates they occurred, from 2000 to 2007 (GeoMAC 2008), within 20 miles of Fort Sumter National Monument and Charles Pinckney National Historic Site.

According to a simulated historical fire severity model (USDA Forest Service 2006), low severity fires accounted for a medium percentage of fire occurrences on the Fort Sumter NM lands; low severity fires accounted for 91 – 100% of fires on the vast majority of the Charles Pinckney NHS property (Figure 10). According to the model, low severity fires have historically dominated the region surrounding the parks, while mixed severity fires were least dominant in the region (Figure 11). Replacement severity fires were slightly more prevalent than mixed on the Fort Sumter NM lands (Figure 12). Low severity fires cause less than 25% average replacement of dominant biomass, medium severity fires cause between 25 and 75% replacement, and replacement severity fires cause greater than 75% average replacement of dominant biomass. The entire Fort Sumter NM property is in the Fire Regime Condition Class III, meaning there is high departure from historic vegetation. According to the LANDFIRE data, the majority of the Charles Pinckney NHS property is classified as agriculture and urban; however, of the area that is under a fire regime condition, the majority is in the Fire Regime Condition Class II, meaning there is a moderate departure from historic vegetation (Figure 13). These data are intended to be used at a landscape scale (USDA Forest Service 2006), so caution should be taken with analysis of these data at a larger, more detailed scale within the Fort Sumter NM and Charles Pinckney NHS boundaries.

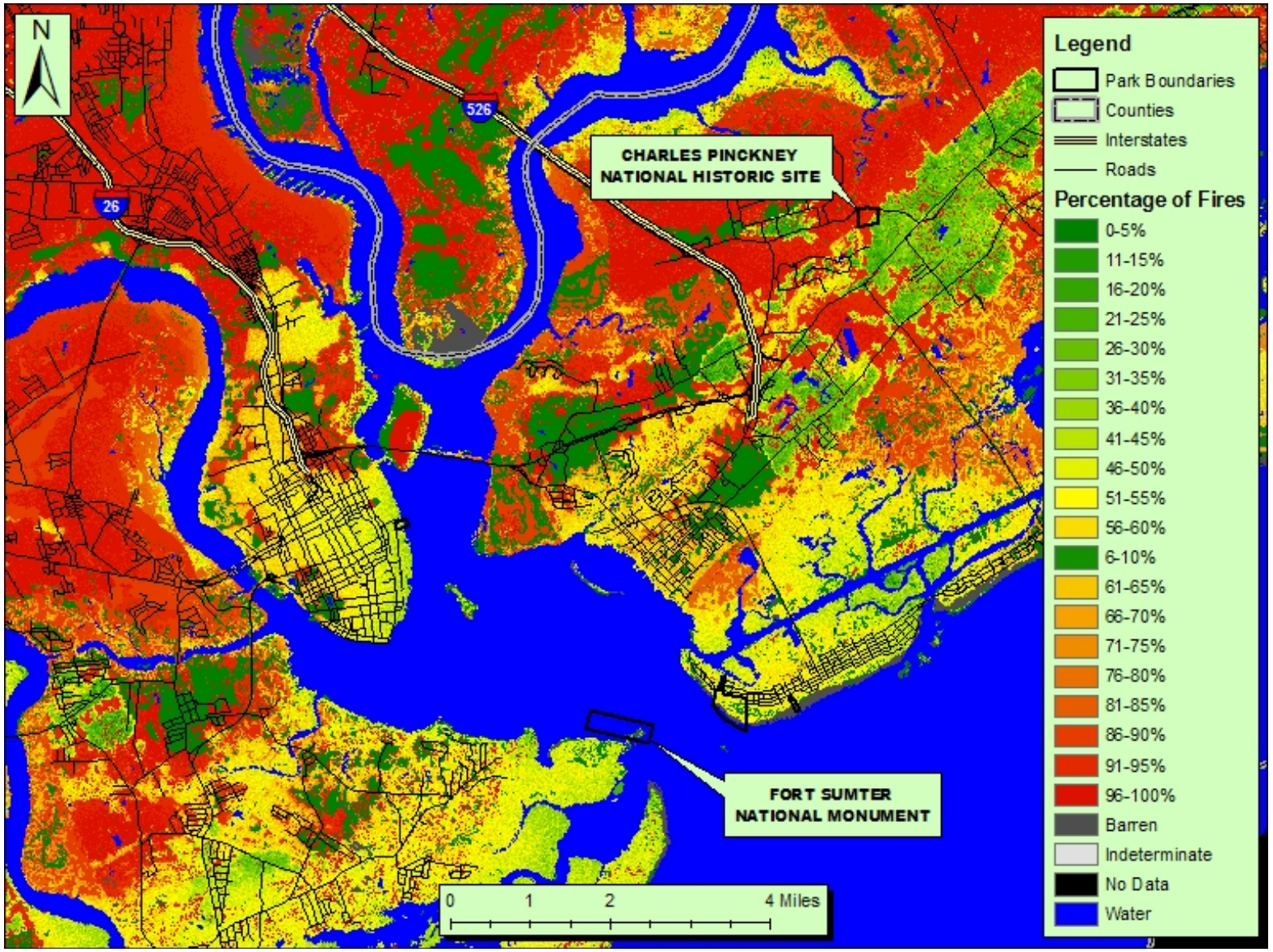

Figure 10. Simulated historical percent of low severity fires according to LANDFIRE (USDA Forest Service 2006) in the region of Fort Sumter National Monument and Charles Pinckney National Historic Site.

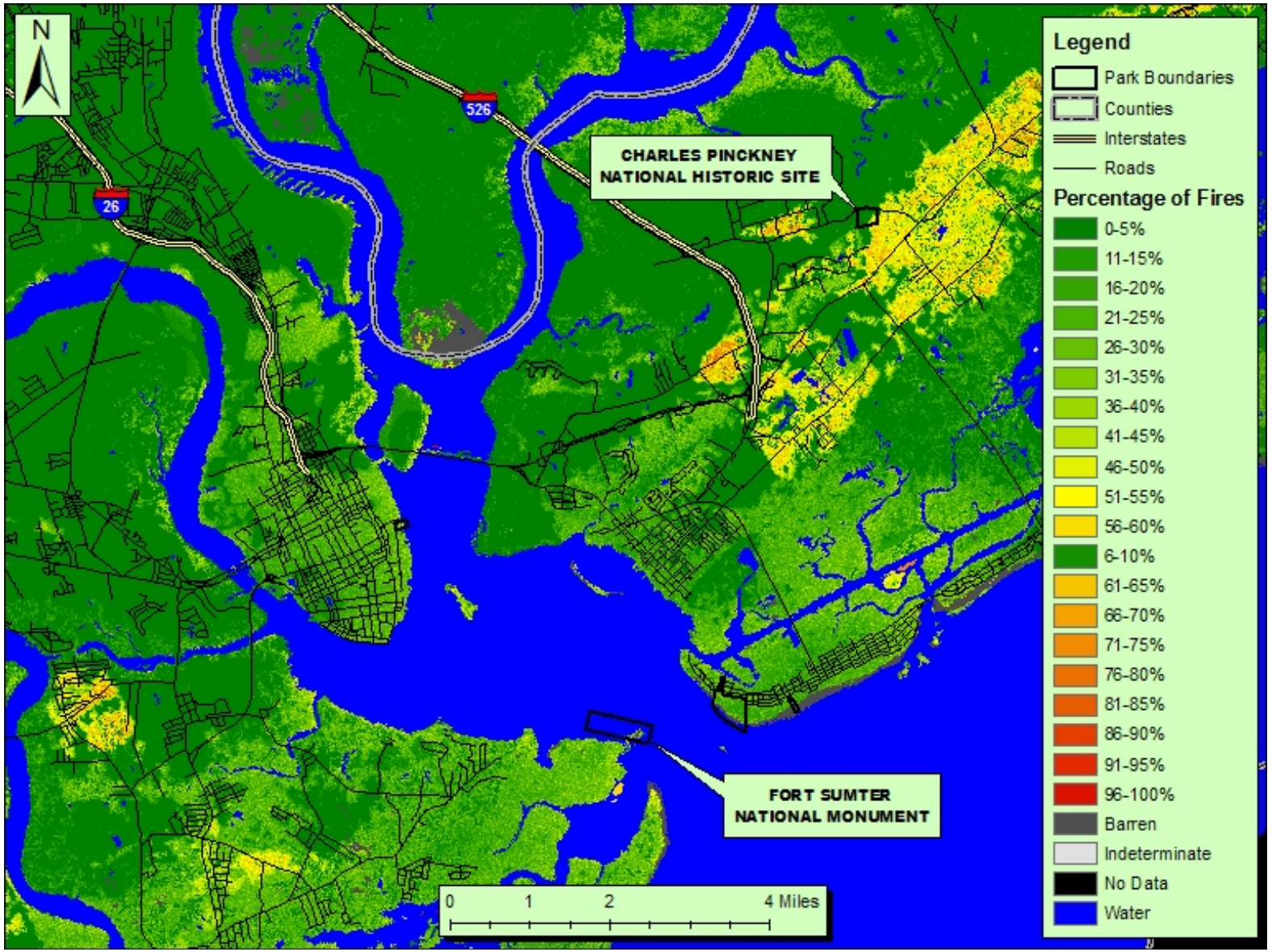

Figure 11. Simulated historical percent of mixed severity fires according to LANDFIRE (USDA Forest Service 2006) in the region of Fort Sumter National Monument and Charles Pinckney National Historic Site.

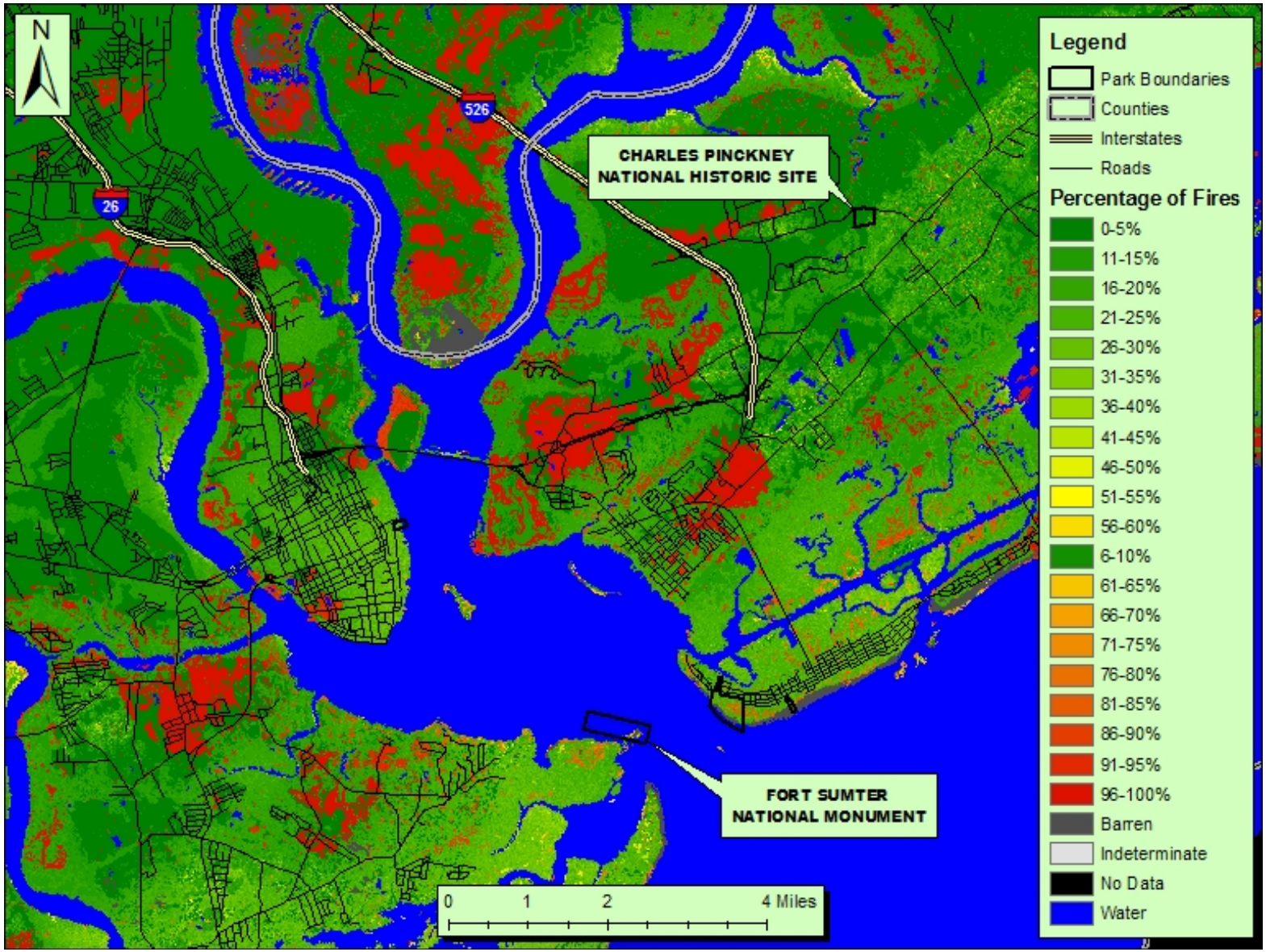

Figure 12. Simulated historical percent of replacement severity fires according to LANDFIRE (USDA Forest Service 2006) in the region of Fort Sumter National Monument and Charles Pinckney National Historic Site.

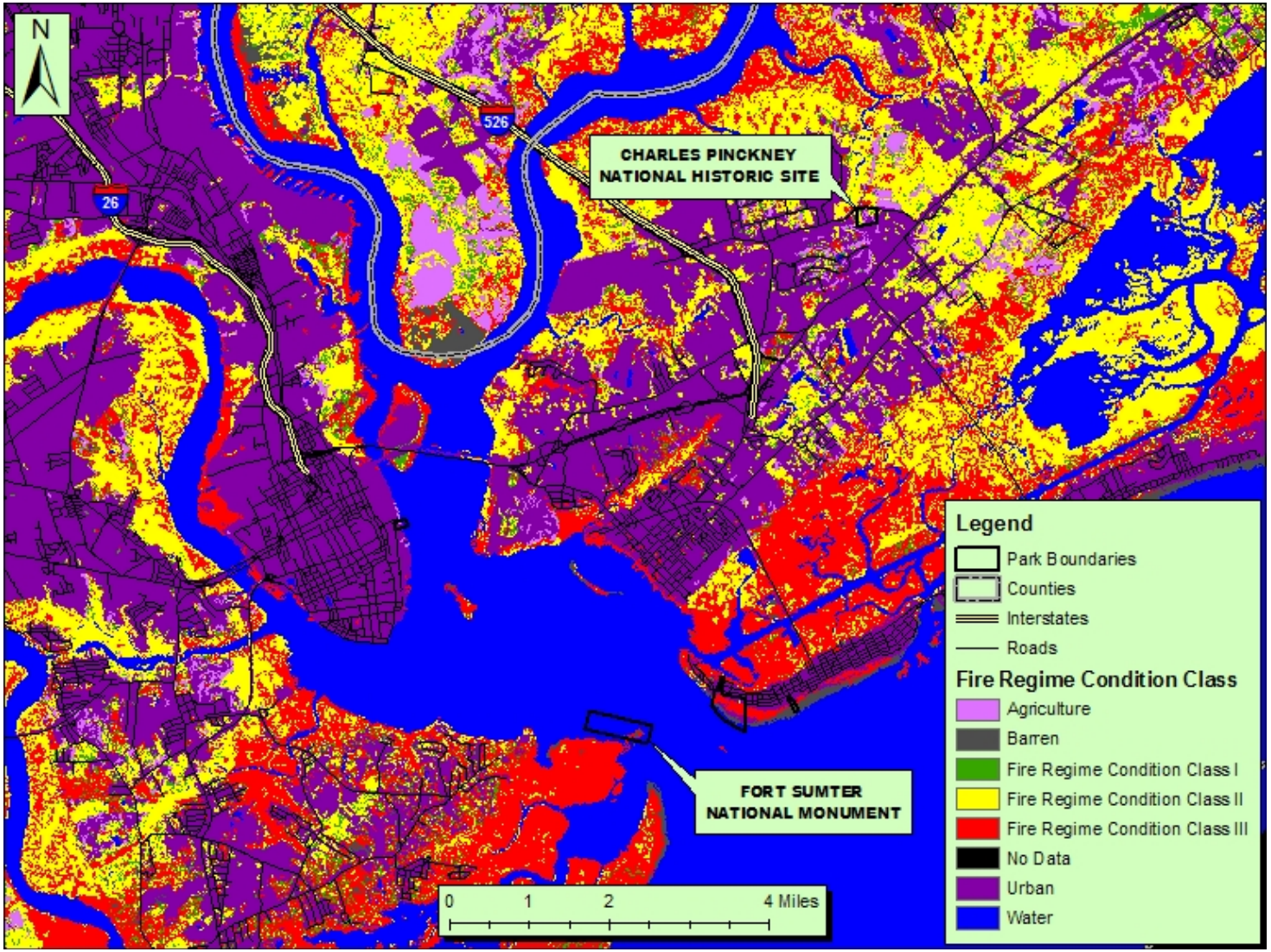

Figure 13. Departure between current vegetation condition and reference vegetation condition according to LANDFIRE (USDA Forest Service 2006) in the region of Fort Sumter National Monument and Charles Pinckney National Historic Site. Fire Regime Condition Class I is low departure from historic vegetation; Condition Class II is moderate departure from historic vegetation; and Condition Class III is high departure from historic vegetation.

3.1.2.b Resource threats and stressors:
Fuel types (Figure 14) and fuel loads are an existing threat and stressor that should be monitored at Fort Sumter NM and Charles Pinckney NHS. As dead and dry plant materials build up, the risk of more catastrophic fire events increases (U.S. Geological Survey 2000).

3.1.2.c Critical knowledge or data gaps:
As mentioned before, there is a data gap since there are no detailed, large-scale vegetation maps available for Fort Sumter NM or Charles Pinckney NHS. With a current vegetation map, we could more thoroughly assess the role of fire in the vegetation communities.

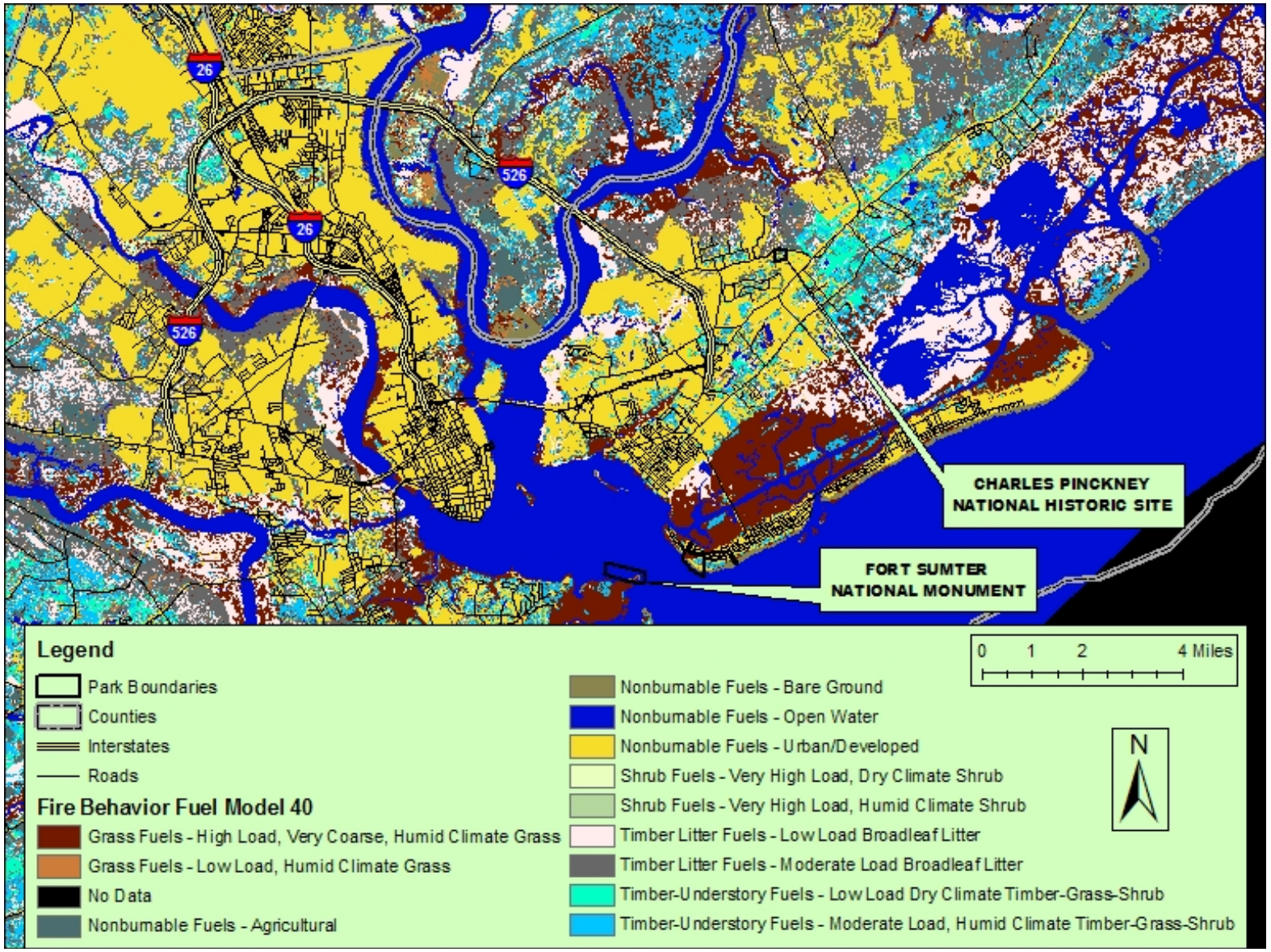

Figure 14. Wildfire fuel types according to LANDFIRE (USDA Forest Service 2006) in the region of Fort Sumter National Monument and Charles Pinckney National Historic Site.

3.1.2.d Condition status summary

Fire and fuel dynamics received a good condition status for both parks because there were very few recorded fires at the parks or in the region (Table 14). If fires were to occur, a large portion of the parks and the region are predicted to be low severity. In addition, the majority of Charles Pinckney NHS and the region exhibit moderate departure from historic vegetation, placing it in Fire Regime Condition Class II.

Table 14. Fire condition status summary for Fort Sumter National Monument and Charles Pinckney National Historic Site. Data quality was rated based on *thematic* (1 = best source; 0 = not the best source), s*patial* (1 = inside park boundary; 0 = outside park boundary), and *temporal* (1 = recent; 0 = older than 5 years). The colors green, yellow, and red refer to good, fair, and poor scores respectively (see Table 1).

Category	***Condition Status***	***Midpoint***	***Data Quality***		
			Thematic	*Spatial*	*Temporal*
Fire dynamics Total			0	1	1
	Good	0.84	2 out of 3		

3.1.2.e Recommendations to park managers:

Fort Sumter NM and Charles Pinckney should continue to record fire occurrence information with the National Wildfire Coordinating Group. The only recorded fires were in 1990 and 1992.

The Wildland Fire Assessment System (USDA Forest Service 2008) has a Fire Danger Rating website: http://www.wfas.net/content/view/17/32/

A daily observed (current) fire danger class and a forecasted fire danger class can be viewed for the United States as well as regional subsets (Figure 15).

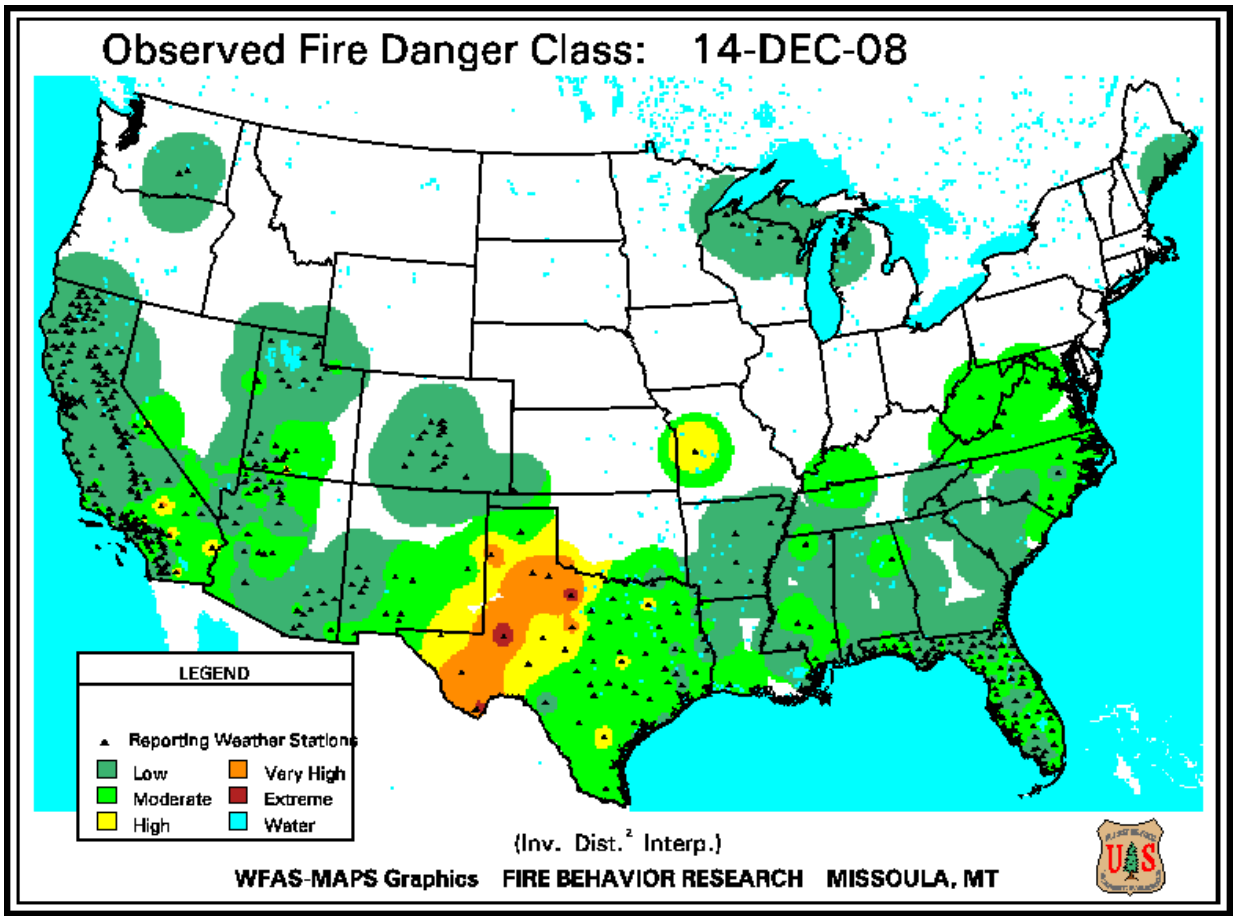

Figure 15. A recent observed fire danger class map for the United States (USDA Forest Service 2008).

3.2 Human Use

3.2.1 Non-point Source Human Effects

In the region of Fort Sumter NM and Charles Pinckney NHS, human population and resulting development pressures are growing. This encroachment of human population and development is arguably the most important threat or stressor the monument must consider. Development may lead to increasing point and non-point source pollution, affecting air and water quality. Increased vehicle emissions can occur as more people move to the area. In-park biological integrity may also be stressed from these outside influences.

3.2.1.a Current condition:

We examined two factors to assess the current condition of human effects in the Fort Sumter NM and Charles Pinckney NHS area. First, census data was obtained from the U.S. Census Bureau and trends were analyzed. The second factor we examined was relative impervious surfaces within the Fort Sumter NM and Charles Pinckney NHS boundaries, and in the broader subbasin study area.

Human Population:
Although seemingly intuitive, several studies have quantitatively researched the relationship between human population and the degradation of the world's natural resources (Jones and Clark 1987, Forester and Machlist 1996, McKinney 2001, Parks and Harcourt 2002, Cardillo et al. 2004). In a 2001 study, nonnative plant and fish diversity were negatively correlated with human population (McKinney 2001). Parks and Harcourt (2002) found that the probability of species extinction around western U.S. National Parks was significantly correlated with the surrounding human population density.

Fort Sumter NM is located in the city of Charleston, South Carolina, while Charles Pinckney NHS is located roughly 8 miles east-northeast, in nearby Mount Pleasant, South Carolina. The cities of Charleston and Mount Pleasant are both situated within Charleston County, South Carolina. The city of Charleston serves as the county seat for Charleston County, which is part of the Charleston-North Charleston, South Carolina Metropolitan Statistical Area (MSA). The 2007 population estimate for the Charleston-North Charleston MSA was 630,100 people, ranking 81st out of 363 MSAs nationwide (U.S. Census Bureau 2009b). Moderate population increases from U.S. Census Bureau (2009a) data were evident in this region (Figure 16 and Figure 17). The fastest growing county in the subbasin study area is Dorchester County, which grew from 83,060 to 123,505 individuals between 1990 and 2007, a 49% increase. Georgetown County grew from 46,302 to 60,499 individuals between 1990 and 2007, a 31% increase. Berkeley and Charleston counties, the two remaining counties in the subbasin study area, experienced respective population increases of 27% and 16% from 1990 to 2007. Berkeley grew from 128,776 to 163,622 individuals and Charleston grew from 295,039 to 342,973 individuals.

Along with population change, a good indicator of human effects on natural resources is population density. Charleston County had the highest population density in the study area in 2007 with 98 people/square km. Dorchester County is the second highest with 83 people/square km, while Berkeley and Georgetown counties have respective population densities of 51 and 23 people/square km (Figure 18).

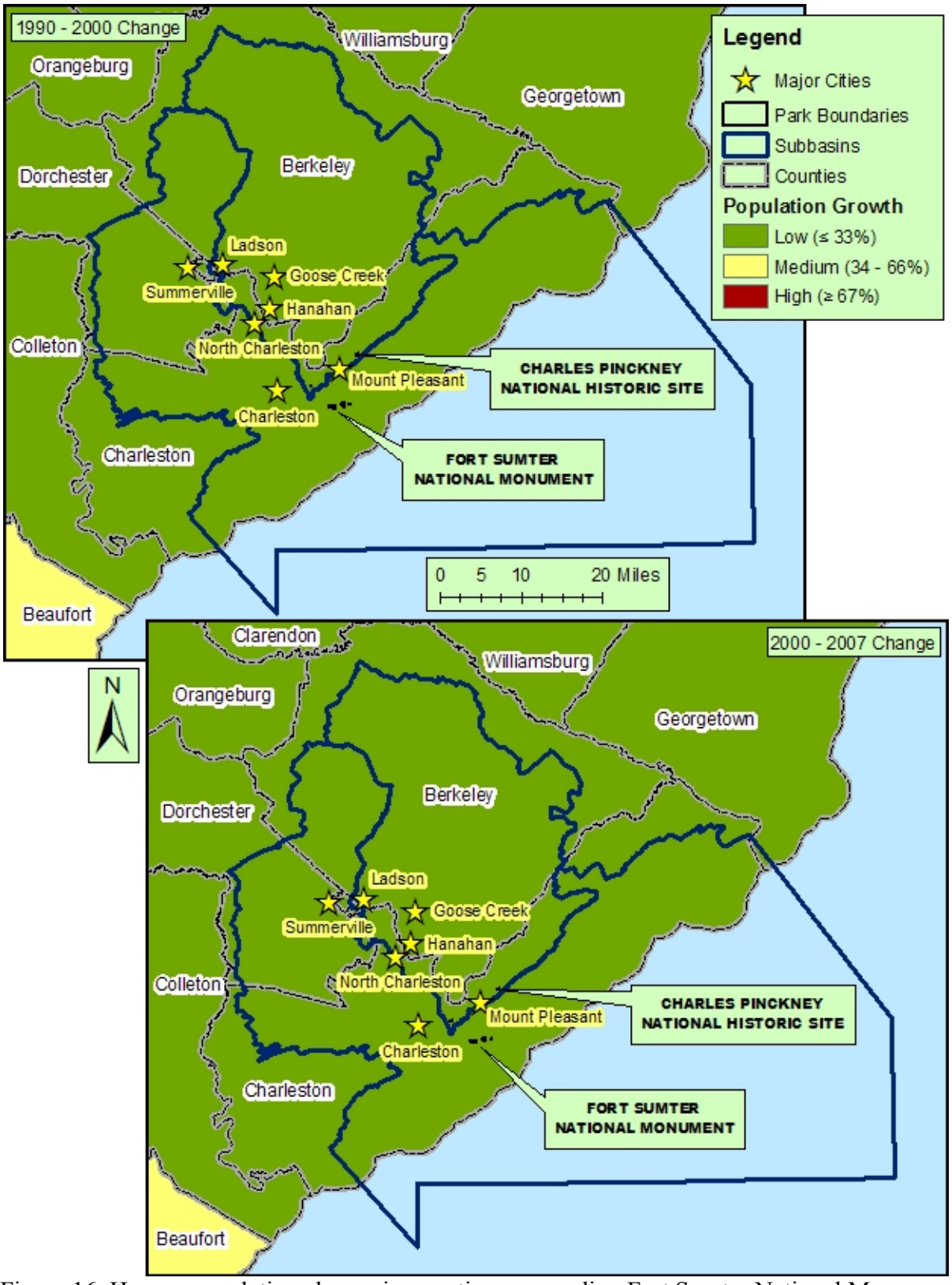

Figure 16. Human population change in counties surrounding Fort Sumter National Monument and Charles Pinckney National Historic Site from 1990 to 2000 and from 2000 to 2007 (U.S. Census Bureau 2009a).

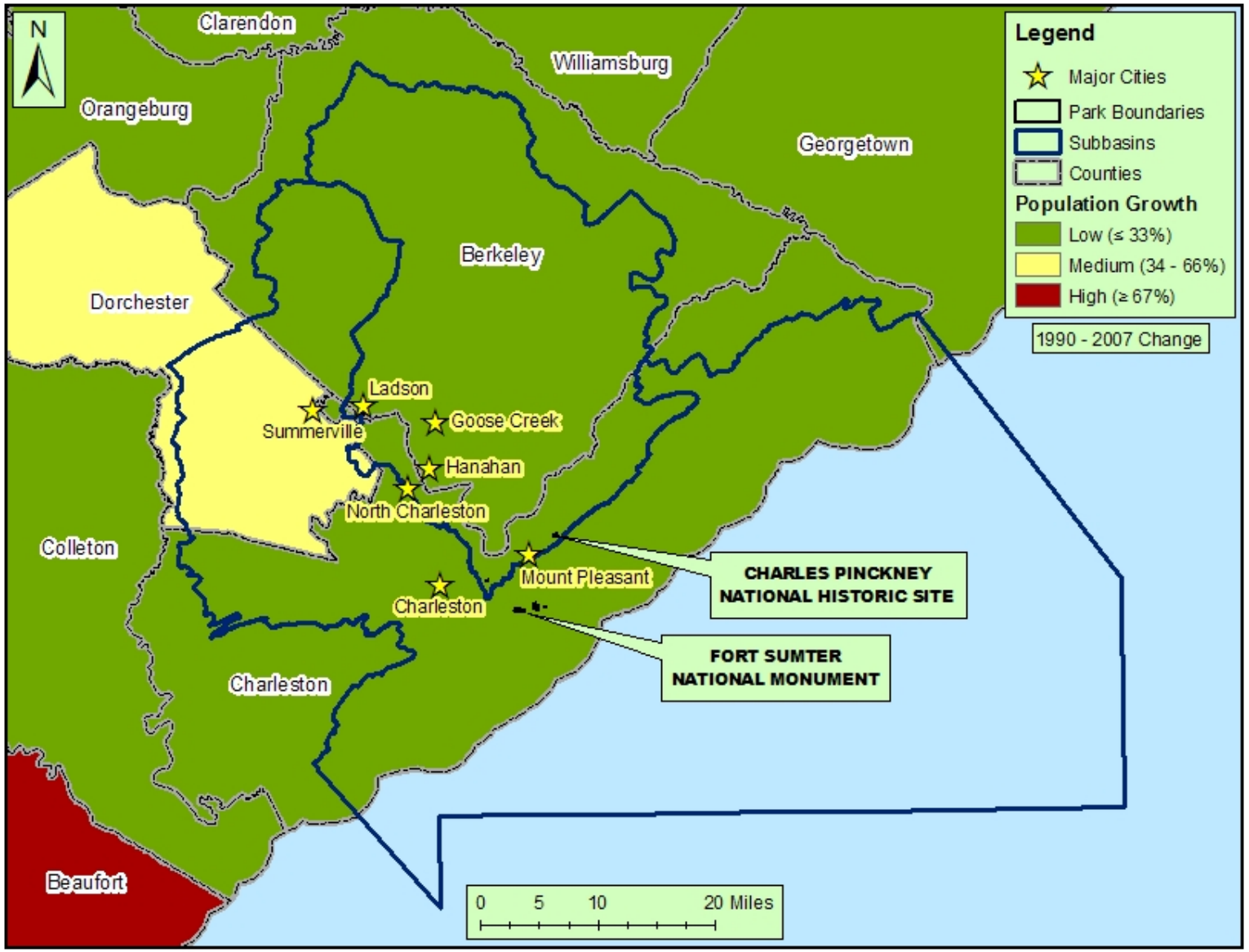

Figure 17. Human population change in counties surrounding Fort Sumter National Monument and Charles Pinckney National Historic Site from 1990 to 2007.

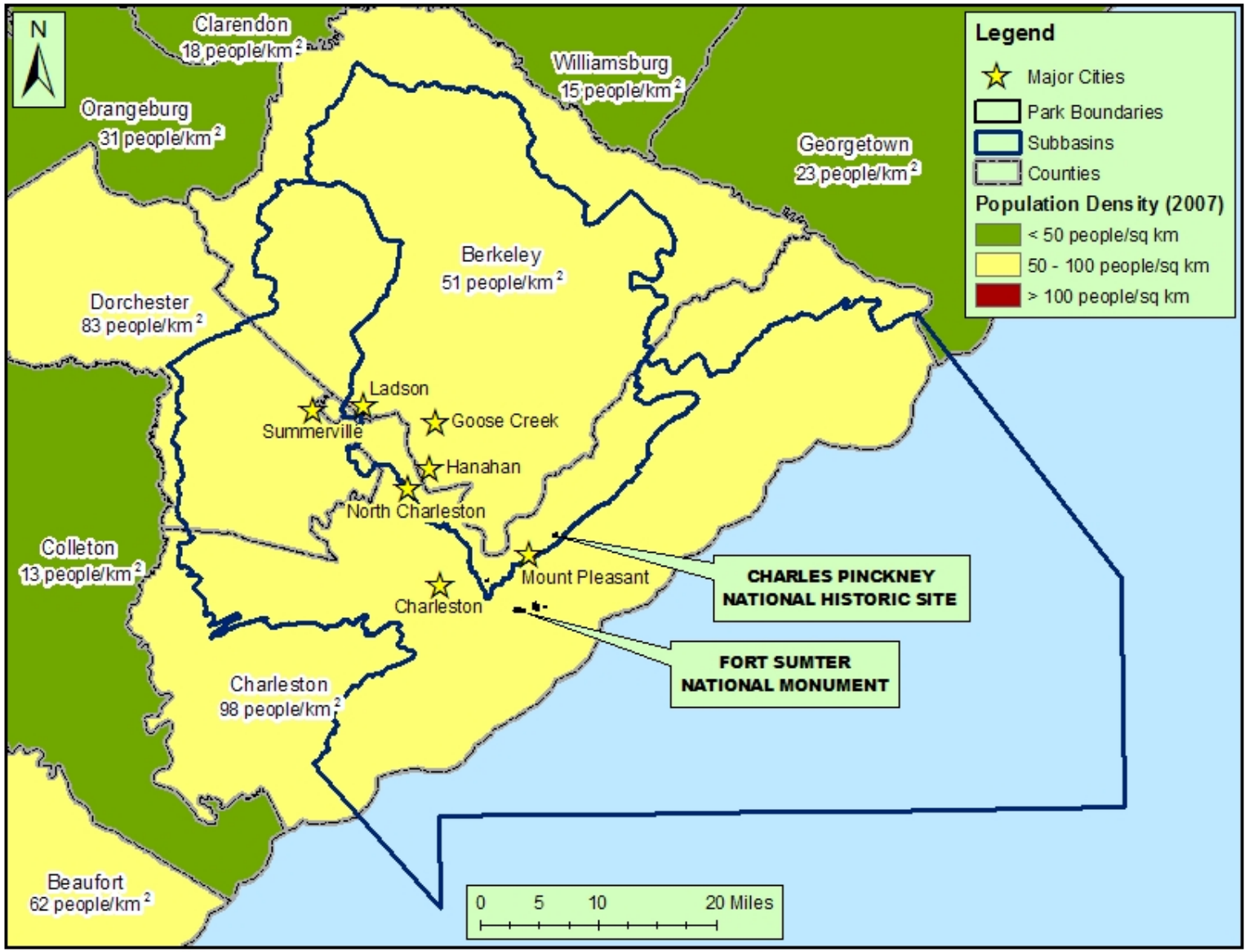

Figure 18. Human population density (people per square kilometer, 2007) for counties surrounding Fort Sumter National Monument and Charles Pinckney National Historic Site (U.S. Census Bureau 2009a).

Impervious Surface:
Studies have shown that increased impervious surface leads to degradations in water quality, hydrology, habitat structure, and aquatic biodiversity (Schueler 2000, Hurd and Civco 2004). In a review of eighteen studies that related stream quality to urbanization, Schueler (2000) suggests using three management categories (Table 15) to group streams by percent impervious surface.

Table 15. Schueler (2000) related percent impervious cover to management category.

Impervious Cover	*Management Category*
1 to 10% impervious	Sensitive streams
11 to 25% impervious	Impacted streams
26 to 100% impervious	Non-supporting streams

We used these groups to find the potential quality within Fort Sumter NM, Charles Pinckney NHS, and within the subbasin study area (Table 16, Figure 19). The majority of Fort Sumter NM, with the exception of the tour boat site/visitor education center, sits within the South Carolina Coastal (HUC 03050202) subbasin and has a relatively moderate percentage of impervious surfaces. The Fort Sumter NM tour boat site/visitor education center sits in a watershed (HUC 0305020105) within the Cooper (HUC 03050201) subbasin, which exhibits a fairly significant percentage of impervious surfaces. Charles Pinckney NHS sits in a watershed (HUC 0305020108) within the Cooper subbasin, which exhibits a relatively moderate percentage of impervious surfaces (Table 16, Figure 19, and Figure 20). It is not surprising that the highest concentration of impervious surfaces in the subbasins and watersheds occurs in the urbanized areas surrounding the 7 cities in the study area, particularly Charleston. The South Carolina Coastal subbasin is above the 10% impervious threshold, with 11% impervious cover, and was therefore classified as impacted. The watershed in which the Fort Sumter NM tour boat site is located (HUC 0305020101) is well below the 10% impervious threshold, with 3.2% impervious cover, and was classified as sensitive. Conversely, the watershed in which Charles Pinckney NHS is located (HUC 0305020108) is above the 10% impervious threshold, with 12.1% impervious cover, and was therefore classified as impacted. Fort Sumter NM was classified as impacted, with 16% impervious cover, while Charles Pinckney NHS was classified as non-supporting streams, with 37.8% impervious cover.

Table 16. Impervious surface totals for Fort Sumter National Monument, Charles Pinckney National Historic Site, and each watershed/subbasin within the study area. Management category from Schueler 2000.

Watershed/ Subbasin	*Pervious (acres)*	*Impervious (acres)*	*Total (acres)*	*Percent Impervious*	*Management Category*
South Carolina Coastal Subbasin (03050202)	522728.1	64403.3	587131.4	11.0	Impacted streams
Watershed 0305020101	84915.6	2777.7	87693.3	3.2	Sensitive streams
Watershed 0305020102	78613.1	2399.4	81012.5	3.0	Sensitive streams
Watershed 0305020103	33130.6	3045.6	36176.2	8.4	Sensitive streams
Watershed 0305020104	121571.9	1639.2	123211.2	1.3	Sensitive streams
Watershed 0305020105	38187.9	12367.6	50555.5	24.5	Impacted streams
Watershed 0305020106	40573.1	8623.4	49196.4	17.5	Impacted streams
Watershed 0305020107	21711.7	16942.1	38653.8	43.8	Non-supporting streams
Watershed 0305020108	64266.0	8828.0	73094.0	12.1	Impacted streams
Total (study area)	1005698.1	121026.2	1126724.3	10.7	Sensitive streams
Fort Sumter NM	195.5	37.1	232.6	16.0	Impacted streams
Charles Pinckney NHS	20.5	12.5	32.9	37.8	Non-supporting streams

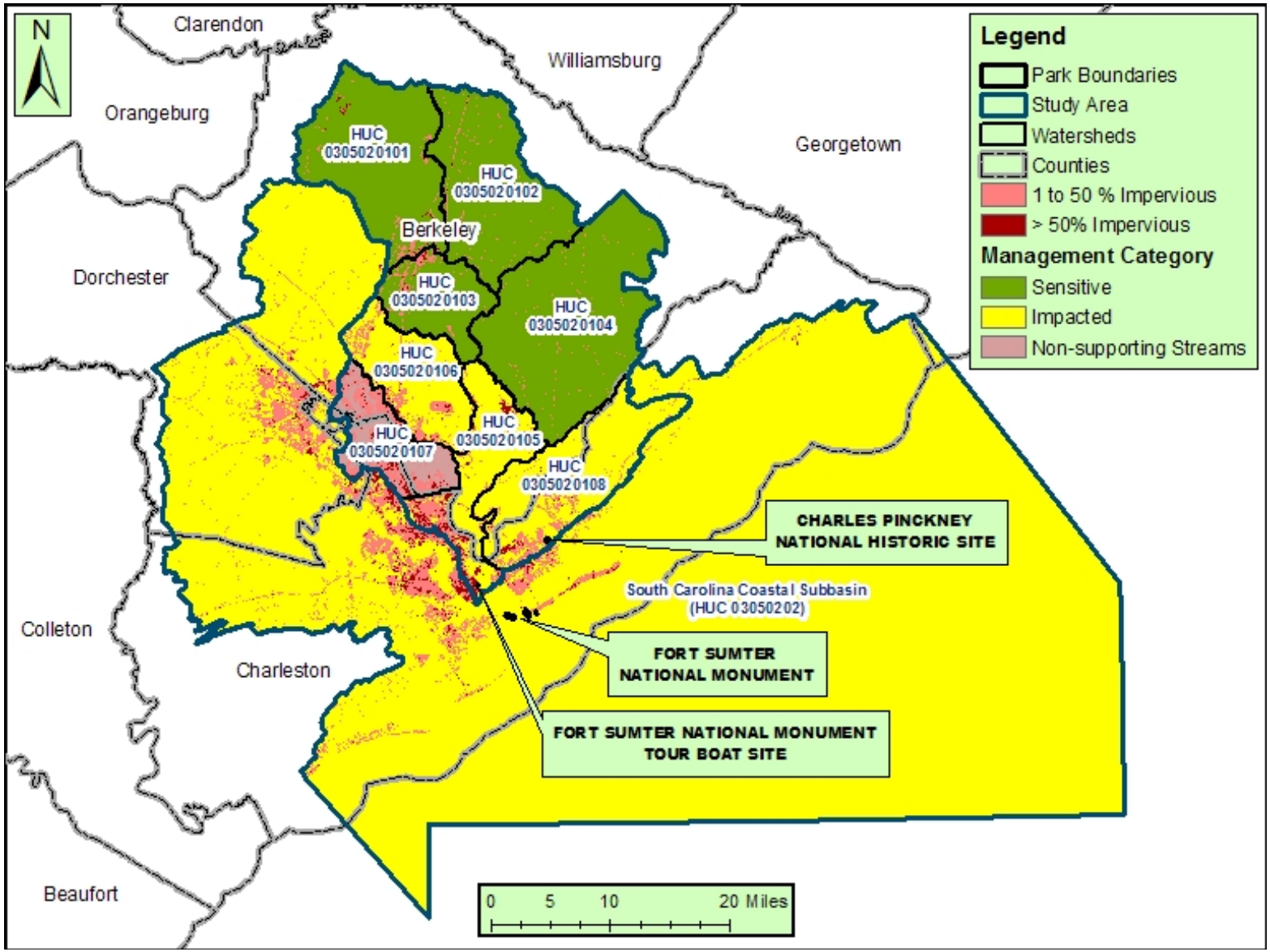

Figure 19. Impervious surface (from National Land Cover Database 2001) in the subbasin study area containing Fort Sumter National Monument and Charles Pinckney National Historic Site.

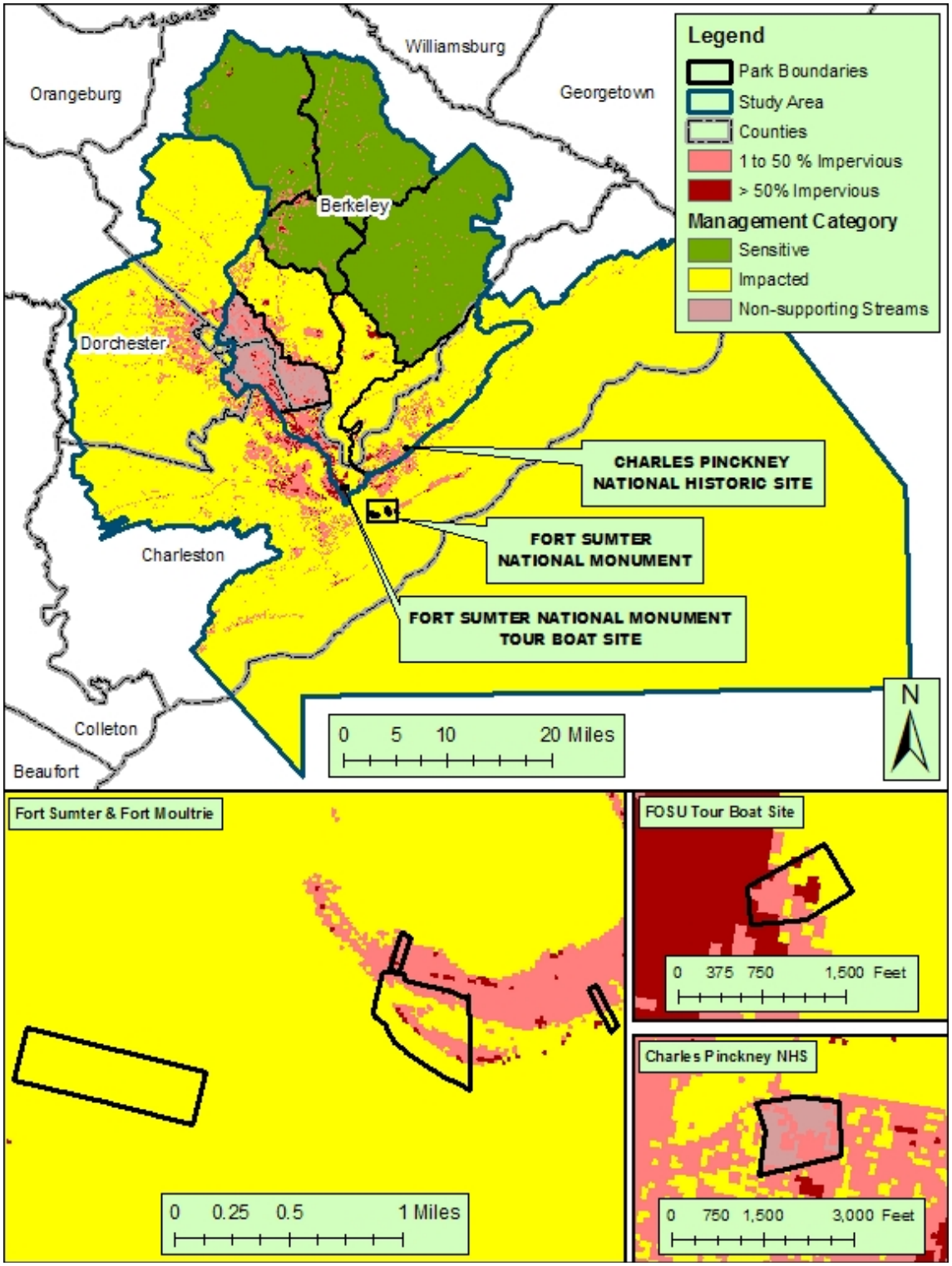

Figure 20. Impervious surface (from National Land Cover Database 2001) in the subbasin study area and within Fort Sumter National Monument and Charles Pinckney National Historic Site boundaries.

3.2.1.b Resource threats and stressors:
The condition assessments for human effects, described in the previous section, are threats and stressors to several natural resources within the parks. We started with these broad-scale conditions so they can be applied as threats and stressors to several of the following natural resource categories. Rapid population increases can lead to unstructured, unplanned development, higher population densities, and overutilization of natural resources.

According to the South Carolina Statistical Abstract (SC Budget and Control Board 2008) the areas around Fort Sumter NM and Charles Pinckney NHS will see marked increases in population in the coming years, with Berkeley County and Dorchester County projected to increase by 50% and 76% respectively by 2030 (Table 17). This growth will bring corresponding increases in development pressure and changing land use outside of the parks' boundaries, with the potential for local resource impacts.

Table 17. Projected population growth around Fort Sumter National Monument and Charles Pinckney National Historic Site based on estimates from the South Carolina Statistical Abstract (SC Budget and Control Board 2008).

County	*April 1, 2000 Census*	*July 1, 2010 Projection*	*Percent Increase, 2000 – 2010*	*July 1, 2020 Projection*	*Percent Increase, 2000 – 2020*	*July 1, 2030 Projection*	*Percent Increase, 2000 – 2030*
Berkeley	142,651	170,270	19.4	192,450	34.9	214,140	50.1
Charleston	309,969	348,370	12.4	366,380	18.2	386,660	24.7
Dorchester	96,413	129,450	34.3	149,300	54.9	170,210	76.5
Orangeburg	91,582	91,450	-0.1	96,400	5.2	100,700	10.0

3.2.1.c Critical knowledge or data gaps:
U.S. Census Bureau population data is a good source of information, but assigning resource thresholds to these data was a challenge that was not easily supported with current literature for the Southeastern U.S. We used somewhat arbitrary thresholds for population growth and density in assigning low, medium, and high impacts to the natural resource. These thresholds can easily be changed as more quantitative relationships are formulated for this area of the U.S.

Small (broad) scale remotely sensed data were a good source for this assessment category. Unfortunately they may be less accurate at the larger scale (more detailed) park level. This was a continual challenge in several of our assessment categories since Fort Sumter NM (232 acres) and Charles Pinckney NHS (33 acres) are fairly small parks. When spatial scale was questionable, we gave thematic a zero for data quality. Table 18 and Table 19 show the summary of condition status and data quality.

3.2.1.d Condition status summary
Human population condition status is in the fair range because the counties in the study area are growing relatively fast and population density is fairly substantial for the region (Table 18, Table 19). Projected population growth within the region was shown to be relatively high, especially for Berkeley and Dorchester Counties (Table 17). Impervious surface coverage for Fort Sumter NM was above the 10% threshold so it is rated as fair for this category (Table 18). Although Charles Pinckney NHS was above the 25% cut-off, putting it in the non-supporting streams

category, it received a fair rating (Table 19). This is because Charles Pinckney NHS is a small park and from our detailed classification (Land cover section), it was evident that the spatial scale had a major impact on data quality for this category. Furthermore, the watershed that Charles Pinckney NHS is a part of fell within the fair (impacted streams) range. The other watershed and subbasin that Fort Sumter is a part of also fell in the fair (impacted streams) range. This may lead to greater impacts from outside the monument boundaries to streams and other resources within the monuments.

Table 18. Human effects condition status summary for Fort Sumter National Monument. Data quality was rated based on *thematic* (1 = best source; 0 = not the best source), s*patial* (1 = inside park boundary; 0 = outside park boundary), and *temporal* (1 = recent; 0 = older than 5 years). The colors green, yellow, and red refer to good, fair, and poor scores respectively (see Table 1).

Category	***Condition Status***	***Midpoint***	***Data Quality***		
			Thematic	*Spatial*	*Temporal*
Human population			1	1	1
	Fair	0.5	3 out of 3		
Impervious surface			0	1	1
	Fair	0.5	2 out of 3		
Human effects total			1	2	2
	Fair	0.50	5 out of 6		

Table 19. Human effects condition status summary for Charles Pinckney National Historic Site. Data quality was rated based on *thematic* (1 = best source; 0 = not the best source), s*patial* (1 = inside park boundary; 0 = outside park boundary), and *temporal* (1 = recent; 0 = older than 5 years). The colors green, yellow, and red refer to good, fair, and poor scores respectively (see Table 1).

Category	***Condition Status***	***Midpoint***	***Data Quality***		
			Thematic	*Spatial*	*Temporal*
Human population			1	1	1
	Fair	0.5	3 out of 3		
Impervious surface			0	1	1
	Fair	0.5	2 out of 3		
Human effects total			1	2	2
	Fair	0.50	5 out of 6		

3.2.1.e Recommendations to park managers:
Higher population densities have been correlated with a myriad of environmental impacts. However, focusing development and human population growth restrictions on high population centers may not be the most productive course. Studies have found that nonnative species introductions (McKinney 2001) and species extinctions (Balmford 1996) occur more rapidly in fast-growing, lower human populated areas as opposed to highly populated areas. Thus, it may be prudent to focus structured development, nonnative species, and other natural resource education campaigns on low population centers with a high potential for growth.

Although human population increase and development is in most cases an outside threat, unmanageable by the park, there are instances in which park interpretation and education can play a large role in surrounding resource protection. In addition, focusing efforts on sustainable development and limiting impervious surfaces within park boundaries is important for in-park resource management. These campaigns may also increase the knowledge and perceived importance of structured development within surrounding locales.

3.2.2 Visitor and Recreation Use

The National Park Service was established to provide for its visitors. The NPS mission is to "preserve unimpaired the natural and cultural resources and values of the national park system for the enjoyment, education, and inspiration of this and future generations." In fact, the top guiding principle to accomplish this mission is excellent service for park visitors and partners (National Park Service 2008a). Visitors are no doubt the primary reason the NPS exists and continues to be an important part of this country.

Visitor and recreation use, however, has been shown to negatively affect the other half of the NPS mission, which is to protect natural and cultural resources. Several studies have shown a negative correlation between outdoor recreation and the various natural resources covered in this assessment (Taylor and Knight 2003, Wood et al. 2006, Park et al. 2008). As visitation to parks increases, these two parts of the mission often work against each other.

3.2.2.a Current condition:

The number of visitors per year to Fort Sumter NM has been steadily on the rise and experienced a precipitous spike in visitation in 2001. Between 2000 and 2001, the number of visitors to Fort Sumter NM went from 319,147 to 919,443 patrons, which equates to a 188% increase in the number of visitors to the monument (Figure 21). The number of visitors to Charles Pinckney NHS has been increasing overall, but the range of available data (1995 – 2008) is insufficient to identify definitive trends. It is apparent, however, that Charles Pinckney NHS receives significantly less patronage compared with Fort Sumter NM (Figure 22). Visitation to Fort Sumter NM is relatively constant throughout the year, with spikes occurring in April and July (Figure 23). Likewise, visitation to Charles Pinckney NHS is fairly constant throughout the year, with March, April, and July being the busiest months (Figure 24). Fort Sumter NM was third out of 21 in the number of visitors to NPS Forts in 2007 (Table 20) and sixth out of 68 National Monuments visited in 2007.

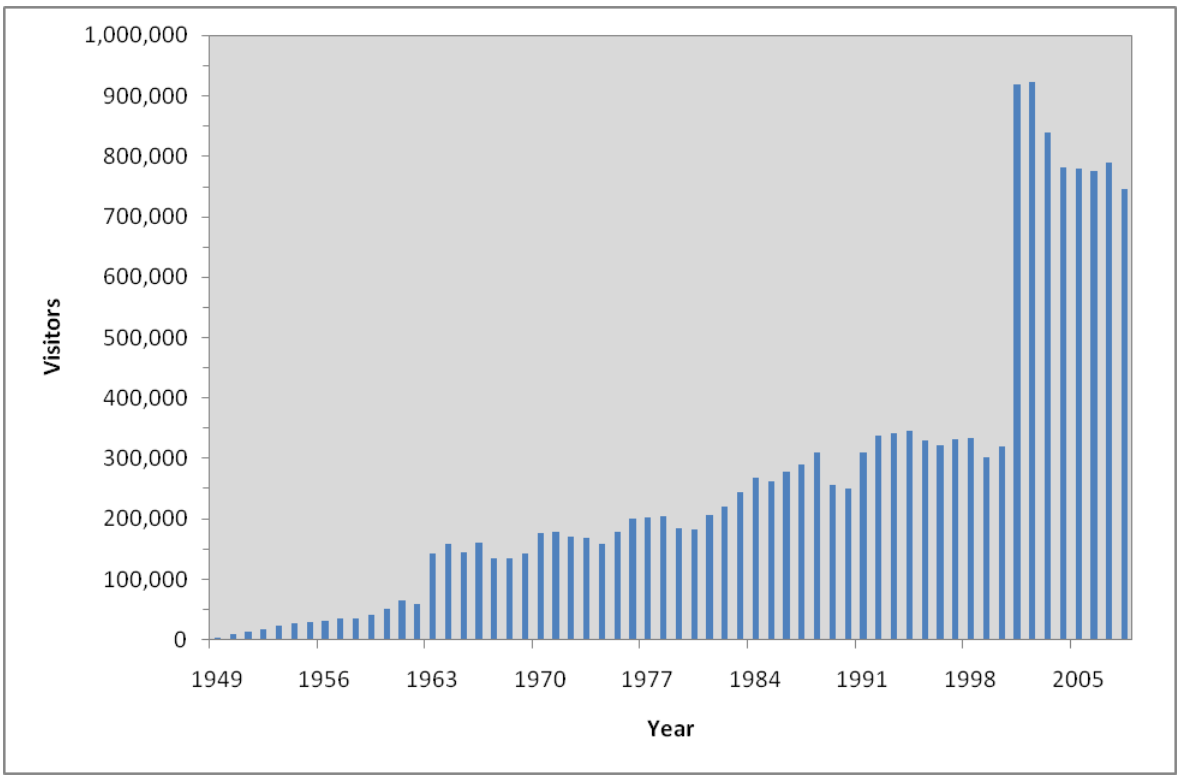

Figure 21. Number of visitors per year to Fort Sumter NM from 1949 to 2008. Data from NPS (2009).

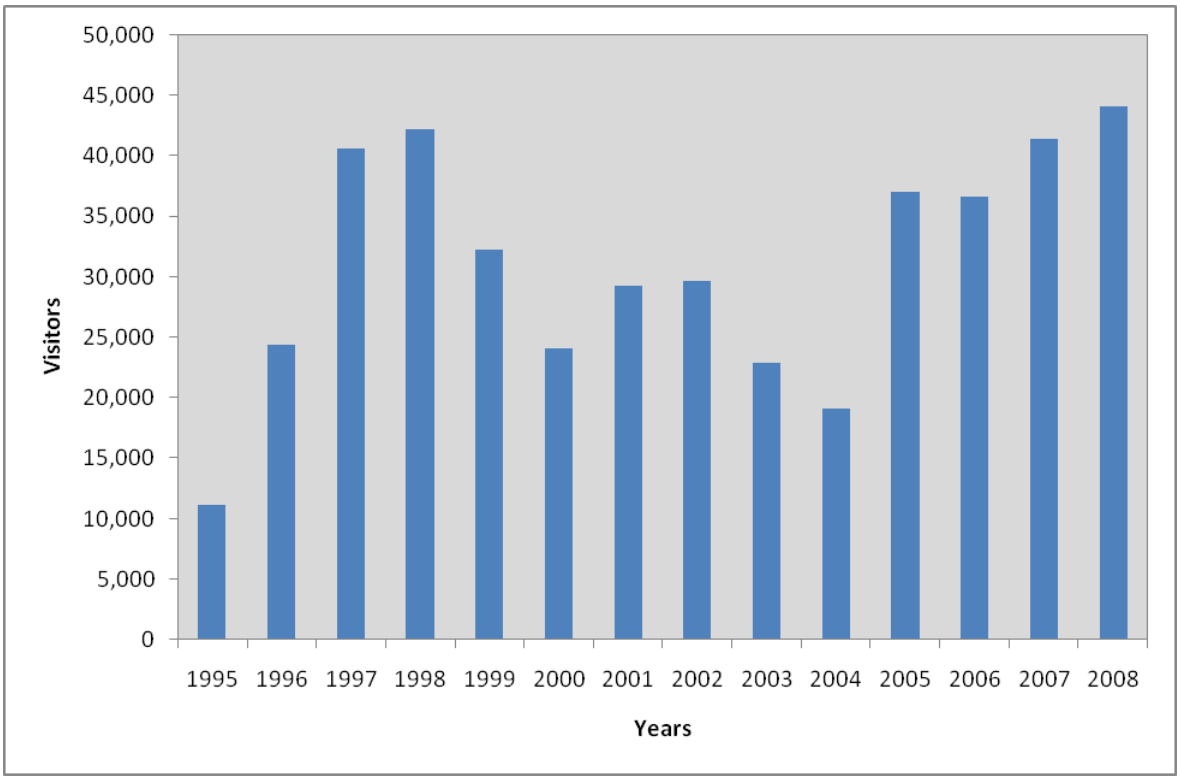

Figure 22. Number of visitors per year to Charles Pinckney NHS from 1995 to 2008. Data from NPS (2009).

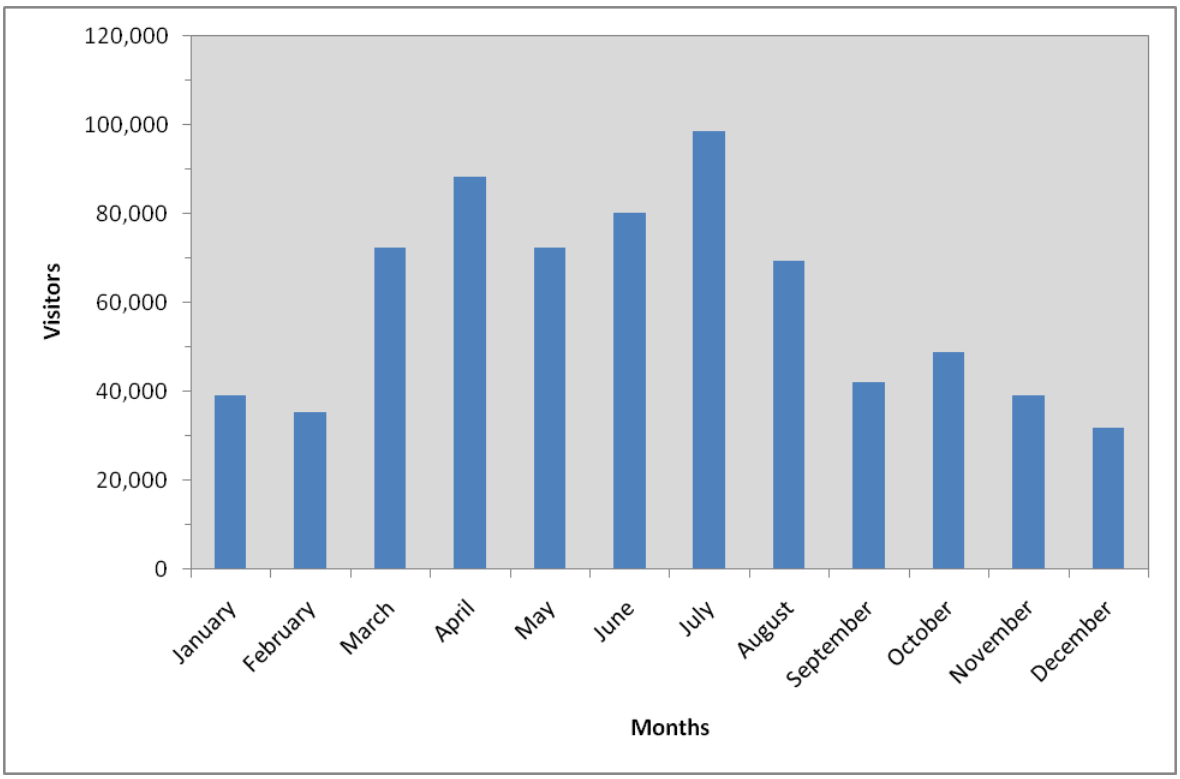

Figure 23. Average monthly visitors (from the past 10 years, 1999 – 2008) to Fort Sumter National Monument. Data from NPS (2009).

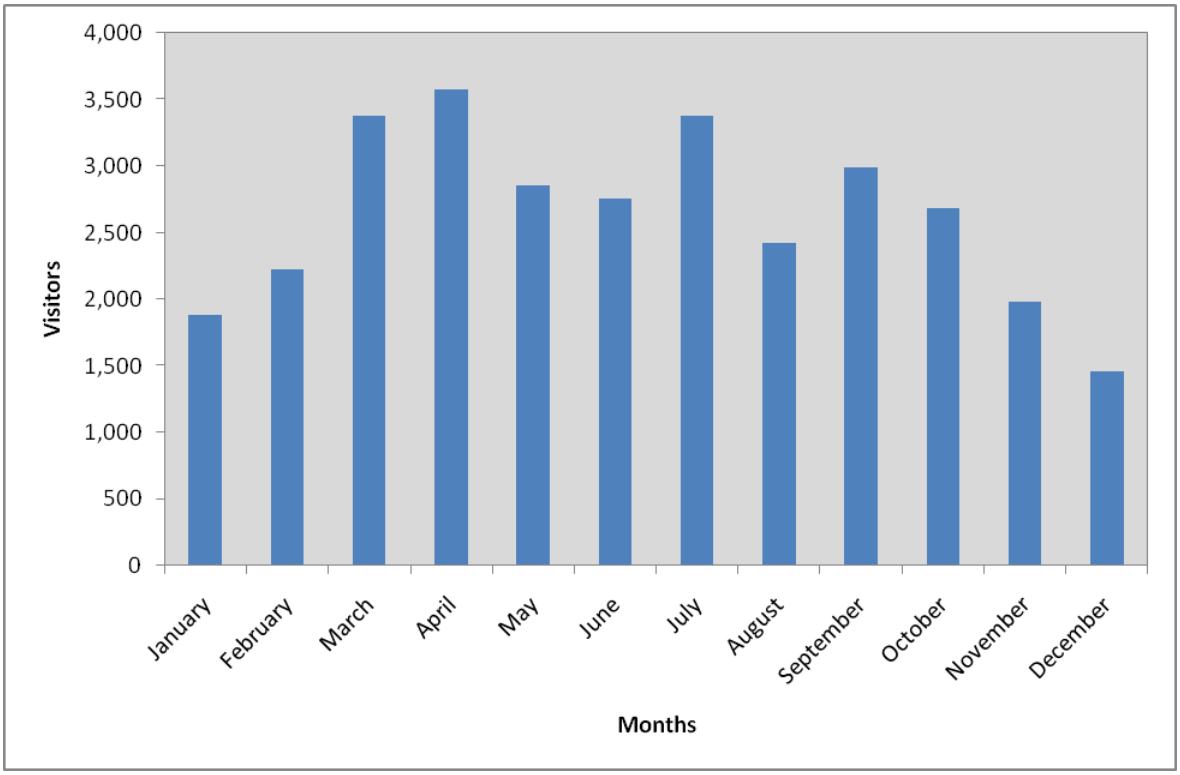

Figure 24. Average monthly visitors (from the past 10 years, 1999 – 2008) to Charles Pinckney National Historic Site. Data from NPS (2009).

Table 20. Number of National Park Service Fort visitors in ranked order.

Park	*Visitors*	*% of Fort visitors*	*Rank*
Fort Point NHS	1,552,141	21.8	1
Fort Matanzas NM	830,672	11.7	2
Fort Sumter NM	788,838	11.1	3
Fort Vancouver NHS	682,645	9.6	4
Castillo de San Marcos NM	632,048	8.9	5
Fort McHenry NM & HS	574,924	8.1	6
Fort Necessity NB	353,296	5.0	7
Fort Raleigh NHS	321,717	4.5	8
Fort Pulaski NM	317,349	4.5	9
Fort Frederica NM	264,586	3.7	10
Fort Caroline NMEM	250,616	3.5	11
Fort Donelson NB	233,205	3.3	12
Fort Smith NHS	83,850	1.2	13
Fort Stanwix NM	59,643	0.8	14
Fort Davis NHS	51,435	0.7	15
Fort Laramie NHS	40,263	0.6	16
Fort Larned NHS	30,471	0.4	17
Fort Scott NHS	22,314	0.3	18
Fort Union Trading Post NHS	12,405	0.2	19
Fort Union NM	10,534	0.1	20
Fort Bowie NHS	10,027	0.1	21
Fort Total	7,122,979	100.0	

3.2.2.b Resource threats and stressors:
Visitor and recreation use is itself a threat and stressor to the natural resources of Fort Sumter NM and Charles Pinckney NHS. With that said, visitor use statistics and current data do not indicate that this is a large threat to natural resources within park boundaries.

3.2.2.c Critical knowledge or data gaps:
An examination of in-park degradation due to visitor use would be a good addition to these analyses. Trail spatial data or on-the-ground impact surveys would help to quantify the effects of visitor use on the natural resources. These data were not available (Table 21 and Table 22).

3.2.2.d Condition status summary:
Visitor use is in the fair range for Fort Sumter NM because statistics indicated a sharp increase in visitors and it has been one of the most visited forts managed by the NPS (Table 21). The condition status is good for Charles Pinckney NHS visitor use because visitation has been relatively consistent and low (Table 22).

Table 21. Visitor use condition status summary for Fort Sumter National Monument. Data quality was rated based on *thematic* (1 = best source; 0 = not the best source), s*patial* (1 = inside park boundary; 0 = outside park boundary), and *temporal* (1 = recent; 0 = older than 5 years). The colors green, yellow, and red refer to good, fair, and poor scores respectively (see Table 1).

Category	***Condition Status***	***Midpoint***	***Data Quality***		
			Thematic	*Spatial*	*Temporal*
Visitor use total			0	1	1
	Fair	0.5	2 out of 3		

Table 22. Visitor use condition status summary for Charles Pinckney National Historic Site. Data quality was rated based on *thematic* (1 = best source; 0 = not the best source), s*patial* (1 = inside park boundary; 0 = outside park boundary), and *temporal* (1 = recent; 0 = older than 5 years). The colors green, yellow, and red refer to good, fair, and poor scores respectively (see Table 1).

Category	***Condition Status***	***Midpoint***	***Data Quality***		
			Thematic	*Spatial*	*Temporal*
Visitor use total			0	1	1
	Good	0.84	2 out of 3		

3.2.2.e Recommendations to park managers:
We recommend continuing to collect visitor use statistics and identify and monitor trends in recreation. Collecting additional visitor statistics and recreation use parameters, such as percent trail degradation would be a useful addition to data and analysis.

3.3 Air and Climate

3.3.1 Air Quality

The U.S. Environmental Protection Agency (EPA) requires monitoring of six pollutants considered harmful to human health and the environment. The six “criteria” pollutants are listed below (U.S. Environmental Protection Agency 2008b). The first two are considered problematic in hundreds of counties across the U.S., and the last four are of concern only in a handful of locations at most.

Ozone (O_3) is "good up high but bad nearby." Ozone high in the atmosphere protects us from ultraviolet (UV) radiation, but ozone at ground-level can negatively affect plant populations and can cause respiratory irritation when humans or animals breathe it. Symptoms include coughing, wheezing, breathing difficulties, inflammation of the airways, and aggravation of asthma. Ozone is not directly emitted; rather it is formed from reactions involving volatile organic compounds and nitrogen oxides in the presence of sunlight.

Particulate matter (PM) is subdivided into two categories by size:
Fine particulate matter ($PM_{2.5}$) consists of particles smaller than 2.5 micrometers. For comparison, the average human hair is 70 micrometers in diameter. Fine particles can be inhaled deeply into the lungs and can cause respiratory irritation and, over the long term, are associated with elevated levels of cardiovascular disease and mortality. Particles also obscure visibility and

affect global climate. Fine particles are generated by combustion; major sources include industry and motor vehicles. Such particles can also be formed in the atmosphere through reactions involving gases.
Coarse particulate matter (PM_{10}) consists of particles smaller than 10 micrometers. They may cause respiratory irritation. Coarse particles stem from grinding and other mechanical processes and include wind-blown dust.

Sulfur dioxide (SO_2) originates mostly from coal combustion and causes respiratory irritation. It also contributes to acid rain and particle formation.

Carbon monoxide (CO) is a colorless, odorless gas that is formed during incomplete combustion of fuels. Its major sources include vehicles and fires. Exposure to high levels of carbon monoxide can cause dizziness, headaches, confusion, blurred vision, and ultimately coma and death.

Lead (Pb) is a metal found in particles and can adversely affect the nervous system, kidney function, immune system, reproductive and developmental systems and the cardiovascular system. In children, it has been found to lower IQ. Lead originates mainly from the processing of metals in industry.

Nitrogen dioxide (NO_2) is a brownish gas that is generated during high-temperature combustion. It is a member of a family of chemicals called nitrogen oxides, or NO_x. Major sources of NO_x include coal-fired power plants, industrial boilers, and motor vehicles. Like ozone, it causes respiratory irritation. It is also important because it can react to form ozone and particles, contribute to acid rain, deposit into water bodies and upset the nutrient balance, and degrade visibility.

The National Ambient Air Quality Standards are levels not to be exceeded for each pollutant (U.S. Environmental Protection Agency 2008a). Air quality is summarized for the public in terms of the Air Quality Index (AQI, Table 23), a scale that runs from 0 to 500, where any number over 100 is considered to be unhealthy (AirNow 2008a). Based on measurements or predicted levels of pollutants, an AQI is calculated for each of the criteria pollutants, and the highest value is reported to the public.

Table 23. The Air Quality Index (AQI) is a cross-agency U.S. Government venture whose purpose is to explain air quality health implications to the public.

Air Quality Index Levels of Health Concern	Numerical Value	Meaning
Good	0-50	Air quality is considered satisfactory, and air pollution poses little or no risk.
Moderate	51-100	Air quality is acceptable; however, for some pollutants there may be a moderate health concern for a very small number of people who are unusually sensitive to air pollution.
Unhealthy for Sensitive Groups	101-150	Members of sensitive groups may experience health effects. The general public is not likely to be affected.
Unhealthy	151-200	Everyone may begin to experience health effects; members of sensitive groups may experience more serious health effects.
Very Unhealthy	201-300	Health alert: everyone may experience more serious health effects.
Hazardous	> 300	Health warnings of emergency conditions. The entire population is more likely to be affected.

Environmental effects:
In addition to health, air pollution has also been shown to impact visibility, vegetation, surface waters, soils, and fish and wildlife at National Park Service sites in the Southeast Coast Network. In 2003, the National Park Service conducted an Air Quality Inventory and Monitoring Assessment of the Southeast Coast Network that reported on atmospheric deposition of compounds that can affect acidity, nutrient balances, and wildlife in surface waters; air toxics; surface water chemistry in the context of acidification due to atmospheric deposition; fine particulate matter and ozone; and ozone-sensitive plant species (National Park Service 2003). The report concluded that although only two of the seventeen parks have monitors on-site, existing monitors within ~100 miles are sufficiently representative. Only two parks, Congaree Swamp NM and Moores Creek NB, were deemed extremely sensitive to acidification from atmospheric deposition. Ozone concentrations were high enough in all parks to potentially cause plant damage.

The NPS Air Resources Division (ARD) has developed methods and target values to evaluate air quality conditions important for natural resource planning and management. The ARD approach to air quality assessment includes thresholds for ozone, atmospheric (wet) deposition in the form of nitrogen and sulfur, and visibility (National Park Service 2007). Based on certain criteria, these categories are given a score of "good," "moderate," or "significant concern." Although Fort Sumter NM and Charles Pinckney NHS do not have any air quality monitoring stations on-site, the ARD interpolates data from all available monitors in the region into five-year averages. This document utilizes the most recent data interpolations from the 2003 – 2007 period for ozone, wet deposition, and visibility.

3.3.1.a Current condition:

Monitoring sites:

South Carolina's state environmental agency operates four air quality monitoring sites in Charleston County, within ~30 km of the Fort Sumter NM and the Charles Pinckney NHS. They measure O_3, $PM_{2.5}$, PM_{10}, SO_2, and CO. Table 24 and Figure 25 show the air quality index in 2007 for each of the pollutants measured. Blank cells mean that the pollutant was not measured at the site.

Table 24. Air quality index in 2007 at monitoring sites near Fort Sumter National Monument and Charles Pinckney National Historic Site. Blank cells mean that the pollutant was not measured at the site.

Site ID	*Common name*	*State*	*County*	*City*	*Latitude*	*Longitude*	*O_3*	*$PM_{2.5}$*	*PM_{10}*	*SO_2*	*CO*	*NO_2*
450190046	Bulls Island Rd.	SC	Charleston	Not in city	32.941023	-79.657187	104		30		7	
450190048	Elms Plantation Blvd.	SC	Charleston	North Charleston	32.980254	-80.06501		74				
450190049	Fishburne St.	SC	Charleston	Charleston	32.790984	-79.958694		69				
450190003	Jenkins Ave.	SC	Charleston	North Charleston	32.882289	-79.977538			56	19		

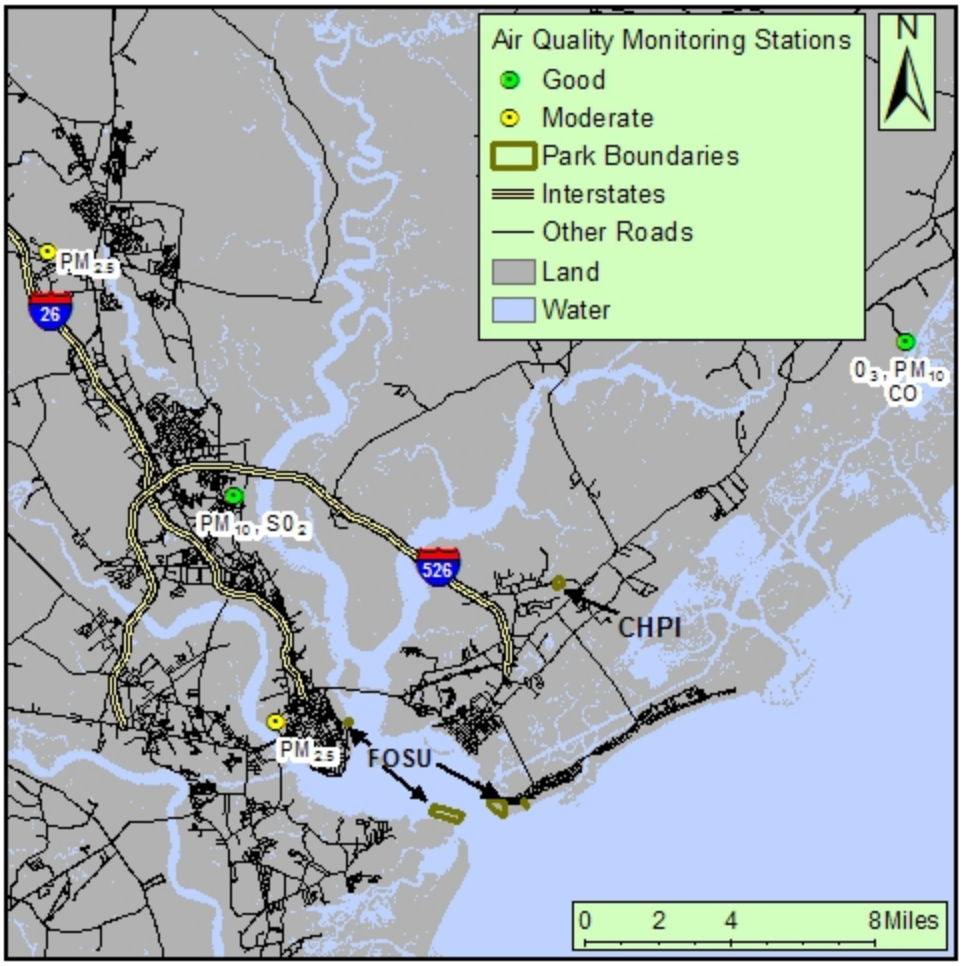

Figure 25. Air quality monitoring sites near Fort Sumter National Monument and Charles Pinckney National Historic Site. Green indicates "good" air quality and yellow indicates "moderate" air quality at these sites in 2007.

There are multiple standards, over varying averaging periods, for some criteria pollutants. In some cases, the standard is based on the annual average while in others, it is based on a maximum (or 4th-highest or 98th percentile) in a year. Furthermore, some standards are based on averages over multiple years. The exact details are provided in the footnotes of the National Ambient Air Quality Standards table (U.S. Environmental Protection Agency 2008a). For each of the pollutants, we selected the traditionally more problematic averaging period, extracted the relevant average or high concentration from the EPA's Air Quality System Data Mart (U.S. Environmental Protection Agency 2008d), and converted it to an Air Quality Index value using the AQI calculator (AirNow 2008b). The values shown in Table 24 correspond to metrics described below.

O_3: 8-hour average, 4th highest in a year
$PM_{2.5}$: 24-hour average, 98th percentile in a year
PM_{10}: 24-hour average, maximum in a year
SO_2: 24-hour average, maximum in a year

Air quality trends:
Trends in ozone and fine particulate matter, two pollutants posing a serious risk to health, are shown in Figure 26 and Figure 27. The figures show the number of times the national standard was violated in a year, known as "exceedances," on the left axis and an indicator of the highest concentration in a year on the right axis. The air quality standards are based on the 4th highest concentration in a year for ozone and the 98th percentile concentration for $PM_{2.5}$. Ignoring the very highest concentration in a year allows for unusual events that may cause anomalies.

The ozone measurements shown are from the Bulls Island Road site (Figure 26). Ozone exceedances have been steady over the last several years, with a noticeable spike of seven in 2006. There was only one exceedance in 2007. Additional years of data are needed to determine whether there is a true downward trend in ozone or whether favorable meteorological conditions in 2007 produced the low number of exceedances. The EPA standard for 8-hour ozone is based on the 4th highest measurement in a year.

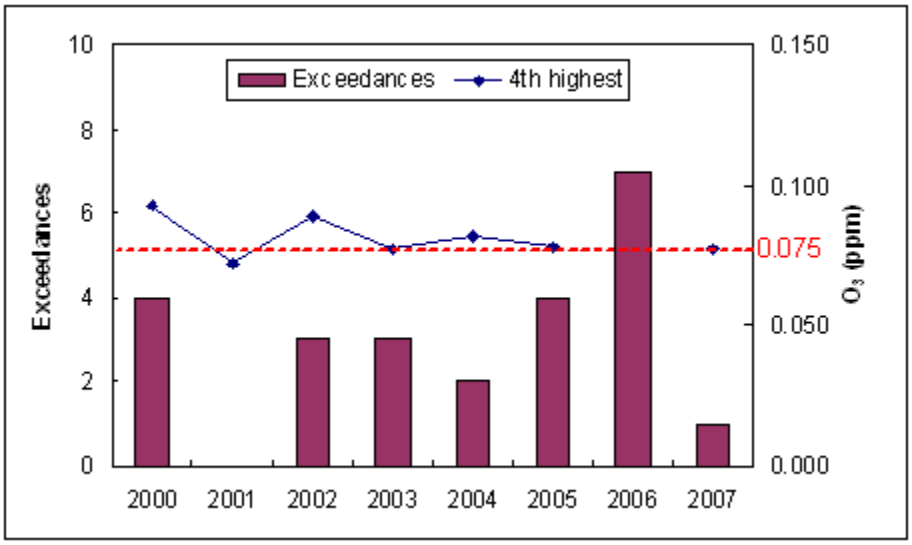

Figure 26. Eight-hour ozone for Fort Sumter National Monument and Charles Pinckney National Historic Site.

The $PM_{2.5}$ measurements shown in Figure 27 are from the Elms Plantation Blvd. site. A $PM_{2.5}$ exceedance has not occurred since 2000 at this particular site. The EPA standard for 24-hour $PM_{2.5}$ is based on the 98th percentile of measurements in a year, and this metric has fluctuated between 20 and ~33 micrograms per cubic meter, compared to the standard of 35.

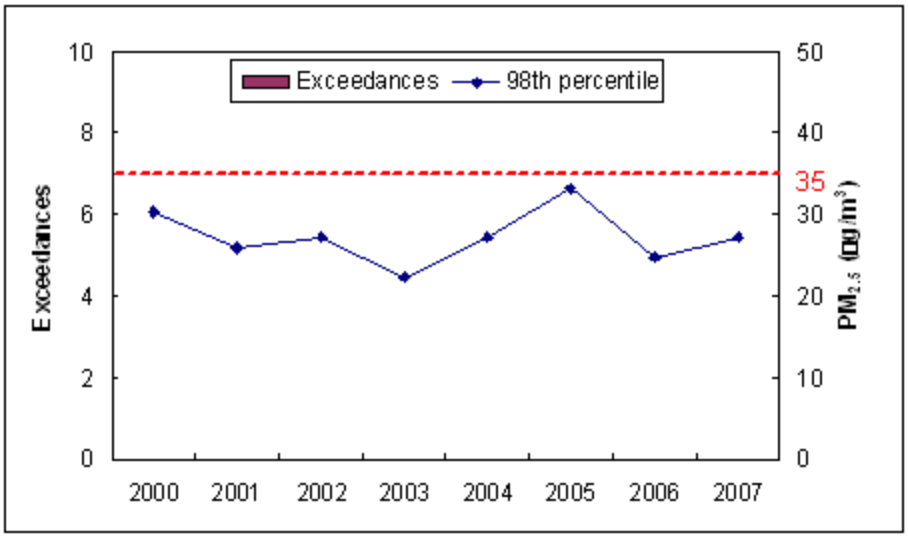

Figure 27. 24-hour $PM_{2.5}$ for Fort Sumter National Monument and Charles Pinckney National Historic Site.

Air quality forecast:
The location nearest Fort Sumter NM and Charles Pinckney NHS with a daily air quality forecast is the Aiken-Augusta, SC/GA area, which is approximately 225 km to the west. The AQI forecast (AirNow 2008c) is provided for both ozone (O_3) (in the summer and fall only) and fine particulate matter ($PM_{2.5}$). The Aiken-Augusta forecast is a reasonable indicator for Fort Sumter NM and Charles Pinckney NHS, but because of the large distance between the locations and their inland versus coastal settings, the forecast may not always apply. There is also a daily air quality forecast in Columbia, SC (200 km to the northwest) which predicts an AQI for ozone only (AirNow 2008d). However, prevailing weather patterns make the Aiken-August forecast more representative most of the time.

Ozone (O3):
The ARD criterion for ozone utilizes the newly revised 2008 national standard for ozone air quality as a baseline. The national standard requires that the 3-year average of the fourth-highest daily maximum 8-hour average ozone concentrations measured at each monitor within an area over each year must not exceed 75 parts per billion (ppb) (U.S. Environmental Protection Agency 2009). In assessing air quality within national parks, the ARD mandates that if the interpolated five-year average of the fourth-highest daily maximum 8-hour average ozone concentrations is greater than or equal to 76 ppb, then ozone is classified as a "significant concern" in the park. If the interpolated five-year average is between 61 ppb and 75 ppb, concentrations greater than 80-percent of the national standard, then the park is classified as "moderate." To receive a "good" ozone rating, a park must have a five-year average ozone concentration less than 61 ppb (concentrations less than 80-percent of the national standard). Table 25 illustrates how ARD uses the five-year average concentrations to classify ozone air quality conditions in national parks. The ARD mandates for ozone air quality are designed to reflect the idea that simply meeting the national standard does not guarantee "unimpaired" parks for future generations.

Table 25. Air Resources Division ozone air quality condition classifications and corresponding condition status. The 5-year average ozone concentration at Fort Sumter NM and Charles Pinckney NHS was 70.86 ppb.

ARD Condition	*Condition Status*	*Ozone concentration (ppb)*
Significant Concern	Poor	≥ 76
Moderate Concern	Fair	61 – 75
Good Condition	Good	≤ 60

Vegetation sensitivity to ozone is also taken into consideration when conducting air quality assessments in national parks. A 2004 vegetation risk assessment identified 14 plant species present at Fort Sumter NM that are sensitive to ozone (National Park Service 2004a). This risk assessment indicated that the risk of injury to plants is low at Fort Sumter NM due to low levels of ozone exposure coupled with soil moisture conditions which inhibit the uptake of ozone. The 2004 report also identifies seven bioindicator species that can be monitored at Fort Sumter NM to indicate increased ozone injury to vegetation. The ARD uses the vegetation risk evaluation to modify the average ozone concentration air quality condition status when assigning parks a final ozone condition rating. If a park is evaluated as a high risk of plant injury, the ARD would assign that park the next more severe ozone condition status (i.e., reclassify "moderate" to "significant concern").

Atmospheric Deposition:
The ARD uses wet deposition in evaluating atmospheric conditions in national parks, primarily due to the general lack of available dry deposition data. Using wet deposition data, however, may be problematic for accurately assessing atmospheric deposition in parks situated in arid climates where dry deposition data would prove to be more useful. In the continental United States, wet deposition is calculated by multiplying nitrogen (N from nitrate and ammonium ions) or sulfur (S from sulfate ions) concentrations in precipitation by a normalized precipitation value. The precipitation values, obtained from the PRISM database, are normalized over a 30-year period to minimize interannual variations in deposition caused by interannual fluctuations in precipitation (Oregon State University 2008). The nitrogen and sulfur deposition concentrations used for interpolation are obtained from the National Atmospheric Deposition Program (University of Illinois at Urbana-Champaign 2009). The ARD takes natural background deposition estimates and deposition effects on ecosystems under consideration when evaluating atmospheric deposition conditions.

Table 26 illustrates how the ARD rates atmospheric deposition conditions according to the amount of estimated wet deposition at a park. Estimates of natural background deposition for total deposition are approximately 0.25 kilograms per hectare per year (kg/ha/yr) in the West and 0.50 kg/ha/yr in the East, for either N or S. For wet deposition only, this is roughly equivalent to 0.13 kg/ha/yr in the West and 0.25 kg/ha/yr in the East. Although the proportion of wet to dry deposition varies by location, wet deposition is at least one-half of the total deposition in most areas. Certain sensitive ecosystems respond to levels of deposition on the order of 3 kg/ha/yr total deposition, or about 1.5 kg/ha/yr wet deposition (Fenn et al. 2003, Krupa 2003).

Table 26. Air Resources Division wet deposition condition classifications and corresponding condition status. The wet deposition values refer to either nitrogen or sulfur individually, not the sum of the two. Total wet nitrogen deposition at Fort Sumter NM and Charles Pinckney NHS is estimated at 3.03 kg/ha/yr, and total wet sulfur deposition is estimated at 4.49 kg/ha/yr.

ARD Condition	*Condition Status*	*Wet Deposition (kg/ha/yr)*
Significant Concern	Poor	> 3
Moderate Concern	Fair	1 – 3
Good Condition	Good	< 1

Visibility:
Individual park scores for visibility are based on the deviation of the current Group 50 visibility conditions from estimated Group 50 natural visibility conditions, where Group 50 is defined as the mean of the visibility observations falling within the range between the 40th and 60th percentiles. Natural visibility conditions are those that have been estimated to exist in a given area in the absence of anthropogenic visibility impairment. Visibility is described in terms of a Haze Index, a measure derived from calculated light extinction, and expressed in deciviews (dv) (U.S. Environmental Protection Agency 2003). Visibility worsens as the Haze Index increases. The visibility condition is expressed as:

Visibility Condition = (current Group 50 visibility) –
(estimated Group 50 visibility under natural conditions)

As illustrated in Table 27, parks with a visibility condition estimate of less than two dv above estimated natural conditions receive a "good" visibility condition classification. Those parks with visibility condition estimates between two and eight dv above natural conditions are classified as "moderate," and parks with visibility condition estimates greater than eight dv above natural conditions are classified as a "significant concern." While the dv ranges for each category are somewhat subjective, they reflect as nearly as possible the variation in visibility conditions across the visibility monitoring network.

Table 27. Air Resources Division visibility condition classifications and corresponding condition status. The current Group 50 deviation at Fort Sumter NM and Charles Pinckney NHS is 12.30 dv.

ARD Condition	*Condition Status*	*Current Group 50 – Estimated Group 50 Natural (dv)*
Significant Concern	Poor	> 8
Moderate Concern	Fair	2 – 8
Good Condition	Good	< 2

Environmental effects:
Using the methods developed by the ARD discussed above, the air quality condition status at Fort Sumter NM and Charles Pinckney NHS takes into account ozone concentration, wet atmospheric deposition, and visibility. The 5-year (2003 – 2007) average ozone concentrations were 70.86 ppb, earning the parks a "moderate" or "fair" ozone condition rating (Table 25). The 2004 vegetation risk assessment indicated that both parks are at low risk for plant injury, and the ARD consequently maintained the original ozone air quality condition status of "moderate."

Atmospheric deposition at Fort Sumter NM and Charles Pinckney NHS is classified as a "significant concern" or "poor" condition status (Table 26). The total wet nitrogen deposition at Fort Sumter NM is estimated at 3.03 kg/ha/yr, and the total estimated wet sulfur deposition is 4.49 kg/ha/yr. There is no current information to indicate whether ecosystems at Fort Sumter NM are sensitive to nitrogen or sulfur deposition, but deposition is elevated. Nitrogen deposition, in particular, may affect the integrity of vegetation communities at Fort Sumter NM because excess nitrogen has been found to encourage growth of invasive plant species at the expense of native species.

The visibility condition at Fort Sumter NM and Charles Pinckney NHS is classified as a "significant concern" because the current Group 50 visibility at both parks is 12.30 dv above estimated Group 50 natural conditions (Table 27).

Trends cannot be evaluated from the interpolated 5-year averages utilized by the ARD. However, the NPS ARD evaluates 10-year trends in air quality for parks with on-site or nearby monitoring. Maps in the most recently available progress report show trends in ozone, deposition, and visibility that can be used to discern regional trends (National Park Service 2007). For the period 1996 – 2005, ozone concentrations and nitrogen and sulfur deposition in the Southeast appear to be decreasing, while visibility is relatively unchanged.

3.3.1.b Resource threats and stressors:
Threats to the parks' air quality include new point sources, such as power plants and large industrial facilities that are located upwind. Emissions from such sources can travel hundreds of kilometers and influence the monuments' air quality. Additionally, development near the parks could lead to an increase in vehicle traffic and its associated emissions that could impact the parks' air quality.

3.3.1.c Critical knowledge or data gaps:
An air monitoring site on the parks' property would provide the best information about its air quality. Such sites are expensive to install and maintain; however, it is feasible that if a nearby monitoring site needs to be relocated, the state environmental agency might be willing to consider moving it to one of the parks. The spatial component of data quality received a zero for atmospheric deposition and visibility because the available data could be more local (Table 28). There are, however, monitoring stations for ozone within close proximity to the parks so we gave this data quality component a one.

3.3.1.d Condition status summary
From the environmental and natural resource management perspective, air quality at Fort Sumter NM and Charles Pinckney NHS is poor overall (Table 28). As previously discussed, a 2004 risk assessment determined that the ozone threat to vegetation at Fort Sumter NM and Charles Pinckney NHS is low. Risk of plant injury is low, despite periodic elevated ozone exposures at the parks, because the low soil moisture conditions that prevail during periods of high ozone exposure limit stomatal uptake of ozone (National Park Service 2004a).

The NPS Inventory and Monitoring (I&M) Program is currently conducting risk assessments to evaluate the threats from several sources. The assessments will evaluate nitrogen deposition (complete in late 2009), acidic deposition from nitrogen and sulfur (complete in 2010), and mercury deposition (complete in 2010) in national parks. These I&M assessments will be available on the NPS ARD website and will assist managers in determining what park resources are at risk from air pollution, and what type of air quality monitoring might be needed.

Table 28. Air quality condition status summary for Fort Sumter National Monument and Charles Pinckney National Historic Site. Data quality was rated based on *thematic* (1 = best source; 0 = not the best source), s*patial* (1 = inside park boundary; 0 = outside park boundary), and *temporal* (1 = recent; 0 = older than 5 years). The colors green, yellow, and red refer to good, fair, and poor scores respectively (see Table 1).

Category	***Condition Status***	***Midpoint***	***Data Quality***		
			Thematic	*Spatial*	*Temporal*
Ozone			1	1	1
	Fair	0.50	3 out of 3		
Atmospheric Deposition			1	0	1
	Poor	0.17	2 out of 3		
Visibility			1	0	1
	Poor	0.17	2 out of 3		
Air quality total			3	1	3
	Poor	0.28	7 out of 9		

3.3.1.e Recommendations to park managers:
Collaborative efforts are needed to tackle the region's air pollution. Park managers are urged to participate in and to promote regional-scale approaches to improve the area's air quality and visibility through the organizations listed in Table 29.

Table 29. List of recommended air quality organizations to participate with and promote regional approaches.

	Organization	*Webpage*
1.	Visibility Improvement State and Tribal Association of the Southeast (VISTAS)	http://www.vistas-sesarm.org/
2.	EPA Region 4	http://www.epa.gov/region4/air/index.htm
3.	Georgia Department of Natural Resources - Environmental Protection Division - Air Protection Branch	http://www.georgiaair.org/

3.3.2 Climate

Climate is the long-term pattern and processes of weather events for a given location. Climate is one of the most significant abiotic factors dictating biotic components anywhere on the Earth.

There is much interest in climate recently due to increasing temperatures and changing weather patterns across the globe (Blaustein et al. 2001, Walther et al. 2002, Corn 2005). Such changes have the potential to impact natural resources by shifting dominant vegetation communities, impacting animal species at the frontiers of their range, and impacting fundamental ecosystem processes.

We included some basic assessments on the climate of the landscape around Fort Sumter NM and Charles Pinckney NHS. This information can be used to provide some insight into potential direct and indirect impacts a changing climate might have on their natural resources.

3.3.2.a Current condition status:

Climate is a complex amalgam of long-term weather events. Our assessment includes several of these factors examined over the long term (> 30 years). We attempted to narrow the suite of factors down to those metrics where data was available and long-term trends were easily established. These include temperature, precipitation, available moisture, phenology through growing degree days, and extreme weather events (e.g., hurricane) which act as agents of major landscape change and disturbance ecology.

Temperature:

We used data provided by the Southeast Regional Climate Center (SERCC 2008) to assess temperature change for Fort Sumter NM and Charles Pinckney NHS. The SERCC is a regional climate center headquartered at the University of North Carolina at Chapel Hill and is directed and overseen by the National Oceanic and Atmospheric Administration (NOAA) National Climatic Data Center (NCDC) and National Environmental Satellite, Data and Information Service (NESDIS). Charleston, South Carolina is one of the cities available for long-term climate information summaries provided through the SERCC Historical Climate Summaries product. This product permits access to annual, monthly, and daily climate information, including mean temperature (The Southeast Regional Climate Center 2008).

We used the "monthly average temperature" option to examine temperature trends annually as well as seasonally. The data was partitioned for seasonal analysis as follows: Winter (December – February), Spring (March – May), Summer (June – August), and Fall (September – November)

seasons. The range of dates for which the data was available was 1948 – 2008, however, due to incomplete data for the years of 1948 and 2008, this assessment utilizes data from 1949 – 2007.

The mean annual temperature for Charleston, South Carolina has increased approximately 0.20 degrees Fahrenheit per decade (mean = 66.46 °F) from 1901 to 2007 (Figure 28). This observed trend was similar for all four seasons (Figure 29 – Figure 32). Although the most potentially biologically significant increase was observed during the winter and summer seasons, temperatures in Charleston, South Carolina are fairly constant and increasing at a relatively negligible rate.

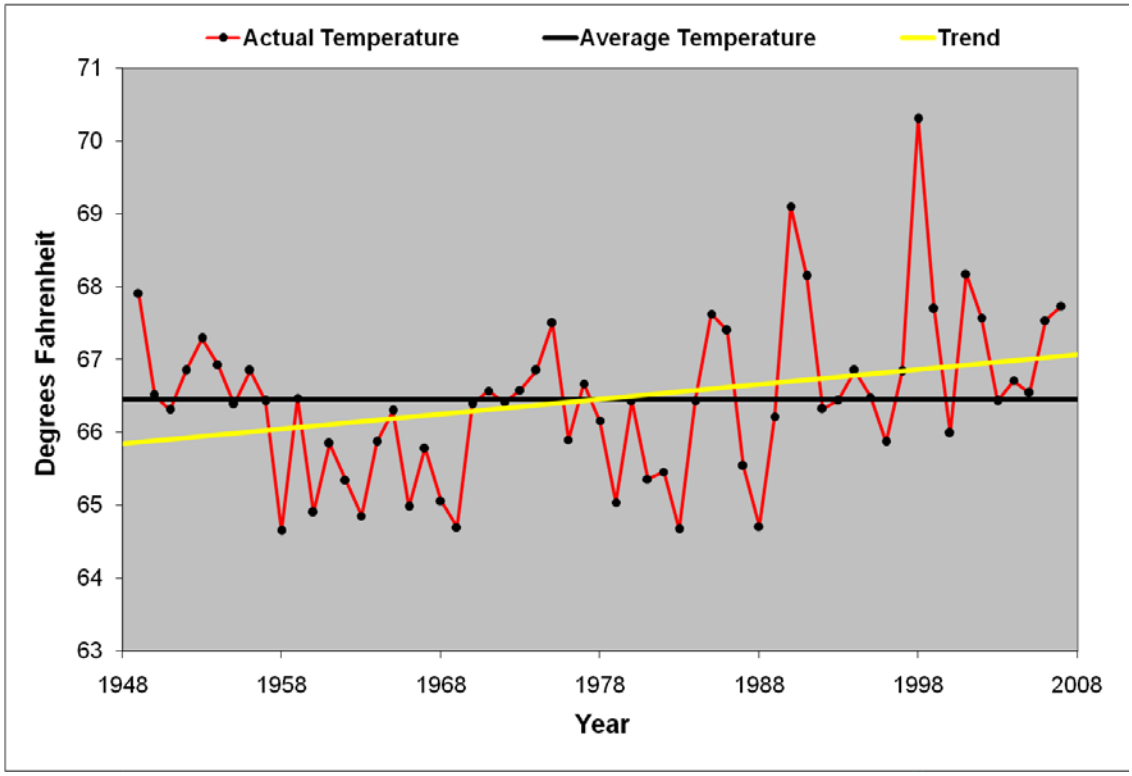

Figure 28. Annual temperature for Charleston, SC from 1949 to 2007. The mean annual temperature is 66.46 °F. The trend is 0.20 °F per decade.

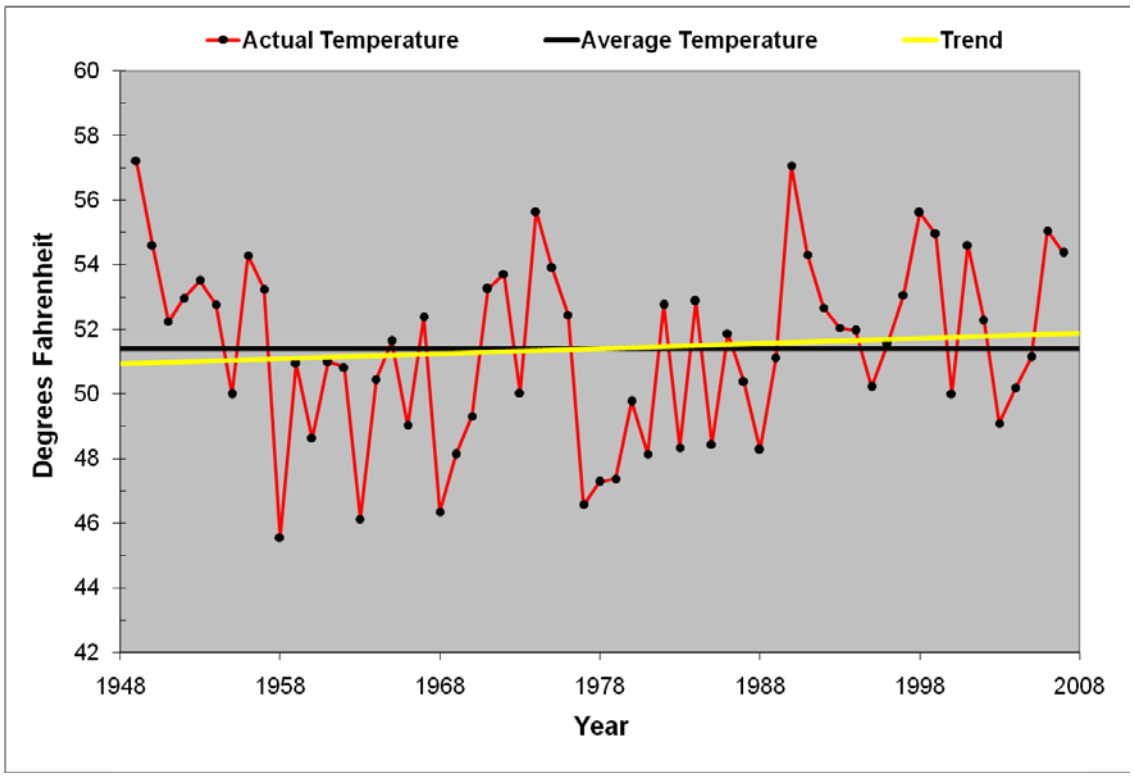

Figure 29. Winter temperature for Charleston, SC from 1949 to 2007. The mean temperature was 51.42 °F. The trend is 0.16 °F per decade.

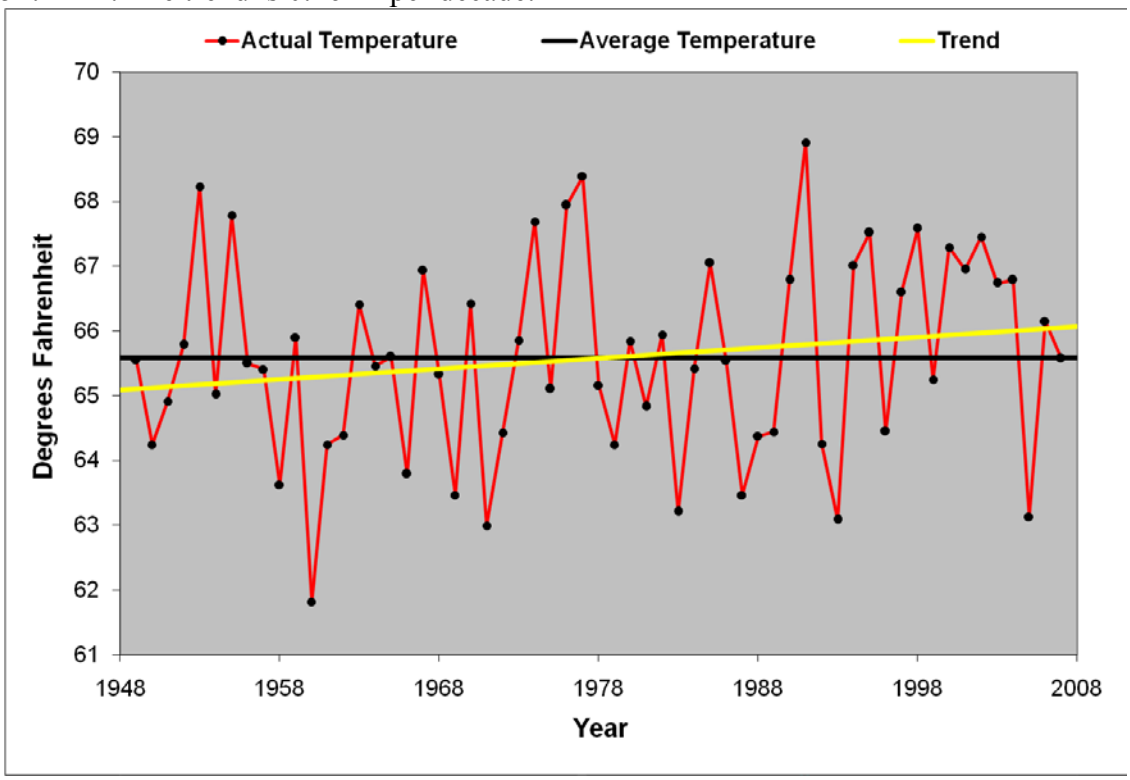

Figure 30. Spring temperature for Charleston, SC from 1949 to 2007. The mean temperature was 65.58 °F. The trend is 0.16 °F per decade.

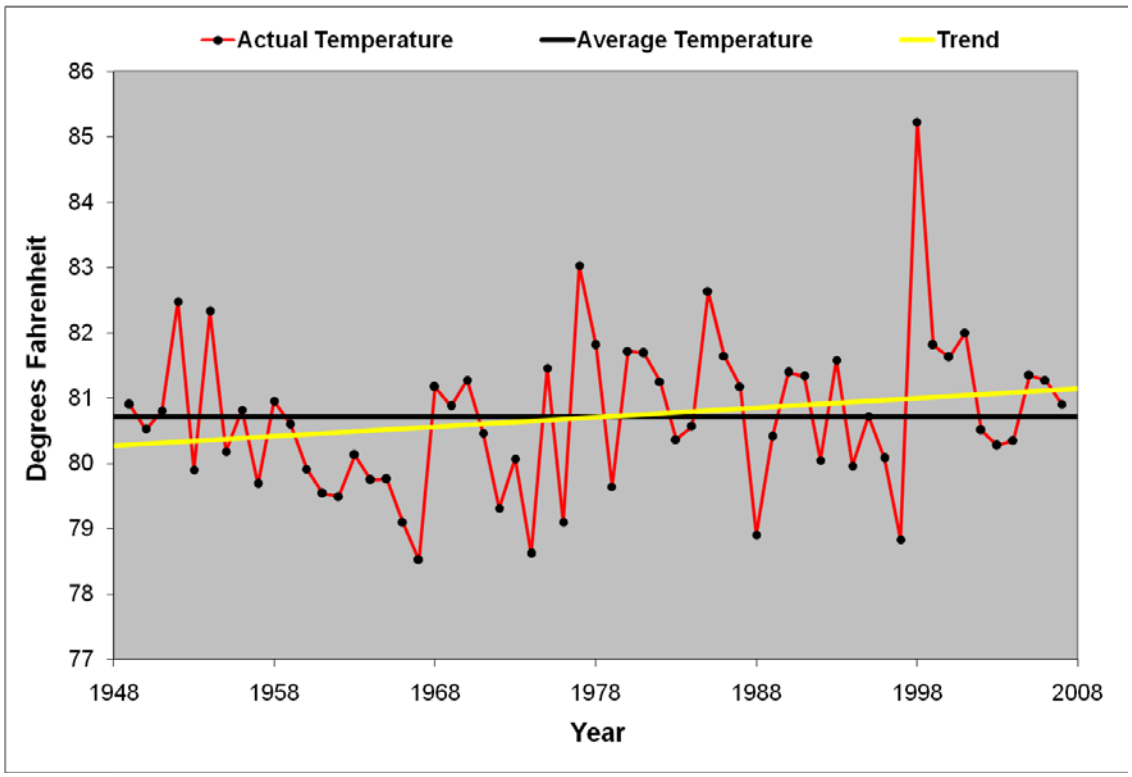

Figure 31. Summer temperature for Charleston, SC from 1949 to 2007. The mean temperature was 80.71 °F. The trend is 0.15 °F per decade.

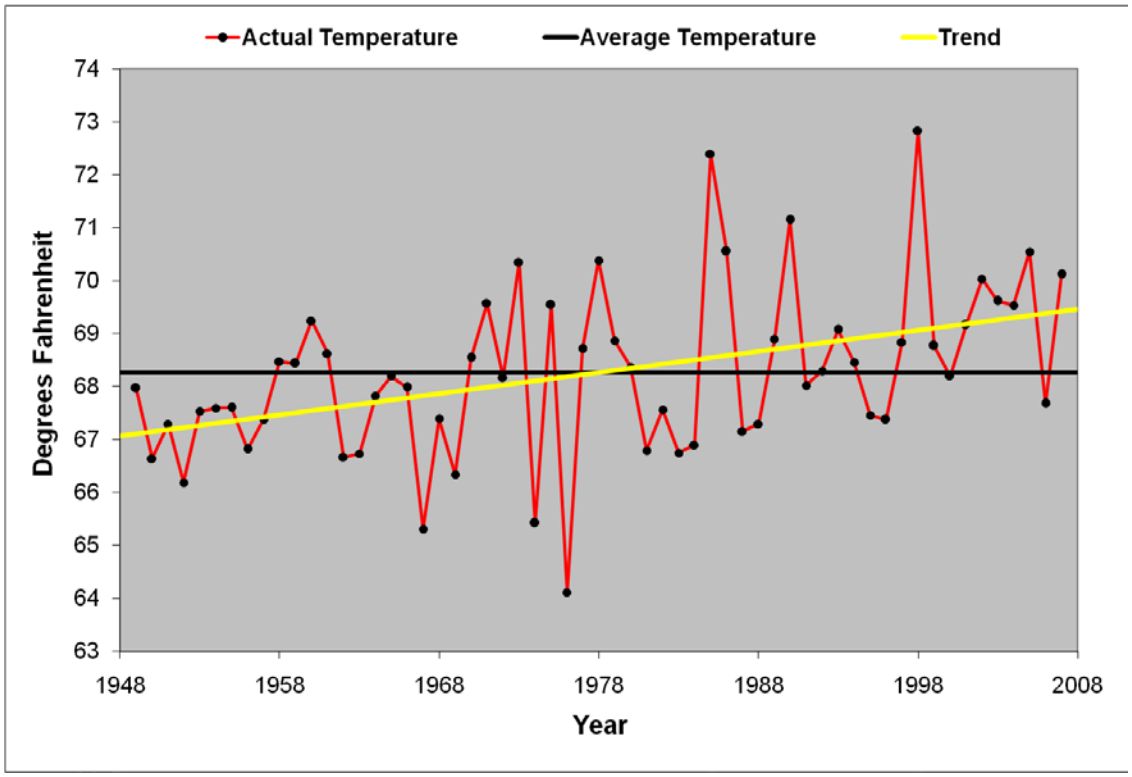

Figure 32. Fall temperature for Charleston, SC from 1949 to 2007. The mean temperature was 68.27 °F. The trend is 0.40 °F per decade.

Since the upland habitats at Fort Sumter NM and Charles Pinckney NHS developed over a similar timeframe, the present vegetation communities may be more reflective of this increasing thermal condition more so than similar older, longer-standing vegetation communities.

Precipitation:
Similar analyses were conducted for precipitation using data collected at Charleston, SC. The annual precipitation at Charleston shows considerable variation through time and has a decreasing trend of approximately -0.79 inches per decade (Figure 33). We also examined precipitation seasonally (as described in temperature above) for winter, spring, summer, and fall from 1901 to 2007 (Figure 34 – Figure 37).

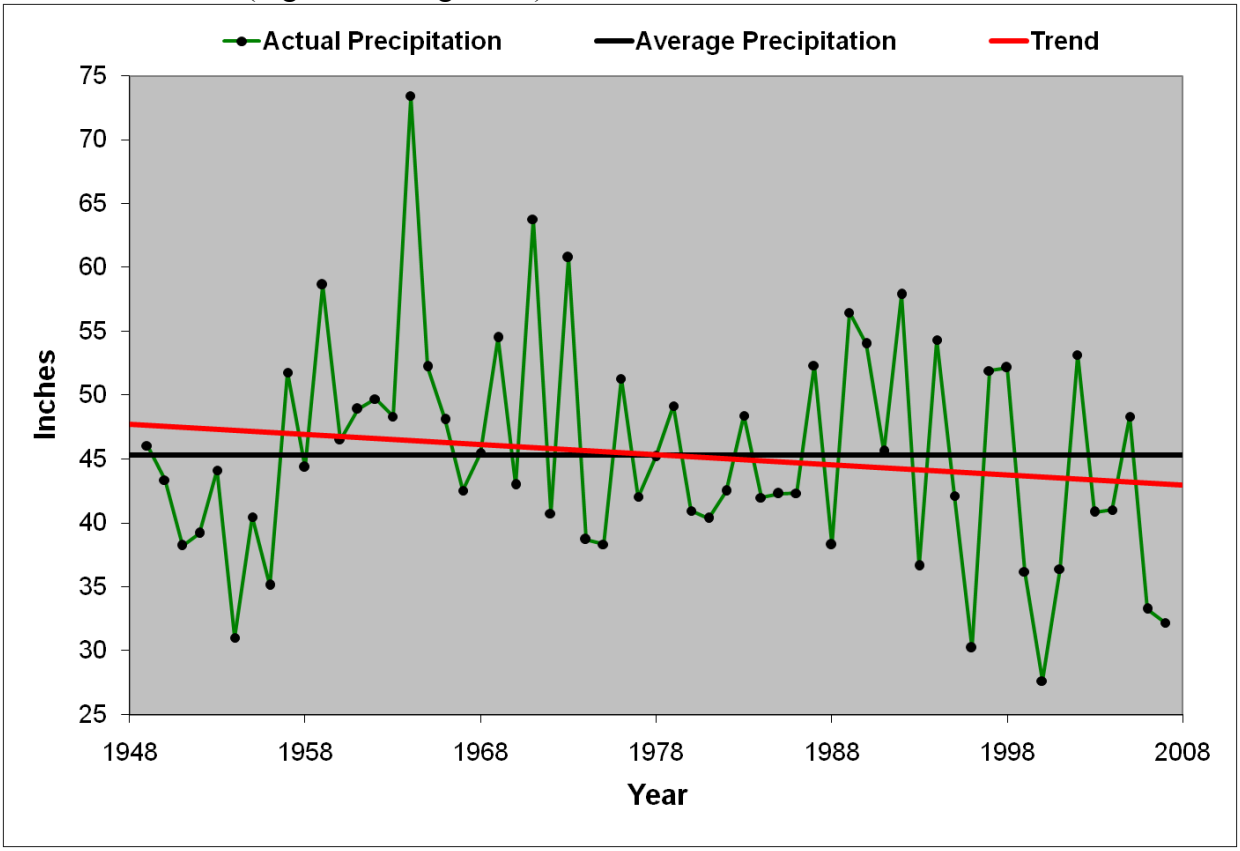

Figure 33. Annual precipitation for Charleston, SC. The mean annual precipitation is 45.33 inches with a decreasing trend of -0.79 inches per decade.

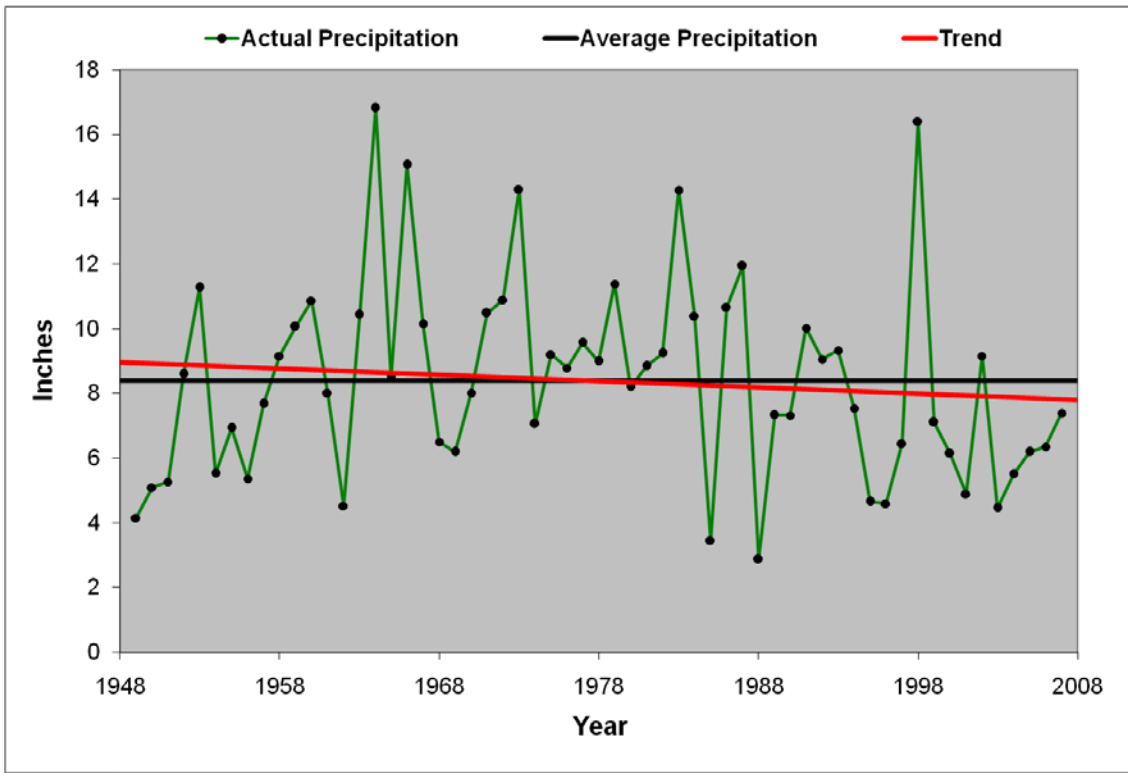

Figure 34. The winter precipitation for Charleston, SC. The mean precipitation is 8.38 inches with a decreasing trend of -0.19 inches per decade.

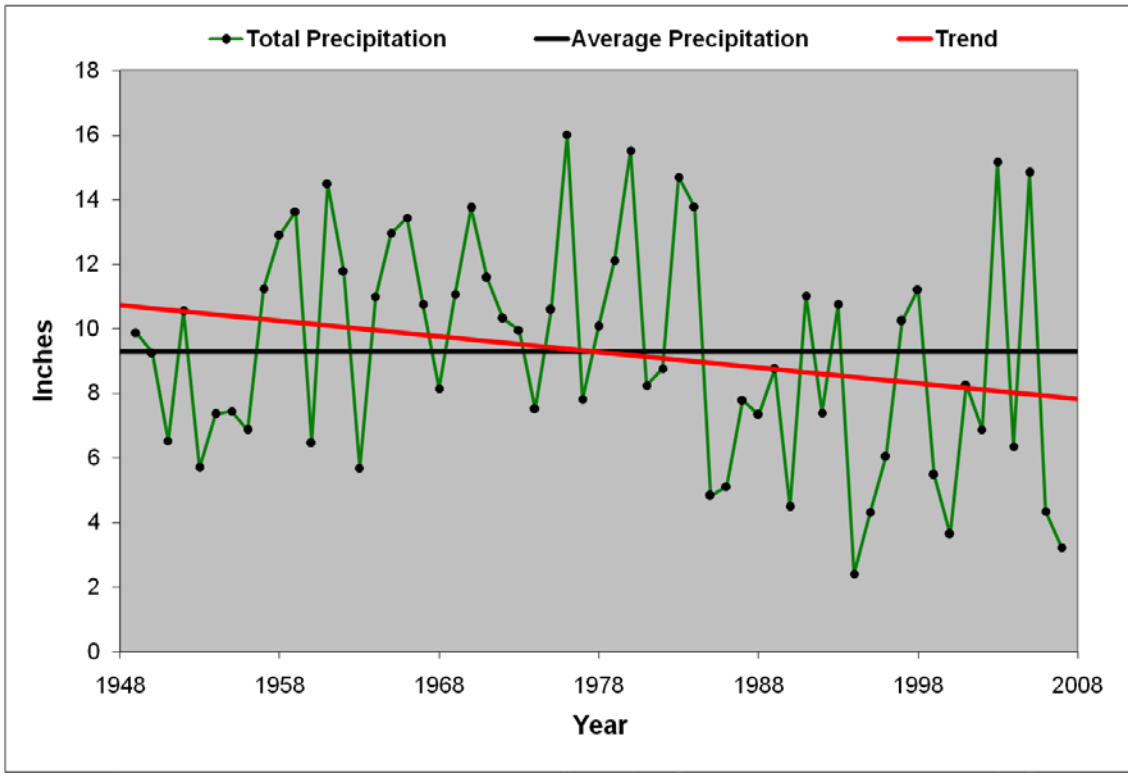

Figure 35. The spring precipitation for Charleston, SC. The mean precipitation is 9.28 inches with a decreasing trend of -0.49 inches per decade.

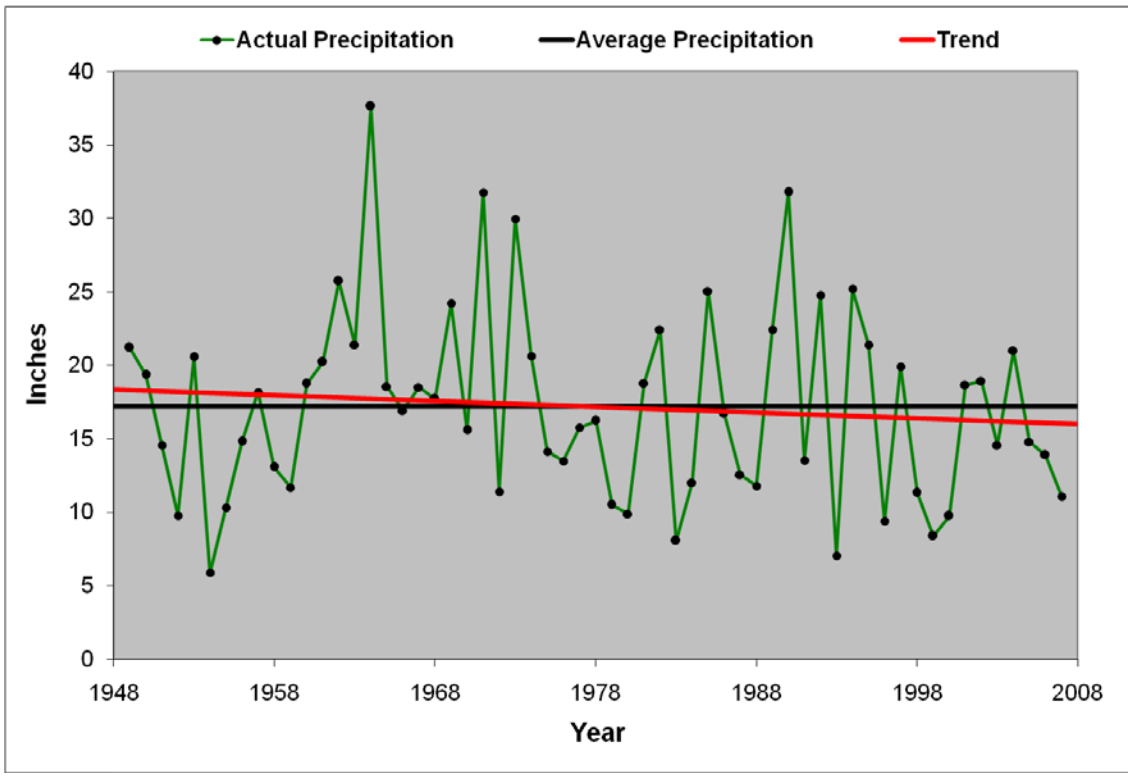

Figure 36. The summer precipitation for Charleston, SC. The mean precipitation is 17.18 inches with a decreasing trend of -0.40 inches per decade.

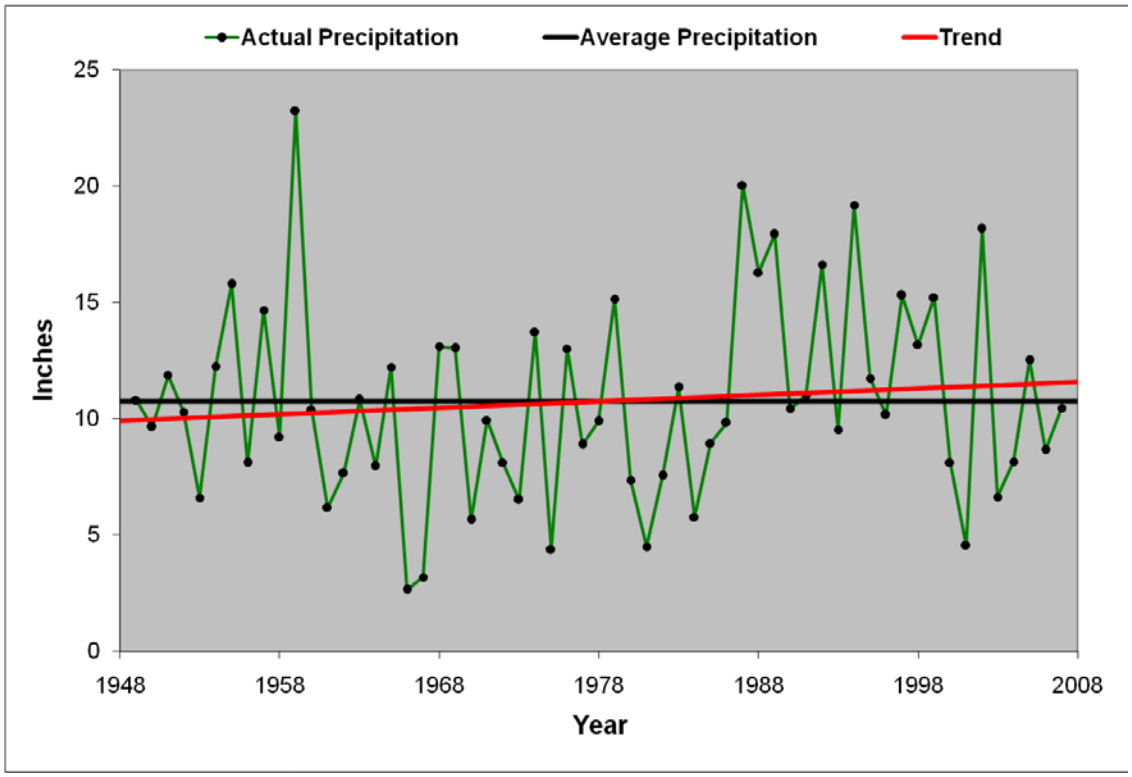

Figure 37. The fall precipitation for Charleston, SC. The mean precipitation is 10.75 inches with an increasing trend of 0.27 inches per decade.

Overall, Charleston is receiving a decreasing amount of precipitation, with the fall season exhibiting the only deviation from this trend. While Charleston is receiving a fairly modest increase in precipitation during the fall months, the prevailing negative trend is significant given the observed increase in temperatures for the same seasonal period. Taken together, it is reasonable to assume that increasing temperatures and decreasing precipitation will result in a decrease in available water and an increase in drying. This may lead to more frequent or increasingly severe drought conditions that will impact biotic resources, particularly during extremes.

Moisture:
We also summarized information on drought severity using monthly data from NOAA for coastal South Carolina from 1896 – 2007 (Figure 38). Drought severity was measured with the Palmer Drought Severity Index (PDSI, also known as the Palmer Drought Index [PDI]). The PDSI attempts to measure the duration and intensity of the long-term drought-inducing circulation patterns. Long-term drought is cumulative, so the intensity of drought during the current month is dependent on the current weather patterns plus the cumulative patterns of previous months.

The PDSI values reflect the severity of drought, and are classified into several levels (Table 30). We used these classes for each monthly PDSI value from 1896 to 2007 then determined the proportion of months in each class for each 8-year period for ease of comparison (Figure 38).

Table 30. Classification used for PDSI values.

PDSI Range	Class Description
-3 or less	Severely Dry
-2 to -3	Excessively Dry
-1 to -2	Abnormally Dry
-1 to 1	Slightly Dry/Favorably Moist
1 to 2	Abnormally Wet
2 to 3	Wet
3 or greater	Excessively Wet

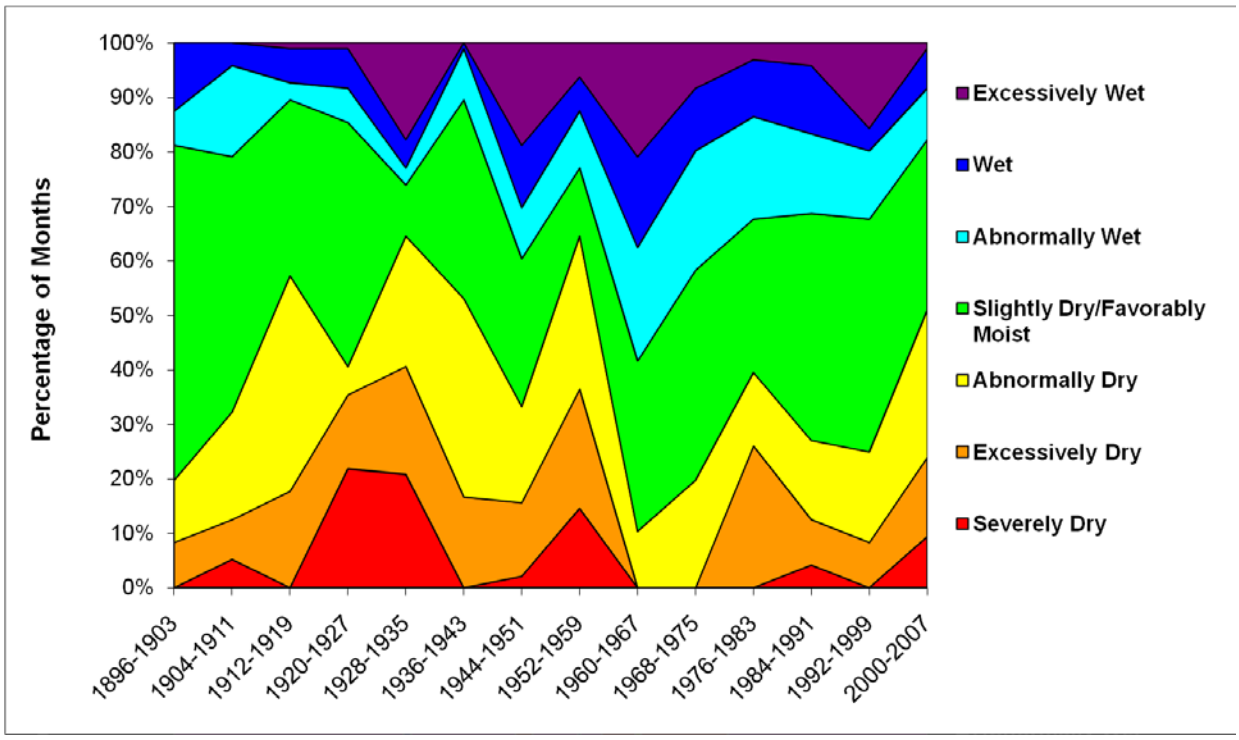

Figure 38. PDSI values for Charleston, SC in 8-year blocks from 1896 – 2007.

The data indicate a clear increase in the proportion of months classified as "abnormally dry" or "excessively dry" since 1975. The yellow and orange bands clearly increase in width relative to the classes at the wetter end of the scale after that period. It is also evident that drought severity has fluctuated greatly in the past, with the majority of months falling into the "slightly dry/favorably moist" category. This supplies additional support to our observations that increasing temperature and decreasing precipitation may lead to increased instance of drought conditions in Charleston.

Phenology (Growing Degree Days):
Temperature and precipitation have seasonal variation. The patterns of seasonal variation in these abiotic factors impact the biological processes of all local biota. These cycles are reflected in the timing of migration, flowering, and the birth of young. The study of such cycles and seasonal timing is termed "phenology" and changes in these annual cycles can provide information regarding important issues like the length of the growing season.

The best metric available for recording the passage of phenological time are "growing degree days." Growing degree days (GDD) can vary depending on the reference temperature corresponding to the species or process of interest, but the reference temperature is often set to 40 °F. At this temperature, plants can photosynthesize, and typically this equates to growing season. GDDs cannot be equated to calendar days, they are their own unit of measure. In this case, GDDs accumulate anytime the average temperature is more than 40 °F.

We calculated the approximate number of growing degree days per month for Fort Sumter NM and Charles Pinckney NHS by using monthly mean temperature data for nearby weather

collection stations in Charleston, South Carolina. Monthly temperature was available from 1949 to 2007 and was used to calculate the monthly growing degree day total with a simple formula:

$$GDD = (T_m - 40)\, D_m$$

Where GDD = Growing degree days

T_m = monthly mean temperature

D_m = number of days in month

The number of growing degree days for each month were summed to determine the approximate number of growing degree days per year. These values were plotted against time (year) to illustrate the long-term trends in the numbers of growing degree days at Fort Sumter NM and Charles Pinckney NHS (Figure 39).

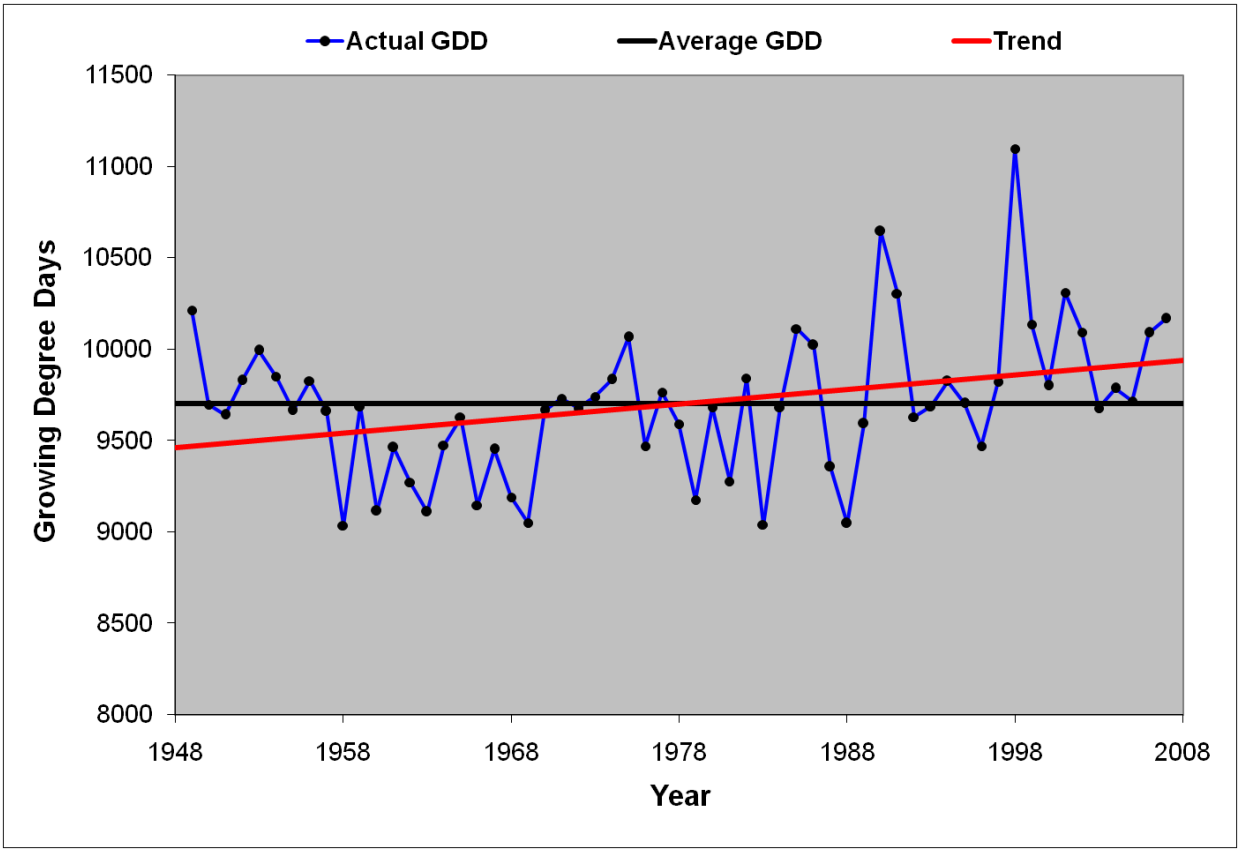

Figure 39. The total growing degree days per year for Charleston, SC from 1949 – 2007. The long term mean annual growing degree total is 9701.51 (black line). The red trend line indicates an increasing trend (R^2=0.12).

We observed an increase in the number of growing degree days that may indicate an increase in the growing season through time. To better illustrate this, we elected to examine the same data in terms of phenology. Much research has been completed equating phenological events to growing degree days (McMaster and Wilhelm 1997, University of Massachusetts Extension 2008, Virginia Tech FORSITE 2008). We attempted to put this in the context of a calendar year by selecting an arbitrary GDD threshold (1200 GDD) and estimating the date at which that number

of growing degree days was achieved. This would be analogous to estimating the specific date a phenological event was to occur (e.g., the blooming of dogwood trees).

Since our source data is comprised of monthly mean daily temperature, we calculated the total monthly accumulated GDD by multiplying the mean daily temperature by the number of days in the month. We then set a reference number of GDDs at 1200 to approximate a springtime phenological event. Historically, this value was achieved during the month of either March or April. We used the total GDD accumulated for the year through March 31 (sum of January, February, and March) then calculated the difference from 1200.

We estimated the number of days required to achieve the 1200 GDD by calculating the slope of the line for the appropriate month. If the difference was positive, we estimated the exact date where 1200 was achieved by determining the slope of the line between the total GDD for March and the total for April. If negative, the same procedure was used between February and March. This permitted us to use the most accurate daily rate in our estimation.

Using this process we determined the calendar date that 1200 GDD was achieved for each year in the dataset and plotted it over time (Figure 40).

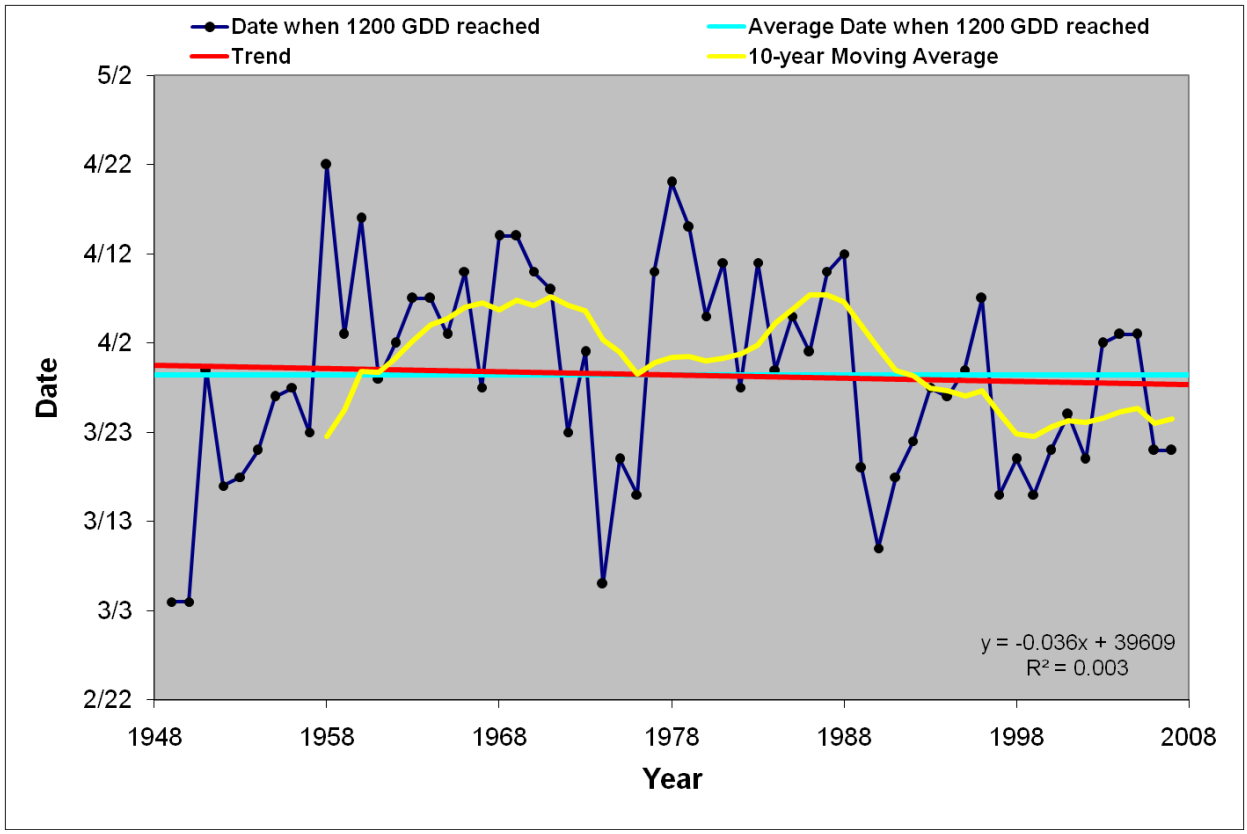

Figure 40. The approximate date when 1200 GDD has been reached for each year (1949 – 2007). The decreasing trend indicates that this date is arriving earlier each year (trend is 0.37 days per decade).

This illustrates that the phenology of Fort Sumter NM and Charles Pinckney NHS may be advancing which, in turn, may allow species found in warmer climates with longer growing seasons to expand into this area while perhaps limiting those more northern species. However, the annual variation for this factor is high making the correlation for this trend extremely weak ($R^2 = 0.003$). More detailed information is needed.

Extreme Weather Events:
To observe extreme weather events and trends, we obtained historic storm tracks from NOAA's Coastal Services Center (National Oceanic and Atmospheric Administration 2008b). We acquired storm data for 1851 – 2007, which was loaded into a GIS. We then selected all storms that occurred within 100 nautical miles (nm) of the Fort Sumter NM and Charles Pinckney NHS park boundaries to assess those storms which were most likely to have an impact on the ecosystems and processes associated with the parks.

Each storm category is defined as a separate event, so we combined storms that occurred on successive days into one storm event and maintained the most severe storm rating assigned to any one of the storms. This was necessary to accurately and efficiently understand storm frequency and the impacts of extreme weather on Fort Sumter NM and Charles Pinckney NHS and the surrounding areas. Additionally, it is worth noting that storms were not named until around 1950. In our assessment, we included storms rated as tropical depressions (TD), tropical storms (TS), and category 1 – 4 hurricanes. There were no Category 5 hurricanes in the historical data that came within 100nm of Fort Sumter NM or Charles Pinckney NHS.

Storms categorized as tropical depressions are those with maximum sustained winds of 38 mph or less. Tropical storms are those with maximum sustained winds of 39 to 73 mph (U.S. Department of Commerce 2001). The Saffir/Simpson Hurricane Scale (Table 31) rates and categorizes hurricanes on a scale of 1 through 5 based on wind speeds (Blake et al. 2007). A major hurricane is any storm categorized as 3, 4, or 5 on the Saffir/Simpson Scale.

Table 31. Saffir/Simpson Hurricane Scale (Blake et al. 2007).

Scale Number (Category)	*Wind Speed (mph)*	Typical Characteristics of Hurricanes by Category			
		Millibars	*Inches*	*Surge (feet)*	*Damage*
1	74 – 95	> 979	> 28.91	4 to 5	Minimal
2	96 – 110	965 – 979	28.50 – 28.91	6 to 8	Moderate
3	111 – 130	945 – 964	27.91 – 28.47	9 to 12	Extensive
4	131 – 155	920 – 944	27.17 – 27.88	13 to 18	Extreme
5	> 155	< 920	< 27.17	> 18	Catastrophic

Upon analyzing the historic hurricane data, we were able to better understand the frequency and magnitude of extreme weather events affecting Fort Sumter NM and Charles Pinckney NHS. We observed the data in terms of monthly occurrence as well as yearly occurrence. Figure 41 through Figure 43 illustrate various combinations of storm activity during the annual monthly cycles, while Figure 44 through Figure 46 illustrate various combinations of storm activity broken down decennially to adequately facilitate illustration and interpretation.

The majority of all storm activity within 100nm of Fort Sumter NM and Charles Pinckney NHS occurs later in the year, between the months of August and October, with September experiencing the most (Figure 41). When the storms are divided into groups designated as either major or minor, these findings remain constant. Breaking the storms into groups, however, illustrates that minor storms (TD, TS, or Cat 1 or 2 hurricanes) pose a greater threat to Fort Sumter NM and Charles Pinckney NHS than do major storms (Figure 42).

Dissecting the data further, we were able to illustrate the frequency of each storm category and the potential impacts on Fort Sumter NM and Charles Pinckney NHS. According to the data, the parks are affected most by tropical storms, followed by Cat 1 hurricanes, both of which are relatively minor storm systems (Figure 43).

The annual data, combined into ten-year blocks, permits the interpretation of historic storm trends and the opportunity to infer future storm activity and the potential impacts on Fort Sumter NM and Charles Pinckney NHS. When all storm categories are combined, the data show that storm activity is on a relative decline (Figure 44). The graphic also illustrates that although the trend is declining slightly, storm activity peaks an average of every forty years since the 1900 – 1909 decennial block. Based on these data alone, storm activity is currently in its historic slump, but should peak in the 2020 – 2029 decennial block and continue the historic downward trend in the following decades.

When the annual data is split into major and minor storms, it is evident that Fort Sumter NM and Charles Pinckney NHS are threatened more by minor storms than major storms (Figure 45). The graph illustrates that minor storm activity generally appears to be increasing slightly, and Fort Sumter NM and Charles Pinckney NHS exhibit a stable oscillation where storm activity has peaked in twenty and forty year intervals since the 1880 – 1889 decennial block. According to the trends, minor storms should peak in the 2010 – 2019 decennial block and continue to decline in the following decade. The data also suggests that Fort Sumter NM and Charles Pinckney NHS may expect a major storm event in the coming years. The trends for major storm indicate that activity peaks every twenty to forty years, with the last peak occurring in the 1980 – 1989 decennial block.

Splitting the annual data into its primary components permits the observation of each storm category and its trends since 1851 (Figure 46). Fort Sumter NM and Charles Pinckney NHS have historically been affected most by Tropical Storms, followed by a secondary influence from Cat 1 hurricanes. The data also illustrates that Fort Sumter NM and Charles Pinckney NHS are clearly experiencing an increasing trend in Tropical Depressions and Cat 1 hurricanes, while experiencing fewer storms in other categories.

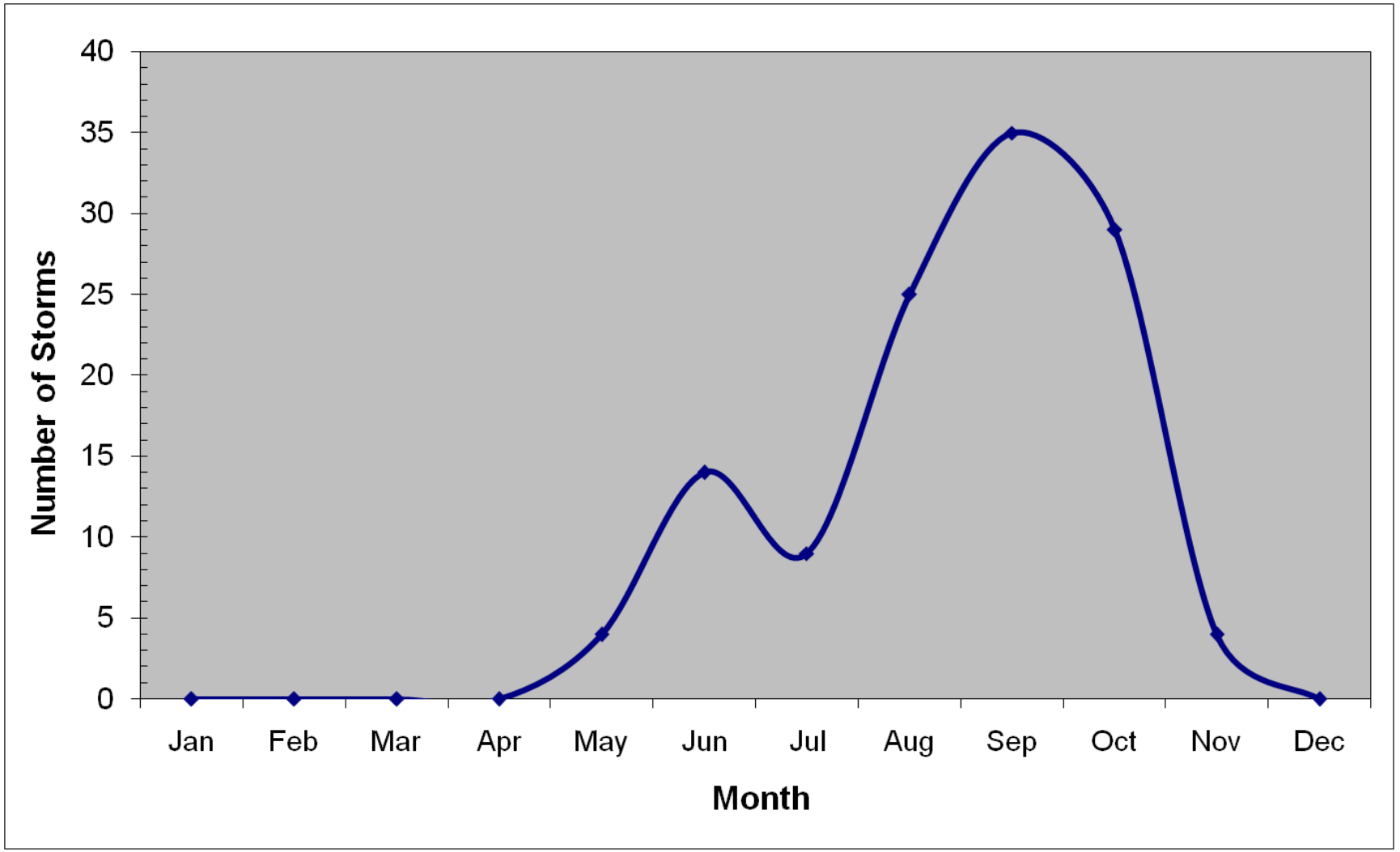

Figure 41. Total number of all storms per month (1851 – 2007) occurring within 100 nautical miles of Fort Sumter National Monument and Charles Pinckney National Historic Site.

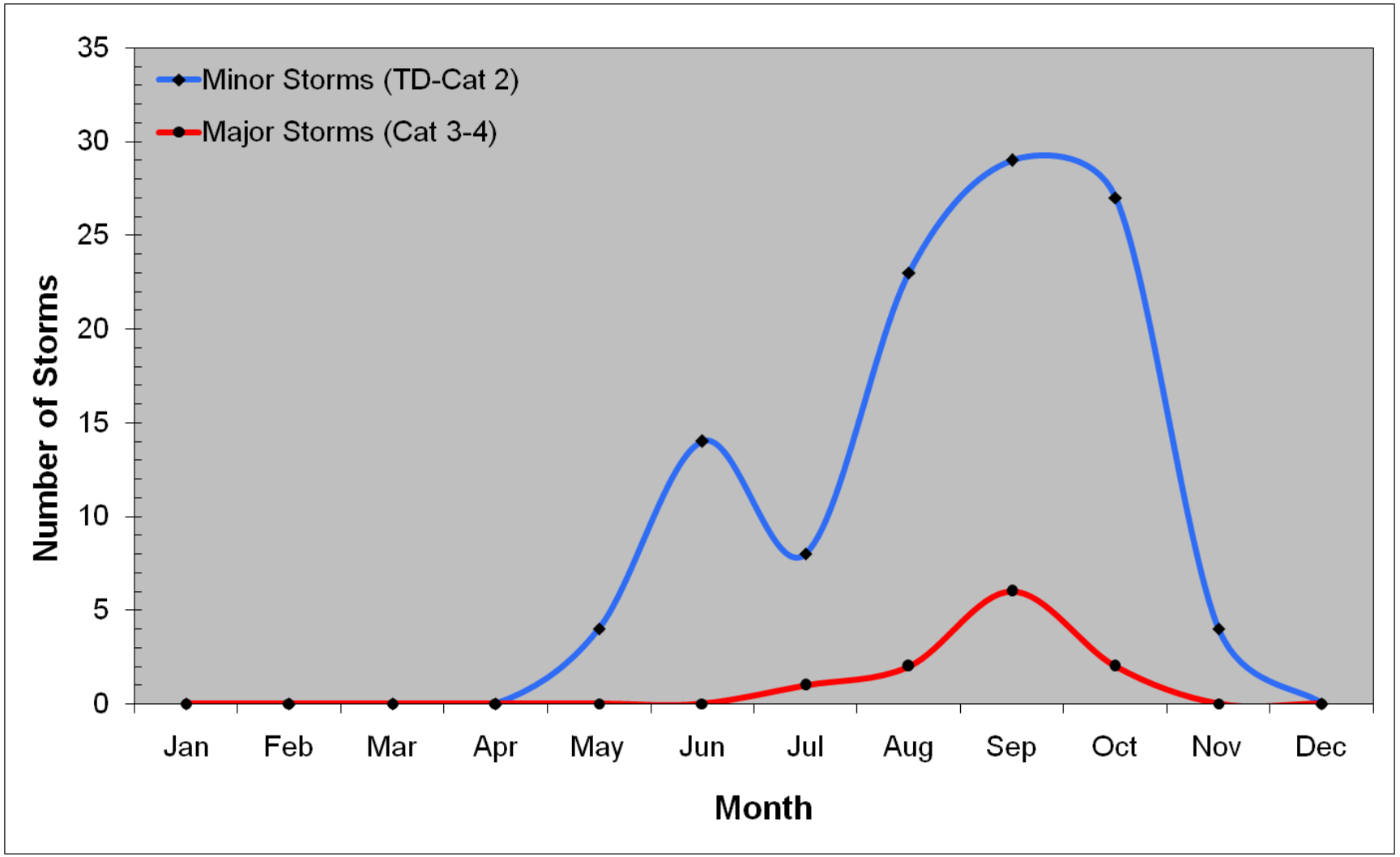

Figure 42. Total number of major and minor storms per month (1851 – 2007) occurring within 100 nautical miles of Fort Sumter National Monument and Charles Pinckney National Historic Site.

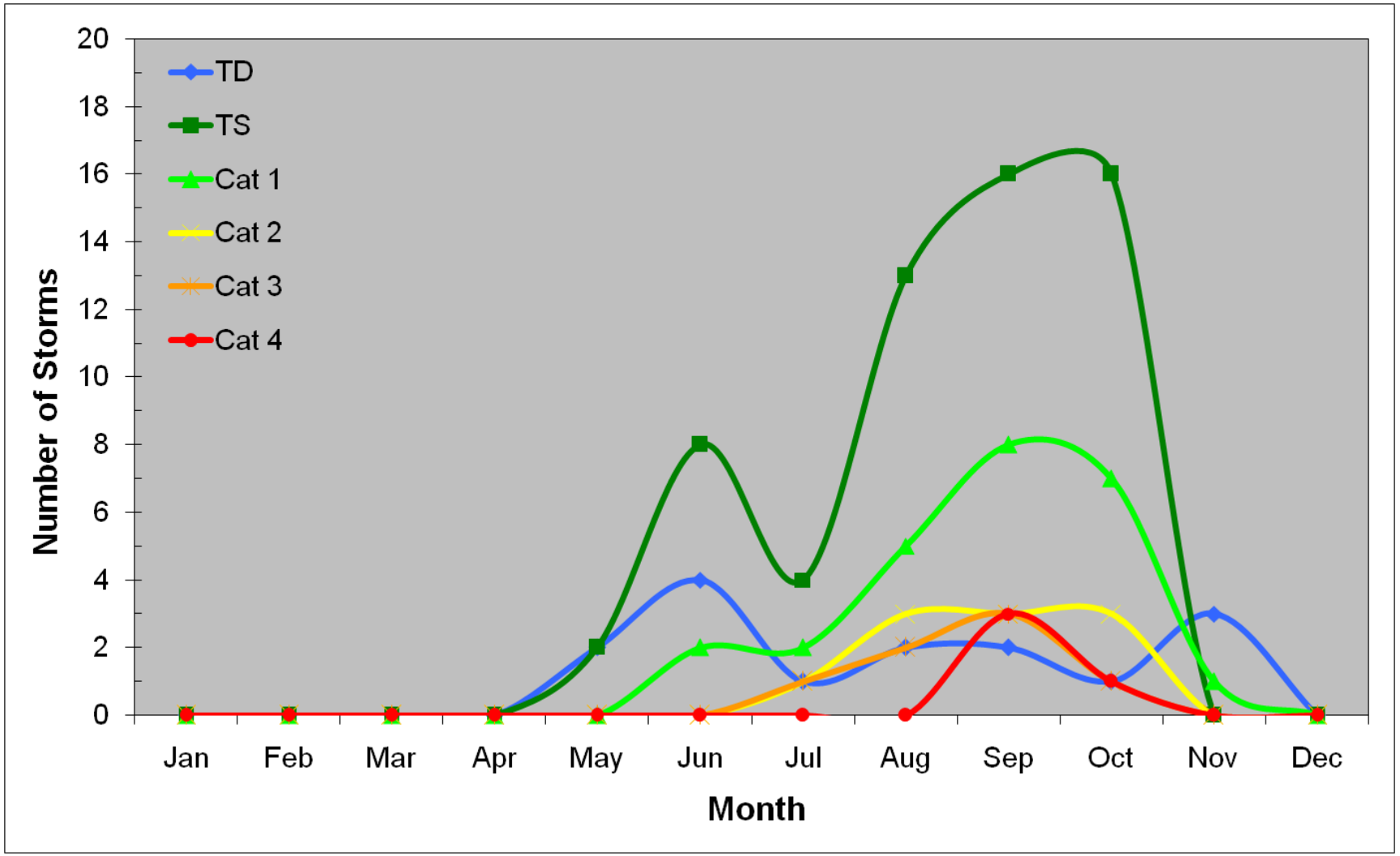

Figure 43. Total number of storms by category per month (1851 – 2007) occurring within 100 nautical miles of Fort Sumter National Monument and Charles Pinckney National Historic Site. Tropical depressions (TD) have 38 mph sustained wind speeds or less, tropical storms (TS) have 39 to 73 mph wind speeds, and the remaining hurricane categories (1-4) are from Saffir/Simpson Hurricane Scale (Table 31).

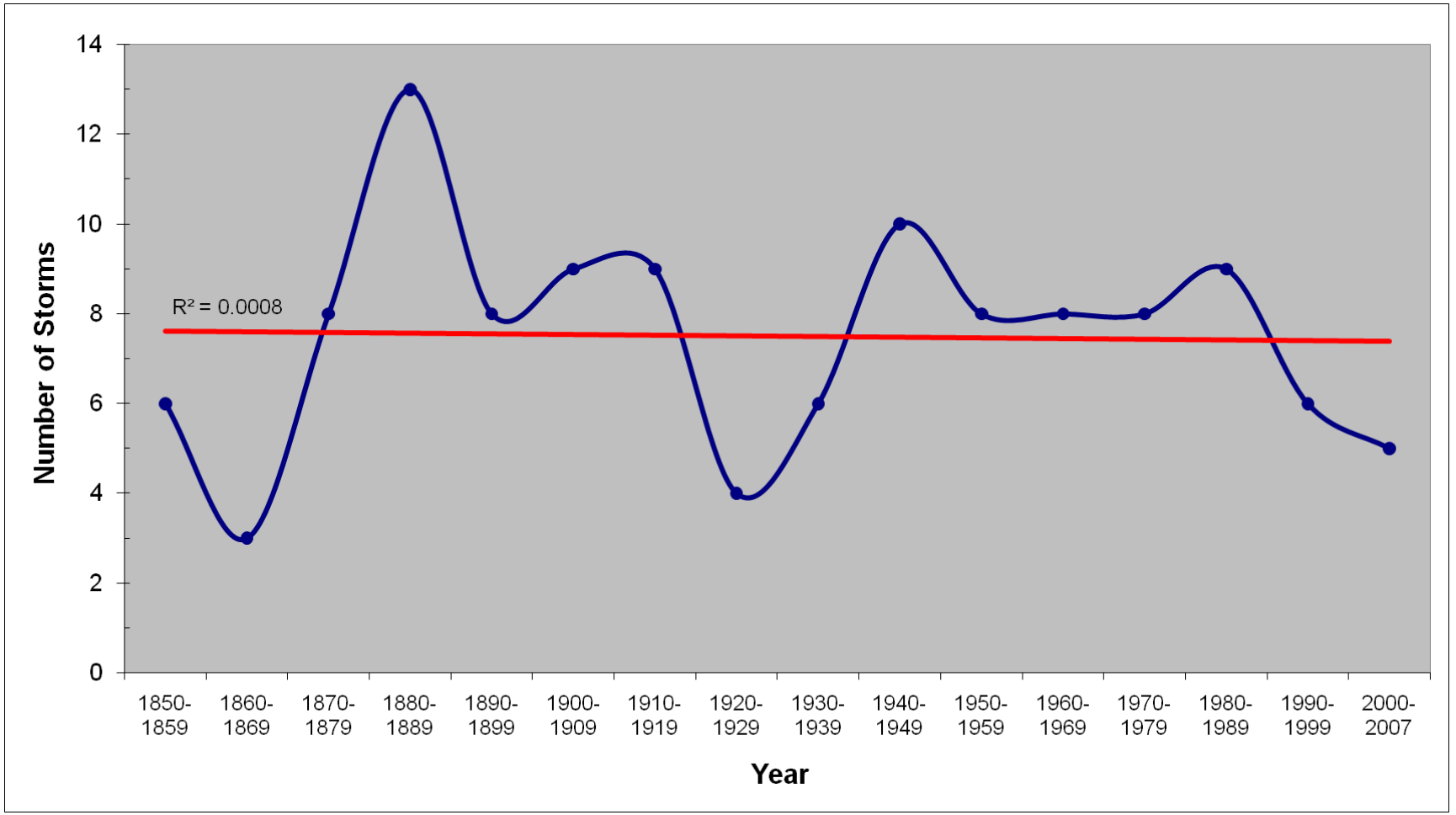

Figure 44. Total number of all storms per decade (1851 – 2007) occurring within 100 nautical miles of Fort Sumter National Monument and Charles Pinckney National Historic Site.

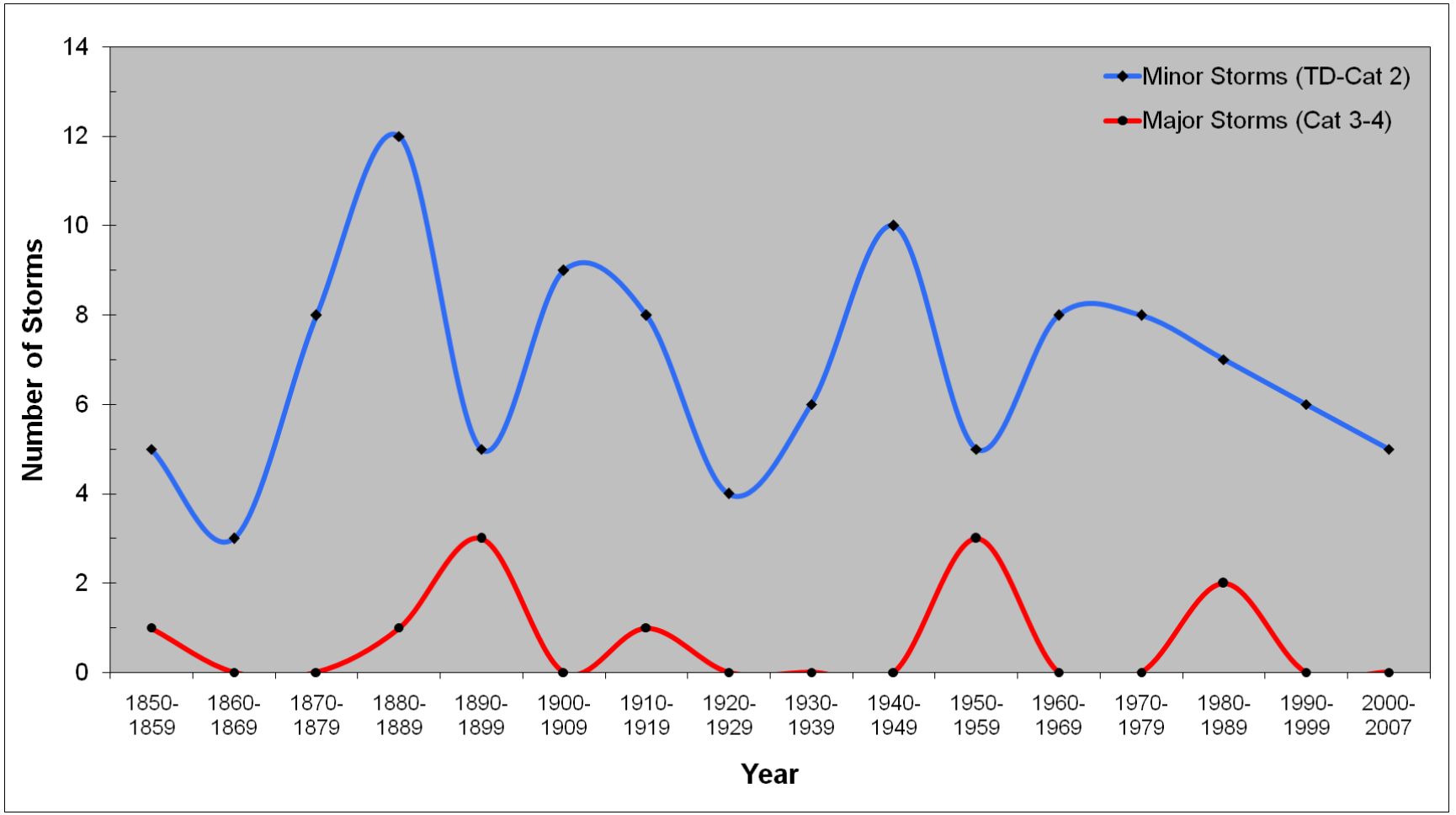

Figure 45. Total number of major and minor storms per decade (1851 – 2007) occurring within 100 nautical miles of Fort Sumter National Monument and Charles Pinckney National Historic Site.

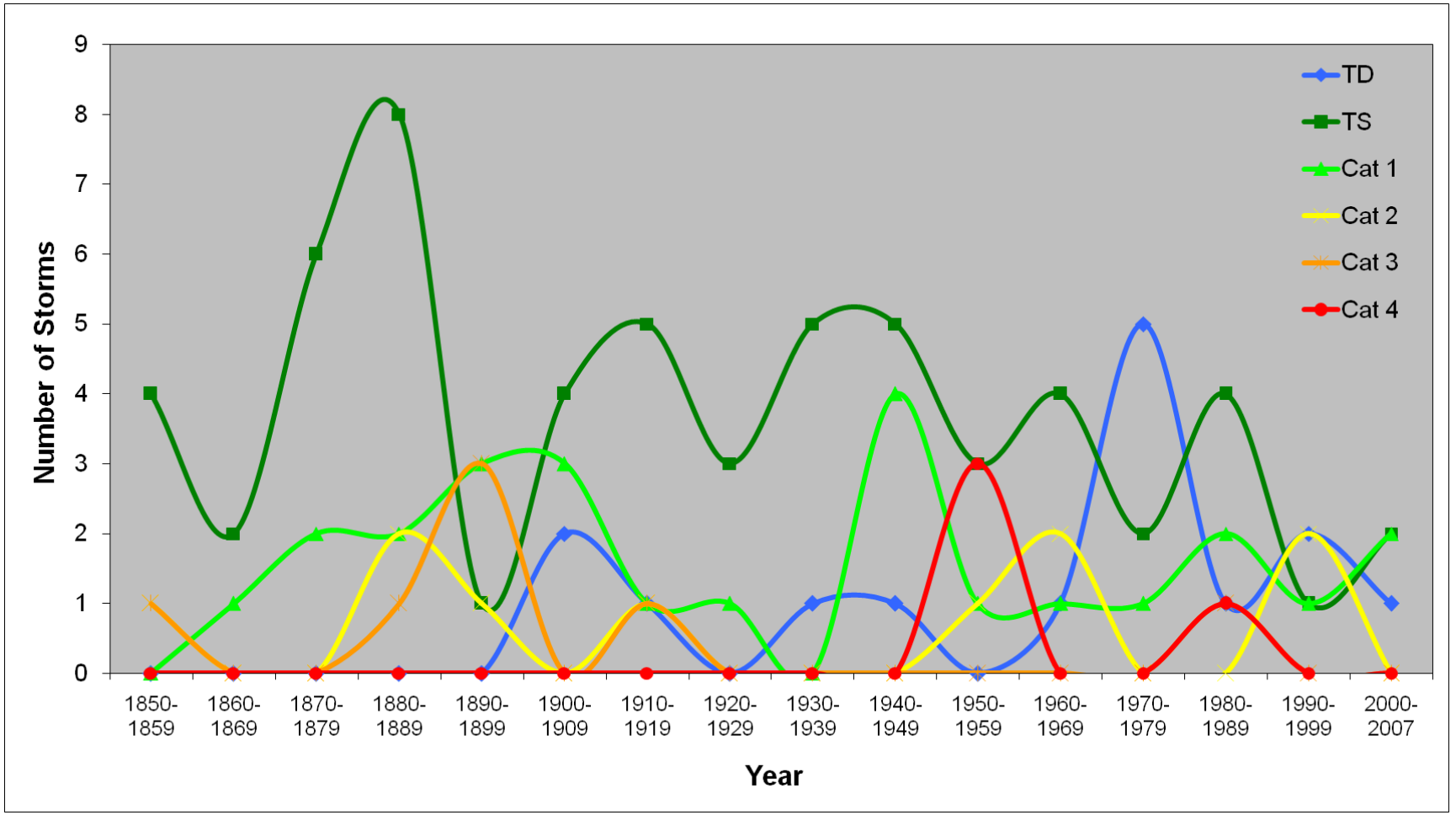

Figure 46. Total number of storms by category per decade (1851 – 2007) occurring within 100 nautical miles of Fort Sumter National Monument and Charles Pinckney National Historic Site. Tropical depressions (TD) have 38 mph sustained wind speeds or less, tropical storms (TS) have 39 to 73 mph wind speeds, and the remaining hurricane categories (1 – 4) are from Saffir/Simpson Hurricane Scale (Table 31).

3.3.2.b Resource threats and stressors:
The threat of changing climate is real, and much research points to the high likelihood of broad ecological impacts as a result. How these changes will impact specific park resources is yet unknown, but they are likely to be comprehensive. That is not to say that those changes will be catastrophic. While specific biota or processes will be impacted, climate change may not result in extinctions or degradations. An important and immediate trend to consider is the increase in likelihood of drier summer periods and the impact this may have on the various natural communities at Fort Sumter NM and Charles Pinckney NHS.

3.3.2.c Critical knowledge or data gaps:
Data quality is relatively good for the climate categories. We gave spatial a zero because these data were not collected at Fort Sumter NM and Charles Pinckney NHS, but it could be argued that these should receive a one (Table 32). All the data used for climate were taken from long-term datasets for Charleston, South Carolina. It is unlikely that the climate at Fort Sumter NM and Charles Pinckney NHS varies much from this data but without even the most basic climate variable information taken on-site this remains a critical assumption. Since climate is the product of long-term weather variables, simply initiating weather data collection now will not yield useful information for some time unless it is used to calibrate the dataset available for Charleston.

It would be advisable for the parks to maintain basic phenological information. This could be used along with data gathered throughout the region to quantify the changing phenology over a reasonably short time frame. The parks can easily identify specific events (e.g., the appearance of the first bloom) that should be monitored and recorded annually as part of other ongoing activities.

Assigning condition status was a bit of a challenge for this assessment category. Although we have tracked and displayed these data in a thorough manner, there are little historical or experimental outcomes to which these climatic and extreme weather events can be compared (Table 32).

3.3.2.d Condition status summary:
Temperature is in the good range for Fort Sumter NM and Charles Pinckney NHS because temperatures are fairly constant and increasing at a relatively negligible rate (Table 32). The condition status was fair for precipitation due to a negative trend (Table 32). Moisture's condition status was fair because an increase in the proportion of months classified as "abnormally dry" or "excessively dry" since 1975 (Table 32). Phenology is in the fair range due to the observed increase in the number of growing degree days that may indicate an increase in the growing season through time (Table 32). Extreme weather events received a fair condition status because despite storm activity being on a relative decline, there was an increasing trend in Tropical Depressions and Cat 1 hurricanes, and activity may peak within the next 10 to 20 years. Minor storms may peak as early at 2010 (Table 32).

Table 32. Climate condition status summary for Fort Sumter National Monument and Charles Pinckney National Historic Site. Data quality was rated based on *thematic* (1 = best source; 0 = not the best source), s*patial* (1 = inside park boundary; 0 = outside park boundary), and *temporal* (1 = recent; 0 = older than 5 years). The colors green, yellow, and red refer to good, fair, and poor scores respectively (see Table 1).

Category	***Condition Status***	***Midpoint***	***Data Quality***		
			Thematic	*Spatial*	*Temporal*
Temperature			1	0	1
	Good	0.84	2 out of 3		
Precipitation			1	0	1
	Fair	0.5	2 out of 3		
Moisture			1	0	1
	Fair	0.5	2 out of 3		
Phenology (GDD)			1	0	1
	Fair	0.5	2 out of 3		
Extreme weather events			1	1	1
	Fair	0.5	3 out of 3		
Climate total			5	1	5
	Fair	0.57	11 out of 15		

3.3.2.e Recommendations to park managers:
Simple measures to monitor the climate changes at Fort Sumter NM and Charles Pinckney NHS should be considered. This does not require a comprehensive or expensive program, but simply a dedicated effort to raise awareness of the changes on the park as they occur. We recommend:

- Attention to the summer season temperature and precipitation to anticipate the threat of marsh stress and the potential for it contributing to salt marsh dieback.

- Participation in national and regional investigations into phenological changes. The US National Phenology Network (http://www.usanpn.org/) provides information and protocol for low-cost programs.

3.4 Water

3.4.1 Hydrology

Hydrologic issues at Fort Sumter NM are wide and varied. Charles Pinckney NHS has minimal hydrologic issues, but there are some wetlands to examine more closely. At Fort Sumter NM, the unique interaction of coastal water processes in conjunction with the Charleston Harbor and arrangement of wetlands make for a complicated array of hydrologic function. We examined both parks first within the context of the wetlands through a National Wetlands Inventory assessment protocol (Tiner 2003a). In addition, there are several local hydrologic issues that are important to the parks. Fort Sumter NM is concerned with Charleston Harbor dredging and spoil disposal, shoreline change, erosion, and impacts of rising sea-levels (Kana et al. 1984, National Park Service 1998).

3.4.1.a Current condition:
There are 156 acres of wetlands at Fort Sumter NM and 3 acres of wetlands at Charles Pinckney NHS according to the U.S. Fish and Wildlife Service, National Wetlands Inventory (NWI). NWI designed a straightforward way of assessing watershed function in a spatial context using available NWI classifications. The newer wetland landscape position, landform, water flow path, and waterbody type descriptors (LLWW) (Tiner 2003b) are also needed to perform this correlation. There are ten functions that NWI has designed to evaluate wetlands. These are: 1) surface water detention, 2) coastal storm surge detention, 3) streamflow maintenance, 4) nutrient transformation, 5) sediment and other particulate retention, 6) shoreline stabilization, 7) provision of fish and shellfish habitat, 8) provision of waterfowl and waterbird habitat, 9) provision of other wildlife habitat, and 10) conservation of biodiversity.

The criteria that were developed by Tiner (2003a) have been reviewed by wetland specialists working in Maryland, Delaware, New York, and Maine. These criteria may need to be modified slightly for South Carolina, but we work under the assumption that these functional analyses will operate similarly for the Southeastern U.S. The first 6 functions are covered in this hydrology section.

Surface Water Detention:
Virtually all of Fort Sumter NM wetlands and 36% of Charles Pinckney NHS wetlands are highly rated for surface water detention (Table 33, Figure 47). These wetland types have been shown to provide flood storage and reduce downstream floods and flood heights (Tiner 2003a).

Table 33. Surface water detention correlation to National Wetland Inventory classification within Fort Sumter National Monument and Charles Pinckney National Historic Site.

NWI Correlation	*FOSU Acres*	*% of FOSU Wetlands*	*CHPI Acres*	*% of CHPI Wetlands*
High	155.03	99.61	1.0	36.19
Moderate	0.61	0.39	1.8	63.81
	155.64	100.00	2.8	100.00

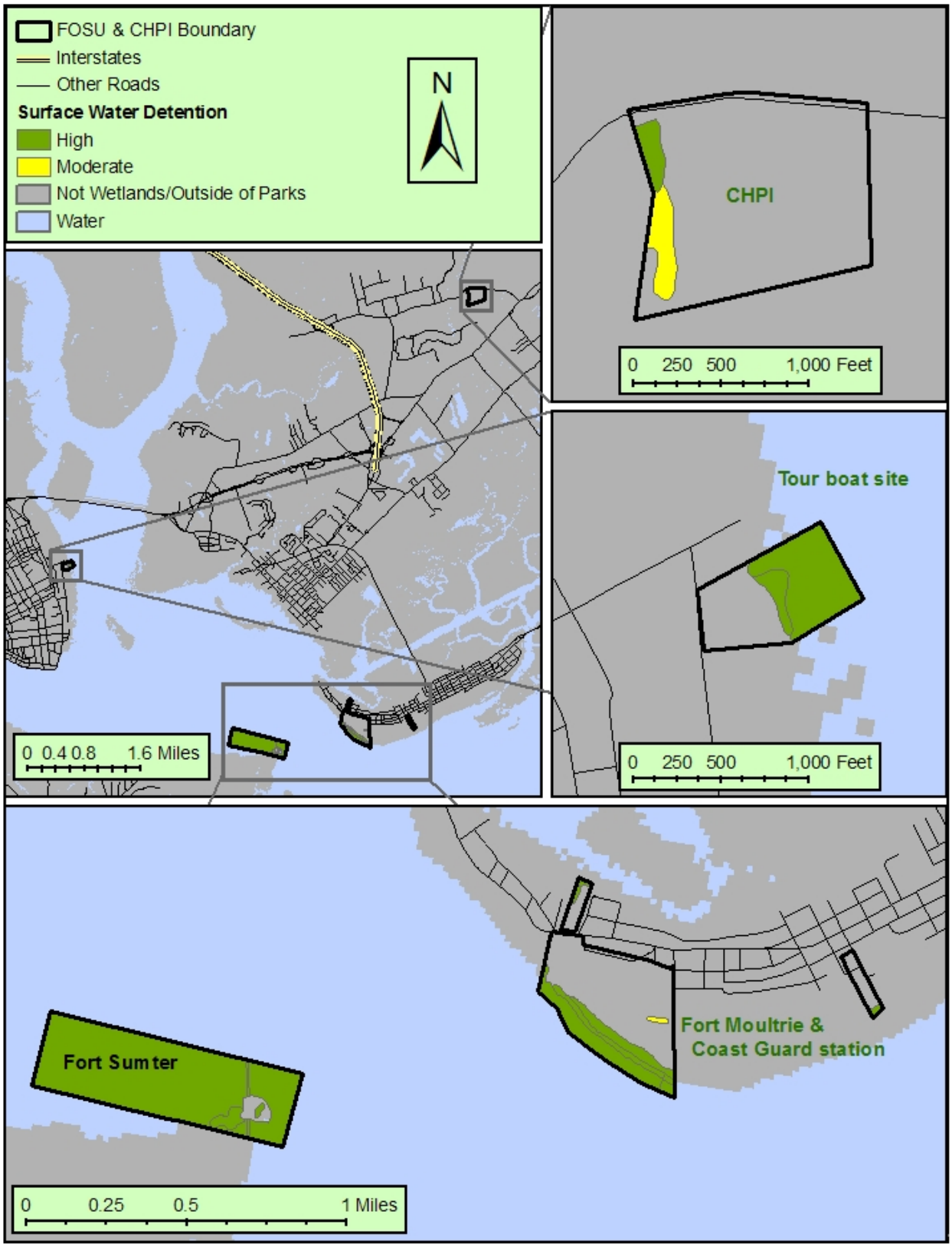

Figure 47. Surface water detention correlation to National Wetland Inventory classification within Fort Sumter National Monument and Charles Pinckney National Historic Site.

Coastal Storm Surge Detention:
Table 34 and Figure 48 illustrate that only 12% of Fort Sumter NM wetlands and 36% of Charles Pinckney NHS wetlands are capable of offering high levels of coastal storm surge detention. These are wetlands that will function as temporary water storage under the pressure of large storms such as hurricanes and tropical storms (Tiner 2003a).

Table 34. Coastal storm surge detention correlation to National Wetland Inventory classification within Fort Sumter National Monument and Charles Pinckney National Historic Site.

NWI Correlation	*FOSU Acres*	*% of FOSU Wetlands*	*CHPI Acres*	*% of CHPI Wetlands*
High	18.0	11.56	1.0	36.19
Not Correlated/Poor	137.6	88.44	1.8	63.81
	155.6	100.00	2.8	100.00

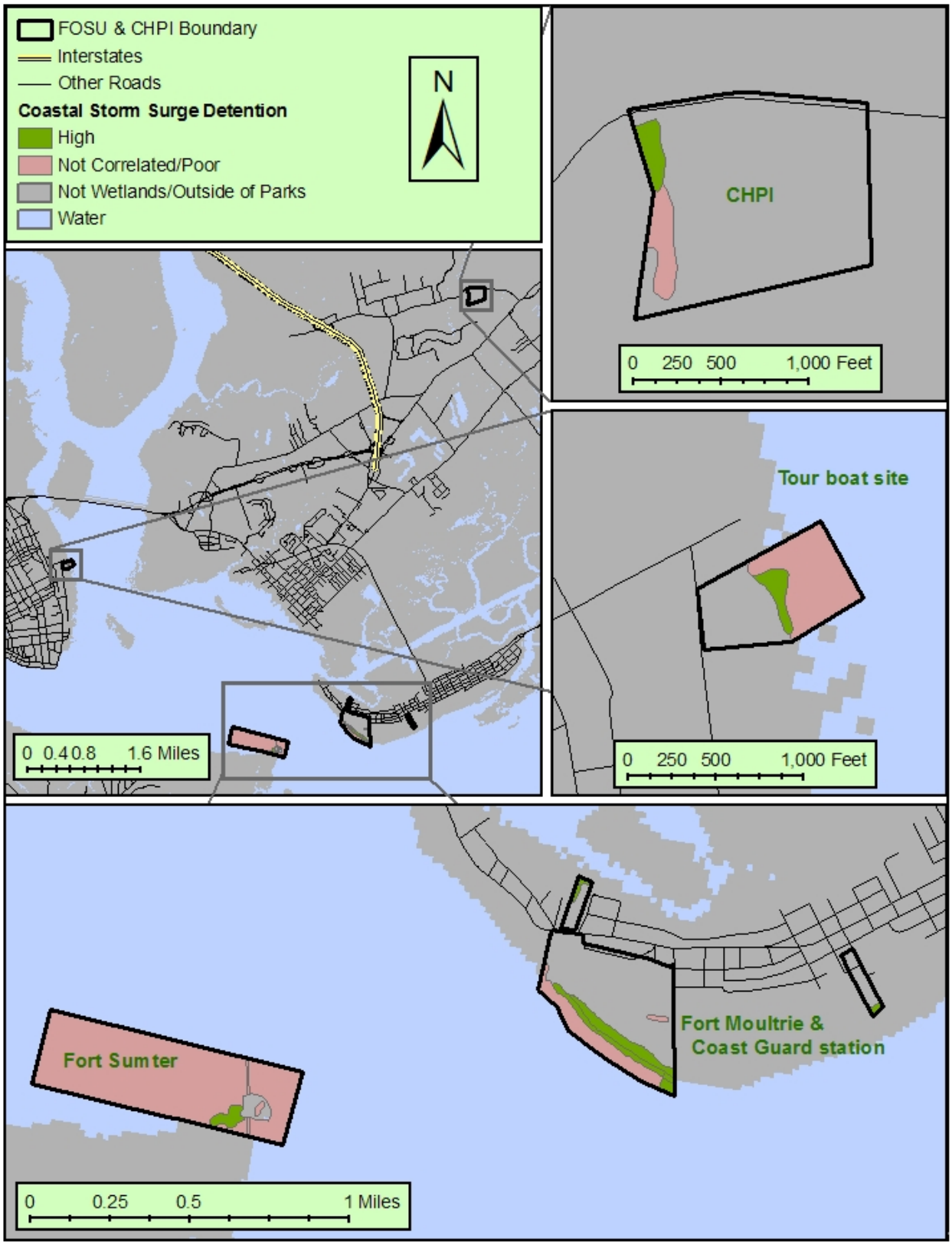

Figure 48. Coastal storm surge detention correlation to National Wetland Inventory classification within Fort Sumter National Monument and Charles Pinckney National Historic Site.

Streamflow Maintenance:
The location of Fort Sumter NM and Charles Pinckney NHS, on the coast, precludes them from offering much in the way of streamflow maintenance (Table 35, Figure 49). Headwater wetlands, far upstream from the parks operate to increase streamflow (Tiner 2003a).

Table 35. Streamflow maintenance correlation to National Wetland Inventory classification within Fort Sumter National Monument and Charles Pinckney National Historic Site.

NWI Correlation	*FOSU Acres*	*% of FOSU Wetlands*	*CHPI Acres*	*% of CHPI Wetlands*
Not Correlated /Poor	155.6	100.00	2.8	100.00
	155.6	100.00	2.8	100.00

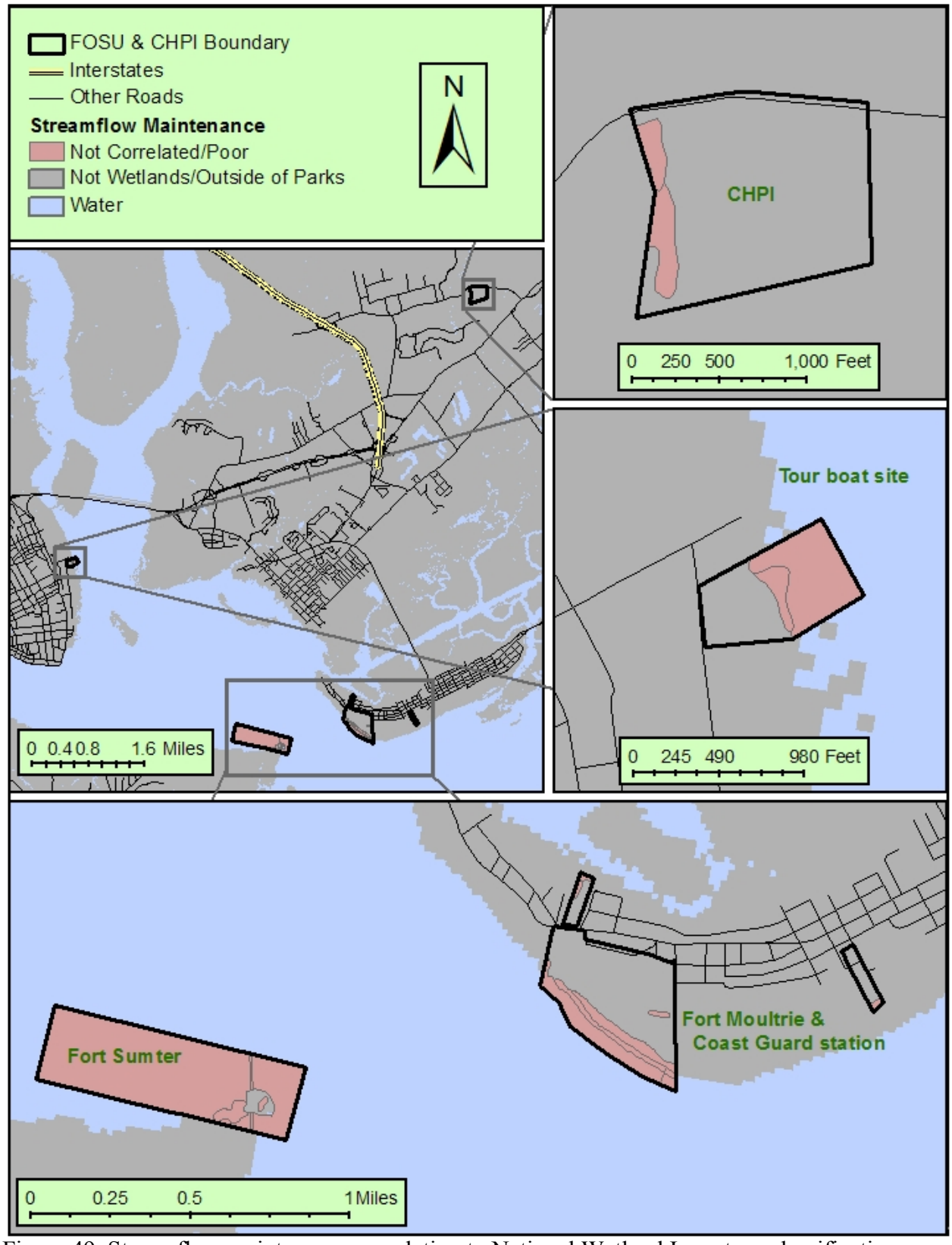

Figure 49. Streamflow maintenance correlation to National Wetland Inventory classification within Fort Sumter National Monument and Charles Pinckney National Historic Site.

Nutrient Transformation:
Nutrient transformation occurs most readily in permanently flooded wetlands whereas temporarily flooded wetlands have only moderate potential (Tiner 2003a). Eleven percent of the wetlands at Fort Sumter NM and 100% of wetlands at Charles Pinckney NHS are highly correlated to this function (Table 36, Figure 50). Irregularly exposed wetlands and subtidal rivers/streams do not offer much in the way of nutrient transformation because they are continuously saturated and anaerobic.

Table 36. Nutrient transformation correlation to National Wetland Inventory classification within Fort Sumter National Monument and Charles Pinckney National Historic Site.

NWI Correlation	*FOSU Acres*	*% of FOSU Wetlands*	*CHPI Acres*	*% of CHPI Wetlands*
High	17.5	11.25	2.8	100.00
Not Correlated /Poor	138.1	88.75	0.0	0.00
	155.6	100.00	2.8	100.00

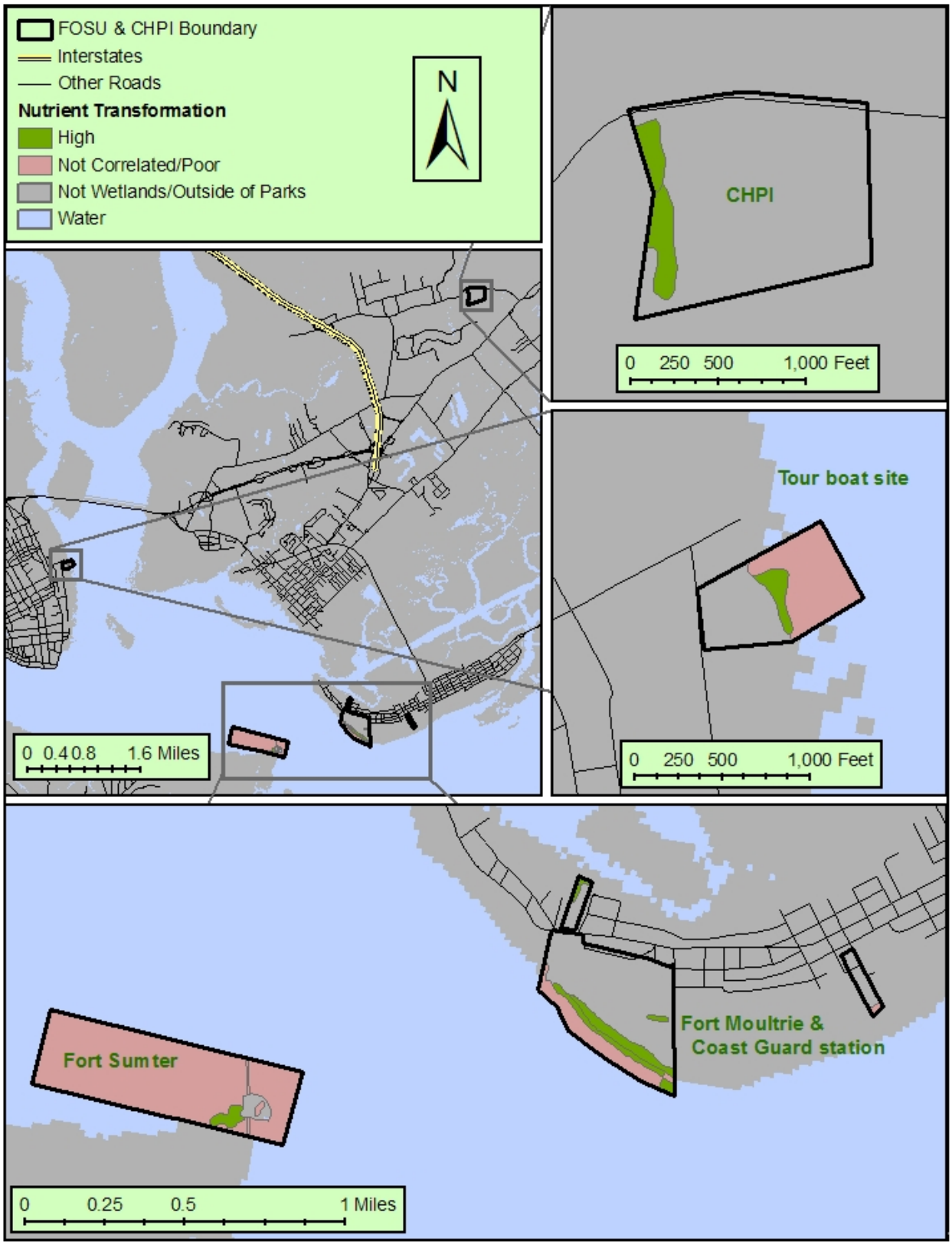

Figure 50. Nutrient transformation correlation to National Wetland Inventory classification within Fort Sumter National Monument and Charles Pinckney National Historic Site.

Sediment and Other Particulate Retention:
There is a low correlation of wetlands at Fort Sumter NM (10%) with the retention of sediments and other particulates. Conversely, all of the wetlands at Charles Pinckney NHS are highly or moderately correlated with the retention of sediments and other particulates (Table 37, Figure 51). Water quality is supported through this wetland function (Tiner 2003a). Maintenance of healthy native vegetation is an important way to insure that sediment and particulate retention is maximized.

Table 37. Sediment and other particulate retention correlation to National Wetland Inventory classification within Fort Sumter National Monument and Charles Pinckney National Historic Site.

NWI Correlation	*FOSU Acres*	*% of FOSU Wetlands*	*CHPI Acres*	*% of CHPI Wetlands*
High	15.8	10.12	1.0	36.19
Moderate	2.9	1.83	1.8	63.81
Not Correlated /Poor	137.0	88.04	0.0	0.00
	155.6	100.00	2.8	100.00

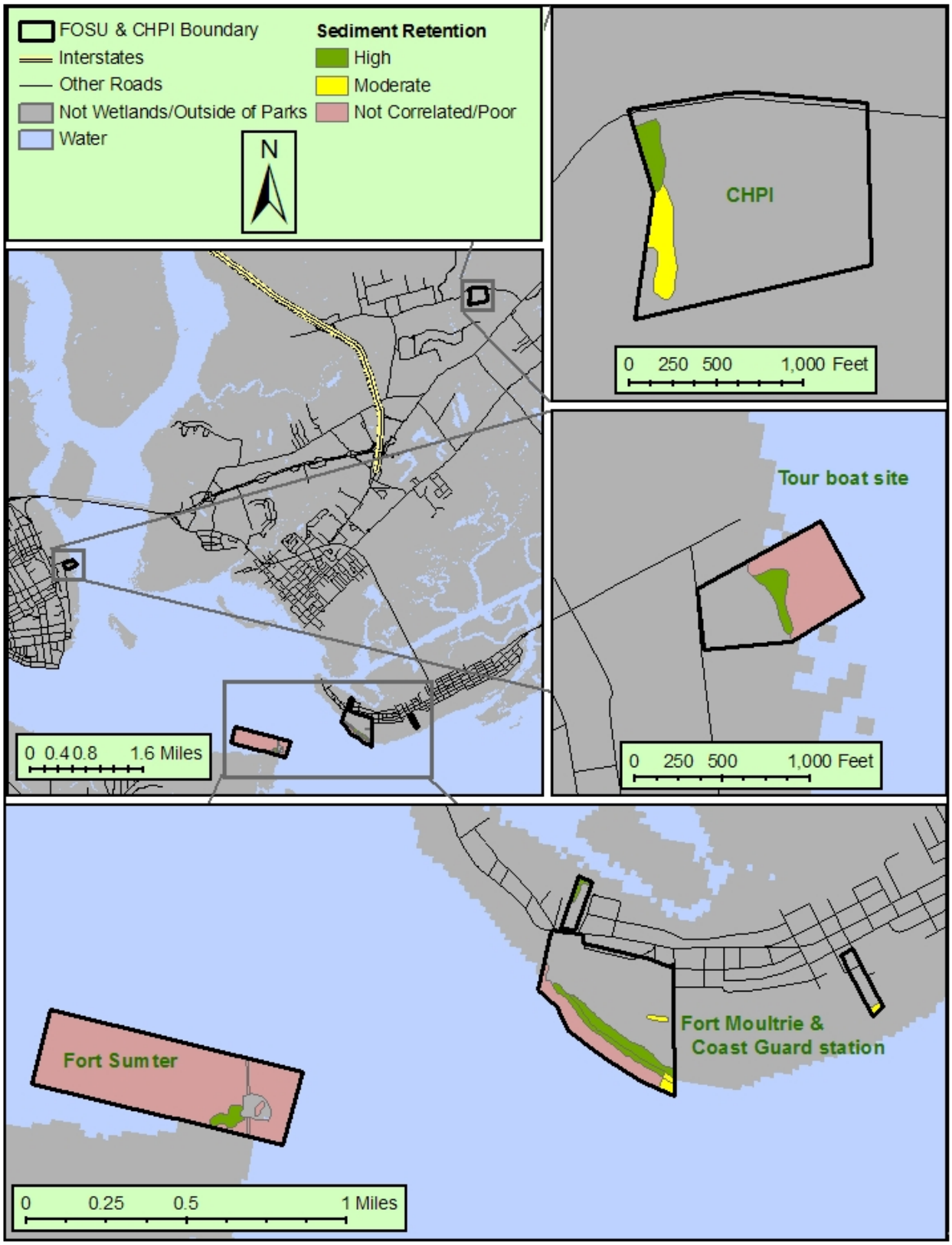

Figure 51. Sediment and other particulate retention correlation to National Wetland Inventory classification within Fort Sumter NM and Charles Pinckney National Historic Site.

Shoreline Stabilization:
Shoreline stabilization is an important function for Fort Sumter NM. Erosion, flooding, loss of wetlands, saltwater intrusion, and higher water tables are of greater concern as sea levels are projected to rise (National Park Service 1998).

NWI correlations (Tiner 2003a) show a low level of shoreline stabilization functionality within all of the wetlands of Fort Sumter NM. Shoreline stabilization functionality at Charles Pinckney NHS is only somewhat higher (Table 38, Figure 44).

Table 38. Shoreline stabilization correlation to National Wetland Inventory classification within Fort Sumter National Monument and Charles Pinckney National Historic Site.

NWI Correlation	*FOSU Acres*	*% of FOSU Wetlands*	*CHPI Acres*	*% of CHPI Wetlands*
High	15.8	10.12	1.0	36.19
Not Correlated /Poor	139.9	89.88	1.8	63.81
	155.6	100.00	2.8	100.00

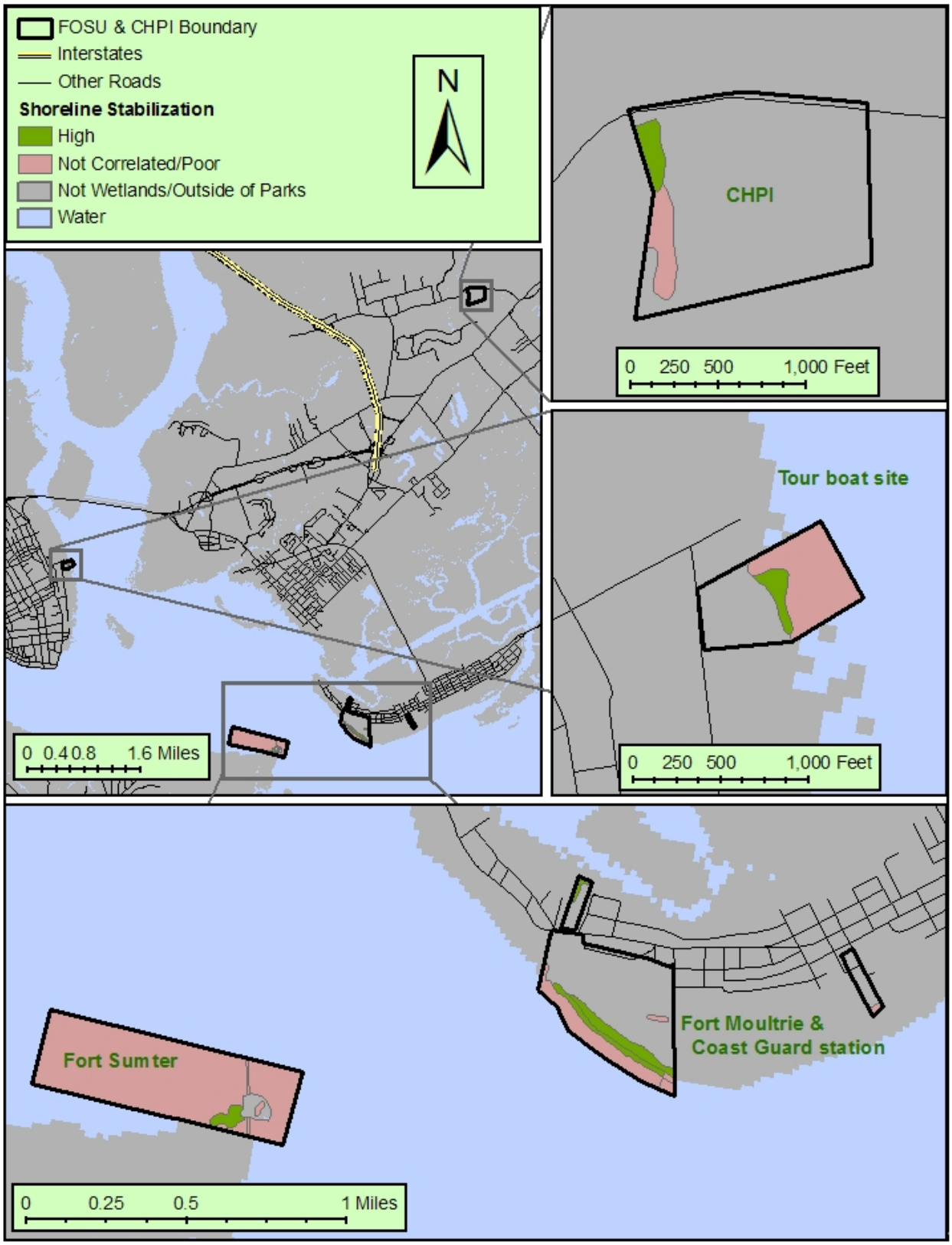

Figure 44. Shoreline stabilization correlation to National Wetland Inventory classification within Fort Sumter National Monument and Charles Pinckney National Historic Site.

3.4.1.b Resource threats and stressors:
Sea level rise and flooding are a real concern at Fort Sumter NM (Kana et al. 1984). A recent study (Craft et al. 2009) showed that salt marshes on the Georgia coast may decline in area by 20 to 40% due to predicted sea level rise in this century. Craft et al. (2009) also predicted that under a mean scenario, tidal freshwater marshes will increase by 2% and under a maximum scenario they will decline by 39%. The mean scenario assumes a 52-cm (1.7-foot) increase in sea level, resulting in an overall, 184 km^2 loss of Georgia tidal marsh.

We examined the effect of a 2-foot and 4-foot storm surge or sea-level rise on the land area of Fort Sumter NM and Charles Pinckney NHS (Figure 52 – Figure 54). In a 2-foot surge, the area of water associated with Fort Sumter showed no change, remaining constant at 157 acres, or 68% of Fort Sumter NM total area. In a 4-foot surge, the area of water at Fort Sumter NM increased to 169 acres, leaving approximately 73% of Fort Sumter NM under water. Charles Pinckney NHS proved to be unaffected in both storm surge models, with 100% of its 33 total acres remaining above water. The Federal Emergency Management Agency (2008) also shows Fort Sumter NM an part of Charles Pinckney NHS as special flood hazard areas (Figure 55).

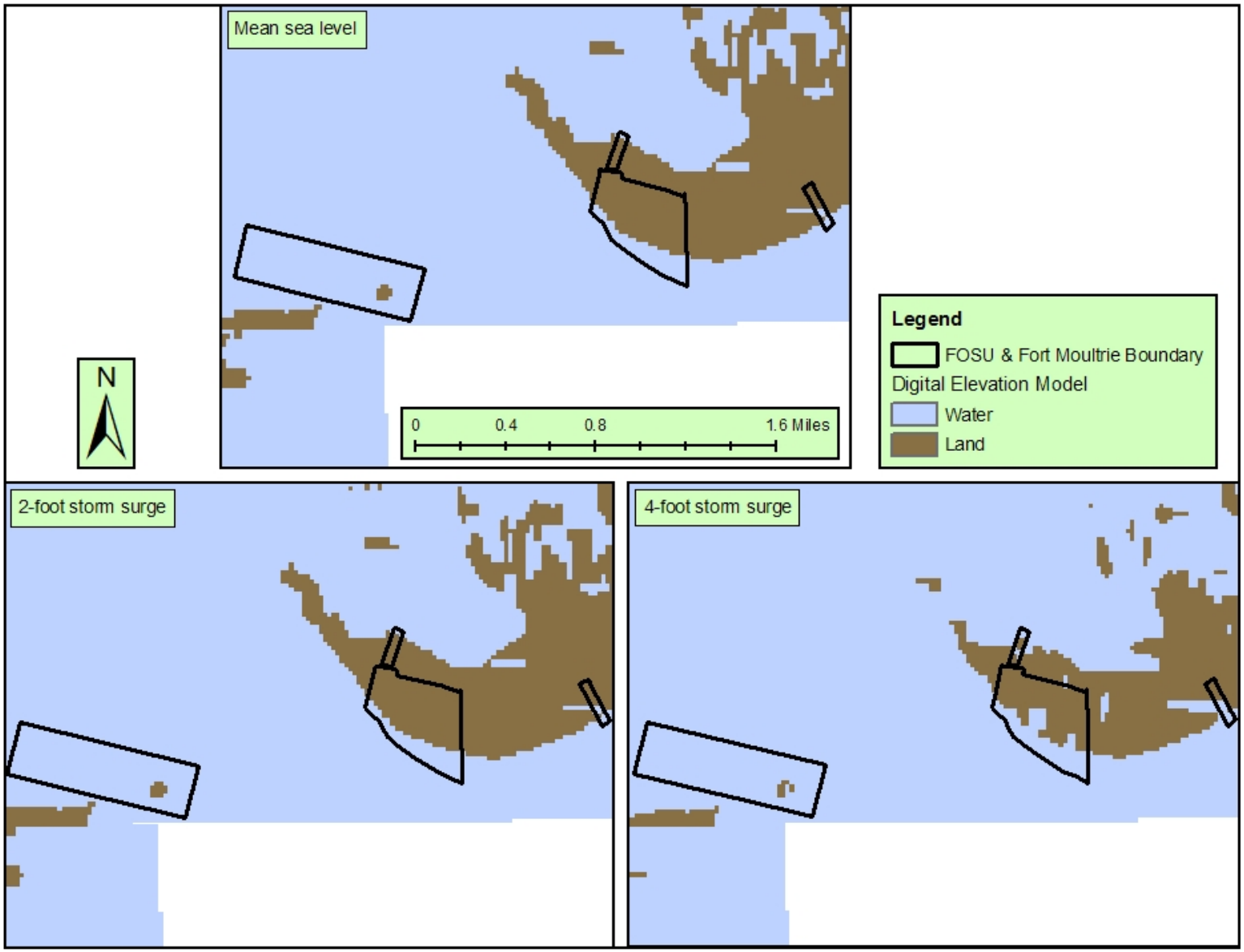

Figure 52. Digital elevation model (DEM) of Fort Sumter NM, Fort Moultrie, and the Coast Guard station showing mean sea level, and approximate two foot, and four foot storm surge.

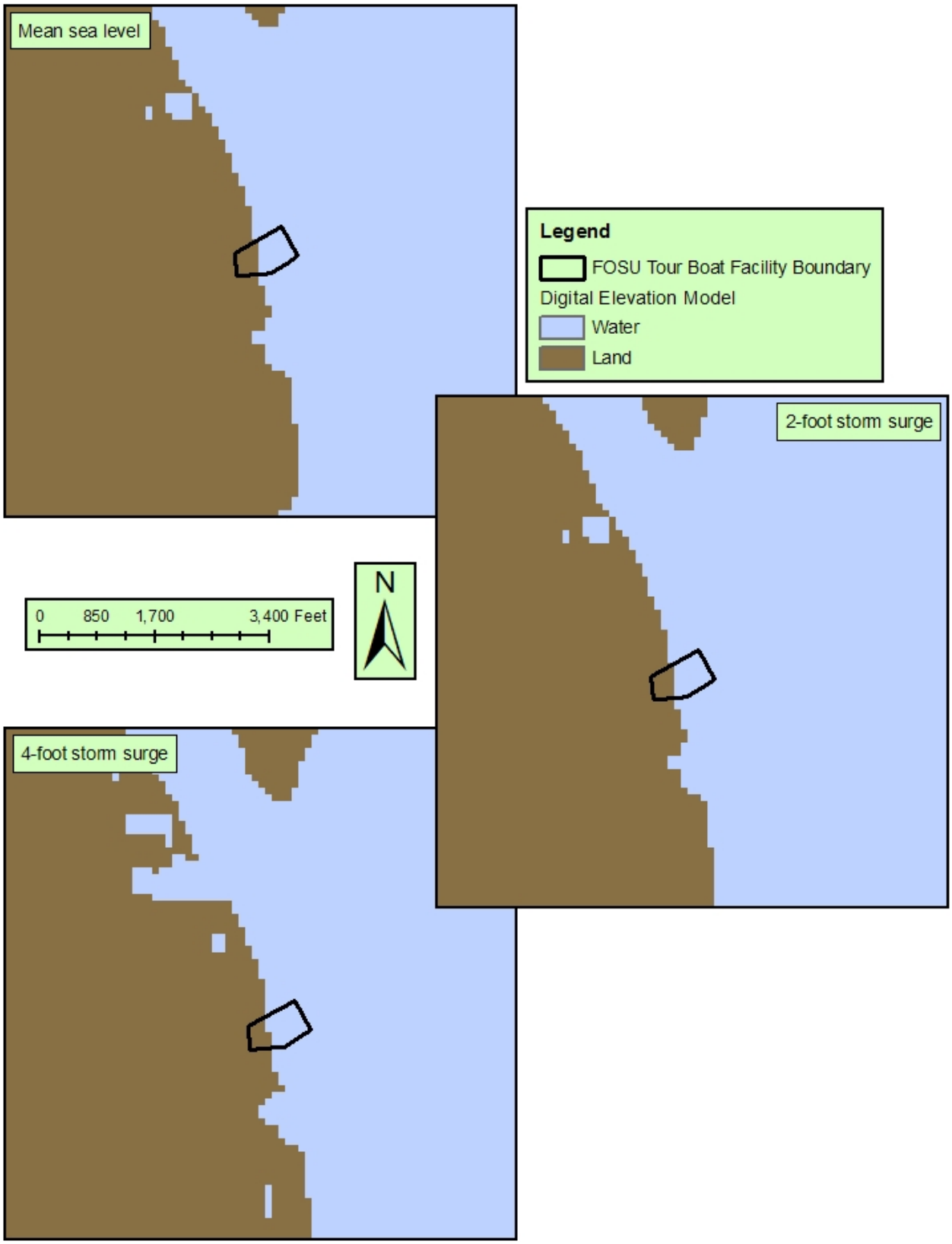

Figure 53. Digital elevation model (DEM) of the Fort Sumter NM tour boat site showing mean sea level, and approximate two foot, and four foot storm surge.

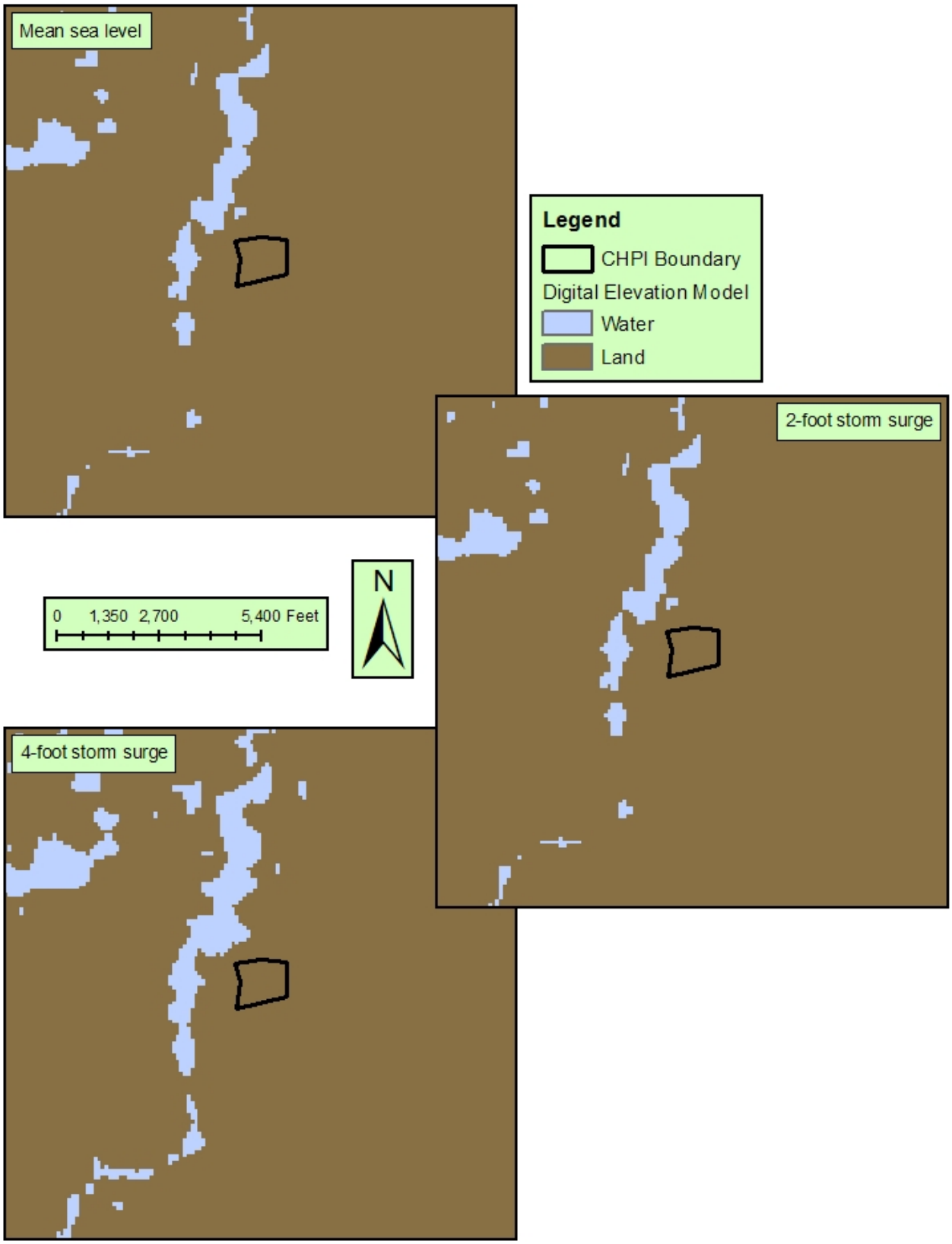

Figure 54. Digital elevation model (DEM) of the Charles Pinckney NHS region showing mean sea level, and approximate two foot, and four foot storm surge.

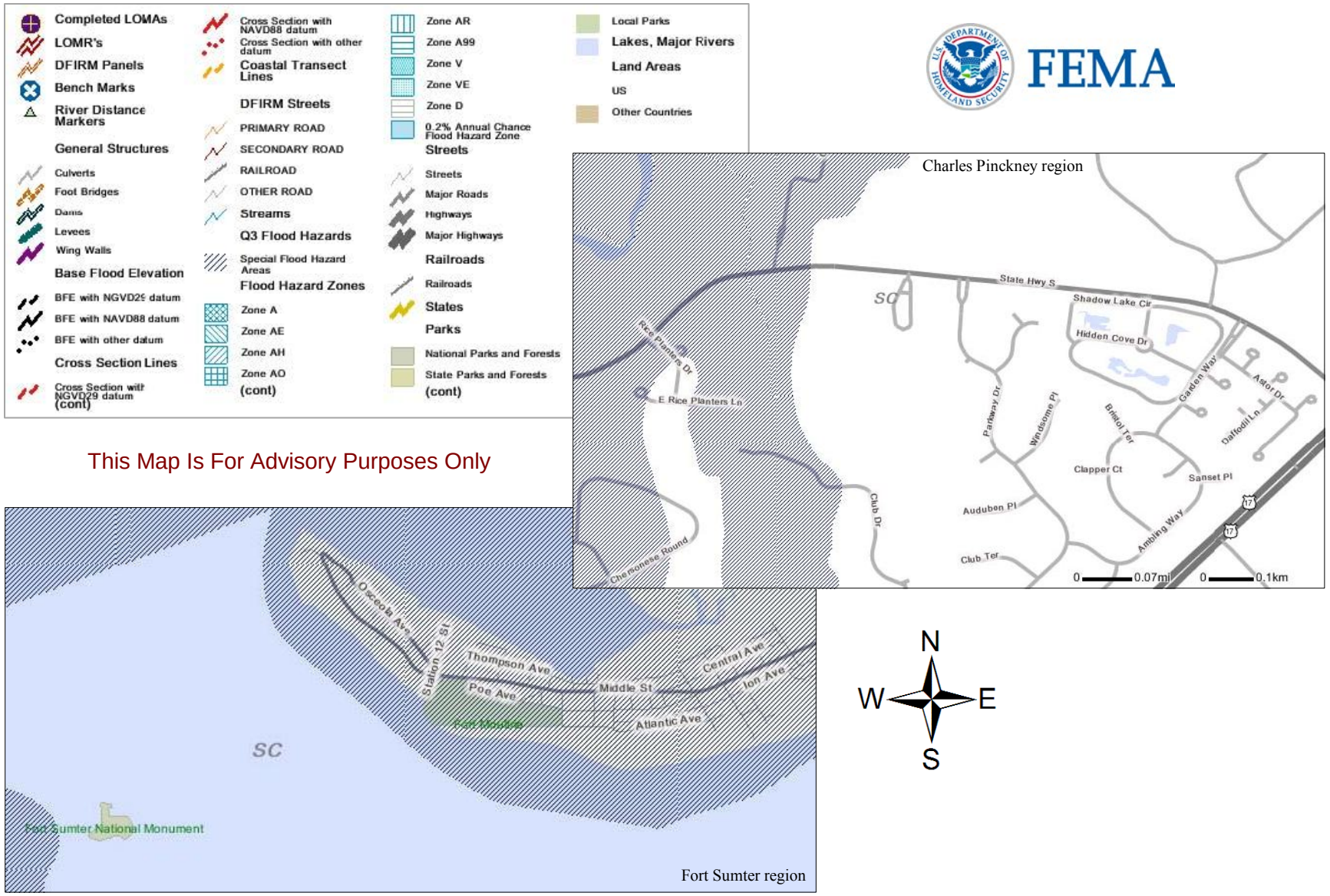

Figure 55. Federal Emergency Management Agency (FEMA, 2008) flood maps for the Fort Sumter NM and Charles Pinckney NHS regions, showing all areas are under flood hazard.

3.4.1.c Critical knowledge or data gaps:
Data quality is relatively good for this assessment category (Table 39, Table 40). Local-scale wetland and hydrology analysis, specific to Fort Sumter NM and Charles Pinckney NHS, would add detail to this assessment. When spatial scale was questionable, we gave thematic a zero for data quality. Table 39 and Table 40 show the summaries of condition status and data quality.

3.4.1.d Condition status summary
Surface water detention is the only wetland correlation that falls in the good range for Fort Sumter NM (Table 39). The remainder are poor or not correlated. It could be argued that more of these correlations could be considered not applicable. However, it is important to note their poor or no correlation status even if they are not used in the overall condition status summary. Nutrient transformation is in the good range for Charles Pinckney NHS. Surface water detention, coastal storm surge detention, sediment and other particulate retention, and shoreline stabilization are all in the fair range because there was either a combination of high and poor or moderate and poor correlations for Charles Pinckney NHS wetlands (Table 40). In addition, the parks' wetlands do not offer much in the way of streamflow maintenance because of their coastal location. Headwater wetlands, far upstream from the Fort Sumter NM and Charles Pinckney NHS operate to increase streamflow so this category is not applicable (Table 39, Table 40).

Table 39. Hydrology condition status summary for Fort Sumter National Monument. Data quality was rated based on *thematic* (1 = best source; 0 = not the best source), s*patial* (1 = inside park boundary; 0 = outside park boundary), and *temporal* (1 = recent; 0 = older than 5 years). The colors green, yellow, and red refer to good, fair, and poor scores respectively (see Table 1).

Category	***Condition Status***	***Midpoint***	***Data Quality***		
			Thematic	*Spatial*	*Temporal*
Surface water detention			0	1	1
	Good	0.84	2 out of 3		
Coastal storm surge detention			0	1	1
	Poor	0.17	2 out of 3		
Streamflow maintenance			0	1	1
	N/A	--	2 out of 3		
Nutrient transformation			0	1	1
	Poor	0.17	2 out of 3		
Sediment and other particulate retention			0	1	1
	Poor	0.17	2 out of 3		
Shoreline stabilization			0	1	1
	Poor	0.17	2 out of 3		
Hydrology total			0	6	6
	Poor	0.30	12 out of 18		

Table 40. Hydrology condition status summary for Charles Pinckney National Historic Site. Data quality was rated based on *thematic* (1 = best source; 0 = not the best source), s*patial* (1 = inside park boundary; 0 = outside park boundary), and *temporal* (1 = recent; 0 = older than 5 years). The colors green, yellow, and red refer to good, fair, and poor scores respectively (see Table 1).

Category	***Condition Status***	***Midpoint***	***Data Quality***		
			Thematic	*Spatial*	*Temporal*
Surface water detention			0	1	1
	Fair	0.5		2 out of 3	
Coastal storm surge detention			0	1	1
	Fair	0.5		2 out of 3	
Streamflow maintenance			0	1	1
	N/A	--		2 out of 3	
Nutrient transformation			0	1	1
	Good	0.84		2 out of 3	
Sediment and other particulate retention			0	1	1
	Fair	0.5		2 out of 3	
Shoreline stabilization			0	1	1
	Fair	0.5		2 out of 3	
Hydrology total			0	6	6
	Fair	0.57		12 out of 18	

3.4.1.e Recommendations to park managers:
We recommend avoiding excavation in the tidal marshes as well as filling and building on the tidal marsh soils. Park managers should be aware of and follow all wetland protection regulations.

3.4.2 Water Quality

Fort Sumter NM and Charles Pinckney NHS are part of South Carolina's Cooper River/Ashley River basin which is broken into two subbasins, the Cooper River subbasin (hydrologic unit code (HUC) 03050201) and the Ashley River subbasin (or South Carolina Coastal, HUC 03050202). The Cooper River subbasin holds Charles Pinckney NHS and Fort Sumter NM falls into the Ashley River subbasin (Figure 56).

The Ashley River (SC Coastal) subbasin spans 895 square miles with 377 stream miles, 4,232 acres of lake cover, and 32,700 acres of estuarine areas (SCDHEC - South Carolina Department of Health and Environmental Control 2005). Fort Sumter is located on an island in the Charleston Harbor and Fort Moultrie, a unit of Fort Sumter NM, is on the opposite side of the harbor on Sullivan's Island (Figure 57).

The Cooper River subbasin is 845 square miles made up of eight different watersheds. There is 587 stream miles, 60,192 acres of lake water, and 13,060 acres of estuarine areas in this subbasin (SCDHEC 2005). Charles Pinckney NHS is located in the coastal plain in the Wando River

watershed (HUC 0305020108) not far from Boone Hall Creek which connects to the Wando River and flows into the Charleston Harbor (Figure 58).

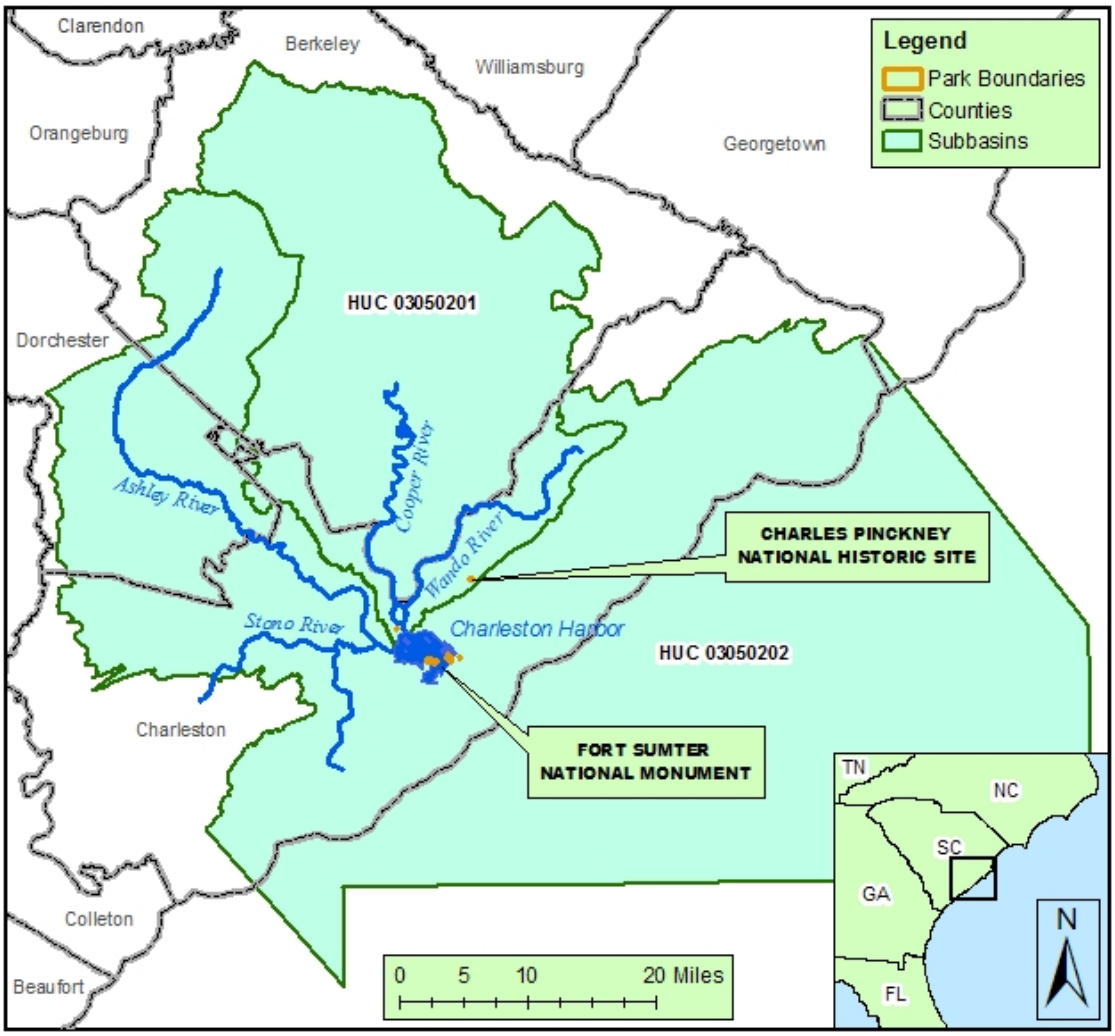

Figure 56. The South Carolina Coastal subbasin (or Ashley River subbasin, HUC 03050202) contains Fort Sumter National Monument and the Cooper River subbasin (HUC 03050201) contains Charles Pinckney National Historic Site.

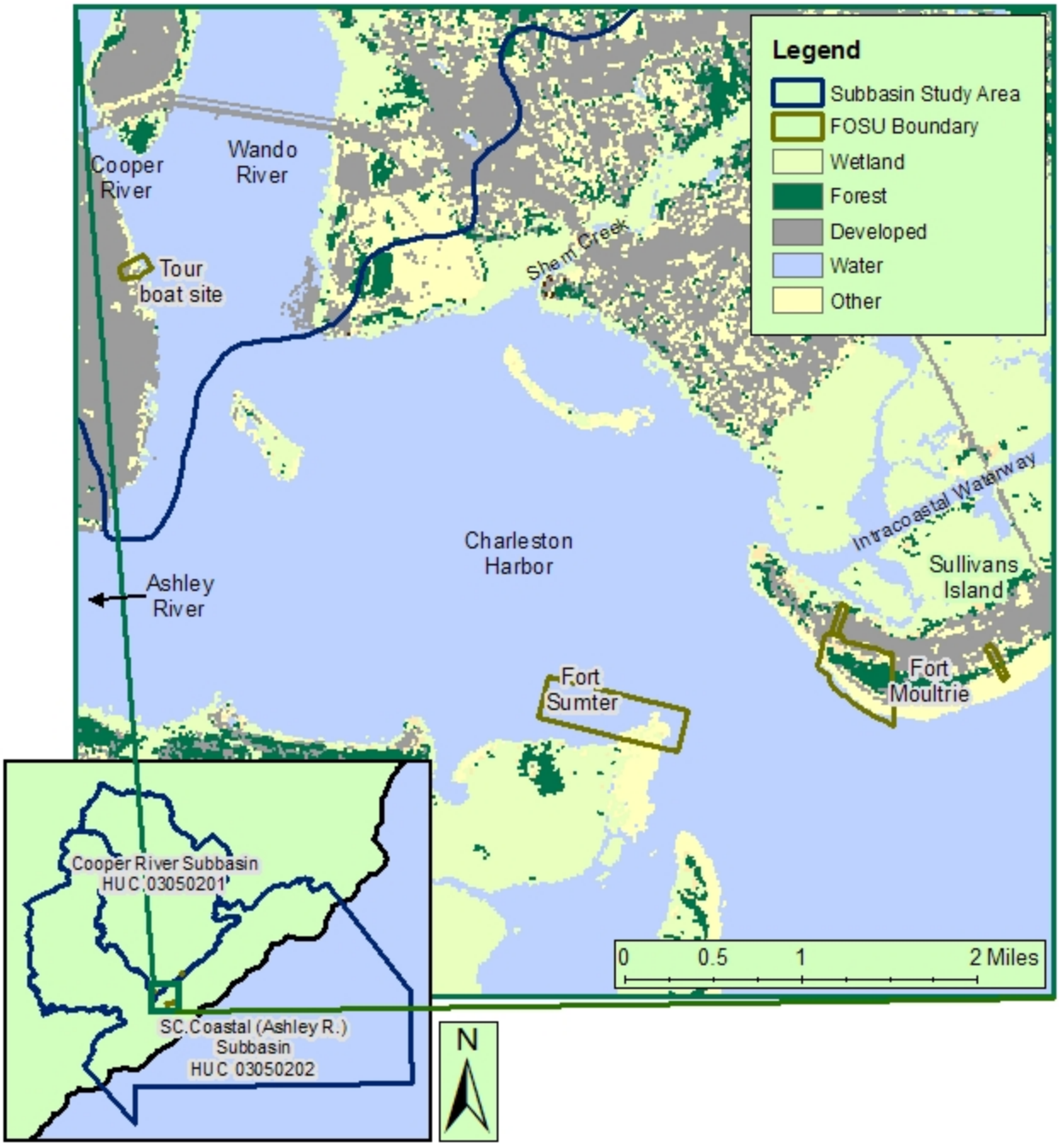

Figure 57. Water resources surrounding Fort Sumter National Monument, in HUC 03050202.

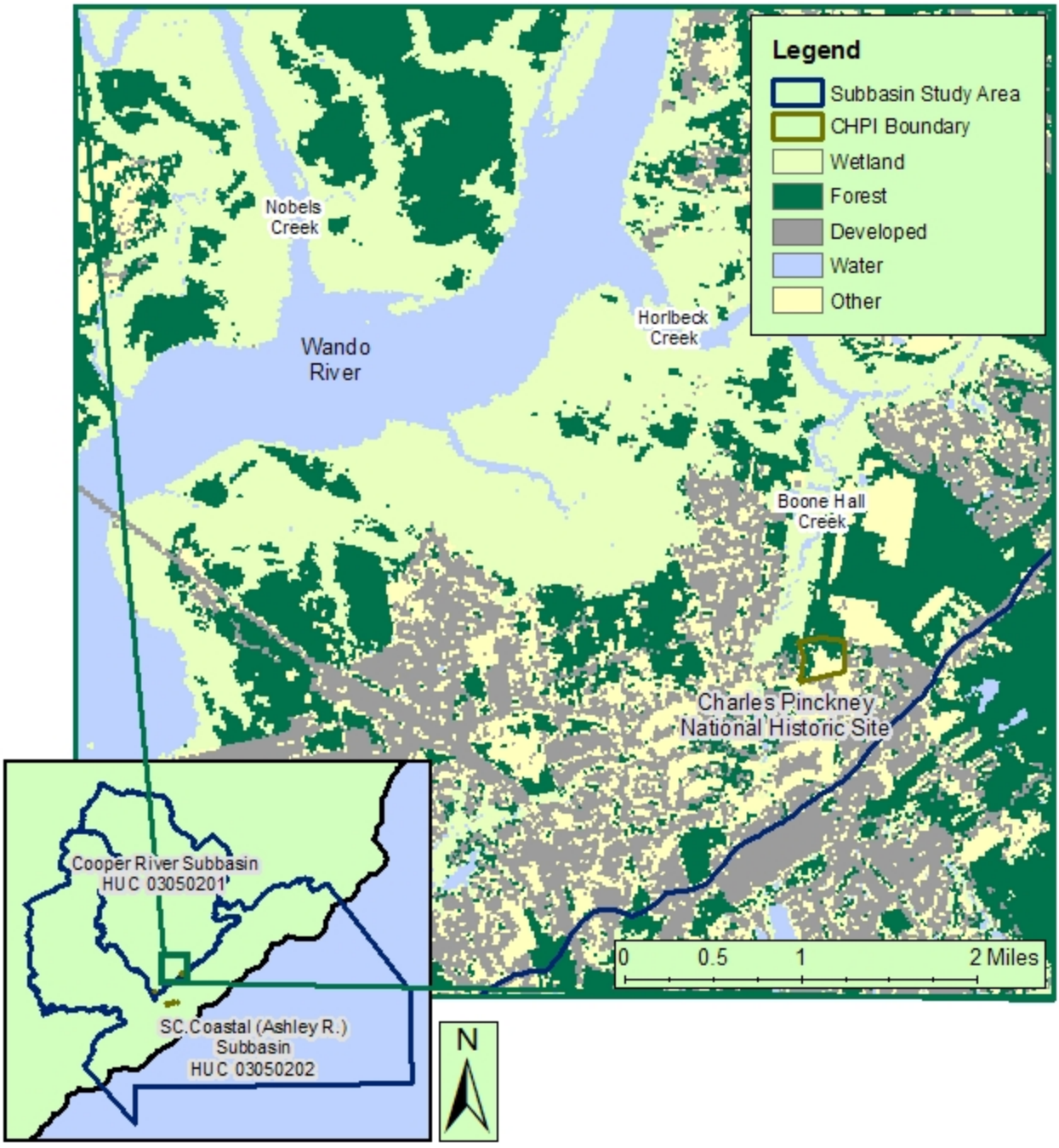

Figure 58. Water resources surrounding Charles Pinckney National Historic Site, in HUC 03050201.

South Carolina Department of Health and Environmental Control (SCDHEC) has established a classification and standards system to establish general rules and specific water quality criteria to protect water resources and the public health and welfare, and maintain and enhance water quality in the State. Table 41 summarizes SCDHEC standards and guidelines for key relevant water quality categories.

Table 41. Water Quality Standards for South Carolina from SCDHEC (2008b) R. 61-68 Water Classification and Standards.

Water Classification	*Dissolved Oxygen*	*Fecal Coliform*	*Nutrients*	*Contaminants*
Trout waters	Not < 6.0mg/L	Not to exceed geometric mean of 200/100mL, based on five consecutive samples during any 30 day period; nor shall more than 10% of the total samples during any 30 day period exceed 400/100mL	No numeric criteria[4]	Specific to the contaminant
Freshwaters	Daily average not <5.0mg/L and never <4.0mg/L	Not to exceed geometric mean of 200/100mL, based on five consecutive samples during any 30 day period; nor shall more than 10% of the total samples during any 30 day period exceed 400/100mL	No numeric criteria[4]	Specific to the contaminant
Shellfish Harvesting waters	Daily average not <5.0mg/L and never <4.0mg/L	Not to exceed an MPN fecal coliform geometric mean of 14/100 mL; nor shall more than 10% of the samples exceed an MPN of 43/100mL	No numeric criteria[4]	Specific to the contaminant
Class SA[1]	Daily average not <5.0mg/L and never <4.0mg/L	Not to exceed an MPN fecal coliform geometric mean of 200/100 mL; nor shall more than 10% of the samples exceed an MPN of 400/100mL	No numeric criteria[4]	Specific to the contaminant
Class SB[2]	Not <4.0mg/L	Not to exceed an MPN fecal coliform geometric mean of 200/100 mL; nor shall more than 10% of the samples exceed an MPN of 400/100mL	No numeric criteria[4]	Specific to the contaminant
ONRW & ORW[3]	Site Specific	Site Specific	No numeric criteria[4]	Specific to the contaminant

[1] Class SA , tidal saltwater suitable for primary and secondary contact recreation, crabbing, fishing, except 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.
[2] Class SB are tidal saltwater suitable for primary and secondary contact recreation, crabbing, and fishing, except harvesting of clams, mussels, or oysters for market purposes or human consumption. Also suitable for the survival and propagation of a balanced indigenous aquatic community of marine fauna and flora.
[3]Outstanding National Resource Waters (ONRW) and Outstanding Resource Waters (ORW)
[4] Numeric criteria are applicable to lakes of 40 acres or more. Other water bodies protected by narrative criteria.

SCDHEC collects water quality data from stations located throughout the subbasins. Stations closest to each of the monuments with appropriate available water quality data were used as an index of the condition of the water resources in and around the monuments (Table 42, Table 43, and Figure 59).

Table 42. Names and locations of water monitoring stations closest to Fort Sumter National Monument with appropriate available water quality from U.S. Environmental Protection Agency data within the past five years. (U.S. Environmental Protection Agency 2008c). Distance estimated using the EPA EnviroMapper.

Station Name	*Station ID*	*Latitude*	*Longitude*	*Estimated distance from monument*
CHTN Harbor at Ft Johnson	MD-165	32.7540556	-79.8985	0.7
Charleston Harbor Over Mt. Pleasant Diffuser	MD-247	32.7695278	-79.8755278	1.0
Unnamed Tributary to Parrot Point CK 0.8 MI S of Ft Johnson	RT-042072	32.740039	-79.899793	1.2
Ben Sawyer Mem BRDG at SC 703 at Inn	MD-069	32.7726389	-79.8423889	2.1
Shem CK at US 17	MD-071	32.7926389	-79.8814167	2.5

Table 43. Names and locations of water monitoring stations closest to Charles Pinckney National Historic Site with appropriate available water quality from U.S. Environmental Protection Agency data within the past five years (U.S. Environmental Protection Agency 2008c). Distance estimated using the EPA EnviroMapper.

Station Name	*Station ID*	*Latitude*	*Longitude*	*Estimated distance from monument*
Boone Hall Creek Opposite Cnty Recreation Area	09B-07	32.8647222	-79.8244444	1.4
Boone Hall CK 1.5 MI WNW of Intersection of US 17 and SC 41	RT-052100	32.8652815	-79.822434	1.4
Foster Creek at Conf with Wando River	09B-19	32.865	-79.8616667	2.5
Wando River at Horlbeck Creek	09B-02	32.88	-79.8469444	2.8
Wando River at Nowell Creek	09B-01	32.8766667	-79.8736111	3.6
Wando River at I-526 Expressway (09B-15)	MD-264	32.86014	-79.895905	4.2
Bereford CK 5.3 MI NNE of Wando and Cooper RVR Confluence	RO-056092	32.8870763	-79.876263	4.2
Wando River at SC 41	MD-115	32.9226111	-79.8275278	5.4
Toomer Creek 2.5 MI E SC 41 Bridge Over Wando River	RO-06012	32.9210016	-79.783095	5.8

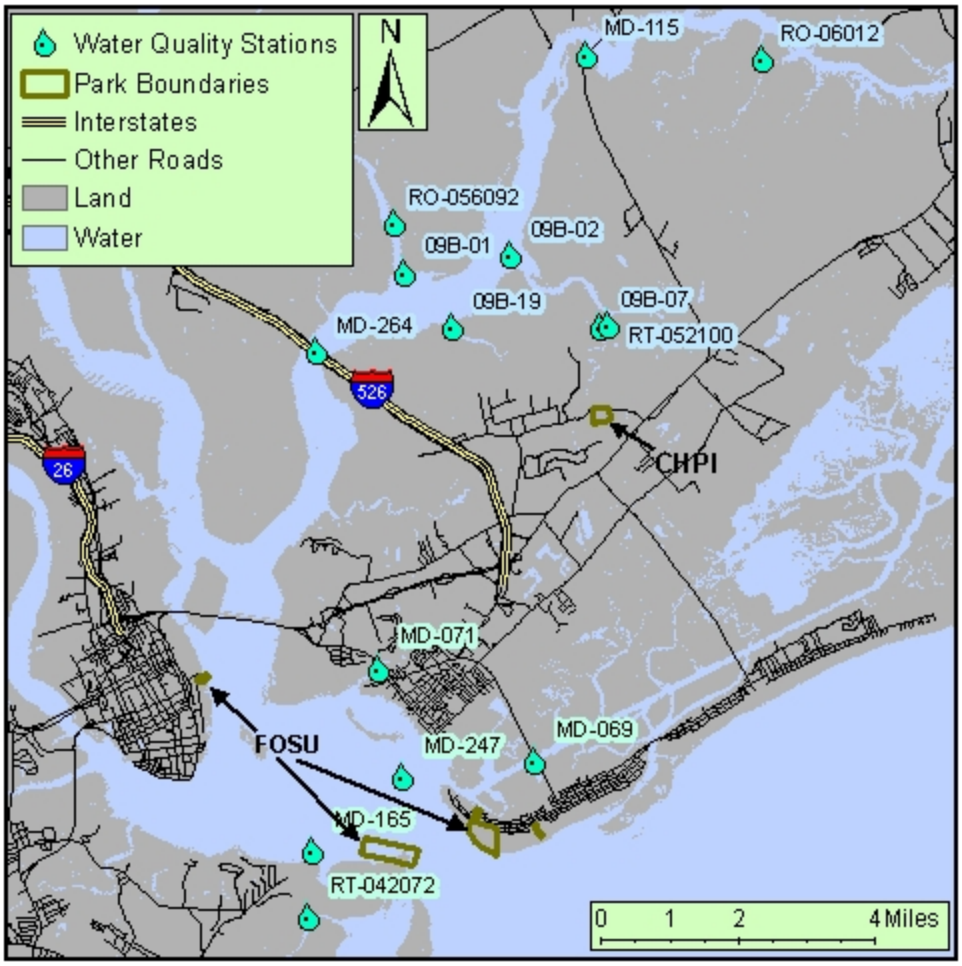

Figure 59. Location of water quality monitoring stations used for Fort Sumter National Monument and Charles Pinckney National Historic Site Natural Resource Assessment

3.4.2.a Current condition:

Dissolved oxygen (DO):

Dissolved oxygen (DO) is a relative measure of volume of oxygen, O_2, dissolved in water, and is often measured in mg/L. It is considered relative because temperature, pressure, and salinity, affect the capacity of water to hold oxygen. Both high (i.e., supersaturation) and low DO concentrations can be harmful in aquatic systems, though low DO concentrations are more common. Low DO concentrations may result from excess organic matter in aquatic systems, as aerobic (oxygen-consuming) decomposition breaks down organic material. Low dissolved oxygen levels are most prevalent during the warm summer months when water temperatures rise and mixing of the water column is reduced.

Data available through STORET for DO at water quality monitoring stations around Fort Sumter NM and Charles Pinckney NHS are reported by SCDHEC from January 15, 2004 to December 28, 2006. DO concentrations inherently vary by time of day along with the photosynthetic activity of aquatic vegetation, with the lowest DO levels occurring at sunrise. Many samples were taken midday and so likely do not represent daily minimums. Sampling intensities (*n*) varied between sites and so some reported averages are based on more data points than others.

Most of the South Carolina water quality standards for DO are expressed in terms of daily averages but the STORET data collected at SCDHEC monitoring stations near the parks during the last 5 years report DO levels as a single point value (i.e., reporting one single value per day) and report only one value per month, so direct comparison to daily average standards is potentially problematic. According to SCDHEC Watershed Water Quality Assessment (2005) for some parameters "the monthly sampling frequency employed… is insufficient for strict interpretation of the standards…When the sampling method or frequency (of sample data) does not agree with the intent of the particular (USEPA or SCDHEC) criterion, any conclusion about water quality should be considered as only an indication of conditions, not as a proven circumstance".

Fort Sumter National Monument:
DO concentrations ranged from 3.3 to 15.7 mg/L and averaged 7.1 ± 3.5 milligrams/liter (mg/L) overall. Sixty-seven percent (97 of 144) of the individual DO measurements reported met the most restrictive standard of 6 mg/L for Trout waters. Ninety percent (129 of 144) met the minimum daily average for all other waters with specified standards of 5.0 mg/L. Ninety-five percent (137 of 144) exceeded the minimum single point value for all other waters with specified standards of 4 mg/L. Average DO values from all data reported are provided (Table 44).

Table 44. Dissolved oxygen levels and number of replicates of the stations closest to FOSU. Averages taken from all values available in the past five years on the EPA STORET (2008c).

Station Name	*Station ID*	*Average DO (mg/L)*	*n*	*Lowest DO (mg/L)*
CHTN Harbor at Ft Johnson	MD-165	7.3	35	5.06
Charleston Harbor Over Mt. Pleasant Diffuser	MD-247	7.9	34	5.03
Unnamed Tributary to Parrot Point CK 0.8 MI S of Ft Johnson	RT-042072	6.0	10	3.97
Ben Sawyer Mem BRDG at SC 703 at Inn	MD-069	7.0	32	3.90
Shem CK at US 17	MD-071	6.5	33	3.33

Only one water body in HUC 03050202 has a section listed as impaired based on DO levels according to the South Carolina 2008 Florida 303(d) listing (Table 45).

Table 45. This waterbody was listed on the South Carolina 2008 303(d) (SCDHEC 2008a) with low Dissolved Oxygen levels as the cause of its impairment.

Waterbody	*County*	*Designated Use*
Stono River	Charleston	Aquatic Life, Shellfish Harvesting

Charles Pinckney National Historic Site:
DO concentrations ranged from 3.2 to 10.4 milligrams/liter (mg/L) and averaged 6.8 ± 3.4 mg/L overall. Sixty-three percent (68 of 108) of the individual DO measurements reported exceeded the most restrictive standard of 6 mg/L for Trout waters. Seventy-nine percent (85 of 108) exceeded the minimum daily average for all other waters with specified standards of 5.0 mg/L. Ninety-four percent (102 of 108) exceeded the minimum single point value for all other waters

with specified standards of 4 mg/L. Average DO values from all data reported are provided (Table 46).

Table 46. Dissolved oxygen levels and number of replicates of the stations closest to Charles Pinckney National Historic Site. Averages taken from all values available in the past five years on the U.S. EPA STORET (2008c).

Station Name	*Station ID*	*Average DO (mg/L)*	*n*	*Lowest DO (mg/L)*
Boone Hall CK 1.5 MI WNW of Intersection of US 17 and SC 41	RT-052100	6.2	12	3.34
Wando River at I-526 Expressway (09B-15)	MD-264	7.2	34	4.62
Bereford CK 5.3 MI NNE of Wando and Cooper RVR Confluence	RO-056092	7.2	13	3.75
Wando River at SC 41	MD-115	6.5	36	3.53
Toomer Creek 2.5 MI E SC 41 Bridge Over Wando River	RO-06012	6.2	13	3.17

There are at least nine water bodies in HUC 03050201 with sections that are listed as impaired based at least in part on DO levels according to the South Carolina 2008 303(d) listing (SCDHEC - South Carolina Department of Health and Environmental Control 2008a) (Table 47).

Table 47. Waterbodies listed on the South Carolina 2008 303(d) (SCDHEC 2008a) in HUC 03050201 listed as impaired due at least in part to low Dissolved Oxygen levels.

Waterbody	*County*	*Designated Use*
Back River Reservoir	Berkeley	Aquatic Life, Fish Consumption
Beresford Creek	Berkeley	Aquatic Life
Dorchester Creek	Dorchester	Aquatic Life
Foster Creek	Berkeley	Aquatic Life
Goose Creek	Charleston	Aquatic Life, Recreational Use
Goose Creek Reservoir	Berkeley	Aquatic Life, Fish Consumption
James Island Creek	Charleston	Aquatic Life, Recreational Use
Sawmill BR	Dorchester	Aquatic Life
Toomer Creek	Charleston	Aquatic Life

Nutrients:

According to the U.S. EPA, nutrient pollution, especially from nitrogen and phosphorus, has consistently ranked as one of the top causes of water degradation in the U.S. (U.S. Environmental Protection Agency 2008e). Nutrients increase the biological oxygen demand (BOD) and therefore lower DO concentrations in water. This process occurs because nutrients stimulate the growth of algae and other aquatic plants, which eventually die. Once dead, this organic material is decomposed by oxygen-consuming processes, resulting in low DO. Nutrients often enter aquatic systems from agricultural runoff, storm water runoff, waste-water treatment plants, and septic systems (U.S. Environmental Protection Agency 2008f).

Currently SCDHEC only applies numeric criteria to lakes of 40 acres or more. Other water bodies in South Carolina are assessed according to narrative criteria. According to SCDHEC's R.

61-68, Water Classification and Standards (2008b) "consideration needs to be given to the control of nutrients reaching the waters of the State… Discharges of nutrients from all sources, including point and nonpoint, to waters of the State shall be prohibited or limited if the discharge would result in or if the waters experience growths of microscopic or macroscopic vegetation such that the water quality standards would be violated or the existing or classified uses of the waters would be impaired. Loading of nutrients shall be addressed on an individual basis as necessary to ensure compliance with the narrative and numeric criteria."

The U.S. EPA's National Coastal Condition Report II (2005) does establishes some numeric criteria for nutrient levels for U.S. coastal waters (Table 48) and classifies samples as "good," "fair," or "poor," based upon their nutrient concentrations.

Table 48. Water quality standards for nutrient concentrations as developed for the National Coastal Condition Report II (2005). DIN refers to total dissolved inorganic nitrogen. DIP refers to total dissolved inorganic phosphorous.

	Good	*Fair*	*Poor*
DIN	< 0.1 mg N/l	0.1 – 0.5 mg N/l	> 0.5 mg N/l
DIP	< 0.01 mg P/l	0.01 – 0.05 mg P/l	> 0.05 mg P/l

Fort Sumter National Monument:
All of the measures of nitrogen (N) recorded at water quality monitoring stations near Fort Sumter NM (n = 32) in the last 5 years (January 15, 2004 – November 02, 2006) were well below the USEPA 2005 standard cited in Table 48. However, nitrogen exists in water in many forms, including inorganic, organic, dissolved, and particulate. Dissolved inorganic nitrogen (DIN) often refers to the sum of nitrate, nitrite, and ammonium concentrations in a water sample (Dodds 2002). STORET data from water quality monitoring stations near Fort Sumter NM reports nitrogen levels in terms of "Total Nitrogen, Nitrite (NO2) + Nitrate (NO3) as N" so while data are not readily evaluated by these criteria, the measure of Total N in these samples also all fall easily into the "Good" range for DIN.

The most recent measures of phosphorus (P) measures recorded at water quality monitoring stations near Fort Sumter NM (n = 8) were in 2002 (May 29 – December 12). Seventy-five percent (6 of 8) fell into the "Fair" range of the USEPA 2005 standard cited in Table 48 and 25% (2 of 8) would be classified in the "Poor" range.

The samples reflected in SCDHEC STORET data for phosphorus were analyzed in terms of Total Phosphorus (P) and the USEPA 2005 standard in Table 48 is based on Dissolved Inorganic Phosphorus (DIP), so application of the standard to these data is also in question. Total phosphorous is a measure of all phosphorus present in a sample regardless of form, and DIP is a measure of phosphorus in a sample after being filtered through a 0.45 micron filter (U.S. Environmental Protection Agency 1983). This means that these total phosphorus values may or may not be higher than they would be in terms of DIP.

No water bodies in HUC 03050202 are listed as impaired due to excessive nutrient levels according to the South Carolina 2008 Florida 303(d) listing (SCDHEC 2008a).

Charles Pinckney National Historic Site:
All of the measures of nitrogen (N) recorded at water quality monitoring stations near Charles Pinckney NHS (n = 48) in the last 5 years (January 20, 2004 – December 28, 2006) were well below the USEPA 2005 standard cited in Table 48. However, nitrogen exists in water in many forms, including inorganic, organic, dissolved, and particulate. Dissolved inorganic nitrogen (DIN) often refers to the sum of nitrate, nitrite, and ammonium concentrations in a water sample (Dodds 2002). STORET data from water quality monitoring stations near Charles Pinckney NHS reports nitrogen levels in terms of "Total Nitrogen, Nitrite (NO2) + Nitrate (NO3) as N." While data are not readily evaluated by these criteria, the measure of Total N in these samples all fall easily into the "Good" range for DIN.

Seventy-two percent (34 of 47) of the measures of phosphorus (P) recorded at water quality monitoring stations near Charles Pinckney NHS (n = 47) in the last 5 years (January 20, 2004 – December 28, 2006) would be classified in the "Fair" range based on the USEPA 2005 standard cited above (Table 48), and 28% (13 of 47) would be classified in the "Poor" range.

The samples reflected in SCDHEC STORET data for phosphorus were analyzed in terms of Total Phosphorus (P) and the USEPA 2005 standard in Table 48 is based on Dissolved Inorganic Phosphorus (DIP), so application of the standard to these data is also in question. Total phosphorous is a measure of all phosphorus present in a sample regardless of form, and DIP is a measure of phosphorus in a sample after being filtered through a 0.45 micron filter (U.S. Environmental Protection Agency 1983). This means that these total phosphorus values may or may not be higher than they would be in terms of DIP.

There are at least three water bodies in HUC 03050201 with sections that are listed as impaired due to excessive nutrient levels according to the South Carolina 2008 Florida 303(d) listing (SCDHEC 2008a) (Table 49).

Table 49. Waterbodies listed on the South Carolina 2008 303(d) (SCDHEC 2008a) in HUC 03050201 as impaired due to excess nutrient levels.

Waterbody	*County*	*Designated Use*	*Reason for Impairment*
Dorchester Creek	Dorchester	Aquatic Life	N in the form of NH_3
Goose Creek Reservoir	Berkeley	Aquatic Life, Fish Consumption	Chlorophyll a, and Total Phosphorus
Wando River	Charleston	Aquatic Life, Shellfish Harvesting	N in the form of NH_3

Bacterial Contamination (fecal coliform):
Fecal coliform bacteria contamination is the most common form of bacterial contamination in many water bodies. Its presence in aquatic environments is a human health hazard and may indicate the presence of other dangerous pathogens as well. Fecal coliform bacteria often enter waterways through the direct discharge of untreated (or insufficiently treated) human waste and agricultural and municipal runoff.

South Carolina water quality standards for fecal coliform are expressed in terms of "geometric mean based on five consecutive samples during any 30 day period". SCDHEC data available on STORET for the last 5 years report fecal coliform levels as a single point value (i.e., reporting one single value per day) so direct comparison to the geometric mean standard is potentially problematic, but all values reported fall well below the most restrictive geometric mean and daily maximum standards.

Fort Sumter National Monument:
One hundred twenty-seven measures of fecal coliform are reported from water quality monitoring stations near FOSU between January 15, 2004 and December 28, 2006, usually with one value reported per month. Forty-three percent of the single point data (54 of 127) exceeded the most restrictive geometric mean standard of 14 MPN/100ml (shellfish harvesting waters), and 10% (13 of 127) of the values reported exceeded the geometric mean standard for all other waters with specified standards of 200 MPN/100ml (Table 52). Most notable is Station MD-071 where the mean single point value exceeds the geometric mean standard of 200 MPN/ml, and of the 14 single point values that exceed that standard, 64% (9 of 14) were collected at Station MD-071. It should be noted that these data are not expressed in terms of geometric mean and are thus "insufficient for strict interpretation of the standards (because) the sampling method or frequency does not agree with the intent of the (fecal coliform) criterion, any conclusion about water quality should be considered as only an indication of conditions, not as a proven circumstance" (SCDHEC 2005).

Table 50. Fecal coliform values and number of replicates of the stations closest to Fort Sumter National Monument. Averages taken from all values available in the past five years on the U.S. EPA STORET (2008c) (does not represent geometric mean).

Station Name	*Station ID*	*Range of Fecal Coliform values (MPN)*	*Average MPN*	*n*
CHTN Harbor at Ft Johnson	*MD-165*	2 – 300	31	33
Charleston Harbor Over Mt. Pleasant Diffuser	MD-247	2 – 900	59	28
Unnamed Tributary to Parrot Point CK 0.8 MI S of Ft Johnson	RT-042072	4 – 80	25	8
Ben Sawyer Mem BRDG at SC 703 at Inn	MD-069	2 – 300	24	26
Shem CK at US 17	MD-071	2 – 1600	231	32

Sections of six waterbodies in HUC 03050202 are cited as impaired on the South Carolina 303(d) listing (SCDHEC 2008a) due to fecal coliform levels (Table 51).

Table 51. Waterbodies in HUC 03050202 listed in the South Carolina 2008 303(d) list (SCDHEC 2008a) as having fecal coliform contributing to the reason for impairment.

Waterbody	*County*	*Designated Use*
Abbapoola Creek	Charleston	Recreational Use, Shellfish Harvesting
Bass Creek	Charleston	Shellfish Harvesting
Cinder Creek	Charleston	Shellfish Harvesting
Log Bridge Creek	Charleston	Recreational Use
Rantowles Creek	Charleston	Shellfish Harvesting
Stono River	Charleston	Aquatic Life, Shellfish Harvesting

Charles Pinckney National Historic Site:
One hundred twenty-three measures of fecal coliform are reported from water quality monitoring stations near Charles Pinckney NHS between February 02, 2004 and June 30, 2005, usually with one value reported per month. Twenty-eight percent of the single point data (34 of 123) exceeded the most restrictive geometric mean standard of 14 MPN/100ml (shellfish harvesting waters), and only 3% (4 of 123) of the values reported exceeded the geometric mean standard for all other waters with specified standards of 200 MPN/100ml (Table 52). It should be noted that these data are not expressed in terms of geometric mean and are thus "insufficient for strict interpretation of the standards (because) the sampling method or frequency does not agree with the intent of the (fecal coliform) criterion, any conclusion about water quality should be considered as only an indication of conditions, not as a proven circumstance" (SCDHEC 2005).

Table 52. Fecal coliform values and number of replicates of the stations closest to Charles Pinckney National Historic Site. Averages taken from all values available in the past five years on the EPA STORET (2008c) (does not represent geometric mean).

Station Name	*Station ID*	*Range of Fecal Coliform values (MPN)*	*Average MPN*	*n*
Boone Hall Creek Opposite Cnty Recreation Area	09B-07	1.9 – 280	48.0	36
Boone Hall CK 1.5 MI WNW of Intersection of US 17 and SC 41	RT-052100	4 – 500	99.5	12
Foster Creek at Conf with Wando River	09B-19	1.9 – 140	15.5	38
Wando River at Horlbeck Creek	09B-02	1.9 – 84	14.6	37
Wando River at Nowell Creek	09B-01	1.9 – 49	9.6	37

Sections of 19 waterbodies in HUC 03050201are listed as impaired on the South Carolina 303(d) listing (SCDHEC 2008a) due to fecal coliform levels (Table 53).

Table 53. Waterbodies in HUC 03050201 with sections listed in the South Carolina 2008 303(d) list (SCDHEC 2008a) as having fecal coliform contributing to the reason for impairment

Waterbody	*County*	*Designated Use*
Ashley River	Charleston, Dorchester	Aquatic Life, Fish Consumption, Recreational Use
Block Island Creek	Charleston	Shellfish Harvesting
Boone Hall Creek	Charleston	Recreational Use, Shellfish Harvesting
Cane Gulley Branch	Berkeley	Recreational Use
Church Creek	Charleston	Recreational Use
Cypress Swamp	Dorchester	Recreational Use
Deep Creek	Charleston	Shellfish Harvesting
Eagle Creek	Dorchester	Aquatic Life, Recreational Use
Filbin Creek	Charleston	Recreational Use
Goose Creek	Berkeley, Charleston	Aquatic Life, Recreational Use
Guerin Creek	Berkeley	Shellfish Harvesting
James Island Creek	Charleston	Aquatic Life, Recreational Use
Rat Hall Creek	Charleston	Shellfish Harvesting
Shem Creek	Charleston	Aquatic Life, Recreational Use
Turkey Creek	Berkeley	Recreational Use
Unnamed Tributary	Berkeley	Recreational Use
Wadboo Swamp	Berkeley	Recreational Use
Walker SW	Berkeley	Recreational Use
Wando River	Charleston	Aquatic Life, Shellfish Harvesting

Contaminants:
Contaminants are substances such as metals, polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), and pesticides. One hundred twenty-six of these "toxic pollutants" are listed in the Clean Water Act as Priority Pollutants. These substances enter waterways through storm water runoff, industrial discharges, agricultural runoff, sewage treatment and atmospheric deposition. Once present in aquatic systems, they may concentrate in sediment and bottom-dwelling organisms. Many of these substances pose a risk to human health and aquatic systems.

In general data on priority pollutants/organic chemicals and metals from any one given site are infrequent owing to the specific sampling techniques required, and EPA STORET data for these contaminants in the Fort Sumter NM and Charles Pinckney NHS watersheds are scarce.

Fort Sumter National Monument:
Two waterbodies in the Fort Sumter NM watershed were listed on the 2008 SC 303(d) report (SCDHEC 2008a) as having contaminants as a reason for impairment (Table 54).

Table 54. Waterbodies in HUC 03050202 with sections listed in the South Carolina 2008 303(d) list (SCDHEC 2008a) as having contaminants contributing to the reason for impairment.

Waterbody	*County*	*Designated Use*	*Reason for Impairment*
Folly River	Charleston	Aquatic Life	Copper
Stono River	Charleston	Aquatic Life, Shellfish Harvesting	Copper

Charles Pinckney National Historic Site:
Eleven water bodies in HUC 03050201 are cited in South Carolina's 303(d) 2008 list (SCDHEC 2008a) as impaired due to contaminants (metals) (Table 55).

Table 55. Waterbodies in HUC 03050201with sections listed in the South Carolina 2008 303(d) list (SCDHEC 2008a) as having contaminants contributing to the reason for impairment.

Waterbody	*County*	*Designated Use*	*Reason for Impairment*
Ashley River	Charleston, Dorchester	Aquatic Life, Fish Consumption, Recreational Use	Mercury
Back River Reservoir	Berkeley	Aquatic Life, Fish Consumption	Mercury
Charleston Harbor	Charleston	Aquatic Life	Copper
Cooper River	Berkeley	Fish Consumption	Mercury
Diversion Canal	Berkeley	Fish Consumption	Mercury
Durham Creek	Berkeley	Fish Consumption	Mercury
Goose Creek Reservoir	Berkeley	Aquatic Life, Fish Consumption	Mercury
ICWW	Charleston	Aquatic Life	Copper
Lake Moultrie	Berkeley	Fish Consumption	Mercury
Shem Creek	Charleston	Aquatic Life, Recreational Use	Copper
Wadboo Creek	Berkeley	Fish Consumption	Mercury

3.4.2.b Resource threats and stressors:
USEPA reports the presence of at least three superfund sites in HUC 03050201 and HUC 03050202 South Carolina Coastal Watershed (Table 56):
http://www.epa.gov/superfund/sites/npl/sc.htm

Table 56. USEPA Superfund sites in HUC 03050201 and HUC 03050202, South Carolina

Site Name	*Contaminants*	*Latitude*	*Longitude*
Koppers Co. Inc. (Charleston Plant)[1]	PAHs, chromium, copper, and zinc	32.822	-79.9583
Macalloy Corporation[2]	Cadmium, chromium, lead, zinc, mercury, and manganese	32.838	-79.9511
Geiger (C & M Oil)[1]	Waste oil, trichloroethane and dimethylbenzene	32.7736	-80.1591

[1]HUC 03050102
[2]HUC 03050101

As mentioned in section 3.2 Human Use, the areas around Fort Sumter NM and Charles Pinckney NHS will see marked increases in population in the coming years. This growth will bring corresponding increases in development pressure and changing land use outside of the parks' boundaries. This may lead to impacts to water quality from increased sediment loads from development activities to long-term increased inputs from sewer and septic systems, greater proportion of impervious surfaces, and associated urban runoff.

3.4.2.c Critical knowledge or data gaps:
The fact that the data currently available is not easily evaluated against State or Federal standards is the most significant impediment to a thorough assessment of water quality in and around Fort Sumter NM and Charles Pinckney NHS.

Available data provides insight into water quality conditions in HUC 03050201 and HUC 03050202 as a whole, but it is not clear as to what extent those conditions are reflected on a local scale. However the close proximity of the monitoring stations to park boundaries (most < 5 miles) make it likely that the conditions assessed here are likely to be reflected in and around the parks themselves.

3.4.2.d Condition status summary
Available data do not indicate water quality problems due to low dissolved oxygen levels around Fort Sumter NM and Charles Pinckney NHS (Table 57 and Table 58). While overall average values of STORET data were good, single point data showed some values below minimum standards. Single point data from Charles Pinckney NHS fell farther below minimum standards than did Fort Sumter NM. Waterbodies elsewhere in both subbasins are cited as impaired due to low DO values.

The nutrients category for nitrogen is assessed in the good range, while phosphorus is assessed as fair based on EPA criteria but conclusions are less robust due to lack of appropriate data (Table 57 and Table 58). Waterbodies elsewhere in HUC 03050201(Charles Pinckney NHS) are cited as impaired due to excessive nutrient values while no such listing was found in HUC 03050202 (Fort Sumter NM).

Available data do not indicate water quality problems due to fecal coliform levels around Fort Sumter NM or Charles Pinckney NHS. While overall average values of STORET data were good, single point data showed some values that exceeded minimum standards. Single point data from Fort Sumter NM exceeded minimum standards to a greater extent than did Charles Pinckney NHS, so Fort Sumter NM was assessed in the fair/poor range based on low average values from one station, and low single point data (Table 57 and Table 58). Waterbodies elsewhere in both subbasins are cited as impaired due to excessive fecal coliform levels.

Data for contaminants proximate to Fort Sumter NM and Charles Pinckney NHS are scarce but there are many waterbodies within both subbasins that are listed as impaired due to contaminant levels. While there is no direct evidence of contaminants within the parks, water quality at both Fort Sumter NM and Charles Pinckney NHS are assessed as fair based on the proximity of contaminant-impaired sites and waterbodies (Table 57 and Table 58).

Table 57. Water quality condition status summary within Fort Sumter National Monument. Data quality was rated based on *thematic* (1 = best source; 0 = not the best source), s*patial* (1 = proximate to park boundary; 0 = > 5 miles from park boundary), and *temporal* (1 = recent; 0 = older than 5 years). The colors green, yellow, and red refer to good, fair, and poor scores respectively.

Category	***Condition Status***	***Midpoint***	***Data Quality***		
			Thematic	*Spatial*	*Temporal*
Dissolved oxygen			0	1	1
	Good	0.84	2 out of 3		
Nutrients (N/P)			0	1	1
	Good/Fair	0.67	2 out of 3		
Fecal coliform bacteria			0	1	1
	Fair/Poor	0.34	2 out of 3		
Contaminants			0	1	1
	Fair	0.5	2 out of 3		
Water quality total			0	4	4
	Fair	0.59	8 out of 12		

Table 58. Water quality condition status summary within Charles Pinckney National Historic Site. Data quality was rated based on *thematic* (1 = best source; 0 = not the best source), s*patial* (1 = proximate to park boundary; 0 = > 5 miles from park boundary), and *temporal* (1 = recent; 0 = older than 5 years). The colors green, yellow, and red refer to good, fair, and poor scores respectively.

Category	***Condition Status***	***Midpoint***	***Data Quality***		
			Thematic	*Spatial*	*Temporal*
Dissolved oxygen			0	1	1
	Fair	0.5	2 out of 3		
Nutrients (N/P)			0	1	1
	Good/Fair	0.67	2 out of 3		
Fecal coliform bacteria			0	1	1
	Fair	0.5	2 out of 3		
Contaminants			0	1	1
	Fair	0.5	2 out of 3		
Water quality total			0	4	4
	Fair	0.54	8 out of 12		

3.3.2.e Recommendations to park managers:
We highlight the water quality specific recommendations in Table 59.

Table 59. Recommendations to improve water quality and monitoring at Fort Sumter and Charles Pinckney National Historic Site.

1.	Work towards improved regional cooperation
2.	Initiate regular water quality monitoring at FOSU and CHPI
3.	Collect additional water quality information
4.	Improve access to state and federal water quality data and improved metadata

3.5 Geology and Soils

3.5.1 Geology and Soils

As outlined in the park and resources section of this report, the Coastal Plain region is composed of undeformed sedimentary rock layers whose ages range from the Late Cretaceous to the present Holocene sediments of the coast. Beneath Coastal Plain sediments are harder igneous and metamorphic rocks, such as those found in the Piedmont. Usually referred to as the "basement rocks," these hard rocks occur at greater and greater depths toward the south and east, reaching depths of up to 10,000 feet or more beneath the modern Georgia coast (Frazier 2007). Sediment from the upper Piedmont region eroded into the Coastal Plain over the past 100 million years. In addition to recent alluvium, organic and marine deposits make up some of the sediment found in the Coastal Plain (UGA Department of Geology 2008). Human-dredged and deposited sediments are abundant along the coastlines. Specifically, the region near Fort Sumter NM is a mix of Pleistocene-aged marine deposits, Holocene-aged alluvium, and human-modified material. The region near Charles Pinckney NHS is a Pleistocene-aged deposit of marine origin (Figure 60).

Figure 60. The region near the circles at Fort Sumter National Monument (Fort Sumter on the south harbor mouth and Fort Moultrie and the Coast Guard Station on the north harbor mouth) is

a Holocene-aged barrier island sand, and the area at the tour boat dock upstream is a mix of Pleistocene-aged marine deposits, Holocene-aged alluvium and human-modified material. Charles Pinckney National Historic Site is located near the star in a Pleistocene-aged deposit of marine origin (U.S. Geological Survey 2005).

The area surrounding Fort Sumter and Charles Pinckney National Monuments is considered under major earthquake risk due to a history of seismic activity and the Woodstock Fault. The last major shock occurred in 1886, causing a large amount of damage (National Park Service 1998).

Fort Sumter NM encompasses four separate sites: the man-made island of Fort Sumter, Fort Moultrie, a historic Coast Guard station, and the NPS tour boat site. All of these sites are located on major water bodies with Fort Sumter Island centrally located at the entrance to the Charleston Harbor. Fort Moultrie, the headquarter office, and the Coast Guard station are to the northeast of Fort Sumter on the southwestern end of Sullivan's Island, a developed barrier island. The tour boat facility is in the city of Charleston, on the west bank of the Cooper River. These sites are generally composed of flat terrain, salt water marshes, and some dune, salt marsh, and maritime forest plant communities (National Park Service 1998). Nearby Charles Pinckney NHS has flat terrain, upland habitat, as well as a small portion of wetlands. Some of the property is in the 100-year floodplain (National Park Service 1994).

3.5.1.a Current condition status:
We compared a 1904 soil survey (Table 60, Figure 61) to the current soil data from the Soil Survey Geographic Data Base (SSURGO) (Table 61, Table 62, and Figure 62) to see what changes had occurred. The Fort Sumter NM SSURGO soil data have a version date of August 23, 2006 and are available in GIS format (National Park Service 2006). The version date for Charles Pinckney NHS soil data was September 22, 2006. The National Park Service (NPS) compiled SSURGO data were not available for Charles Pinckney NHS, so data were acquired directly from the USDA Natural Resource Conservation Service (2006). The 1904 soil survey by the U.S. Department of Agriculture was obtained from an on-line collection at University of Alabama (USDA Bureau of Soils 1904). The 1904 soil data were aligned to digital raster graphics (DRG) topographic maps, using the georeferencing tools in ArcGIS (ESRI 2006). We surveyed Charleston, Fort Moultrie, and James Island 1:24,000 topographic maps that made up Fort Sumter NM and Charles Pinckney NHS or were in close proximity to the boundaries. Published data was also used along with photo interpretation to asses both current soil resources and changes.

The soil survey program was near its inception in 1904. The 1904 soil data were obtained by reconnaissance survey methods using a limited set of soil series choices. The 1904 soil survey only includes the Fort Sumter NM tour boat site (Table 60, Figure 61), within the city of Charleston. It appears that this area of Charleston was also urban in 1904. Despite this, the Department of Agriculture gave a soil classification of "Norfolk fine sandy loam" for most of the developed areas of the city. Unfortunately, the remainder of soils in Charleston County were not mapped in 1904 and cannot be compared to other sites within Fort Sumter NM and Charles Pinckney NHS. The tour boat area was mapped as Norfolk soils in 1904, but that soil is now mapped on well drained, older, higher elevation Coastal Plain terraces much further inland. The

area is currently mapped as 40% urban land (the dock and pavements), and the rest as Yuahannah[(1)] -Yemassee[(2)] -Ogeechee[(3)] soils (Table 61). All three of the series now mapped at the site were established long after the 1904 soil survey was completed. These three soils occur as a west-east sequence of loamy soils from the 2 – 3 foot elevation (Yauhannah) park areas to water level (Ogeechee) just above the open water in the estuary. The Yuahannah soil series has a sandy surface texture and loamy subsoil with a subsoil accumulation of clay. Yuahannah is moderately well drained and is younger and less highly weathered than the well drained and highly weathered Norfolk. The Yemassee soil series is similar to Yuahannah but is somewhat poorly drained. The Ogeechee soil series is also similar to Yuahannah but is poorly drained. The change in soil mapping is due to closer inspection of the soils in the newer survey with additional choices of soil series for the soil mappers.

Table 60. Historical soil survey (1904) classification and extent of the tour boat facility at Fort Sumter National Monument.

Soil Code	*Classification Name*	*Description*	*Extent*
Nsl	Norfolk fine sandy loam*	The Norfolk series consists of very deep, well drained, moderately permeable soils on lower, middle, or upper coastal plains uplands with slopes ranging from 0 to 10 percent. Parent material consists of marine deposits or fluviomarine deposits (deposits near the mouth of a river, formed by the combined action of river and sea).[(1)]	≈ 100%

* 1904 historical soil only included the tour boat site of Fort Sumter National Monument
[(1)] http://www2.ftw.nrcs.usda.gov/osd/dat/N/NORFOLK.html

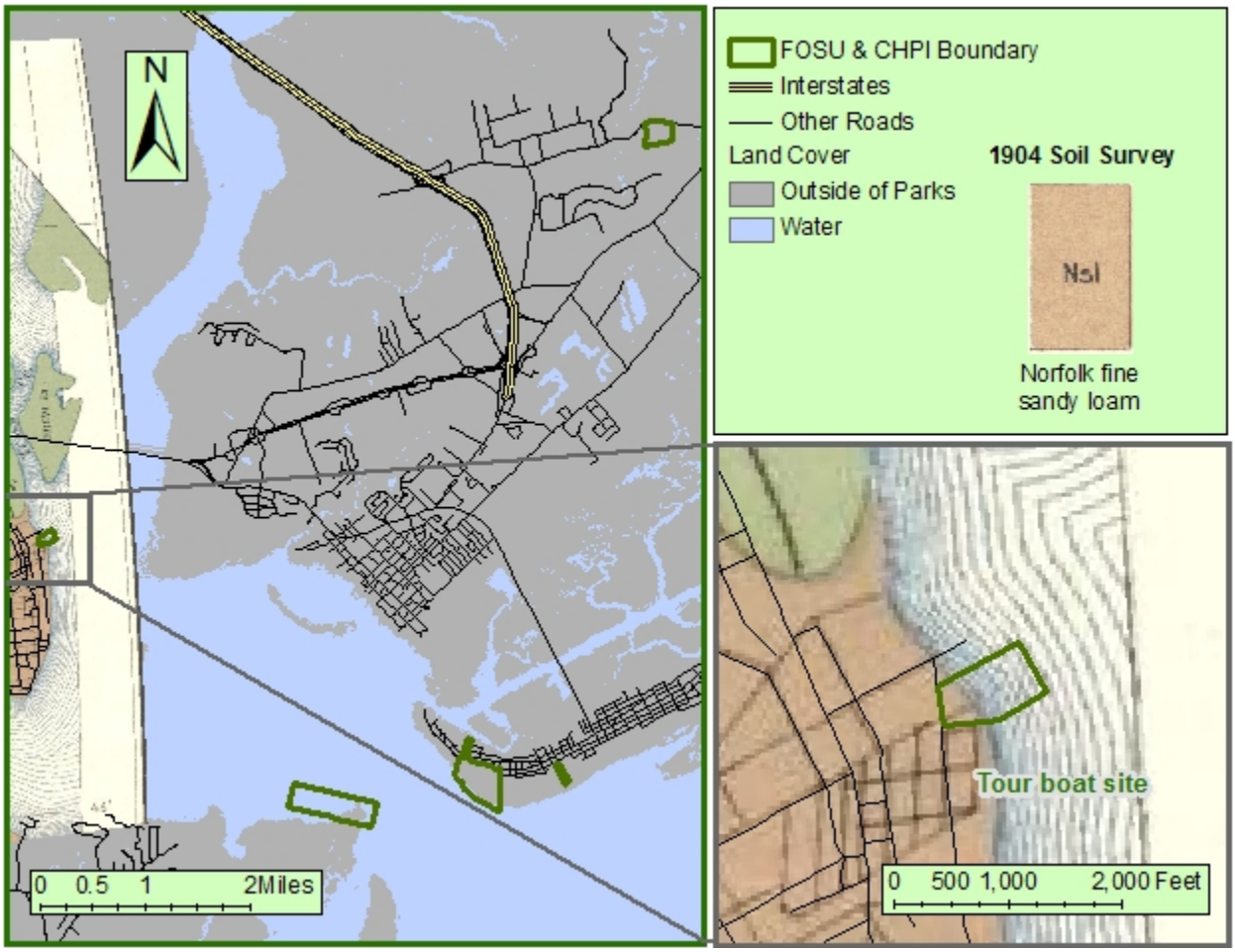

Figure 61. Extent of historical soil survey (1904) at the tour boat facility of Fort Sumter National Monument.

In the 2006 soil survey, there are four soul classes for Fort Sumter NM. These are "Coastal Beaches and Dune Land," "Made Land," "Urban Land-Yuahannah-Yemassee-Ogeechee Association," and "Capers Silty Clay Loam" (Table 61, Figure 62). The park does not contain Prime Farmland or Farmland of Statewide Importance. The "Dune Land" part of the "Coastal Beaches and Dune Land" is the only Highly Erodible Land in within the monument boundary.

The "Made Land" map unit cannot be classified to a soil series with the information given. Therefore any maps of land use interpretations will have to rely on on-site investigations.

Clayey tidal marsh soils such as Capers contain reduced sulfides and are called cat clays because of the formation of a gray and yellow pattern when they are exposed to oxygen by dredging or ditching. The gray is the background color of the subaqueous, reduced soil and the yellow mottles are iron-sulfates (jarosite) formed by oxidation and precipitation of sulfides in the exposed sediment. The formation of jarosite leads to release of sulfuric acid and thus lowers the pH to levels too low to support native vegetation, until the soil pH is raised through additions of calcium or leaching of sulfates.

Table 61. Current soil survey (2006) classification, acreages, and percent of total acreage for Fort Sumter National Monument.

Map Symbol	*Map Unit Name*	*Description*	*FOSU Acres*	*FOSU %*
W	Water-Irrigation and Farm Ponds	Water	141	61.0
Co	Coastal Beaches and Dune Land	Gently undulating to steep excessively drained soil along beaches and waterways of Atlantic Coast. Beaches are sandy shores washed and rewashed by waves. The areas may be partly covered with water during high tides or storms. Slopes range from 1 to 5 percent. This is not a soil but a miscellaneous land type, since it is not stabilized by vegetation.	54	23.4
Ma	Made Land	Material remaining after the overlying developed soil has been removed or composed of material dredged from rivers or waterways. The soil consists of loamy material that is dominantly a sandy clay loam.	30	13.0
UR	Urban Land-Yuahannah[(2)] - Yemassee[(3)] - Ogeechee[(4)] Association	Urban land is a miscellaneous land type mostly covered by impervious streets, parking lots, buildings, and other structures of urban areas. The other named soil series occur in complex patterns with the Urban Land, on very low terraces above open water.	5	2.2
Cg	Capers Silty Clay Loam[(5)]	Nearly level, very poorly drained soils of tidal marshes that are subject to tidal flooding by saline water. The water table is at +1.0 to -1.0 feet. These soils have a very dark grayish brown silty clay surface layer about 16 inches thick and subsurface layers of black and very dark gray clay to a depth of 60 inches.	1	0.4
	Total		231	100

[(2)] http://www2.ftw.nrcs.usda.gov/osd/dat/Y/YUAHANNAH.html
[(3)] http://www2.ftw.nrcs.usda.gov/osd/dat/Y/YEMASSEE.html
[(4)] http://www2.ftw.nrcs.usda.gov/osd/dat/O/OGEECHEE.html
[(5)] http://www2.ftw.nrcs.usda.gov/osd/dat/C/CAPERS.html

In the 2006 soil survey, there are four soil classes for Charles Pinckney NHS. These are "Chipley Loamy Fine Sand," "Scranton Loamy Fine Sand," "Yonges Loamy Fine Sand," and "Charleston Loamy Fine Sand" (Table 62, Figure 62). The "Charleston loamy fine sand" is the only map unit that is Prime Farmland. The "Yonges loamy fine sand" map unit is the only Farmland of Statewide Importance. There are no Highly Erodible Lands in within the national historic site boundary.

Table 62. Current soil survey (2006) classification, acreages, and percent of total acreage for Charles Pinckney National Historic Site.

Map Symbol	*Map Unit Name*	*Description*	*CHPI Acres*	*CHPI %*
Cm	Chipley[6] Loamy Fine Sand	Nearly level and gently sloping, somewhat poorly drained sandy soils on uplands. They are rapidly permeable with a seasonal high water table at 1.5 to 3.0 feet. Water holding capacity is low.	26.4	80.6
Sf	Scranton[7] Loamy Fine Sand	Nearly level, somewhat poorly drained sandy soils of the coastal plains on broad flats with a water table at 0.5 and 1.5 feet during wet seasons. They are rapidly permeable. These soils are droughty if overdrained.	2.5	7.7
Yo	Yonges[8] Loamy Fine Sand	Nearly level, poorly drained, moderately slowly permeable soils on nearly level floodplains of the coastal plains. They have a water table within 0.0 to 1.0 feet from surface.	2.3	7.1
Ch	Charleston[9] Loamy Fine Sand	Nearly level, moderately well drained soils with loamy subsoils on small to medium flats and low divides. Permeability is moderate to moderately rapid. The seasonal high water table is 2.0 to 3.5 feet.	1.5	4.6
	Total		32.7	100

[6] http://www2.ftw.nrcs.usda.gov/osd/dat/C/CHIPLEY.html
[7] http://www2.ftw.nrcs.usda.gov/osd/dat/S/SCRANTON.html
[8] http://www2.ftw.nrcs.usda.gov/osd/dat/Y/YONGES.html
[9] http://www2.ftw.nrcs.usda.gov/osd/dat/C/CHARLESTON.html

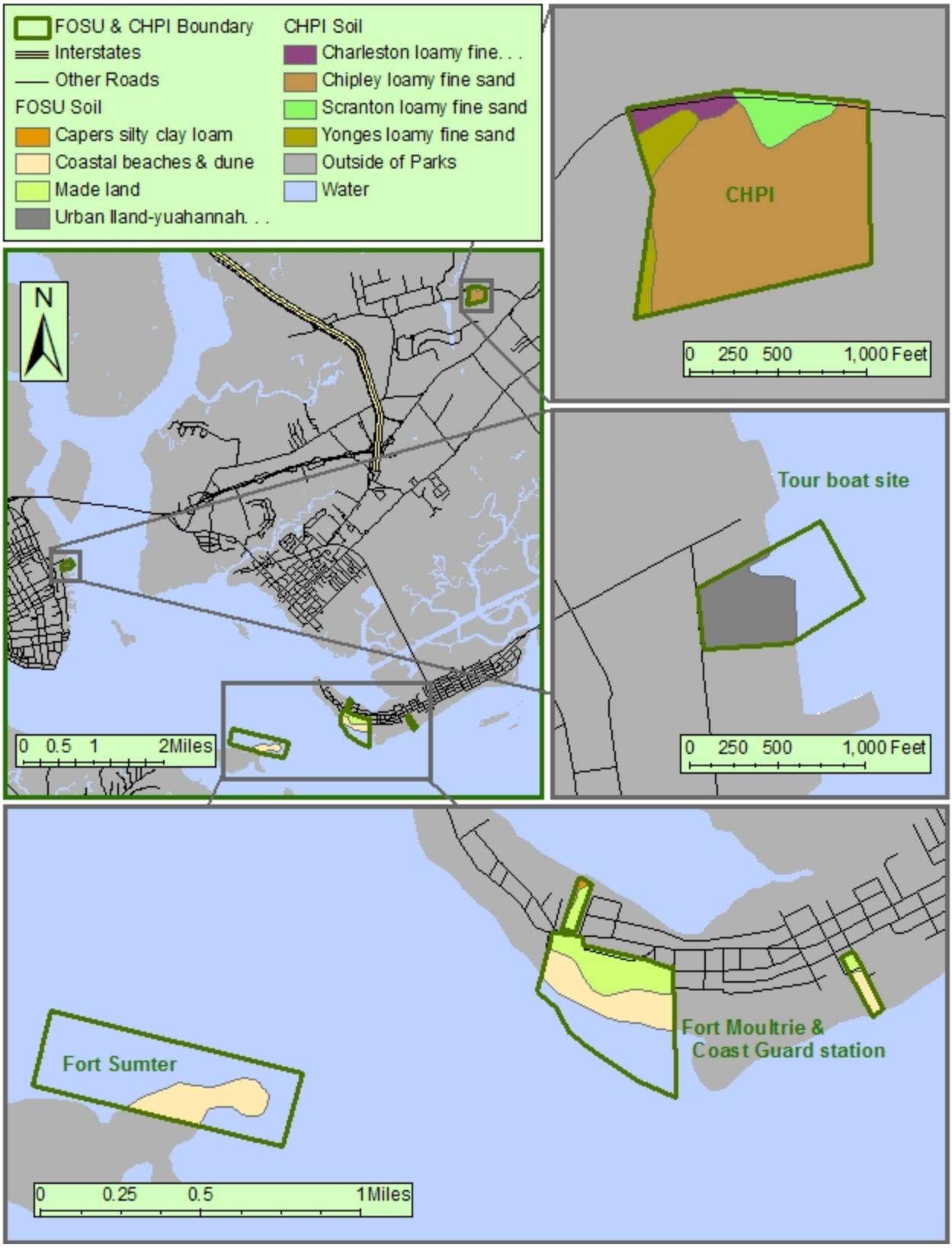

Figure 62. Extent of current soil survey (2006) at Fort Sumter National Monument and Charles Pinckney National Historical Site.

Several soil-based assessments can be assembled from current soil data using the soil databases (National Park Service 2006, USDA Natural Resource Conservation Service 2006) and an extension that runs on ArcGIS (ESRI 2006), the USDA Natural Resource Conservation Service Soil Data Viewer (2008). The soil assessments that we found most useful for the parks included: potential erosion hazard for off-road, off trail traffic (Table 63, Figure 63, Appendix C); flooding frequency class (Table 64, Figure 64, other water features listed in Appendix C); drainage class (Table 65, Figure 65, Appendix C); hydric rating (Figure 66, Appendix C); soil features (Appendix C); camp area, picnic area, and playground ratings (Appendix C); and paths, trails, and golf fairways (Appendix C). Explanations from USDA Natural Resource Conservation Service Soil Data Viewer (2008) follow with more detail in Appendix C.

Potential erosion hazard (off-Road, off-Trail):
"Ratings indicate the hazard or risk of soil loss from off-road and off-trail areas after disturbance activities that expose the soil surface, and are based on slope and soil erodibility factor K. The soil loss is caused by sheet or rill erosion in off-road or off-trail areas where 50 to 75 percent of the surface has been exposed by logging, grazing, mining, or other kinds of disturbance.

The hazard is described as "slight", "moderate", "severe", or "very severe". A rating of "slight" indicates that erosion is unlikely under ordinary climatic conditions; "moderate" indicates that some erosion is likely and that erosion-control measures may be needed; "severe" indicates that erosion is very likely and that erosion-control measures, including revegetation of bare areas, are advised; and "very severe" indicates that significant erosion is expected, loss of soil productivity and off-site damage are likely, and erosion-control measures are costly and generally impractical." (USDA Natural Resource Conservation Service 2008)

Table 63. Potential erosion hazard (off-road, off-trial) according to soil characteristics at Fort Sumter National Monument and Charles Pinckney National Historic Site. *Slight* means erosion is unlikely under ordinary climatic conditions; and *very severe* means that significant erosion is expected, loss of soil productivity and off-site damage likely.

Potential Erosion	*FOSU Acres*	*% of FOSU*	*CHPI Acres*	*% of CHPI*
Not rated	0.0	0.00	0.0	0.00
Slight	172.5	74.32	32.7	100.00
Very severe	59.6	25.68	0.0	0.00
	232.1	100.00	32.7	100.00

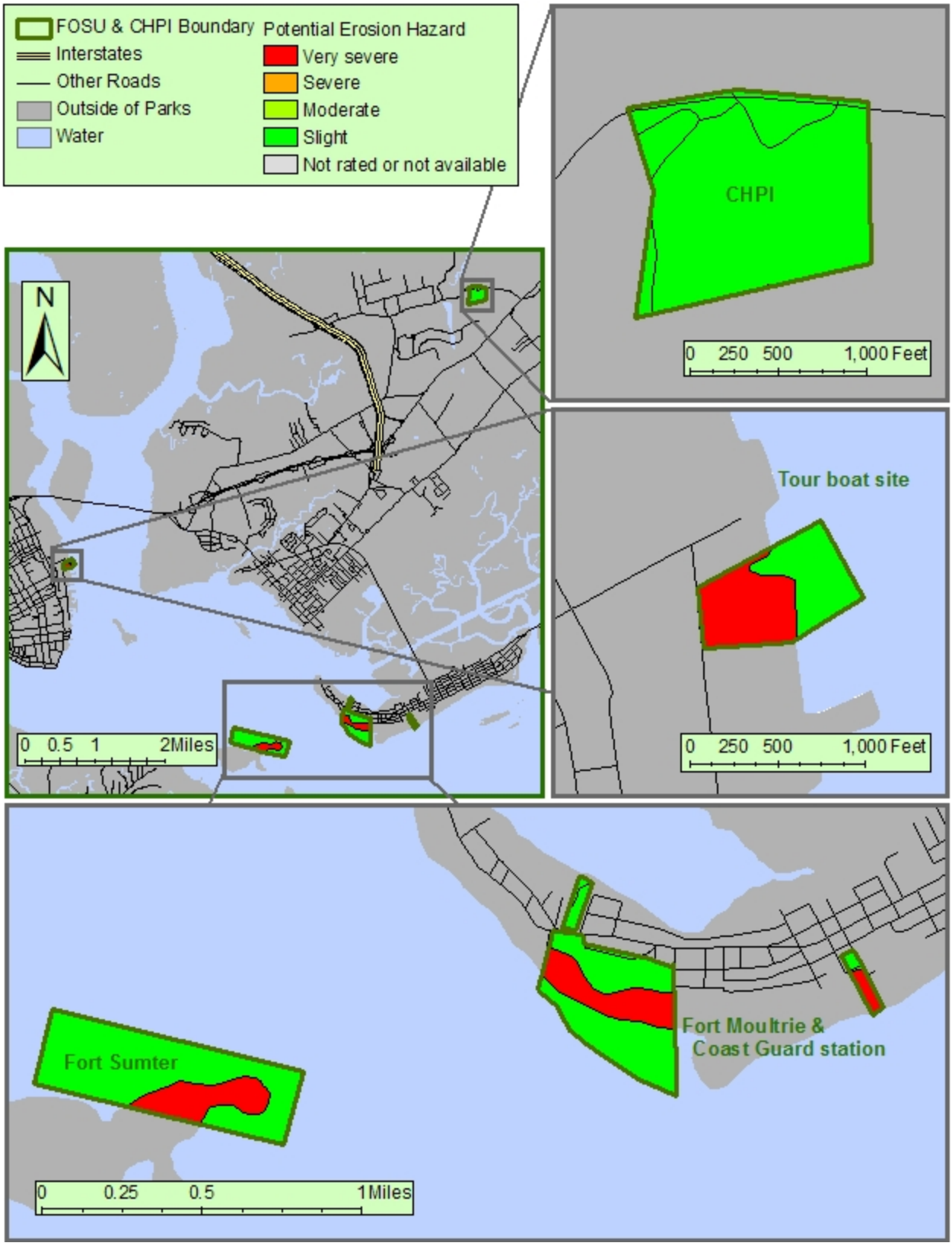

Figure 63. Potential erosion hazard (off-road, off-trial) according to soil characteristics at Fort Sumter National Monument and Charles Pinckney National Historic Site. *Slight* means erosion is

unlikely under ordinary climatic conditions; *moderate* means that some erosion is likely and that erosion-control measures may be needed; *severe* means that erosion is very likely, erosion-control measures advised; and *very severe* means that significant erosion is expected, loss of soil productivity and off-site damage likely.

Flooding frequency class:
"Flooding is the temporary inundation of an area caused by overflowing streams, by runoff from adjacent slopes, or by tides. Water standing for short periods after rainfall or snowmelt is not considered flooding, and water standing in swamps and marshes is considered ponding rather than flooding.

Flooding frequency class is the number of times flooding occurs over a period of time and is expressed as a class. Flooding Frequency Classes are based on the interpretation of soil properties and other evidence gathered during soil survey field work. The classes are:

None - Flooding is not probable, near 0 percent chance of flooding in any year or less than 1 time in 500 years.
Very rare - Flooding is very unlikely but possible under extremely unusual weather conditions (the chance of flooding is less than 1 percent in any year).
Rare - Flooding is unlikely but possible under unusual weather conditions (the chance of flooding is 1 to 5 percent in any year).
Occasional - Flooding occurs infrequently under normal weather conditions (the chance of flooding is 5 to 50 percent in any year).
Frequent - Flooding is likely to occur often under normal weather conditions (the chance of flooding is more than 50 percent in any year but is less than 50 percent in all months in any year).
Very frequent - Flooding is likely to occur very often under normal weather conditions (the chance of flooding is more than 50 percent in all months of any year)."
(USDA Natural Resource Conservation Service 2008)

Table 64. Flooding frequency according to soil characteristics at Fort Sumter National Monument and Charles Pinckney National Historic Site. *None* means flooding is not probable; *frequent* means flooding is likely to occur often; and *very frequent* means flooding is likely to occur very often under normal weather conditions.

Flooding Frequency	*FOSU Acres*	*% of FOSU*	*CHPI Acres*	*% of CHPI*
None	176.6	76.06	32.7	100.00
Frequent	54.5	23.47	0.0	0.00
Very Frequent	1.1	0.47	0.0	0.00
	232.2	100.00	32.7	100.00

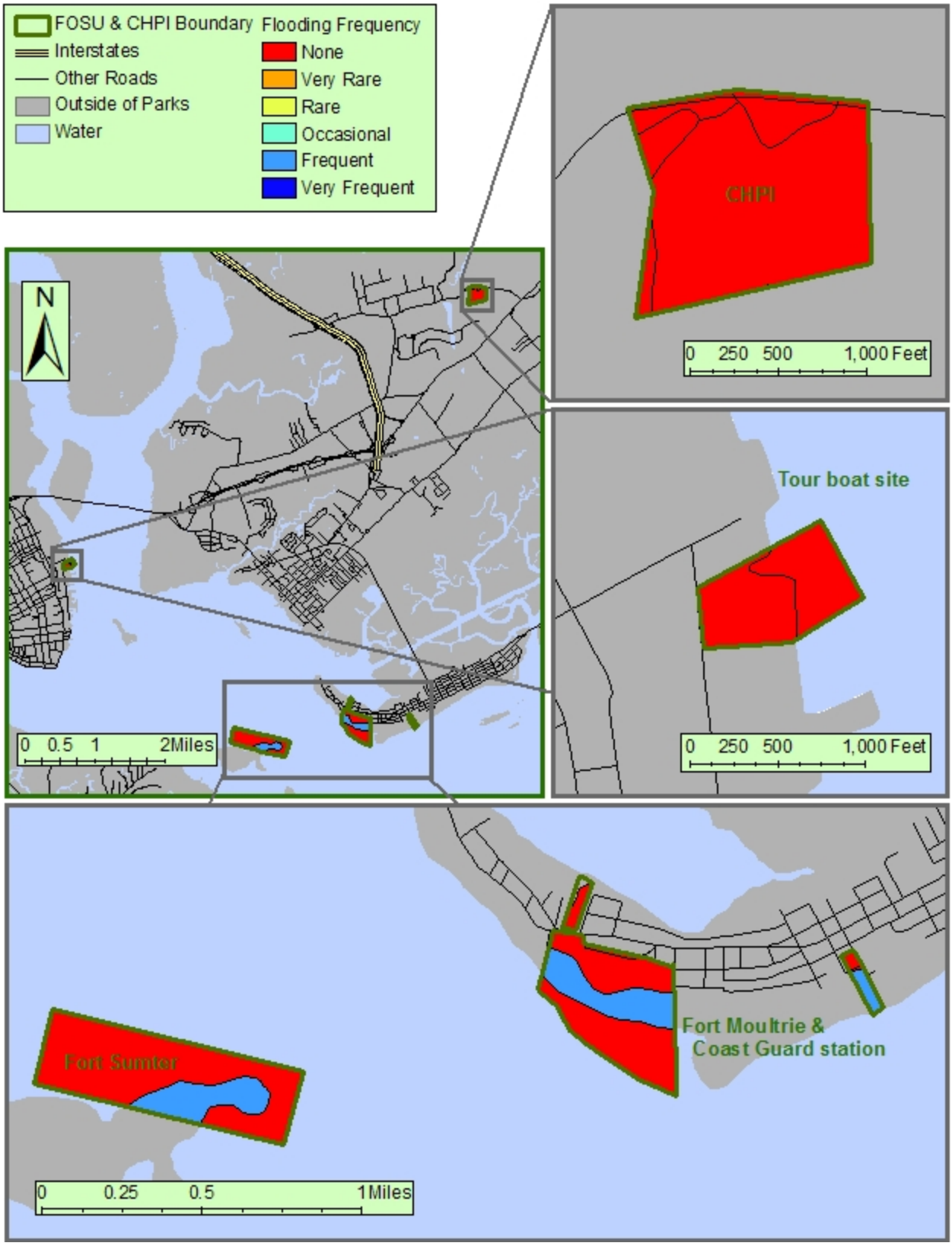

Figure 64. Flooding frequency according to soil characteristics at Fort Sumter National Monument and Charles Pinckney National Historic Site. *None* means flooding is not probable;

very rare means flooding is very unlikely; *rare* means flooding is unlikely but possible under unusual weather conditions; *occasional* means flooding occurs infrequently under normal weather conditions; *frequent* means flooding is likely to occur often; and *very frequent* means flooding is likely to occur very often under normal weather conditions.

Drainage class:
"Drainage class (natural) refers to the frequency and duration of wet periods under conditions similar to those under which the soil formed. Alterations of the water regime by human activities, either through drainage or irrigation, are not a consideration unless they have significantly changed the morphology of the soil. Seven classes of natural soil drainage are recognized -- excessively drained, somewhat excessively drained, well drained, moderately well drained, somewhat poorly drained, poorly drained, and very poorly drained." (USDA Natural Resource Conservation Service 2008)

Table 65. Drainage classes according to soil characteristics at Fort Sumter National Monument and Charles Pinckney National Historic Site.

Drainage Class	*FOSU Acres*	*% of FOSU*	*CHPI Acres*	*% of CHPI*
Not rated	146.1	62.92	0.0	0.00
Moderately well drained	30.5	13.14	27.9	85.32
Somewhat poorly drained	0.0	0.00	2.5	7.65
Poorly drained	54.5	23.47	2.3	7.03
Very poorly drained	1.1	0.47	0.0	0.00
	232.2	100.00	32.7	100.00

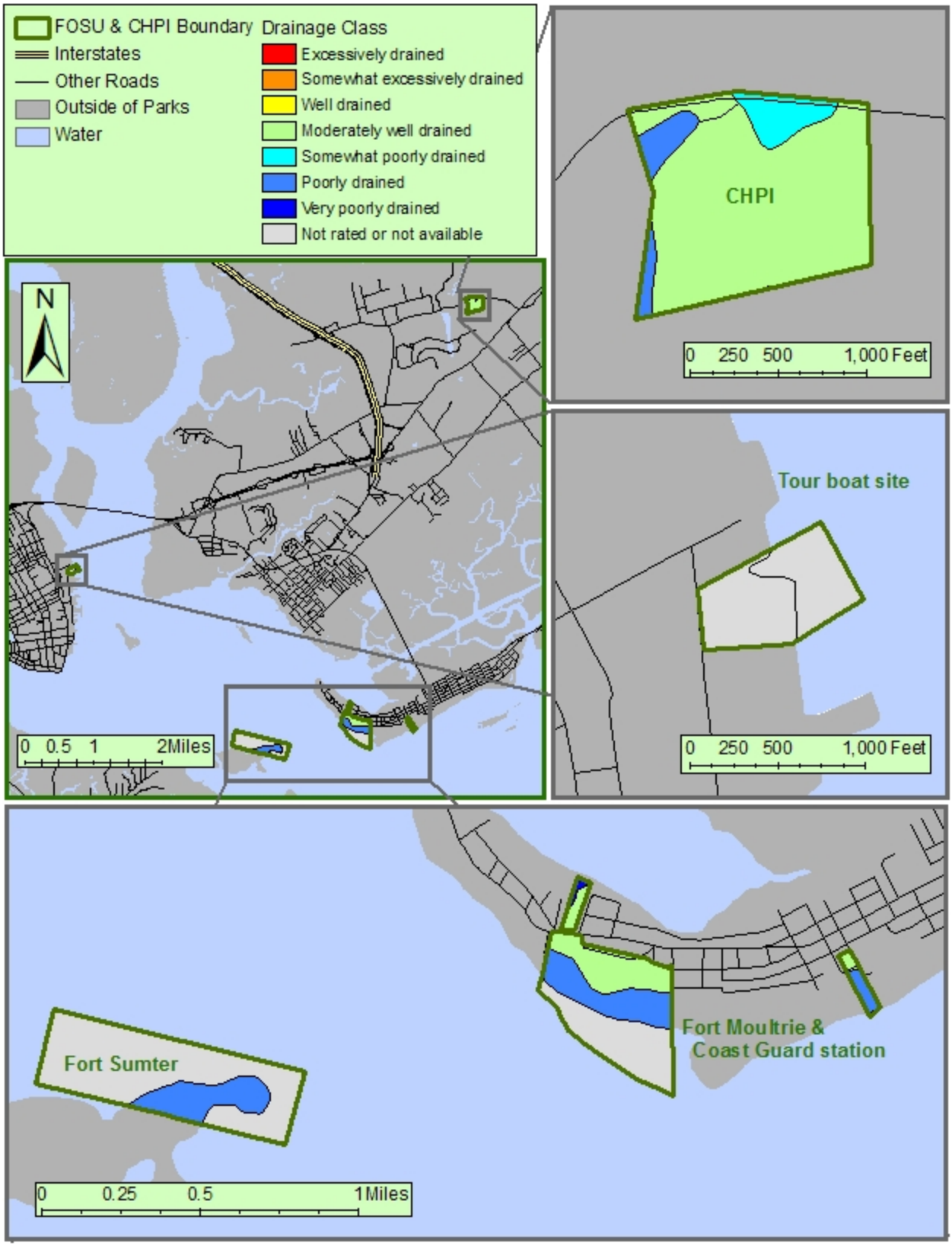

Figure 65. Drainage classes according to soil characteristics at Fort Sumter National Monument and Charles Pinckney National Historic Site.

Map unit hydric rating:
"This rating provides an indication of the proportion of the map unit that meets criteria for hydric soils. Map units that are dominantly made up of hydric soils may have small areas, or inclusions, of nonhydric soils in the higher positions on the landform, and map units dominantly made up of nonhydric soils may have inclusions of hydric soils in the lower positions on the landform

Hydric soils are defined by the National Technical Committee for Hydric Soils (NTCHS) as soils that formed under conditions of saturation, flooding, or ponding long enough during the growing season to develop anaerobic conditions in the upper part. These soils, under natural conditions, are either saturated or inundated long enough during the growing season to support the growth and reproduction of hydrophytic vegetation. . .

. . . If soils are wet enough for a long enough period of time to be considered hydric, they should exhibit certain properties that can be easily observed in the field. These visible properties are indicators of hydric soils. . . ." (USDA Natural Resource Conservation Service 2008)

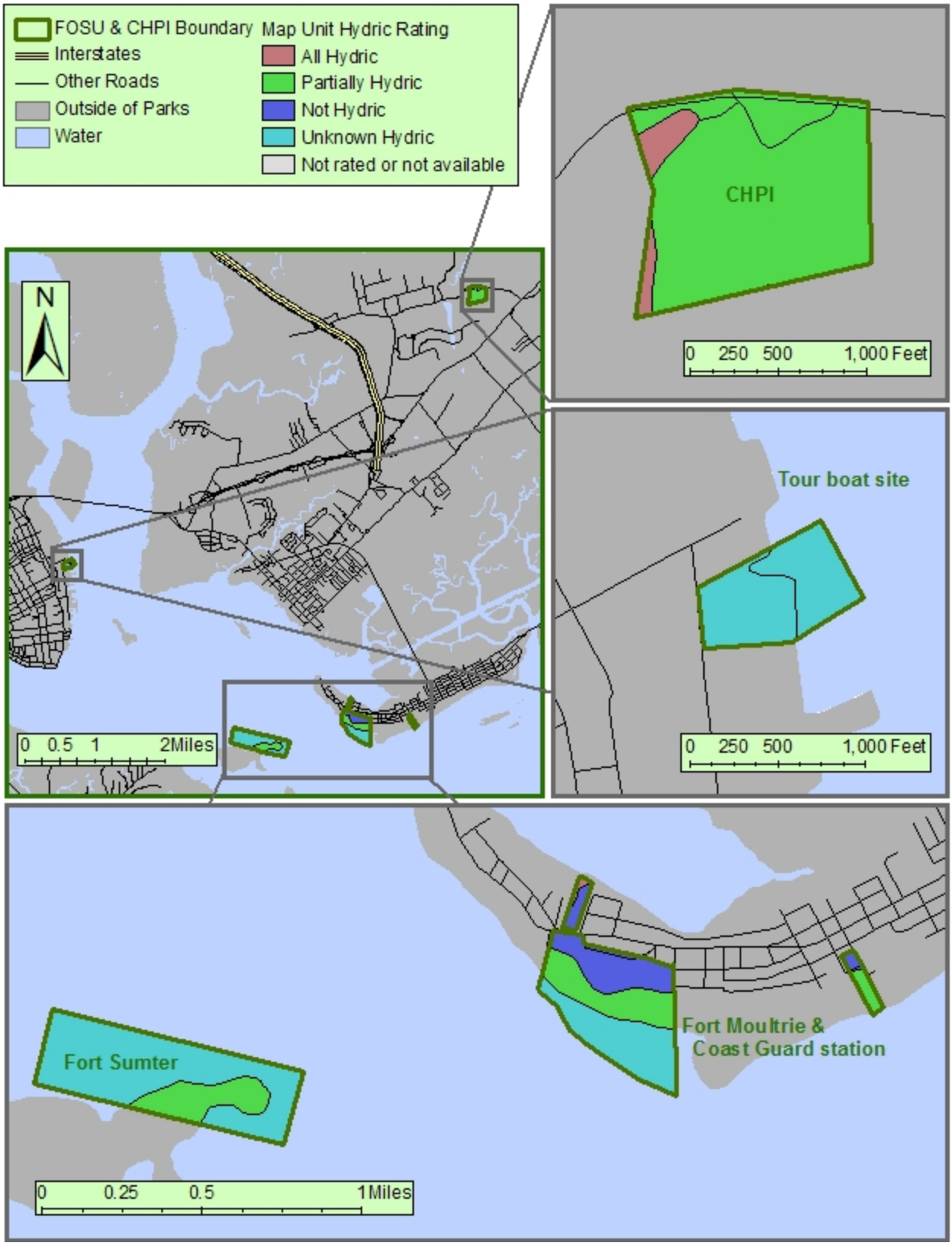

Figure 66. Hydric rating according to soil characteristics at Fort Sumter National Monument and Charles Pinckney National Historic Site.

3.5.1.b Resource threats and stressors:
Flooding from storm tides (Coastal Beaches and Dune Land), daily tides (Capers), and river flow (Yonges and Ogeechee soils) poses concerns. The Capers tidal marsh soils have high salinity and are subject to acidification if drained or oxidized. The "Dune Land" soils in the "Beaches and Dune Land" map units are subject to severe wind erosion if not vegetated. The barrier island south of Fort Moultrie and the Coast Guard Station appears to be growing seaward by accretion of sand from longshore currents. The water around Fort Sumter may be getting shallower, and the barrier island to the west of the fort may be spreading eastward. These accretions of sand are taking place despite a rise in ocean levels. The rise in ocean levels may cause increasing wake and wave action that may damage Fort Sumter.

3.5.1.c Critical knowledge or data gaps:
Data quality is good in most cases (Table 66 and Table 67), but the 1904 soil survey only included the city of Charleston. Local scale, specific soil analysis to Fort Sumter NM and Charles Pinckney NHS may be appropriate to add detail to soil characteristics.

3.5.1.d Condition status summary
Soil properties did not appear to change that drastically from the 1904 soil survey so soil change is in the good range for condition status at Fort Sumter NM (Table 66). However, improvements in soil series choices and mapping technologies were evident in the data. Potential erosion hazard is slight for the majority of soils so this category is rated in the good range (Table 66 and Table 67). The majority of Fort Sumter NM soils (not water) have a frequent flooding class and poorly drained soils, so these categories received a poor condition status (Table 66). One hundred percent of Charles Pinckney NHS soils had no flooding frequency, while 85% were moderately well drained soils. Consequently flooding frequency and drainage class were combined and received a good condition status (Table 67).

Table 66. Soil condition status summary for Fort Sumter National Monument. Data quality was rated based on *thematic* (1 = best source; 0 = not the best source), s*patial* (1 = inside park boundary; 0 = outside park boundary), and *temporal* (1 = recent; 0 = older than 5 years). The colors green, yellow, and red refer to good, fair, and poor scores respectively (see Table 1).

Category	***Condition Status***	***Midpoint***	***Data Quality***		
			Thematic	*Spatial*	*Temporal*
Soil change			0	1	1
	Good	0.84	2 out of 3		
Potential erosion			1	1	1
	Good	0.84	3 out of 3		
Flooding frequency and drainage class			1	1	1
	Poor	0.17	3 out of 3		
Soil total			3	3	3
	Fair	0.62	9 out of 9		

Table 67. Soil condition status summary for Charles Pinckney National Historic Site. Data quality was rated based on *thematic* (1 = best source; 0 = not the best source), s*patial* (1 = inside park boundary; 0 = outside park boundary), and *temporal* (1 = recent; 0 = older than 5 years). The colors green, yellow, and red refer to good, fair, and poor scores respectively (see Table 1).

Category	***Condition Status***	***Midpoint***	***Data Quality***		
			Thematic	*Spatial*	*Temporal*
Soil change			0	0	0
	N/A	--	0 out of 3		
Potential erosion			1	1	1
	Good	0.84	3 out of 3		
Flooding frequency and drainage class			1	1	1
	Good	0.84	3 out of 3		
Soil total			3	3	3
	Good	0.84	9 out of 9		

3.5.1.e Recommendations to park managers:
We recommend controlling wave and wake erosion on the edges of Fort Sumter if the building is in danger as sea level rises. We also advise avoiding excavation in the tidal marsh as well as filling and building on the tidal marsh soils. These soils have low strength and the potential to produce ultra-acidic properties. Tidal flooding and high salinity are a problem in the marsh areas. Shoreline erosion and damage from storm tides should be planned for. Park egress during tropical storms should be planned for. Park managers should be aware of and follow all wetland protection regulations.

3.6 Biological Integrity

3.6.1 Focal Communities and At-risk Biota

The species of plants and animals found within the boundary of Fort Sumter NM and Charles Pinckney NHS are the product of numerous habitat factors. The principal natural land cover classes found on the parks are coastal wetlands and evergreen forest. These classes of vegetation are no doubt comprised of several different plant communities which vary related to wetness, salinity, and management history, among other factors.

The most dominant vegetation communities at Fort Sumter NM are open water, unconsolidated shore, and low intensity developed. At Charles Pinckney NHS, the most dominant vegetation communities include grassland, evergreen forest, and mixed forest (see 3.1.1 Landscape Dynamics for a full description of the land cover classifications at Fort Sumter NM and Charles Pinckney NHS).

The complete assemblage of species, plants and animals, at Fort Sumter NM and Charles Pinckney NHS are a direct result of several different types of vegetation, land use, and hydrologic communities that occur within its boundary. However, the species assemblages observed on the parks are certainly the product of other communities (natural or anthropogenic) outside of the management boundaries.

Ideally, an assessment of the biotic communities at Fort Sumter NM and Charles Pinckney NHS would consist of the complete range of plants and animals known to occur within the parks boundaries as well as the full suite of species found on pristine tracts of similar habitat in the same landscape. The biotic assessment would be performed on the full spectrum of animals and plants from each taxonomic class. Species absences or species located that were not part of that suite of native species would represent decreases in biotic integrity from the reference scenario.

Such a complete assessment is beyond the scope of this project. We can, however, use existing datasets for a few of these taxa to permit some insight as to the likely state of biotic communities at Fort Sumter NM and Charles Pinckney NHS. There have been just a few investigations of animals and plants at these parks over the past 20-plus years (Table 68).

Table 68. List of available animal and plant surveys for Fort Sumter National Monument and Charles Pinckney National Historic Site.

Year	*Community target for survey*	*Author(s)*
2003	Reptiles and Amphibians (FOSU/CHPI)	Tuberville, T. D., J. D. Willson, M. E. Dorcas, and J. W. Gibbons
1986	Tree survey (CHPI)	E. M. Seabrook, Jr., Inc.
1993	Plants (FOSU)	Stalter, R. and E.E. Lamont
1997	Preliminary survey of Camellias (CHPI)	Royall, M.-J. C.
2005	Plants (FOSU/CHPI)	Schmidt, J. P.

These studies have been synthesized into a species information database by the NPS (Certified Organisms: NPSpecies 2008). With this system, users can extract predicted species lists for each park in the system. We used this database to generate list of species (by-taxa) expected to occur within Fort Sumter NM and Charles Pinckney NHS. These lists were reviewed, corrected as necessary, and used in this project as current species lists.

Attempts at locating and utilizing appropriate reference datasets for comparison to Fort Sumter NM and Charles Pinckney NHS community information were more problematic. Such information is either not readily available, or is considered suspect for these purposes. Without defensible reference community assemblages, any assessments drawn using them would be suspect. We elected to focus on those communities for which the most defensible information was available. We also looked to the existing NPS Inventory and Monitoring (I&M) Vital Signs Program for the Southeast Coastal Network to provide some guidance as to which species communities were considered important enough for future monitoring efforts. The I&M program has specifically identified breeding forest birds and amphibians as communities of interest for that program.

3.6.1.a Current Condition:

Avian communities, Fort Sumter National Monument:

The bird community at Fort Sumter NM is reported to contain 200 species, 51 of which are listed as a confirmed “breeder” on the monument (22 of the 200 species are listed as “probably present”) (Certified Organisms: NPSpecies 2008). These species are associated with all the habitats at the monument. Due to the limited monitoring data available on breeding birds at Fort

Sumter NM, we elected to compare this suite of species to that of known breeders from the surrounding landscape.

The reference list of breeding birds was synthesized from data compiled as part of the ongoing USGS Breeding Bird Survey (BBS) effort (U.S. Geological Survey 2008b). We selected BBS routes from the surrounding landscape that had several years of survey data in them from 1966 – 2008 (Figure 67). We selected six routes in the vicinity of Fort Sumter NM for building the reference species list. We compiled the total number of species seen on each route over the 43-year period. We then counted the number of routes on which a species was observed during that period. Those species seen on at least four routes were used to compile the reference breeding bird route for the region. However, there were not adequate trend data available for the routes near Fort Sumter NM and Charles Pinckney NHS. We only used BBS data to compile a reference list, trend data collected in the future will help to better assess the bird community in the areas surrounding the parks.

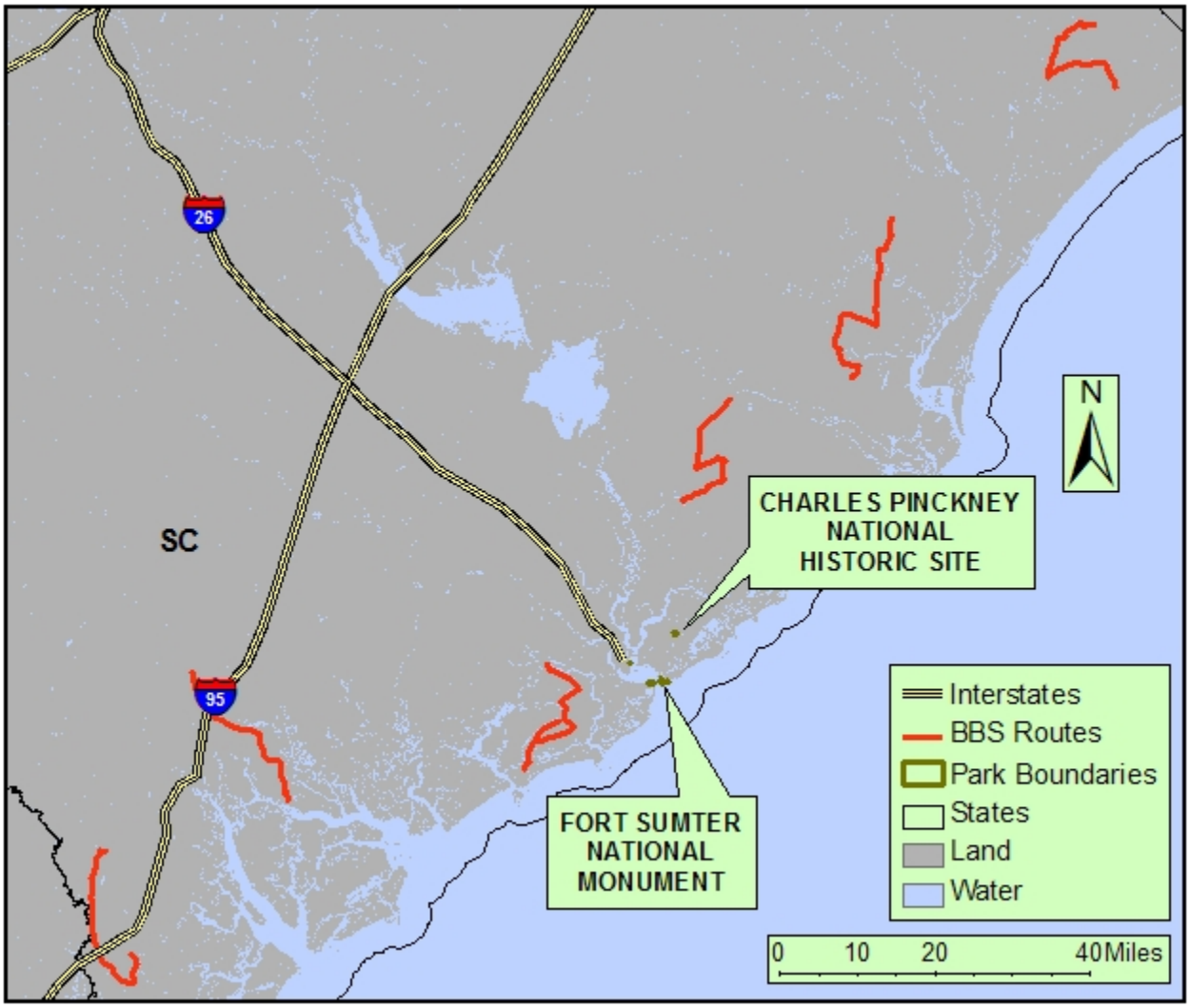

Figure 67. USGS Breeding Bird Survey Routes in the area surrounding Fort Sumter National Monument and Charles Pinckney National Historic Site that were chosen for the assessment.

A total of 79 species were identified as breeding in the landscape surrounding Fort Sumter NM. We then cross-referenced this list to the breeding list obtained for the monument. A total of 42 species were found on both lists. There were 85 species listed as "breeder" or "resident" at Fort Sumter NM that were not found on at least four of the BBS routes used to compile the reference list. The Jaccard Index of Similarity between the reference breeding bird list and the breeding bird list from Fort Sumter NM was 0.26.

The Jaccard Index of Similarity is a simple method for comparing species diversity between two different samples or communities (Krebs 1999). The value is calculated by dividing the number of species found in both samples (a) by the number found in only one sample or the other (b, c):

$S_j = a / (a+b+c)$

Furthermore, there are 46 species listed as "migratory" at the monument. Thirteen of these species were listed on the BBS reference list. If recalculated, the Jaccard Index of Similarity including these species, the index score increases to 0.28.

Additionally, we elected to use species-habitat distribution models published by the South Carolina Gap Analysis Program (South Carolina Department of Natural Resources 2008). These models were synthesized with a combination of literature review, historical records, and expert review. The resulting species-habitat models were applied to real landscapes using a land cover map derived from satellite imagery. Predicted species distributions were then attributed to specific vegetation classes and mapped for the entire state. We extracted the bird species whose distributions placed them within matching land cover classes present on Fort Sumter NM and used that as a reference list.

A total of 239 species were identified from the SC-GAP models as potentially occurring within the land cover classes coincident with Fort Sumter NM (Marine water, Fresh water marsh/emergent wetland, Sandy bare soil, Needle-leaved evergreen mixed forest/woodland, Pine woodland, Grassland/pasture, Cultivated land, Urban development, Urban residential, Low density residential, Maritime shrub complex, Estuarine salt flat/salt shrub thicket, Salt and brackish marsh, Mud/sand flat, Beach, Intertidal beach, and Coastal upland mixed forest). Of these, 155 species were documented at the monument. The Jaccard Similarity Index was calculated as 0.55 between Fort Sumter NM birds and the SC-GAP derived reference set.

Avian communities, Charles Pinckney National Historic Site:
At the time of this report, there are no available bird species reference lists for Charles Pinckney National Historic Site.

Amphibian communities, Fort Sumter National Monument:
Amphibians are of particular interest in biotic condition analysis due to their sensitivity to their surrounding environment. Recent declines in amphibian production elsewhere in the Southeast make them of further interest as part of this assessment.

Amphibians were recently inventoried at Fort Sumter NM along with reptiles (Tuberville et al. 2005). This study employed a variety of survey methods aimed at compiling the most

comprehensive list of amphibians present at the monument. Our assessment was completed using the amphibian species documented during this effort.

A total of three species of amphibian (all anurans) were observed for Fort Sumter NM as part of this survey. This study suggests that four additional amphibian species (three anurans, one salamander) have ranges coincident with Fort Sumter NM. The Jaccard Similarity Index between the observed species and the potential assemblage is 0.57.

A total of 58 species were identified from the SC-GAP models as occurring within the land cover classes coincident with Fort Sumter NM. Of these, four species were documented at Fort Sumter NM. The Jaccard Similarity Index was calculated as 0.07 between Fort Sumter NM amphibians and the SC-GAP derived reference set. However, this value represents the most conservative application of this score. A number of these are clearly without habitat at Fort Sumter NM and should be excluded from the reference potential assemblage.

These indices reflect a relatively low overlap between the amphibians present at Fort Sumter NM relative to similar habitats. That is, areas outside of the monument with similar habitat characteristics will have more species than were observed here. This, however, may be due to the fact Fort Sumter NM is a man-made island and lacks fresh water. Furthermore, the movement of amphibians from mainland populations and habitats to the island is difficult.

Amphibian communities, Charles Pinckney National Historic Site:
A total of three species of amphibian were observed for Charles Pinckney National Historic Site as part of the Tuberville et al. (2005) survey. This study suggests that five additional amphibian species (all anurans) have ranges coincident with Charles Pinckney NHS but were not observed. Presumably, this is due to a lack of specific local-scale habitat conditions (e.g., fresh water, pine barrens) that these species require. The Jaccard Similarity Index between the observed species and the potential assemblage is 0.38.

Charles Pinckney NHS contains thirteen land cover classes defined by the SC-GAP program (Dry scrub/shrub thicket, Sandy bare soil, Needle-leaved evergreen mixed forest/woodland, Cultivated land, Urban development, Urban residential, Low density residential, Salt and brackish marsh, Swamp/bottomland (types 14-17), and Coastal upland mixed forest). A total of 59 species were identified from the SC-GAP models as occurring within the land cover classes coincident with Charles Pinckney NHS. Of these, three species were documented at the historic site. The Jaccard Similarity Index was calculated as 0.05 between Charles Pinckney NHS amphibians and the SC-GAP derived reference set.

These indices reflect a relatively low overlap between the amphibians present at the historic site relative to similar habitats. That is, areas outside of Charles Pinckney NHS with similar habitat characteristics will have more species than were observed here. Because Charles Pinckney NHS is surrounded by urban development, the movement of amphibians from/to the historic site is difficult. Although Charles Pinckney NHS has relatively few frogs and salamanders, this is likely due to the small size of the site.

Reptile communities, Fort Sumter National Monument:
A total of four species of reptiles are documented present at Fort Sumter NM. We completed a community composition analysis for reptiles similar to our methods for amphibians. Reptiles were surveyed recently (Tuberville et al. 2005) along with amphibians using similar methods. The survey suggests the potential for 38 additional species with overlapping ranges (although habitat may not be found on the monument). This yields a Jaccard Similarity Index of 0.10.

As with amphibians, we elected to utilize predicted distributions of reptile species from the SC-GAP. The SC-GAP models predicted the occurrence of 71 species in all for the land cover classes present at Fort Sumter NM. Of the 71 predicted species, four species have been observed on Fort Sumter NM, Jaccard Similarity Index of 0.06.

Reptile communities, Charles Pinckney National Historic Site:
Five species of reptiles are documented in the NPS database as present at Charles Pinckney NHS. Tuberville et al. (2005) suggests the potential for 34 additional species with overlapping ranges (although habitat may not be found on the monument). The Jaccard Similarity Index between the observed species and the potential assemblage is 0.13.

The SC-GAP models predicted the occurrence of 73 species in all. All species observed at Charles Pinckney NHS are included, so the Jaccard Similarity Index was calculated at 0.07.

Mammal communities, Fort Sumter National Monument:
There are nine species on Fort Sumter NM including one non-native species, the domestic dog (*Canis familiaris*).

We used the SC-GAP species distribution models as a reference list for comparison of mammals. The SC-GAP models predicted the presence of 62 species for the land cover classes present at Fort Sumter NM. Eight species observed on Fort Sumter NM were predicted by the SC-GAP models with a Jaccard Similarity Index of 0.13.

Mammal communities, Charles Pinckney National Historic Site:
There are 16 species at Charles Pinckney NHS including the domestic cat (*Felis catus*) and domestic dog (*Canis familiaris)*.

SC-GAP models predicted the presence of 67 species for the land cover classes present at Charles Pinckney NHS. All 14 native species observed at Charles Pinckney NHS were predicted by the SC-GAP models, Jaccard Similarity Index of 0.21.

Other communities:
There are several other key biotic communities that should be examined as part of this assessment. For the salt marsh vegetation communities, these include fish (especially breeding salt marsh species) and invertebrates (crabs and bivalves in particular). For both upland areas and salt marsh, plants are important as well.

The biotic species list compiled from the NPS biotic database (Certified Organisms: NPSpecies 2008) indicates there are 80 species of fish that utilize Fort Sumter NM. At Charles Pinckney

NHS, 3 fish species have been documented utilizing habitats for some period of their annual or seasonal life requisites.

Beall (2009) performed an analysis of the aquatic condition for Fort Sumter NM. The analysis compared native fish species documented at the monument to native fish that occur in the watersheds based on NatureServe data. Percent similarity of native fish collected at the monument was 0.28 (14/50).

Without recent field-verified studies, it is difficult to draw assessment conclusions about additional biotic groups. Factors such as abundance, distribution, and health for each group or species provide the information necessary to begin to assess their condition.

At-risk biota:
At-risk biota refers to those species that are listed as threatened or endangered (T&E) under the authority of the Endangered Species Act (U.S. Fish and Wildlife Service 2008). We took this a step further to identify those species that are listed in the State of South Carolina as endangered, threatened, rare, or priority species under the SC Comprehensive Wildlife Conservation Strategy (South Carolina Department of Natural Resources 2005). In addition, these species were cross referenced to NatureServe's global and state rankings (NatureServe 2008). The bird list was also cross referenced to the Partners in Flight Priority Species (Partners in Flight 2005) and Audubon WatchList (National Audubon Society 2007). Appendix E through Appendix P contain complete species lists with associated state and global ranks and federal and state status.

Fort Sumter NM supports a large number of priority species. There are 57 priority bird species documented at Fort Sumter NM (Table 69). This is 51% of the total number of priority species identified for South Carolina in the Comprehensive Wildlife Conservation Strategy (South Carolina Department of Natural Resources 2005). There are 99 fish (these species are listed as "probably present") and four mammal species of conservation need present within park boundaries.

Charles Pinckney NHS has low species richness for most taxonomic groups. This is partly due to the lack of surveys and the small size of the site. There has been one priority fish species documented present at the site (Table 70).

Table 69. Total number of species documented at Fort Sumter NM, number of priority species from the South Carolina Comprehensive Wildlife Conservation Strategy, and % of high priority species within South Carolina that are found on Fort Sumter NM.

Taxonomic Group	*# species documented at FOSU**	*# unconfirmed species*	*# SC high priority species***	*# high priority species at FOSU*	*% high priority species at FOSU*
Fish	--	133	225	99	44[+]
Birds	200	22	111	57	51
Mammals	9	--	24	1	4
Amphibians	4	--	19	0	--
Reptiles	4	--	32	0	--
Plants	275	--	--	--	--

*Including non-native species
**** SC DNR Comprehensive Wildlife Conservation Strategy list
[+] All unconfirmed species

Table 70. Total number of species documented at Charles Pinckney National Historic Site, number of priority species from the South Carolina Comprehensive Wildlife Conservation Strategy, and % of high priority species within South Carolina that are found on Charles Pinckney National Historic Site.

Taxonomic Group	*# species documented at CHPI**	*# unconfirmed species*	*# SC high priority species***	*# high priority species at CHPI*	*% high priority species at CHPI*
Fish	3	--	225	3	1
Birds	--	--	111	--	--
Mammals	16	--	24	0	0
Amphibians	3	--	19	0	0
Reptiles	5	--	32	0	0
Plants	77	3	--	--	--

*Including non-native species
**** SC DNR Comprehensive Wildlife Conservation Strategy list

3.6.1.b Resource threats and stressors:
The biotic communities and at-risk species of Fort Sumter NM and Charles Pinckney NHS are under constant stress from agents within and outside the parks. These threats and stressors have the ability to reduce the natural resource condition within the parks. Therefore, it is important that managers and decision makers at Fort Sumter NM and Charles Pinckney NHS identify those threats, how they may affect the natural resource condition, and how severe and imminent they may be.

Invasive species:
Invasive species, particularly those that are exotic, have the potential to degrade native species and their habitat. They occupy habitat niches that would otherwise support native species, thereby degrading species communities. Invasive species are present at Fort Sumter NM and Charles Pinckney NHS (Table 71 and Table 72). Invasive plant species comprise 26% of all plant species at Fort Sumter NM and 20% of all plant species at Charles Pinckney NHS. The South Carolina Exotic Pest Plant Council (2008) lists species of greatest concern for the state of

South Carolina. Fort Sumter NM has seven species listed as a "severe threat" and four listed as a "significant threat." Charles Pinckney NHS has four "severe threat" species and two "significant threat" species. Severe threat species present on both sites include: mimosa, chinaberry, Chinese tallow tree, thorny-olive, Japanese privet, Chinese privet, Japanese honeysuckle, Chinese wisteria, bahia grass, and Johnson grass.

Table 71. Proportion of invasive species by taxa at Fort Sumter National Monument.

Taxonomic Group	*# Native species*	*# Non-native Species*	*% Non-native species*
Birds	196	4	2
Amphibians	4	0	0
Reptiles	4	0	0
Mammals	8	1	11
Fish	133	0	0
Plants	204	70	26

Table 72. Proportion of invasive species by taxa at Charles Pinckney National Historic Site.

Taxonomic Group	*# Native species*	*# Non-native Species*	*% Non-native species*
Birds	--	--	--
Amphibians	5	0	0
Reptiles	7	0	0
Mammals	16	3	16
Fish	--	--	--
Plants	77	19	20

External threats and stressors:
There are many external threats to the biotic communities of Fort Sumter NM and Charles Pinckney NHS from factors external to the boundaries, and management authority of the NPS. These factors have been covered extensively in previous sections and include:

1. Surrounding population growth, resulting in increased potential impacts to air and water quality near Charles Pinckney National Historic Site.
2. Sea level rise at Fort Sumter NM.
3. Dredging of the Charleston Harbor area.
4. Invasive aquatic invertebrate species inhabiting the Charleston Harbor estuary.

3.6.1.c Critical knowledge or data gaps:
Vital Signs Program for the Southeast Coastal Network (DeVivo et al. 2008) provides some guidance as to which species communities were considered important enough for future monitoring efforts. A lack of comprehensive survey efforts certainly contributes to some of the observed differences. Similarity index scores for birds, for example, may increase with more comprehensive data from within the monument. These surveys should not only focus on species inventory, but should also address abundance which, over time, will provide better information to complete biotic community assessments.

The following are specific knowledge gaps identified:

1. Extent of invasive species and their effects on the natural resources within park boundaries.
2. Unknown abundance of the majority of all faunal species, particularly population size and residency of most bird species.

3.6.1.d Condition status summary

The Jaccard similarity index scores were cross referenced to report on the condition status for each of the major taxa (Table 73 and Table 74). The overall condition status is in the poor range for biological integrity for both Fort Sumter NM and Charles Pinckney NHS. The species assemblages present at the parks do not appear to reflect the more complete biotic communities observed in the surrounding areas. Relatively low similarity scores for most taxa may reflect the relatively low diversity at Fort Sumter NM and Charles Pinckney NHS as a result. This is primarily due to the small size of the parks and the fact that the majority of the land cover surrounding and on the parks is developed.

Table 73. Biotic community condition status summary for Fort Sumter National Monument. Data quality was rated based on *thematic* (1 = best source; 0 = not the best source), s*patial* (1 = inside park boundary; 0 = outside park boundary), and *temporal* (1 = recent; 0 = older than 5 years). The colors green, yellow, and red refer to good, fair, and poor scores respectively.

Category	***Condition Status***	***Score Midpoint***	***Data Quality***		
			Thematic	*Spatial*	*Temporal*
Bird community composition		(0.26 - 0.55)	1	0	1
	Fair	0.5		2 out of 3	
Amphibian community		(0.07 – 0.38)	1	0	1
	Poor	0.17		2 out of 3	
Reptile community		(0.06 – 0.10)	1	0	1
	Poor	0.17		2 out of 3	
Mammal community		(0.13)	1	0	1
	Poor	0.17		2 out of 3	
Fish community		(0.28)	0	1	1
	Poor	0.17		2 out of 3	
Biological integrity total			5	0	5
	Poor	0.24		10 out of 15	

Table 74. Biotic community condition status summary for Charles Pinckney National Historic Site. Data quality was rated based on *thematic* (1 = best source; 0 = not the best source), s*patial* (1 = inside park boundary; 0 = outside park boundary), and *temporal* (1 = recent; 0 = older than 5 years). The colors green, yellow, and red refer to good, fair, and poor scores respectively.

Category	***Condition Status***	***Score Midpoint***	***Data Quality***		
			Thematic	*Spatial*	*Temporal*
Amphibian community		(0.05 - 0.38)	1	0	1
	Poor	0.17	2 out of 3		
Reptile community		(0.07 – 0.13)	1	0	1
	Poor	0.17	2 out of 3		
Mammal community		(0.21)	1	0	1
	Poor	0.17	2 out of 3		
Biological integrity total					
	Poor	0.17	6 out of 9		

3.6.1.e Recommendations to park managers:
Park managers are aware of the need for long-term monitoring data. However, there are several factors limiting park personnel to conduct needed surveys and monitoring programs. Clearly, if surveys were conducted over several years where population trend data were available, personnel would be better able to assess habitat quality.

The following are recommended projects for Fort Sumter NM when the opportunity arises:

1. Conduct invasive species monitoring, aquatics and plants.
2. Continue amphibian and reptile monitoring
3. Continue to monitor and protect underwater resources. Two endangered species, the manatee and the loggerhead turtle, migrate through the waters adjacent to Fort Sumter, but do not live or nest within the park itself.
4. Determine the status and trends of fisheries take in waters inside the park boundaries (DeVivo et al. 2008).

The following are recommended projects for Charles Pinckney NHS when the opportunity arises:

1. Complete a breeding bird inventory. Develop relationship with the Charleston Natural History Society, the local Audubon chapter, etc.
2. Initiate invasive species monitoring.
3. Initiate amphibian and reptile monitoring.

4.0 Summary and Conclusion

The overall condition status for Fort Sumter NM is in the fair range (0.47; Table 76); Charles Pinckney NHS is also in the fair range (0.59; Table 77). Midpoint scores were averaged for each NPS ecological monitoring framework level 2 category (Fancy et al. 2008) to come up with the overall condition status for the monument. The data quality scores were summed for each category.

At Fort Sumter NM, fire dynamics is the only category to score in the good range. Fire dynamics is a broad-scale assessment category upon which Fort Sumter NM has limited management influence. Consistent reporting and collaboration are essential for these categories.

Human effects, visitor use, climate, water quality, and soils are all in the fair range at Fort Sumter NM. Human effects are plentiful in this region and impervious surface coverage for Fort Sumter NM and within the subbasin study area are relatively high. Visitor and recreation use is rated fair because statistics indicated a sharp increase in visitors and it has been one of the most visited forts managed by the NPS. Climate and water quality are categories that will need coordination with other management organizations to improve. The limiting factors for water quality were fecal coliform and contaminants. Soils have remained relatively consistent, but flooding frequency and drainage class were poor.

Landscape dynamics, hydrology, and biological integrity for Fort Sumter NM were extremely limiting. This is more than likely due to the fact that this monument is within a highly urbanized area and the monument is focused on cultural resource management. Despite these findings, improvements could be made. The landscape was rated within the monument and shows there is very little natural vegetation. Wetland functionality was rated poor in most cases. In addition, the species assemblages present at Fort Sumter NM do not appear to reflect the more complete biotic communities observed in the surrounding areas. Additionally, air quality at Fort Sumter NM received a poor rating. Despite a fair ozone exposure score, the poor rating was a result of high levels of estimated atmospheric deposition and poor visibility due to a high Haze Index score. Similar to landscape, fire, and human effects, air quality is a broad-scale assessment category upon which Fort Sumter NM has limited management influence.

For Charles Pinckney NHS, landscape dynamics, fire dynamics, visitor use, and soils scored in the good range. Landscape and fire are broad-scale assessment categories upon which Charles Pinckney NHS has limited management influence. Consistent reporting and collaboration are essential for these categories. Statistics do not indicate a sharp increase in visitors and there is no additional data to indicate a negative correlation between visitor use and natural resource condition. Soils have remained relatively consistent with the only limiting factor being the flooding frequency.

Categories that scored in the fair range included human effects, climate, hydrology, and water quality. Human effects are plentiful in this region and impervious surface coverage for Charles Pinckney NHS and within the subbasin study area are relatively high. Climate and water quality are categories that will need coordination with other management organizations to improve. The

limiting factors for water quality were dissolved oxygen, fecal coliform, and contaminants. The wetland functionality was fair in most cases with nutrient transformation receiving a good rating.

Air quality and biological integrity received a poor rating at Charles Pinckney NHS. Despite a fair ozone exposure score, the poor air quality rating was a result of high levels of estimated atmospheric deposition and poor visibility due to a high Haze Index score. Similar to landscape, fire, human effects, and climate, air quality is a broad-scale assessment category upon which Charles Pinckney NHS has limited management influence. Pertaining to the poor biological integrity score, the species assemblages present at the historic site do not appear to reflect the more complete biotic communities observed in the surrounding areas. Relatively low similarity scores for most taxa may reflect the relatively low diversity at both Fort Sumter NM and Charles Pinckney NHS as a result. This is primarily due to the small size of the parks and the fact that the majority of the landcover surrounding and within the parks is developed.

For both parks, thematic (best-source) and spatial proximity, to a lesser degree, are the limiting factors in data quality. Thematic is often in the fair range for data quality mostly due to needing more local-scale data. These parks were established primarily to protect cultural resources, so a minimal amount of natural resource data has been collected on-site. There are plans to map vegetation communities and continue species and community inventory and monitoring. An observation that is present in several of the assessment categories is the importance of coordination with outside management organizations. It is also noted in several categories that additional local-scale data collection could improve assessment and management.

The good, fair, poor scoring system (Table 75) has its limitations. It is somewhat subjective, especially when pre-established thresholds and criteria were missing. However, in most cases we were able to find thresholds from other agencies or peer-reviewed publications. We make note of the cases where established rating systems or thresholds were not available. With these caveats in mind, we effectively reported on the condition status of important natural resource management categories while providing further information on data quality.

Table 75. Condition status scoring system for Fort Sumter National Monument and Charles Pinckney National Historic Site Natural Resource Assessment.

Score	*Range*	*Midpoint*
Good	0.67 – 1.00	0.84
Fair	0.34 – 0.66	0.5
Poor	0.00 – 0.33	0.17

Table 76. Overall condition status summary for Fort Sumter National Monument. Data quality was rated based on *thematic* (1 = best source; 0 = not the best source), s*patial* (1 = inside park boundary; 0 = outside park boundary), and *temporal* (1 = recent; 0 = older than 5 years). The colors green, yellow, and red refer to good, fair, and poor scores respectively (see Table 75).

Category	***Condition Status***	***Score***	***Data Quality***		
			Thematic	*Spatial*	*Temporal*
Landscape dynamics total			0	3	0
	Poor	0.28	3 out of 9		
Fire dynamics total			0	1	1
	Good	0.84	2 out of 3		
Human effects total			1	2	2
	Fair	0.50	5 out of 6		
Visitor use total			0	1	1
	Fair	0.50	2 out of 3		
Air quality total			3	1	3
	Poor	0.28	7 out of 9		
Climate total			5	1	5
	Fair	0.57	11 out of 15		
Hydrology total			0	6	6
	Poor	0.30	12 out of 18		
Water quality total			3	4	1
	Fair	0.59	8 out of 12		
Soil total			2	3	3
	Fair	0.62	8 out of 9		
Biotic total			5	0	5
	Poor	0.24	10 out of 15		
FOSU overall			19	22	25
	Fair	0.47	66 out of 99		

Table 77. Overall condition status summary for Charles Pinckney National Historic Site. Data quality was rated based on *thematic* (1 = best source; 0 = not the best source), s*patial* (1 = inside park boundary; 0 = outside park boundary), and *temporal* (1 = recent; 0 = older than 5 years). The colors green, yellow, and red refer to good, fair, and poor scores respectively (see Table 75).

Category	***Condition Status***	***Score***	***Data Quality***		
			Thematic	*Spatial*	*Temporal*
Landscape dynamics total			0	3	0
	Good	0.73	3 out of 9		
Fire dynamics total			0	1	1
	Good	0.84	2 out of 3		
Human effects total			1	2	2
	Fair	0.50	5 out of 6		
Visitor use total			0	1	1
	Good	0.84	2 out of 3		
Air quality total			3	1	3
	Poor	0.28	7 out of 9		
Climate total			5	1	5
	Fair	0.57	11 out of 15		
Hydrology total			0	6	6
	Fair	0.57	12 out of 18		
Water quality total			3	4	1
	Fair	0.54	8 out of 12		
Soil total			2	2	2
	Good	0.84	6 out of 9		
Biotic total			3	0	3
	Poor	0.17	6 out of 9		
CHPI overall			17	21	24
	Fair	0.59	62 out of 93		

This project provided a comprehensive amount of organized tabular data and many geospatial data layers and maps that will aid in the management of Fort Sumter NM and Charles Pinckney NHS. These data are provided on an accompanying disk and can be used to compare current status to future conditions. This is merely a first step to compiling data and reporting on current condition status, data gaps, and threats and stressors. A well established assessment protocol will include follow-up and future analysis.

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Appendices

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Appendix A: Land cover calculation methods.

We used "Extract by Mask" in ArcToolbox (ESRI 2006) to clip each land cover dataset to the study areas. In some cases when the study areas went into another state, multiple datasets were mosaicked (combined) in ERDAS Imagine (Leica Geosystems Geospatial Imaging 2004). In some cases we performed grid reclassification and relabeling of class name to simplify and to make the raster files that were produced more useable.

NOAA Coastal Change Analysis Program Classification Scheme (National Oceanic and Atmospheric Administration 2008a):

Uplands
Consisting of areas above sea level where saturated soils and standing water are absent. Also, the Hydrologic regime is not sufficiently wet to support vegetation associated with wetlands. Upland features are divided into classes such as High, Medium, Low Intensity Development, Cultivated land, Grassland, Pasture/ Hay, Barren land, Scrub/Shrub, Dwarf Shrub, Deciduous, Evergreen and Mixed Forest.

2- *Developed, High Intensity* – Includes highly developed areas where people reside or work in high numbers. Impervious surfaces account for 80 to 100 percent of the total cover.
Characteristic land cover features: Large commercial/industrial complexes and associated parking, commercial strip development, large barns, hangars, interstate highways, and runways.

3- *Developed, Medium Intensity* – Includes areas with a mixture of constructed materials and vegetation. Impervious surfaces account for 50 to 79 percent of the total cover.
Characteristic land cover features: Small buildings such as single family housing units, farm outbuildings, and large sheds.

4- *Developed, Low Intensity* – Includes areas with a mixture of constructed materials and vegetation. Impervious surfaces account for 21 to 49 percent of total cover.
Characteristic land cover features: Same as Medium Intensity Developed with the addition of streets and roads with associated trees and grasses. If roads or portions of roads are present in the imagery they are represented as this class in the final land cover product.

5- *Developed, Open Space* – Includes areas with a mixture of some constructed materials, but mostly vegetation in the form of lawn grasses. Impervious surfaces account for less than 20 percent of total cover.
Characteristic land cover features: Parks, lawns, athletic fields, golf courses, and natural grasses occurring around airports and industrial sites.

6- *Cultivated Crops* – Areas used for the production of annual crops. Crop vegetation accounts for greater than 20 percent of total vegetation. This class also includes all land being actively tilled.
Characteristic land cover features: Crops (corn, soybeans, vegetables, tobacco, and cotton), orchards, nurseries, and vineyards.

7- *Pasture/Hay* – Areas of grasses, legumes, or grass-legume mixtures planted for livestock grazing or the production of seed or hay crops, typically on a perennial cycle and not tilled. Pasture/hay vegetation accounts for greater than 20 percent of total vegetation.
Characteristic land cover features: Crops such as alfalfa, hay, and winter wheat.

8- *Grassland/Herbaceous* – Areas dominated by grammanoid or herbaceous vegetation, generally greater than 80 percent of total vegetation. These areas are not subject to intensive management such as tilling, but can be utilized for grazing.
Characteristic land cover features: Prairies, meadows, fallow fields, clear-cuts with natural grasses, and undeveloped lands with naturally occurring grasses.

9- *Deciduous Forest* – Areas dominated by trees generally greater than 5 meters tall and greater than 20 percent of total vegetation cover. More than 75 percent of the tree species shed foliage simultaneously in response to seasonal change.
Characteristic species: Maples (*Acer*), Hickory (*Carya*), Oaks (*Quercus*), and Aspen (*Populus tremuloides*).

10- *Evergreen Forest* – Areas dominated by trees generally greater than 5 meters tall and greater than 20 percent of total vegetation cover. More than 75 percent of the tree species maintain their leaves all year. Canopy is never without green foliage.
Characteristic species: Longleaf pine (*Pinus palustris*), slash pine (*Pinus ellioti*), shortleaf pine (*Pinus echinta*), loblolly pine (*Pinus taeda*), and other southern yellow (*Picea*); various spruces and balsam fir (*Abies balsamea*); white pine (*Pinus strobus*), red pine (*Pinus resinosa*), and jack pine (*Pinus banksiana*); hemlock (*Tsuga canadensis*); and such western species as Douglas-fir (*Pseudotsuga menziesii*), redwood (*Sequoia sempervirens*), ponderosa pine (*Pinus monticola*), Sitka spruce (*Picea sitchensis*), Engelmann spruce (*Picea engelmanni*), western red cedar (*Thuja plicata*), and western hemlock (*Tsuga heterophylla*).

11- *Mixed Forest* – Areas dominated by trees generally greater than 5 meters tall, and greater than 20 percent of total vegetation cover. Neither deciduous nor evergreen species are greater than 75 percent of total tree cover.
Characteristic species: Those listed in 9 and 10.

12- *Scrub/Shrub* – Areas dominated by shrubs less than 5 meters tall with shrub canopy typically greater than 20 percent of total vegetation. This class includes tree shrubs, young trees in an early successional stage, or trees stunted from environmental conditions.
Characteristic species: Those listed in 9 and 10 as well as chaparral species such as chamise (*Adenostoma fasciculatum*), chaparral honeysuckle (*Lonicera interrupta*), scrub oak (*Quercus beberidifolia*), sagebrush (*artemisia tridentate*), and manzanita (*Arctostaphylos spp.*).

Wetlands
Areas dominated by saturated soils and often standing water. Wetlands vegetation is adapted to withstand long-term immersion and saturated, oxygen-depleted soils. These are divided into two salinity regimes: Palustrine for freshwater wetlands and Estuarine for saltwater wetlands. These

are further divided into Forested, Shrub/Scrub, and Emergent wetlands. Unconsolidated Shores are also included as wetlands.

13- *Palustrine Forested Wetland* – Includes all tidal and nontidal wetlands dominated by woody vegetation greater than or equal to 5 meters in height, and all such wetlands that occur in tidal areas in which salinity due to ocean-derived salts is below 0.5 percent. Total vegetation coverage is greater than 20 percent.
Characteristic species: Tupelo (Nyssa), Cottonwoods (*Populus deltoids*), Bald Cypress (*Taxodium distichum*), American elm (*Ulmus Americana*), Ash (*Fraxinus*), and tamarack.

14- *Palustrine Scrub/Shrub Wetland* – Includes all tidal and non tidal wetlands dominated by woody vegetation less than 5 meters in height, and all such wetlands that occur in tidal areas in which salinity due to ocean-derived salts is below 0.5 percent. Total vegetation coverage is greater than 20 percent. The species present could be true shrubs, young trees and shrubs, or trees that are small or stunted due to environmental conditions (Cowardin et al. 1979).
Characteristic species: Alders (*Alnus spp*.), willows (*Salix spp*.), buttonbush (*Cephalanthus occidentalis*), red osier dogwood *(Cornus stolonifera*), honeycup (*Zenobia pulverenta*), spirea (*Spiraea douglassii*), bog birch (*Betula pumila*), and young trees such as red maple (*Acer rubrum*) and black spruce (*Picea mariana*).

15- *Palustrine Emergent Wetland (Persistent)* – Includes all tidal and nontidal wetlands dominated by persistent emergent vascular plants, emergent mosses or lichens, and all such wetlands that occur in tidal areas in which salinity due to ocean-derived salts is below 0.5 percent. Plants generally remain standing until the next growing season. Total vegetation cover is greater than 80 percent.
Characteristic species: Cattails (*Typha spp*.), sedges (*Carex spp.*), bulrushes (*Scirpus spp.*), rushes (*Juncus spp*.), saw grass (*Cladium jamaicaense*), and reed (*Phragmites australis*).

16- *Estuarine Forested Wetland* – Includes all tidal wetlands dominated by woody vegetation greater than or equal to 5 meters in height, and all such wetlands that occur in tidal areas in which salinity due to ocean-derived salts is equal to or greater than 0.5 percent. Total vegetation coverage is greater than 20 percent.
Characteristic species: Red Mangrove (*Rhizophora mangle*), Black Mangrove (*Avicennia germinans*) and White Mangrove (*Languncularia racemosa*)

17- *Estuarine Scrub / Shrub Wetland* – Includes all tidal wetlands dominated by woody vegetation less than 5 meters in height, and all such wetlands that occur in tidal areas in which salinity due to ocean-derived salts is equal to or greater than 0.5 percent. Total vegetation coverage is greater than 20 percent.
Characteristic species: Sea-myrtle (*Baccharis halimifolia*) and marsh elder (*Iva frutescens*).

18- *Estuarine Emergent Wetland* – Includes all tidal wetlands dominated by erect, rooted, herbaceous hydrophytes (excluding mosses and lichens). Wetlands that occur in tidal areas in which salinity due to ocean-derived salts is equal to or greater than 0.5 percent and that are present for most of the growing season in most years. Perennial plants usually dominate these wetlands. Total vegetation cover is greater than 80 percent.

Characteristic species: Cordgrass (*Spartina spp.*), needlerush (*Juncus roemerianus*), narrow leaved cattail (*Typha angustifolia*), southern wild rice (*Zizaniopsis miliacea*), common pickleweed (*Salicornia virginica*), sea blite (*Suaeda californica*), and arrow grass (*Triglochin martimum*).

19- *Unconsolidated Shore* – Unconsolidated material such as silt, sand, or gravel that is subject to inundation and redistribution due to the action of water. Characterized by substrates lacking vegetation except for pioneering plants that become established during brief periods when growing conditions are favorable. Erosion and deposition by waves and currents produce a number of landforms representing this class.
Characteristic land cover features: Beaches, bars, and flats.

20- *Barren Land* – (rock/sand/clay) Barren areas of bedrock, desert pavement, scarps, talus, slides, volcanic material, glacial debris, sand dunes, strip mines, gravel pits, and other accumulations of earth material. Generally, vegetation accounts for less than 10 percent of total cover.
Characteristic land cover features: Quarries, strip mines, gravel pits, dunes, beaches above the high-water line, sandy areas other than beaches, deserts and arid riverbeds, and exposed rock.

21- *Open Water* – All areas of open water, generally with less than 25 percent cover of vegetation or soil.
Characteristic land cover features: Lakes, rivers, reservoirs, streams, ponds, and ocean.

Table A-1. Vegetation reclassification of C-CAP land cover to quantify "natural vegetation," "semi-natural vegetation," and "unnatural vegetation".

Vegetation Class	*C-CAP Class*
Natural Vegetation	Deciduous Forest
	Estuarine Emergent Wetland
	Estuarine Forest Wetland
	Estuarine Shrub/Scrub Wetland
	Evergreen Forest
	Grassland
	Mixed Forest
	Palustrine Emergent Wetland
	Palustrine Forested Wetland
	Palustrine Shrub/Scrub Wetland
	Shrub/Scrub
Semi-natural Vegetation	Cultivated
	Pasture/Hay
	Developed Open Space
Unnatural Vegetation	High Intensity Developed
	Low Intensity Developed
	Medium Intensity Developed
Other	Bare Land
	Unconsolidated Shore
	Water

Appendix B: Hydrology calculation methods.

The 7.5-minute Digital Elevation Model (DEM) raster datasets were produced by the U.S. Geological Survey (2008a), and were obtained from the GeoCommunity website. We used "Extract by Mask" in ArcToolbox (ESRI 2006) to clip each DEM raster to the park boundaries. In some instances, the study areas of interest were contained in multiple quadrangles. In such cases, each raster dataset was clipped to the park boundary using the "Extract by Mask" tool and subsequently merged into one dataset using "Mosaic to New Raster" in ArcToolbox. Having clipped the DEM data to the park boundaries, the data were then reclassified, symbolized, and labeled to illustrate mean sea level, two-foot storm surges, and four-foot storm surges. Each reclassification permitted the analysis of changes in the acreage and percentage of land/water extent in each of the figures.

Appendix C: Soil series description and soil ratings.

Map Unit Description (Brief)

Charleston County Area, South Carolina

[Only those map units that have entries for the selected description categories are included in this report]

Map unit: Cg - Capers silty clay loam

Description category: S5

VERY POORLY DRAINED SOILS OF THE TIDAL MARSHES AND ARE FLOODED BY SALINE WATER. THESE SOILS HAVE A VERY DARK GRAYISH BROWN SILTY CLAY SURFACE LAYER ABOUT 16 INCHES THICK AND SUBSURFACE LAYERS OF BLACK AND VERY DARK GRAY CLAY TO A DEPTH OF 60 INCHES.

Description category: SOI

8w-1 Nearly level, very poorly drained soils that are subject to flooding by tides.

Map unit: Ch - Charleston loamy fine sand

Description category: S5

POORLY DRAINED, SLOWLY PERMEABLE, SOILS ON SMALL TO MEDIUM FLOOD PLAINS AND ON FLATS AND DEPRESSIONS OF THE PIEDMONT. TYPICALLY, THESE SOILS HAVE A LOAM SURFACE LAYER, 7 INCHES THICK. THE UPPER 2 INCHES IS DARK BROWN AND THE LOWER 5 INCHES IS DARK GRAYISH-BROWN. THE UPPER PART OF THE SUBSOIL IS VERY DARK GRAY AND VERY DARK GRAYISH BROWN SANDY CLAY LOAM TO A DEPTH OF 20 IN. THE MIDDLE PART IS DARK GRAY CLAY AND CLAY LOAM TO 48 IN. THE LOWER PART IS MOTTLED SANDY CLAY LOAM TO 67 IN.

Description category: SOI

2w-1 Nearly level, moderately well drained soils with loamy subsoils. Permeability is moderate or moderately rapid. The seasonal high water table is 1.5 to 3.5 feet in natural conditions.

Description category: WSG

3o Soils of the Coastal Plain area with no serious management problems. Suited for pines and hardwoods. Reforestation and harvesting operations are not restricted even during wet periods. When slopes exceed 15 percent logging roads should be on contour and incorporate water diversions to prevent erosion. Suited for pine and hardwood natural regeneration.

Map unit: Cm - Chipley loamy fine sand

Description category: S5

NEARLY LEVEL AND GENTLY SLOPING, MODERATELY WELL DRAINED AND SOMEWHAT POORLY DRAINED SOILS ON STREAM TERRACES AND UPLANDS IN THE COASTAL PLAIN. IN A REPRESENTATIVE PROFILE, THE SURFACE LAYER IS DARK GRAYISH BROWN LOAMY SAND ABOUT 8 INCHES THICK. THE UNDERLYING LAYERS TO A DEPTH OF 80 INCHES IS LOAMY SAND. IT IS LIGHT YELLOWISH BROWN AND BROWNISH YELLOW IN THE UPPER PART AND LIGHT GRAY IN THE LOWER PART. PACTOLUS SOILS FORMED IN SEDIMENTS FROM STREAMS AND THE SEA.

Map unit: Cm - Chipley loamy fine sand

Description category: SOI

3s-4 Nearly level and gently sloping soils that are sandy. They are rapidly permeable with a seasonal high water table at 2.0 to 4.0 feet in natural conditions. Water holding capacity is low.

Description category: WSG

3s Soils in the Coastal Plain, Piedmont or Sandhills areas suitable to southern pines and hardwoods. Soils in this group are moderately droughty to extremely droughty. Seedlings should not be planted during dry periods. Sandy textures may limit equipment mobility. Hardwood and pine natural regeneration are difficult but possible.

Map unit: Co - Coastal beaches and dune land

Description category: S5

BEACHES ARE SANDY SHORES WASHED AND REWASHED BY WAVES. THE AREAS MAY BE PARTLY COVERED WITH WATER DURING HIGH TIDES OR STORMS. SLOPES RANGE FROM 1 TO 5 PERCENT. GENTLY UNDULATING TO STEEP, EXCESSIVELY DRAINED SOIL ALONG THE BEACHES AND WATERWAYS OF THE ATLANTIC COAST. IN A REPRESENTATIVE PROFILE, THE SURFACE LAYER IS GRAYISH BROWN FINE SAND ABOUT 2 INCHES THICK. THE UNDERLYING LAYER TO A DEPTH OF 72 INCHES IS LIGHT GRAY IT IS FINE SAND IN THE UPPER PART AND SAND IN THE LOWER PART.

Description category: SOI

8s-1 Soils or areas that are well drained, sandy, and are affected by salt water or salt spray.

Map unit: Ma - Made land

Description category: S5

MATERIAL REMAINING AFTER THE OVERLYING DEVELOPED SOIL HAS BEEN REMOVED OR OF MATERIAL PUMPED FROM RIVERS OR WATERWAYS. THE SOIL CONSISTS OF LOAMY MATERIAL THAT IS DOMINANTLY A SANDY CLAY LOAM.

Map unit: Sf - Scranton loamy fine sand

Description category: S5

POORLY DRAINED, LEVEL SOILS OF THE COASTAL PLAINS. THESE SOILS ARE ON FLOOD PLAINS OR DEPRESSIONAL LANDSCAPES. IN A REPRESENTATIVE PROFILE, THE SURFACE LAYER IS VERY DARK GRAYISH BROWN LOAMY FINE SAND TO A DEPTH OF 3 INCHES AND DARK GRAY AND GRAYISH BROWN LOAMY SAND BETWEEN DEPTHS OF 3 AND 8 INCHES. THE UNDERLYING LAYERS ARE GRAYISH LOAMY SAND OR SAND TO A DEPTH OF 75 INCHES.

Map unit: Sf - Scranton loamy fine sand

Description category: SOI

3w-1 Nearly level, somewhat poorly and poorly drained sandy soils with a water table at 0.5 and 2.0 feet during wet seasons (in natural conditions). They are rapidly permeable. These soils are droughty if overdrained.

Description category: WSG

3w Soils of the Coastal Plain area which are wet to excessively wet during the winter and spring. Suited to hardwoods and pines. Bedding and/or surface drainage may be necessary to ensure pine seedling survival. Natural regeneration of pine may be difficult in wet years. Suited to hardwood regeneration. Harvesting should be scheduled for dry periods.

Map unit: UR - Urban land-Yauhannah-Yemassee-Ogeechee association

Description category: S5

URBAN LAND IS LAND MOSTLY COVERED BY STREETS, PARKING LOTS, BUILDINGS, AND OTHER STRUCTURES OF URBAN AREAS.

Map unit: Yo - Yonges loamy fine sand

Description category: S5

POORLY DRAINED MODERATELY SLOWLY PERMEABLE SOILS ON FLOODPLAINS OF THE COASTAL PLAINS. TYPICALLY, THE SURFACE LAYER IS DARK GRAYISH BROWN LOAMY FINE SAND 10 INCHES THICK. THE SUBSURFACE LAYER IS LIGHT BROWNISH GRAY FINE SANDY LOAM 4 INCHES THICK. THE NEXT LAYER IS GRAY SANDY CLAY LOAM 28 INCHES THICK. BELOW THIS TO A DEPTH OF 60 INCHES IS GRAY FINE SANDY LOAM.

Description category: SOI

6w-1 Nearly level, poorly and very poorly drained soils that flood or pond and cannot be drained and have a water table within 0.5 feet from the surface.

Description category: WSG

1w Well suited for water-tolerant hardwoods. Southern pines can be planted if special practices such as bedding and/or surface drainage are undertaken to ensure seedling survival. Seasonally very high water table or ponding and/or occasional flooding during the winter and spring. Some of these soils will require other than conventional logging methods because of the wetness limitation. Suited for hardwood natural regeneration.

Map Unit Description (Brief)

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the selected area. The map unit descriptions in this report, along with the maps, can be used to determine the composition and properties of a unit. A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

The "Map Unit Description (Brief)" report gives a brief, general description of the major soils that occur in a map unit. Descriptions of nonsoil (miscellaneous areas) and minor map unit components may or may not be included. This description is written by the local soil scientists responsible for the respective soil survey area data. A more detailed description can be generated by the "Map Unit Description" report.

Additional information about the map units described in this report is available in other Soil Data Mart reports, which give properties of the soils and the limitations, capabilities, and potentials for many uses. Also, the narratives that accompany the Soil Data Mart reports define

Potential Erosion Hazard (Off-Road, Off-Trail)

Aggregation Method: Dominant Condition
Tie-break Rule: Higher

Fort Sumter National Monument, South Carolina
Survey Area Version and Date: 5 - 08/23/2006

Map symbol	Component name and % composition Map unit name	Rating	Rating reasons
Cg	CAPERS SILTY CLAY LOAM	Slight	CAPERS 100%
Co	COASTAL BEACHES AND DUNE LAND	Very Severe	BEACHES 60% Not rated NEWHAN 40% Not rated
Ma	MADE LAND	Slight	HAPLAQUENTS 100%
UR	URBAN LLAND-YAUHANNAH-YEMASSEE-OGEECHEE ASSOCIATION	Very Severe	Urban land 100% Not rated
W	WATER-IRRIGATION AND FARM PONDS	Slight	WATER 100%

Potential Erosion Hazard (Off-Road, Off-Trail)

Rating Options

Attribute Name: Potential Erosion Hazard (Off-Road, Off-Trail)

Ratings indicate the hazard or risk of soil loss from off-road and off-trail areas after disturbance activities that expose the soil surface, and are based on slope and soil erodibility factor K. The soil loss is caused by sheet or rill erosion in off-road or off-trail areas where 50 to 75 percent of the surface has been exposed by logging, grazing, mining, or other kinds of disturbance.

The hazard is described as "slight", "moderate", "severe", or "very severe". A rating of "slight" indicates that erosion is unlikely under ordinary climatic conditions; "moderate" indicates that some erosion is likely and that erosion-control measures may be needed; "severe" indicates that erosion is very likely and that erosion-control measures, including revegetation of bare areas, are advised; and "very severe" indicates that significant erosion is expected, loss of soil productivity and off-site damage are likely, and erosion-control measures are costly and generally impractical.

Aggregation Method: Dominant Condition

Aggregation is the process by which a set of component attribute values is reduced to a single value to represent the map unit as a whole.

A map unit is typically composed of one or more "components". A component is either some type of soil or some nonsoil entity, e.g., rock outcrop. The components in the map unit name represent the major soils within a map unit delineation. Minor components make up the balance of the map unit. Great differences in soil properties can occur between map unit components and within short distances. Minor components may be very different from the major components. Such differences could significantly affect use and management of the map unit. Minor components may or may not be documented in the database. The results of aggregation do not reflect the presence or absence of limitations of the components which are not listed in the database. An on-site investigation is required to identify the location of individual map unit components.

For each of a map unit's components, a corresponding percent composition is recorded. A percent composition of 60 indicates that the corresponding component typically makes up approximately 60% of the map unit. Percent composition is a critical factor in some, but not all, aggregation methods.

For the attribute being aggregated, the first step of the aggregation process is to derive one attribute value for each of a map unit's components. From this set of component attributes, the next step of the aggregation process derives a single value that represents the map unit as a whole. Once a single value for each map unit is derived, a thematic map for soil map units can be generated. Aggregation must be done because, on any soil map, map units are delineated but components are not.The aggregation method "Dominant Condition" first groups like attribute values for the components in a map unit. For each group, percent composition is set to the sum of the percent composition of all components participating in that group. These groups now represent "conditions" rather than components. The attribute value associated with the group with the highest cumulative percent composition is returned. If more than one group shares the highest cumulative percent composition, the corresponding "tie-break" rule determines which value should be returned. The "tie-break" rule indicates whether the lower or higher group value should be returned in the case of a percent composition tie.

The result returned by this aggregation method represents the dominant condition throughout the map unit only when no tie has occurred.

Tie-break Rule: Higher

The tie-break rule indicates which value should be selected from a set of multiple candidate values, or which value should be selected in the event of a percent composition tie.

USDA Natural Resources Conservation Service

Erosion Hazard (Off-Road, Off-Trail)

Aggregation Method: Dominant Condition Tie-break Rule: Higher

Charleston County Area, South Carolina
Survey Area Version and Date: 6 - 09/22/2006

Map symbol	Map unit name	Rating	Component name and % composition Rating reasons
Ch	Charleston loamy fine sand	Slight	Charleston 97% Yonges 3%
Cm	Chipley loamy fine sand	Slight	Pactolus 97% Rutlege 3%
Sf	Scranton loamy fine sand	Slight	Osier 96% Rutlege 4%
Yo	Yonges loamy fine sand	Slight	Yonges 100%

Water Features

Charleston County Area, South Carolina

[Depths of layers are in feet. See text for definitions of terms used in this table. Estimates of the frequency of ponding and flooding apply to the whole year rather than to individual months. Absence of an entry indicates that the feature is not a concern or that data were not estimated]

Map symbol and soil name	Hydrologic group	Surface runoff	Months	Water table			Ponding		Flooding	
				Upper limit	Lower limit	Surface water depth	Duration	Frequency	Duration	Frequency
				Ft	*Ft*	*Ft*				
Cg:										
Capers	D	Very high	January	0.0	>6.0	0.0-1.0	Very long	Frequent	Very long	Very frequent
			February	0.0	>6.0	0.0-1.0	Very long	Frequent	Very long	Very frequent
			March	0.0	>6.0	0.0-1.0	Very long	Frequent	Very long	Very frequent
			April	0.0	>6.0	0.0-1.0	Very long	Frequent	Very long	Very frequent
			May	0.0	>6.0	0.0-1.0	Very long	Frequent	Very long	Very frequent
			June	0.0	>6.0	0.0-1.0	Very long	Frequent	Very long	Very frequent
			July	0.0	>6.0	0.0-1.0	Very long	Frequent	Very long	Very frequent
			August	0.0	>6.0	0.0-1.0	Very long	Frequent	Very long	Very frequent
			September	0.0	>6.0	0.0-1.0	Very long	Frequent	Very long	Very frequent
			October	0.0	>6.0	0.0-1.0	Very long	Frequent	Very long	Very frequent
			November	0.0	>6.0	0.0-1.0	Very long	Frequent	Very long	Very frequent
			December	0.0	>6.0	0.0-1.0	Very long	Frequent	Very long	Very frequent
Ch:										
Charleston	C	Very low	January	2.0-3.5	>6.0	---	---	None	---	None
			February	2.0-3.5	>6.0	---	---	None	---	None
			March	2.0-3.5	>6.0	---	---	None	---	None
			December	2.0-3.5	>6.0	---	---	None	---	None
Yonges	D	Very high	January	0.0-0.5	>6.0	---	---	None	---	None
			February	0.0-0.5	>6.0	---	---	None	---	None
			March	0.0-0.5	>6.0	---	---	None	---	None
			April	0.0-0.5	>6.0	---	---	None	---	None
			May	0.0-0.5	>6.0	---	---	None	---	None
			December	0.0-0.5	>6.0	---	---	None	---	None

Water Features
Charleston County Area, South Carolina

Map symbol and soil name	Hydrologic group	Surface runoff	Months	Water table		Ponding			Flooding	
				Upper limit	Lower limit	Surface water depth	Duration	Frequency	Duration	Frequency
				Ft	*Ft*	*Ft*				
Cm:										
Pactolus	A	Very low	January	1.5-3.0	>6.0	---	---	None	---	None
			February	1.5-3.0	>6.0	---	---	None	---	None
			March	1.5-3.0	>6.0	---	---	None	---	None
			April	1.5-3.0	>6.0	---	---	None	---	None
			December	1.5-3.0	>6.0	---	---	None	---	None
Rutlege	B/D	Very high	January	0.0-1.0	>6.0	---	---	None	Long	Frequent
			February	0.0-1.0	>6.0	---	---	None	Long	Frequent
			March	0.0-1.0	>6.0	---	---	None	Long	Frequent
			April	0.0-1.0	>6.0	---	---	None	Long	Frequent
			May	0.0-1.0	>6.0	---	---	None	Long	Frequent
			November	0.0-1.0	>6.0	---	---	None	Long	Frequent
			December	0.0-1.0	>6.0	---	---	None	Long	Frequent
Co:										
Beaches	D	Very low	January	0.0->6.0	>6.0	---	---	None	Long	Frequent
			February	0.0->6.0	>6.0	---	---	None	Long	Frequent
			March	0.0->6.0	>6.0	---	---	None	Long	Frequent
			April	0.0->6.0	>6.0	---	---	None	Long	Frequent
			May	0.0->6.0	>6.0	---	---	None	Long	Frequent
			June	0.0->6.0	>6.0	---	---	None	Long	Frequent
			July	0.0->6.0	>6.0	---	---	None	Long	Frequent
			August	0.0->6.0	>6.0	---	---	None	Long	Frequent
			September	0.0->6.0	>6.0	---	---	None	Long	Frequent
			October	0.0->6.0	>6.0	---	---	None	Long	Frequent
			November	0.0->6.0	>6.0	---	---	None	Long	Frequent
			December	0.0->6.0	>6.0	---	---	None	Long	Frequent

Water Features
Charleston County Area, South Carolina

Map symbol and soil name	Hydrologic group	Surface runoff	Months	Water table		Ponding			Flooding	
				Upper limit	Lower limit	Surface water depth	Duration	Frequency	Duration	Frequency
				Ft	*Ft*	*Ft*				
Co:										
Newhan	A	Negligible	January	---	---	---	---	None	---	Rare
			February	---	---	---	---	None	---	Rare
			March	---	---	---	---	None	---	Rare
			April	---	---	---	---	None	---	Rare
			May	---	---	---	---	None	---	Rare
			June	---	---	---	---	None	---	Rare
			July	---	---	---	---	None	---	Rare
			August	---	---	---	---	None	---	Rare
			September	---	---	---	---	None	---	Rare
			October	---	---	---	---	None	---	Rare
			November	---	---	---	---	None	---	Rare
			December	---	---	---	---	None	---	Rare
Ma:										
Haplaquents	B	Low	Jan-Dec			---	---	None	---	None
Sf:										
Osier	A/D	Very high	January	0.0-0.5	>6.0	---	---	None	---	None
			February	0.0-0.5	>6.0	---	---	None	---	None
			March	0.0-0.5	>6.0	---	---	None	---	None
			November	0.0-0.5	>6.0	---	---	None	---	None
			December	0.0-0.5	>6.0	---	---	None	---	None
Rutlege	B/D	Very high	January	0.0-1.0	>6.0	---	---	None	Long	Frequent
			February	0.0-1.0	>6.0	---	---	None	Long	Frequent
			March	0.0-1.0	>6.0	---	---	None	Long	Frequent
			April	0.0-1.0	>6.0	---	---	None	Long	Frequent
			May	0.0-1.0	>6.0	---	---	None	Long	Frequent
			November	0.0-1.0	>6.0	---	---	None	Long	Frequent
			December	0.0-1.0	>6.0	---	---	None	Long	Frequent

Water Features
Charleston County Area, South Carolina

Map symbol and soil name	Hydrologic group	Surface runoff	Months	Water table		Ponding			Flooding	
				Upper limit	Lower limit	Surface water depth	Duration	Frequency	Duration	Frequency
				Ft	*Ft*	*Ft*				
UR:										
Urban land	---	Low	Jan-Dec			---	---	None	---	None
Yauhannah	B	Low	January	1.5-2.5	>6.0	---	---	None	---	None
			February	1.5-2.5	>6.0	---	---	None	---	None
			March	1.5-2.5	>6.0	---	---	None	---	None
			December	1.5-2.5	>6.0	---	---	None	---	None
Ogeechee	B/D	Very high	January	0.0-1.0	>6.0	---	---	None	---	None
			February	0.0-1.0	>6.0	---	---	None	---	None
			March	0.0-1.0	>6.0	---	---	None	---	None
			April	0.0-1.0	>6.0	---	---	None	---	None
			May	0.0-1.0	>6.0	---	---	None	---	None
			December	0.0-1.0	>6.0	---	---	None	---	None
Yemassee	C	Very high	January	1.0-1.5	>6.0	---	---	None	---	None
			February	1.0-1.5	>6.0	---	---	None	---	None
			March	1.0-1.5	>6.0	---	---	None	---	None
			December	1.0-1.5	>6.0	---	---	None	---	None
W:										
Water	---	---	Jan-Dec			---	---	None	---	None
Yo:										
Yonges	D	Very high	January	0.0-0.5	>6.0	---	---	None	---	None
			February	0.0-0.5	>6.0	---	---	None	---	None
			March	0.0-0.5	>6.0	---	---	None	---	None
			April	0.0-0.5	>6.0	---	---	None	---	None
			May	0.0-0.5	>6.0	---	---	None	---	None
			December	0.0-0.5	>6.0	---	---	None	---	None

Water Features

This table gives estimates of various soil water features. The estimates are used in land use planning that involves engineering considerations.

"Hydrologic soil groups" are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The four hydrologic soil groups are:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas.

"Surface runoff" refers to the loss of water from an area by flow over the land surface. Surface runoff classes are based on slope, climate, and vegetative cover. The concept indicates relative runoff for very specific conditions. It is assumed that the surface of the soil is bare and that the retention of surface water resulting from irregularities in the ground surface is minimal. The classes are negligible, very low, low, medium, high, and very high.

The "months" in the table indicate the portion of the year in which a water table, ponding, and/or flooding is most likely to be a concern.

"Water table" refers to a saturated zone in the soil. The water features table indicates, by month, depth to the top ("upper limit") and base ("lower limit") of the saturated zone in most years. Estimates of the upper and lower limits are based mainly on observations of the water table at selected sites and on evidence of a saturated zone, namely grayish colors or mottles (redoximorphic features) in the soil. A saturated zone that lasts for less than a month is not considered a water table.

"Ponding" is standing water in a closed depression. Unless a drainage system is installed, the water is removed only by percolation, transpiration, or evaporation. The table indicates "surface water depth" and the "duration" and "frequency" of ponding. Duration is expressed as "very brief" if less than 2 days, "brief" if 2 to 7 days, "long" if 7 to 30 days, and "very long" if more than 30 days. Frequency is expressed as none, rare, occasional, and frequent. "None" means that ponding is not probable; "rare" that it is unlikely but possible under unusual weather conditions (the chance of ponding is nearly 0 percent to 5 percent in any year); "occasional" that it occurs, on the average, once or less in 2 years (the chance of ponding is 5 to 50 percent in any year); and "frequent" that it occurs, on the average, more than once in 2 years (the chance of ponding is more than 50 percent in any year).

"Flooding" is the temporary inundation of an area caused by overflowing streams, by runoff from adjacent slopes, or by tides. Water standing for short periods after rainfall or snowmelt is not considered flooding, and water standing in swamps and marshes is considered ponding rather than flooding.

"Duration" and "frequency" are estimated. Duration is expressed as "extremely brief" if 0.1 hour to 4 hours, "very brief" if 4 hours to 2 days, "brief" if 2 to 7 days, "long" if 7 to 30 days, and "very long" if more than 30 days. Frequency is expressed as none, very rare, rare, occasional, frequent, and very frequent. "None" means that flooding is not probable; "very rare" that it is very unlikely but possible under extremely unusual weather conditions (the chance of flooding is less than 1 percent in any year); "rare" that it is unlikely but possible under unusual weather conditions (the chance of flooding is 1 to 5 percent in any year); "occasional" that it occurs infrequently under normal weather conditions (the chance of flooding is 5 to 50 percent in any year); "frequent" that it is likely to occur often under normal weather conditions (the chance of flooding is more than 50 percent in any year but is less than 50 percent in all months in any year); and "very frequent" that it is likely to occur very often under normal weather conditions (the chance of flooding is more than 50 percent in all months of any year).

The information is based on evidence in the soil profile, namely thin strata of gravel, sand, silt, or clay deposited by floodwater; irregular decrease in organic matter content with increasing depth; and little or no horizon development.

Also considered are local information about the extent and levels of flooding and the relation of each soil on the landscape to historic floods. Information on the extent of flooding based on soil data is less specific than that provided by detailed engineering surveys that delineate flood-prone areas at specific flood frequency levels.

Drainage Class

Aggregation Method: Dominant Condition Tie-break Rule: Higher

Fort Sumter National Monument, South Carolina
Survey Area Version and Date: 5 - 08/23/2006

Map symbol	Map unit name	Rating
Cg	CAPERS SILTY CLAY LOAM	Very poorly drained
Co	COASTAL BEACHES AND DUNE LAND	Poorly drained
Ma	MADE LAND	Moderately well drained
UR	URBAN LLAND-YAUHANNAH-YEMASSEE-OGEECHEE ASSOCIATION	
W	WATER-IRRIGATION AND FARM PONDS	

Drainage Class

Rating Options

Attribute Name: Drainage Class

Drainage class (natural) refers to the frequency and duration of wet periods under conditions similar to those under which the soil formed. Alterations of the water regime by human activities, either through drainage or irrigation, are not a consideration unless they have significantly changed the morphology of the soil. Seven classes of natural soil drainage are recognized -- excessively drained, somewhat excessively drained, well drained, moderately well drained, somewhat poorly drained, poorly drained, and very poorly drained. These classes are defined in the "Soil Survey Manual."

Aggregation Method: Dominant Condition

Aggregation is the process by which a set of component attribute values is reduced to a single value to represent the map unit as a whole.

A map unit is typically composed of one or more "components". A component is either some type of soil or some nonsoil entity, e.g., rock outcrop. The components in the map unit name represent the major soils within a map unit delineation. Minor components make up the balance of the map unit. Great differences in soil properties can occur between map unit components and within short distances. Minor components may be very different from the major components. Such differences could significantly affect use and management of the map unit. Minor components may or may not be documented in the database. The results of aggregation do not reflect the presence or absence of limitations of the components which are not listed in the database. An on-site investigation is required to identify the location of individual map unit components.

For each of a map unit's components, a corresponding percent composition is recorded. A percent composition of 60 indicates that the corresponding component typically makes up approximately 60% of the map unit. Percent composition is a critical factor in some, but not all, aggregation methods.

For the attribute being aggregated, the first step of the aggregation process is to derive one attribute value for each of a map unit's components. From this set of component attributes, the next step of the aggregation process derives a single value that represents the map unit as a whole. Once a single value for each map unit is derived, a thematic map for soil map units can be generated. Aggregation must be done because, on any soil map, map units are delineated but components are not.The aggregation method "Dominant Condition" first groups like attribute values for the components in a map unit. For each group, percent composition is set to the sum of the percent composition of all components participating in that group. These groups now represent "conditions" rather than components. The attribute value associated with the group with the highest cumulative percent composition is returned. If more than one group shares the highest cumulative percent composition, the corresponding "tie-break" rule determines which value should be returned. The "tie-break" rule indicates whether the lower or higher group value should be returned in the case of a percent composition tie.

The result returned by this aggregation method represents the dominant condition throughout the map unit only when no tie has occurred.

Tie-break Rule: Higher

The tie-break rule indicates which value should be selected from a set of multiple candidate values, or which value should be selected in the event of a percent composition tie.

USDA Natural Resources Conservation Service

Drainage Class

Aggregation Method: Dominant Condition
Tie-break Rule: Higher

Charleston County Area, South Carolina
Survey Area Version and Date: 6 - 09/22/2006

Map symbol	Map unit name	Rating
Ch	Charleston loamy fine sand	Moderately well drained
Cm	Chipley loamy fine sand	Moderately well drained
Sf	Scranton loamy fine sand	Somewhat poorly drained
Yo	Yonges loamy fine sand	Poorly drained

Map Unit Hydric Rating

Aggregation Method: Absence/Presence
Tie-break Rule: Lower

Fort Sumter National Monument, South Carolina
Survey Area Version and Date: 5 - 08/23/2006

Map symbol	Map unit name	Rating
Cg	CAPERS SILTY CLAY LOAM	All Hydric
Co	COASTAL BEACHES AND DUNE LAND	Partially Hydric
Ma	MADE LAND	Not Hydric
UR	URBAN LLAND-YAUHANNAH-YEMASSEE-OGEECHEE ASSOCIATION	Unknown Hydric
W	WATER-IRRIGATION AND FARM PONDS	Unknown Hydric

Map Unit Hydric Rating

Rating Options

Attribute Name: Map Unit Hydric Rating

This rating provides an indication of the proportion of the map unit that meets criteria for hydric soils. Map units that are dominantly made up of hydric soils may have small areas, or inclusions, of nonhydric soils in the higher positions on the landform, and map units dominantly made up of nonhydric soils may have inclusions of hydric soils in the lower positions on the landform.

Hydric soils are defined by the National Technical Committee for Hydric Soils (NTCHS) as soils that formed under conditions of saturation, flooding, or ponding long enough during the growing season to develop anaerobic conditions in the upper part (Federal Register, 1994). These soils, under natural conditions, are either saturated or inundated long enough during the growing season to support the growth and reproduction of hydrophytic vegetation.

The NTCHS definition identifies general soil properties that are associated with wetness. In order to determine whether a specific soil is a hydric soil or nonhydric soil, however, more specific information, such as information about the depth and duration of the water table, is needed. Thus, criteria that identify those estimated soil properties unique to hydric soils have been established (Federal Register, 2002). These criteria are used to identify map unit components that normally are associated with wetlands. The criteria used are selected estimated soil properties that are described in "Soil Taxonomy" (Soil Survey Staff, 1999) and "Keys to Soil Taxonomy" (Soil Survey Staff, 2003) and in the "Soil Survey Manual" (Soil Survey Division Staff, 1993).

If soils are wet enough for a long enough period of time to be considered hydric, they should exhibit certain properties that can be easily observed in the field. These visible properties are indicators of hydric soils. The indicators used to make onsite determinations of hydric soils are specified in "Field Indicators of Hydric Soils in the United States" (Hurt and others, 2002).

Aggregation Method: Absence/Presence

Aggregation is the process by which a set of component attribute values is reduced to a single value to represent the map unit as a whole.

A map unit is typically composed of one or more "components". A component is either some type of soil or some nonsoil entity, e.g., rock outcrop. The components in the map unit name represent the major soils within a map unit delineation. Minor components make up the balance of the map unit. Great differences in soil properties can occur between map unit components and within short distances. Minor components may be very different from the major components. Such differences could significantly affect use and management of the map unit. Minor components may or may not be documented in the database. The results of aggregation do not reflect the presence or absence of limitations of the components which are not listed in the database. An on-site investigation is required to identify the location of individual map unit components.

For each of a map unit's components, a corresponding percent composition is recorded. A percent composition of 60 indicates that the corresponding component typically makes up approximately 60% of the map unit. Percent composition is a critical factor in some, but not all, aggregation methods.

For the attribute being aggregated, the first step of the aggregation process is to derive one attribute value for each of a map unit's components. From this set of component attributes, the next step of the aggregation process derives a single value that represents the map unit as a whole. Once a single value for each map unit is derived, a thematic map for soil map units can be generated. Aggregation must be done because, on any soil map, map units are delineated but components are not.The aggregation method "Absence/Presence" returns a value that indicates if, for all components of a map unit, a condition is always present, never present, partially present, or whether the condition's presence or absence is unknown. The exact phrases used for a particular attribute may vary from what is shown below.

"Always present" means that the corresponding condition is present in all of a map unit's components.

"Never present" means that the corresponding condition is not present in any of a map unit's components.

"Partially present" means that the corresponding condition is present in some but not all of a map unit's components, or that the presence or absence of the corresponding condition cannot be determined for one or more components of the map unit.

"Unknown presence" means that for components where presence or absence can be determined, the corresponding condition is never present, but the presence or absence of the corresponding condition cannot be determined for one or more components.

The result returned by this aggregation method quantifies the degree to which the corresponding condition is present throughout the map unit.

Tie-break Rule: Lower

The tie-break rule indicates which value should be selected from a set of multiple candidate values, or which value should be selected in the event of a percent composition tie.

Hydric Rating by Map Unit

Aggregation Method: Absence/Presence
Tie-break Rule: Lower

Charleston County Area, South Carolina
Survey Area Version and Date: 6 - 09/22/2006

Map symbol	Map unit name	Rating
Ch	Charleston loamy fine sand	Partially Hydric
Cm	Chipley loamy fine sand	Partially Hydric
Sf	Scranton loamy fine sand	Partially Hydric
Yo	Yonges loamy fine sand	All Hydric

Soil Features

Charleston County Area, South Carolina

[Absence of an entry indicates that the feature is not a concern or that data were not estimated]

Map symbol and soil name	Restrictive layer				Subsidence		Potential for frost action	Risk of corrosion	
	Kind	Depth to top	Thickness	Hardness	Initial	Total		Uncoated steel	Concrete
		In	*In*		*In*	*In*			
Cg:									
Capers	---	---	---	---	3-6	4-8	None	High	High
Ch:									
Charleston	---	---	---	---	0	---	None	Moderate	High
Yonges	---	---	---	---	0	---	None	High	Moderate
Cm:									
Pactolus	---	---	---	---	0	---	None	Low	High
Rutlege	---	---	---	---	---	---	---	High	High
Co:									
Beaches	---	---	---	---	0	---	---	---	---
Newhan	---	---	---	---	0	---	None	High	Low
Ma:									
Haplaquents	---	---	---	---	0	---	None	Moderate	High
Sf:									
Osier	---	---	---	---	0	---	None	High	High
Rutlege	---	---	---	---	---	---	---	High	High
UR:									
Urban land	---	---	---	---	0	---	None	---	---
Yauhannah	---	---	---	---	0	---	None	Moderate	High

Survey Area Version: 6
Survey Area Version Date: 09/22/2006

Soil Features
Charleston County Area, South Carolina

Map symbol and soil name	Restrictive layer				Subsidence		Potential for frost	Risk of corrosion	
	Kind	Depth to top		Thickness			Hardness	action	Uncoated
Concrete	Kind	Depth to top		Thickness	Hardness	Initial	Total	action	Uncoated
	Concrete Kind	to top		Thickness	Hardness			steel	
		In		*In*		*In*			
UR:									
Ogeechee	---	---		---	---	0	---	None	High	High
Yemassee	---	---		---	---	0	---	None	High	High
W:									
Water	---	---		---	---	---	---	---	---	---
Yo:									
Yonges	---	---		---	---	0	---	None	High	Moderate

Soil Features

This table gives estimates of various soil features. The estimates are used in land use planning that involves engineering considerations.

A "restrictive layer" is a nearly continuous layer that has one or more physical, chemical, or thermal properties that significantly impede the movement of water and air through the soil or that restrict roots or otherwise provide an unfavorable root environment. Examples are bedrock, cemented layers, dense layers, and frozen layers. The table indicates the hardness and thickness of the restrictive layer, both of which significantly affect the ease of excavation. "Depth to top" is the vertical distance from the soil surface to the upper boundary of the restrictive layer.

"Subsidence" is the settlement of organic soils or of saturated mineral soils of very low density. Subsidence generally results from either desiccation and shrinkage, or oxidation of organic material, or both, following drainage. Subsidence takes place gradually, usually over a period of several years. The table shows the expected initial subsidence, which usually is a result of drainage, and total subsidence, which results from a combination of factors.

"Potential for frost action" is the likelihood of upward or lateral expansion of the soil caused by the formation of segregated ice lenses (frost heave) and the subsequent collapse of the soil and loss of strength on thawing. Frost action occurs when moisture moves into the freezing zone of the soil. Temperature, texture, density, saturated hydraulic conductivity (Ksat), content of organic matter, and depth to the water table are the most important factors considered in evaluating the potential for frost action. It is assumed that the soil is not insulated by vegetation or snow and is not artificially drained. Silty and highly structured, clayey soils that have a high water table in winter are the most susceptible to frost action. Well drained, very gravelly, or very sandy soils are the least susceptible. Frost heave and low soil strength during thawing cause damage to pavements and other rigid structures.

"Risk of corrosion" pertains to potential soil-induced electrochemical or chemical action that corrodes or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to such factors as soil moisture, particle-size distribution, acidity, and electrical conductivity of the soil. The rate of corrosion of concrete is based mainly on the sulfate and sodium content, texture, moisture content, and acidity of the soil. Special site examination and design may be needed if the combination of factors results in a severe hazard of corrosion. The steel or concrete in installations that intersect soil boundaries or soil layers is more susceptible to corrosion than the steel or concrete in installations that are entirely within one kind of soil or within one soil layer.

For uncoated steel, the risk of corrosion, expressed as "low," "moderate," or "high," is based on soil drainage class, total acidity, electrical resistivity near field capacity, and electrical conductivity of the saturation extract.

Camp Areas, Picnic Areas, and Playgrounds

Charleston County Area, South Carolina

[The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation. The numbers in the value columns range from 0.01 to 1.00. The larger the value, the greater the potential limitation. The columns that identify the rating class and limiting features show no more than five limitations for any given soil. The soil may have additional limitations]

Map symbol and soil name	Pct. of map unit	Camp areas		Picnic areas		Playgrounds	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
Cg:							
Capers	100	Very limited		Very limited		Very limited	
		Depth to saturated zone	1.00	Ponding	1.00	Depth to saturated zone	1.00
		Flooding	1.00	Depth to saturated zone	1.00	Flooding	1.00
		Ponding	1.00	Flooding	0.60	Ponding	1.00
		Slow water	0.26	Slow water	0.26	Slow water	0.26
Ch:							
Charleston	97	Somewhat limited		Somewhat limited		Somewhat limited	
		Too sandy	0.79	Too sandy	0.79	Too sandy	0.79
Yonges	3	Very limited		Very limited		Very limited	
		Depth to saturated zone	1.00	Depth to saturated zone	1.00	Depth to saturated zone	1.00
		Too sandy	0.79	Too sandy	0.79	Too sandy	0.79
Cm:							
Pactolus	97	Somewhat limited		Somewhat limited		Somewhat limited	
		Too sandy	0.79	Too sandy	0.79	Too sandy	0.79
		Depth to saturated zone	0.07	Depth to saturated zone	0.03	Depth to saturated zone	0.07
Rutlege	3	Very limited		Very limited		Very limited	
		Depth to saturated zone	1.00	Depth to saturated zone	1.00	Depth to saturated zone	1.00
		Flooding	1.00	Flooding	0.40	Flooding	1.00
		Too sandy	0.31	Too sandy	0.31	Too sandy	0.31
Co:							
Beaches	60	Not rated		Not rated		Not rated	
Newhan	40	Very limited		Very limited		Very limited	
		Flooding	1.00	Too sandy	1.00	Too sandy	1.00
		Too sandy	1.00			Slope	0.50
Ma:							
Haplaquents	100	Not limited		Not limited		Somewhat limited	
						Slope	0.13

Camp Areas, Picnic Areas, and Playgrounds

Charleston County Area, South Carolina

Map symbol and soil name	Pct. of map unit	Camp areas		Picnic areas		Playgrounds	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
Sf:							
Osier	96	Very limited		Very limited		Very limited	
		Depth to saturated zone	1.00	Too sandy	1.00	Depth to saturated zone	1.00
		Too sandy	1.00	Depth to saturated zone	1.00	Too sandy	1.00
Rutlege	4	Very limited		Very limited		Very limited	
		Depth to saturated zone	1.00	Depth to saturated zone	1.00	Depth to saturated zone	1.00
		Flooding	1.00	Flooding	0.40	Flooding	1.00
		Too sandy	0.31	Too sandy	0.31	Too sandy	0.31
UR:							
Urban land	40	Not rated		Not rated		Not rated	
Yauhannah	30	Somewhat limited		Somewhat limited		Somewhat limited	
		Too sandy	0.79	Too sandy	0.79	Too sandy	0.79
		Depth to saturated zone	0.39	Depth to saturated zone	0.19	Depth to saturated zone	0.39
Ogeechee	15	Very limited		Very limited		Very limited	
		Depth to saturated zone	1.00	Depth to saturated zone	1.00	Depth to saturated zone	1.00
Yemassee	15	Very limited		Somewhat limited		Very limited	
		Depth to saturated zone	1.00	Depth to saturated zone	0.94	Depth to saturated zone	1.00
		Too sandy	0.91	Too sandy	0.91	Too sandy	0.91
W:							
Water	100	Not rated		Not rated		Not rated	
Yo:							
Yonges	100	Very limited		Very limited		Very limited	
		Depth to saturated zone	1.00	Depth to saturated zone	1.00	Depth to saturated zone	1.00
		Too sandy	0.79	Too sandy	0.79	Too sandy	0.79

Camp Areas, Picnic Areas, and Playgrounds

The soils of the survey area are rated in this table according to limitations that affect their suitability for camp areas, picnic areas, and playgrounds. The ratings are both verbal and numerical. Rating class terms indicate the extent to which the soils are limited by all of the soil features that affect the recreational uses. "Not limited" indicates that the soil has features that are very favorable for the specified use. Good performance and very low maintenance can be expected. "Somewhat limited" indicates that the soil has features that are moderately favorable for the specified use. The limitations can be overcome or minimized by special planning, design, or installation. Fair performance and moderate maintenance can be expected. "Very limited" indicates that the soil has one or more features that are unfavorable for the specified use. The limitations generally cannot be overcome without major soil reclamation, special design, or expensive installation procedures. Poor performance and high maintenance can be expected.

Numerical ratings in the table indicate the severity of individual limitations. The ratings are shown as decimal fractions ranging from 0.01 to 1.00. They indicate gradations between the point at which a soil feature has the greatest negative impact on the use (1.00) and the point at which the soil feature is not a limitation (0.00).

The ratings are based on restrictive soil features, such as wetness, slope, and texture of the surface layer. Susceptibility to flooding is considered. Not considered in the ratings, but important in evaluating a site, are the location and accessibility of the area, the size and shape of the area and its scenic quality, vegetation, access to water, potential water impoundment sites, and access to public sewer lines. The capacity of the soil to absorb septic tank effluent and the ability of the soil to support vegetation also are important. Soils that are subject to flooding are limited for recreational uses by the duration and intensity of flooding and the season when flooding occurs. In planning recreational facilities, onsite assessment of the height, duration, intensity, and frequency of flooding is essential.

The information in this table can be supplemented by other information, for example, interpretations for dwellings without basements, for local roads and streets, and for septic tank absorption fields.

"Camp areas" require site preparation, such as shaping and leveling the tent and parking areas, stabilizing roads and intensively used areas, and installing sanitary facilities and utility lines. Camp areas are subject to heavy foot traffic and some vehicular traffic. The ratings are based on the soil properties that affect the ease of developing camp areas and the performance of the areas after development. Slope, stoniness, and depth to bedrock or a cemented pan are the main concerns affecting the development of camp areas. The soil properties that affect the performance of the areas after development are those that influence trafficability and promote the growth of vegetation, especially in heavily used areas. For good trafficability, the surface of camp areas should absorb rainfall readily, remain firm under heavy foot traffic, and not be dusty when dry. The soil properties that influence trafficability are texture of the surface layer, depth to a water table, ponding, flooding, saturated hydraulic conductivity (Ksat), and large stones. The soil properties that affect the growth of plants are depth to bedrock or a cemented pan, Ksat, and toxic substances in the soil.

"Picnic areas" are subject to heavy foot traffic. Most vehicular traffic is confined to access roads and parking areas. The ratings are based on the soil properties that affect the ease of developing picnic areas and that influence trafficability and the growth of vegetation after development. Slope and stoniness are the main concerns affecting the development of picnic areas. For good trafficability, the surface of picnic areas should absorb rainfall readily, remain firm under heavy foot traffic, and not be dusty when dry. The soil properties that influence trafficability are texture of the surface layer, depth to a water table, ponding, flooding, Ksat, and large stones. The soil properties that affect the growth of plants are depth to bedrock or a cemented pan, Ksat, and toxic substances in the soil.

"Playgrounds" require soils that are nearly level, are free of stones, and can withstand intensive foot traffic. The ratings are based on the soil properties that affect the ease of developing playgrounds and that influence trafficability and the growth of vegetation after development. Slope and stoniness are the main concerns affecting the development of playgrounds. For good trafficability, the surface of the playgrounds should absorb rainfall readily, remain firm under heavy foot traffic, and not be dusty when dry. The soil properties that influence trafficability are texture of the surface layer, depth to a water table, ponding, flooding, Ksat, and large stones. The soil properties that affect the growth of

Paths, Trails, and Golf Fairways

Charleston County Area, South Carolina

[The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation. The numbers in the value columns range from 0.01 to 1.00. The larger the value, the greater the potential limitation. The columns that identify the rating class and limiting features show no more than five limitations for any given soil. The soil may have additional limitations]

Map symbol and soil name	Pct. of map unit	Paths and trails		Off-road motorcycle trails		Golf fairways	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
Cg:							
Capers	100	Very limited		Very limited		Very limited	
		Depth to saturated zone	1.00	Depth to saturated zone	1.00	Ponding	1.00
		Ponding	1.00	Ponding	1.00	Flooding	1.00
		Flooding	0.60	Flooding	0.60	Depth to saturated zone	1.00
						Sulfur content	1.00
Ch:							
Charleston	97	Somewhat limited		Somewhat limited		Not limited	
		Too sandy	0.79	Too sandy	0.79		
Yonges	3	Very limited		Very limited		Very limited	
		Depth to saturated zone	1.00	Depth to saturated zone	1.00	Depth to saturated zone	1.00
		Too sandy	0.79	Too sandy	0.79		
Cm:							
Pactolus	97	Somewhat limited		Somewhat limited		Somewhat limited	
		Too sandy	0.79	Too sandy	0.79	Depth to saturated zone	0.03
						Droughty	0.01
Rutlege	3	Very limited		Very limited		Very limited	
		Depth to saturated zone	1.00	Depth to saturated zone	1.00	Flooding	1.00
		Flooding	0.40	Flooding	0.40	Depth to saturated zone	1.00
		Too sandy	0.31	Too sandy	0.31		
Co:							
Beaches	60	Not rated		Not rated		Not rated	
Newhan	40	Very limited		Very limited		Very limited	
		Too sandy	1.00	Too sandy	1.00	Droughty	1.00
Ma:							
Haplaquents	100	Not limited		Not limited		Not limited	
Sf:							
Osier	96	Very limited		Very limited		Very limited	
		Depth to saturated zone	1.00	Depth to saturated zone	1.00	Depth to saturated zone	1.00
		Too sandy	1.00	Too sandy	1.00	Droughty	1.00

Paths, Trails, and Golf Fairways

Charleston County Area, South Carolina

Map symbol and soil name	Pct. of map unit	Paths and trails		Off-road motorcycle trails		Golf fairways	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
Sf:							
Rutlege	4	Very limited		Very limited		Very limited	
		Depth to saturated zone	1.00	Depth to saturated zone	1.00	Flooding	1.00
		Flooding	0.40	Flooding	0.40	Depth to saturated zone	1.00
		Too sandy	0.31	Too sandy	0.31		
UR:							
Urban land	40	Not rated		Not rated		Very limited	
						Droughty	1.00
Yauhannah	30	Somewhat limited		Somewhat limited		Somewhat limited	
		Too sandy	0.79	Too sandy	0.79	Depth to saturated zone	0.19
Ogeechee	15	Very limited		Very limited		Very limited	
		Depth to saturated zone	1.00	Depth to saturated zone	1.00	Depth to saturated zone	1.00
Yemassee	15	Somewhat limited		Somewhat limited		Somewhat limited	
		Too sandy	0.91	Too sandy	0.91	Depth to saturated zone	0.94
		Depth to saturated zone	0.86	Depth to saturated zone	0.86	Droughty	0.51
W:							
Water	100	Not rated		Not rated		Not rated	
Yo:							
Yonges	100	Very limited		Very limited		Very limited	
		Depth to saturated zone	1.00	Depth to saturated zone	1.00	Depth to saturated zone	1.00
		Too sandy	0.79	Too sandy	0.79		

Paths, Trails, and Golf Fairways

The soils of the survey area are rated in this table according to limitations that affect their suitability for paths, trails, and golf fairways. The ratings are both verbal and numerical. Rating class terms indicate the extent to which the soils are limited by all of the soil features that affect the recreational uses. "Not limited" indicates that the soil has features that are very favorable for the specified use. Good performance and very low maintenance can be expected. "Somewhat limited" indicates that the soil has features that are moderately favorable for the specified use. The limitations can be overcome or minimized by special planning, design, or installation. Fair performance and moderate maintenance can be expected. "Very limited" indicates that the soil has one or more features that are unfavorable for the specified use. The limitations generally cannot be overcome without major soil reclamation, special design, or expensive installation procedures. Poor performance and high maintenance can be expected.

Numerical ratings in the table indicate the severity of individual limitations. The ratings are shown as decimal fractions ranging from 0.01 to 1.00. They indicate gradations between the point at which a soil feature has the greatest negative impact on the use (1.00) and the point at which the soil feature is not a limitation (0.00).

The ratings are based on restrictive soil features, such as wetness, slope, and texture of the surface layer. Susceptibility to flooding is considered. Not considered in the ratings, but important in evaluating a site, are the location and accessibility of the area, the size and shape of the area and its scenic quality, vegetation, access to water, potential water impoundment sites, and access to public sewer lines. The capacity of the soil to absorb septic tank effluent and the ability of the soil to support vegetation also are important. Soils that are subject to flooding are limited for recreational uses by the duration and intensity of flooding and the season when flooding occurs. In planning recreational facilities, onsite assessment of the height, duration, intensity, and frequency of flooding is essential.

"Paths and trails" for hiking and horseback riding should require little or no slope modification through cutting and filling. The ratings are based on the soil properties that affect trafficability and erodibility. These properties are stoniness, depth to a water table, ponding, flooding, slope, and texture of the surface layer.

"Off-road motorcycle trails" require little or no site preparation. They are not covered with surfacing material or vegetation. Considerable compaction of the soil material is likely. The ratings are based on the soil properties that influence erodibility, trafficability, dustiness, and the ease of revegetation. These properties are stoniness, slope, depth to a water table, ponding, flooding, and texture of the surface layer.

"Golf fairways" are subject to heavy foot traffic and some light vehicular traffic. Cutting or filling may be required. Irrigation is not considered in the ratings. The ratings are based on the soil properties that affect plant growth and trafficability after vegetation is established. The properties that affect plant growth are reaction; depth to a water table; ponding; depth to bedrock or a cemented pan; the available water capacity in the upper 40 inches; the content of salts, sodium, or calcium carbonate; and sulfidic materials. The properties that affect trafficability are flooding, depth to a water table, ponding, slope, stoniness, and the amount of sand, clay, or organic matter in the surface layer. The suitability of the soil for traps, tees, roughs, and greens is not considered in the ratings.

Appendix D: Reference species lists are from habitat distribution models published by the South Carolina Gap Analysis Project (South Carolina Department of Natural Resources 2008).

SC GAP Birds (reference for Fort Sumter National Monument):

acadian flycatcher
american avocet
american bittern
american black duck
american coot
american crow
american goldfinch
american kestrel
american oystercatcher
american robin
american swallow-tailed kite
american wigeon
american woodcock
bachman's sparrow
bald eagle
baltimore oriole
barn owl
barn swallow
barred owl
belted kingfisher
black scoter
black skimmer
black vulture
black-and-white warbler
black-bellied plover
blackburnian warbler
black-crowned night-heron
black-necked stilt
black-throated blue warbler
black-throated green warbler
blue grosbeak
blue jay
blue-gray gnatcatcher
blue-headed vireo
blue-winged teal
blue-winged warbler
boat-tailed grackle
bonaparte's gull
brant
brewer's blackbird
brown creeper
brown pelican
brown thrasher
brown-headed cowbird
brown-headed nuthatch
bufflehead
canada goose
canada warbler
canvasback
carolina chickadee
carolina wren
caspian tern
cattle egret
cedar waxwing
chestnut-sided warbler
chimney swift
chipping sparrow
chuck-will's-widow
clapper rail
cliff swallow
common grackle
common ground-dove
common loon
common merganser
common moorhen
common nighthawk
common raven
common snipe
common tern
common yellowthroat
cooper's hawk
dark-eyed junco
dickcissel
double-crested cormorant
downy woodpecker
dunlin
eastern bluebird
eastern kingbird
eastern meadowlark
eastern phoebe

eastern screech-owl
eastern towhee
eastern wood-pewee
european starling
evening grosbeak
field sparrow
fish crow
forster's tern
fox sparrow
gadwall
glossy ibis
golden-crowned kinglet
grasshopper sparrow
gray catbird
great black-backed gull
great blue heron
great crested flycatcher
great egret
great horned owl
greater scaup
greater yellowlegs
green heron
green-winged teal
gull-billed tern
hairy woodpecker
henslow's sparrow
hermit thrush
herring gull
hooded merganser
hooded warbler
horned grebe
horned lark
house finch
house sparrow
house wren
indigo bunting
kentucky warbler
killdeer
king rail
lapland longspur
laughing gull
le conte's sparrow
least bittern
least sandpiper
least tern
lesser scaup
lesser yellowlegs
lincoln's sparrow
little blue heron
loggerhead shrike
long-billed curlew
long-billed dowitcher
mallard
marbled godwit
marsh wren
merlin
mississippi kite
mottled duck
mourning dove
northern bobwhite
northern cardinal
northern flicker
northern harrier
northern mockingbird
northern parula
northern pintail
northern rough-winged swallow
northern saw-whet owl
northern shoveler
oldsquaw
orange-crowned warbler
orchard oriole
osprey
ovenbird
painted bunting
palm warbler
peregrine falcon
pied-billed grebe
pileated woodpecker
pine siskin
pine warbler
piping plover
prairie warbler
prothonotary warbler
purple finch
purple gallinule

purple martin
purple sandpiper
red crossbill
red knot
red-bellied woodpecker
red-breasted merganser
red-breasted nuthatch
red-cockaded woodpecker
red-eyed vireo
redhead
red-headed woodpecker
red-tailed hawk
red-winged blackbird
ring-billed gull
rock dove
royal tern
ruby-crowned kinglet
ruby-throated hummingbird
ruddy duck
ruddy turnstone
ruffed grouse
rusty blackbird
sanderling
sandwich tern
savannah sparrow
seaside sparrow
sedge wren
semipalmated plover
sharp-shinned hawk
short-billed dowitcher
short-eared owl
snow bunting
snow goose
snowy egret
song sparrow
sooty tern
sora
spotted sandpiper
summer tanager
surf scoter
swamp sparrow
tree swallow
tricolored heron
tufted titmouse
tundra swan
turkey vulture
vesper sparrow
virginia rail
water pipit
whimbrel
whip-poor-will
white ibis
white-breasted nuthatch
white-crowned sparrow
white-eyed vireo
white-throated sparrow
white-winged scoter
wild turkey
willet
wilson's plover
winter wren
wood duck
wood stork
wood thrush
yellow rail
yellow warbler
yellow-bellied sapsucker
yellow-billed cuckoo
yellow-breasted chat
yellow-crowned night-heron
yellow-rumped warbler
yellow-throated vireo
yellow-throated warbler

SC GAP Birds (reference for Charles Pinckney National Historic Site):

acadian flycatcher
american avocet
american bittern
american black duck
american coot
american crow
american goldfinch
american kestrel
american oystercatcher
american redstart
american robin
american swallow-tailed kite
american wigeon
american woodcock
anhinga
bachman's sparrow
bald eagle
baltimore oriole
barn owl
barn swallow
barred owl
belted kingfisher
black skimmer
black vulture
black-and-white warbler
black-bellied plover
blackburnian warbler
black-crowned night-heron
black-necked stilt
black-throated blue warbler
black-throated green warbler
blue grosbeak
blue jay
blue-gray gnatcatcher
blue-headed vireo
blue-winged teal
blue-winged warbler
boat-tailed grackle
bonaparte's gull
brewer's blackbird
broad-winged hawk
brown creeper
brown pelican
brown thrasher
brown-headed cowbird
brown-headed nuthatch
bufflehead
canada goose
canada warbler
canvasback
carolina chickadee
carolina wren
caspian tern
cattle egret
cedar waxwing
chestnut-sided warbler
chimney swift
chipping sparrow
chuck-will's-widow
clapper rail
cliff swallow
common grackle
common ground-dove
common merganser
common moorhen
common nighthawk
common raven
common snipe
common tern
common yellowthroat
cooper's hawk
dark-eyed junco
dickcissel
double-crested cormorant
downy woodpecker
dunlin
eastern bluebird
eastern kingbird
eastern meadowlark
eastern phoebe
eastern screech-owl
eastern towhee
eastern wood-pewee
european starling

evening grosbeak
field sparrow
fish crow
forster's tern
fox sparrow
gadwall
glossy ibis
golden-crowned kinglet
gray catbird
great black-backed gull
great blue heron
great crested flycatcher
great egret
great horned owl
greater scaup
greater yellowlegs
green heron
green-winged teal
gull-billed tern
hairy woodpecker
hermit thrush
herring gull
hooded merganser
hooded warbler
horned lark
house finch
house sparrow
house wren
indigo bunting
kentucky warbler
killdeer
king rail
lapland longspur
laughing gull
least bittern
least sandpiper
least tern
lesser scaup
lesser yellowlegs
lincoln's sparrow
little blue heron
loggerhead shrike
long-billed curlew
long-billed dowitcher
louisiana waterthrush
mallard
marbled godwit
marsh wren
merlin
mississippi kite
mourning dove
northern bobwhite
northern cardinal
northern flicker
northern harrier
northern mockingbird
northern parula
northern pintail
northern rough-winged swallow
northern saw-whet owl
northern shoveler
orange-crowned warbler
orchard oriole
osprey
ovenbird
painted bunting
palm warbler
peregrine falcon
pied-billed grebe
pileated woodpecker
pine siskin
pine warbler
piping plover
prairie warbler
prothonotary warbler
purple finch
purple gallinule
purple martin
purple sandpiper
red crossbill
red knot
red-bellied woodpecker
red-breasted merganser
red-breasted nuthatch
red-cockaded woodpecker
red-eyed vireo

redhead
red-headed woodpecker
red-shouldered hawk
red-tailed hawk
red-winged blackbird
ring-billed gull
rock dove
royal tern
ruby-crowned kinglet
ruby-throated hummingbird
ruddy duck
ruddy turnstone
ruffed grouse
rusty blackbird
sanderling
sandwich tern
savannah sparrow
scarlet tanager
seaside sparrow
sedge wren
semipalmated plover
sharp-shinned hawk
short-billed dowitcher
short-eared owl
snow bunting
snow goose
snowy egret
song sparrow
sooty tern
sora
spotted sandpiper
summer tanager
swainson's warbler
swamp sparrow
tree swallow
tricolored heron
tufted titmouse
tundra swan
turkey vulture
vesper sparrow
virginia rail
water pipit
Whimbrel
whip-poor-will
white ibis
white-breasted nuthatch
white-crowned sparrow
white-eyed vireo
white-throated sparrow
wild turkey
willet
wilson's plover
winter wren
wood duck
wood stork
wood thrush
worm-eating warbler
yellow rail
yellow-bellied sapsucker
yellow-billed cuckoo
yellow-breasted chat
yellow-crowned night-heron
yellow-rumped warbler
yellow-throated vireo
yellow-throated warbler

SC GAP Amphibians (reference for Fort Sumter National Monument):

american toad
atlantic coast slimy salamander
barking treefrog
Bullfrog
carpenter frog
cope's gray treefrog
dusky salamander
dwarf salamander
dwarf siren
eastern narrowmouth toad
eastern newt
eastern spadefoot
flatwoods salamander
four-toed salamander
gopher frog
gray treefrog
greater siren
green frog
green treefrog
jordan's salamander
lesser siren
little grass frog
mabee's salamander
many-lined salamander
marbled salamander
mimic glass lizard
mole salamander
mountain dusky salamander
mud salamander
northern cricket frog
oak toad
ornate chorus frog
pickerel frog
pig frog
pine barrens treefrog
pine woods treefrog
rafinesque's big-eared bat
red salamander
shovelnose salamander
south carolina slimy salamander
southern appalachian salamander
southern chorus frog
southern cricket frog
southern dusky salamander
southern leopard frog
southern toad
southern two-lined salamander
spotted salamander
spring peeper
spring salamander
squirrel treefrog
three-lined salamander
tiger salamander
two-toed amphiuma
upland chorus frog
white-spotted slimy salamander
wood frog
woodhouse's toad

SC GAP Amphibians (reference for Charles Pinckney National Historic Site):

american toad
atlantic coast slimy salamander
barking treefrog
bird-voiced treefrog
brimley's chorus frog
Bullfrog
carpenter frog
cope's gray treefrog
dusky salamander
dwarf salamander
dwarf siren
dwarf waterdog
eastern narrowmouth toad
eastern newt
eastern spadefoot
four-toed salamander
gopher frog
gray treefrog
greater siren
green frog
green treefrog
jordan's salamander
lesser siren
little grass frog
mabee's salamander
many-lined salamander
marbled salamander
mole salamander
mountain dusky salamander
mud salamander
northern cricket frog
oak toad
ornate chorus frog
pickerel frog
pig frog
pine barrens treefrog
pine woods treefrog
red salamander
river frog
shovelnose salamander
south carolina slimy salamand
southern appalachian salamand
southern chorus frog
southern cricket frog
southern dusky salamander
southern leopard frog
southern toad
southern two-lined salamander
spotted salamander
spring peeper
spring salamander
squirrel treefrog
three-lined salamander
tiger salamander
two-toed amphiuma
upland chorus frog
white-spotted slimy salamande
wood frog
woodhouse's toad

SC GAP Reptiles (reference for Fort Sumter National Monument):

american alligator
atlantic ridley
banded water snake
black racer
black swamp snake
bog turtle
broadhead skink
brown snake
chicken turtle
coachwhip
coal skink
common musk turtle
copperhead
corn snake
cottonmouth
diamondback terrapin
eastern box turtle
eastern coral snake
eastern diamondback rattlesna
eastern garter snake
eastern glass lizard
eastern hognose snake
eastern kingsnake
eastern mud turtle
eastern ribbon snake
fence lizard
five-lined skink
florida cooter
florida green water snake
florida softshell
glossy crayfish snake
gopher tortoise
green anole
green turtle
ground skink
hawksbill
island glass lizard
leatherback
loggerhead
mimic glass lizard
mole kingsnake
mud snake
northern water snake
painted turtle
pine snake
pine woods snake
pygmy rattlesnake
rainbow snake
rat snake
redbelly snake
redbelly water snake
ringneck snake
river cooter
rough earth snake
rough green snake
scarlet kingsnake (milk)
scarlet snake
six-lined racerunner
slender glass lizard
smooth earth snake
snapping turtle
southeastern crowned snake
southeastern five-lined skink
southern hognose snake
spiny softshell
spotted turtle
striped mud turtle
texas horned lizard
timber rattlesnake
worm snake
yellowbelly slider

SC GAP Reptiles (reference for Charles Pinckney National Historic Site):

american alligator
atlantic ridley
banded water snake
black racer
black swamp snake
bog turtle
broadhead skink
brown snake
brown water snake
chicken turtle
Coachwhip
coal skink
common musk turtle
Copperhead
corn snake
Cottonmouth
diamondback terrapin
eastern box turtle
eastern coral snake
eastern diamondback rattlesna
eastern garter snake
eastern glass lizard
eastern hognose snake
eastern kingsnake
eastern mud turtle
eastern ribbon snake
fence lizard
five-lined skink
florida cooter
florida green water snake
florida softshell
glossy crayfish snake
gopher tortoise
green anole
green turtle
ground skink
Hawksbill
island glass lizard
Leatherback
Loggerhead
mimic glass lizard
mole kingsnake
mud snake
northern water snake
painted turtle
pine snake
pine woods snake
pygmy rattlesnake
queen snake
rainbow snake
rat snake
redbelly snake
redbelly water snake
ringneck snake
river cooter
rough earth snake
rough green snake
scarlet kingsnake (milk)
scarlet snake
six-lined racerunner
slender glass lizard
smooth earth snake
snapping turtle
southeastern crowned snake
southeastern five-lined skink
southern hognose snake
spiny softshell
spotted turtle
striped mud turtle
texas horned lizard
timber rattlesnake
worm snake
yellowbelly slider

SC GAP Mammals (reference for Fort Sumter National Monument):

american beaver
big brown bat
black bear
black rat
Bobcat
brazilian free-tailed bat
carolina short-tailed shrew
common gray fox
common raccoon
cotton mouse
Coyote
eastern chipmunk
eastern cottontail
eastern fox squirrel
eastern gray squirrel
eastern harvest mouse
eastern mole
eastern pipistrelle
eastern red bat
eastern small-footed myotis
eastern spotted skunk
eastern woodrat
evening bat
feral pig
golden mouse
hairy-tailed mole
hispid cotton rat
hoary bat
house mouse
least shrew
long-tailed weasel
marsh rabbit
marsh rice rat
masked shrew
meadow jumping mouse
meadow vole
Mink
Muskrat
new england cottontail
nine-banded armadillo
northern long-eared myotis
northern river otter
northern short-tailed shrew
northern yellow bat
norway rat
oldfield mouse
rafinesque's big-eared bat
red fox
red squirrel
seminole bat
silver-haired bat
southeastern myotis
southeastern shrew
southern flying squirrel
star-nosed mole
striped skunk
swamp rabbit
virginia opossum
white-footed mouse
white-tailed deer
woodchuck
woodland vole

SC GAP Mammals (reference for Charles Pinckney National Historic Site):

american beaver
big brown bat
black bear
black rat
bobcat
brazilian free-tailed bat
carolina short-tailed shrew
common gray fox
common raccoon
cotton mouse
coyote
eastern chipmunk
eastern cottontail
eastern fox squirrel
eastern gray squirrel
eastern harvest mouse
eastern mole
eastern pipistrelle
eastern red bat
eastern small-footed myotis
eastern spotted skunk
eastern woodrat
evening bat
feral pig
golden mouse
hairy-tailed mole
hispid cotton rat
hoary bat
house mouse
least shrew
little brown myotis
long-tailed weasel
marsh rabbit
marsh rice rat
masked shrew
meadow jumping mouse
meadow vole
mink
muskrat
new england cottontail
nine-banded armadillo
northern long-eared myotis
northern river otter
northern short-tailed shrew
northern yellow bat
norway rat
oldfield mouse
pygmy shrew
rafinesque's big-eared bat
red fox
red squirrel
seminole bat
silver-haired bat
smoky shrew
southeastern myotis
southeastern shrew
southern flying squirrel
southern red-backed vole
star-nosed mole
striped skunk
swamp rabbit
virginia opossum
white-footed mouse
white-tailed deer
Woodchuck
woodland jumping mouse
woodland vole

Appendix E: The following species lists (Appendix F through Appendix P) have been cross-referenced to NatureServe's global and state rankings (NatureServe 2008); and the South Carolina Conservation Wildlife Conservation Strategy (South Carolina Department of Natural Resources 2005) listings for endangered, threatened, or of concern. These are further explanations of the rank and status abbreviations.

NatureServe Ranks (NatureServe 2008)

Global Ranks:
G#G#: NatureServe Global Conservation Status Rank, Range Rank - A numeric range rank (e.g., G2G3) is used to indicate the rank of uncertainty in the status of a species or community. Ranges cannot skip more than one rank (e.g., GU should be used rather than G1G4).

G1: Critically Imperiled
At very high risk of extinction due to extreme rarity (often 5 or fewer populations), very steep declines, or other factors.

G2: Imperiled
At high risk of extinction due to very restricted range, very few populations (often 20 or fewer), steep declines, or other factors.

G3: Vulnerable
At moderate risk of extinction due to a restricted range, relatively few populations (often 80 or fewer), recent and widespread declines, or other factors.

G4: Apparently Secure
Uncommon but not rare; some cause for long-term concern due to declines or other factors.

G5: Secure
Common; widespread, and abundant.

State Ranks:
S#S#: NatureServe Subnational Conservation Status Rank - Range Rank-A numeric range rank (e.g., S2S3) is used to indicate the range of uncertainty about the status of the species or community. Ranges cannot skip more than one rank (e.g., SU should be used rather than S1S4).

S?: Unranked
State/Province conservation status not yet assessed.

S1: Critically Imperiled
Critically imperiled in the state or province because of extreme rarity (often 5 or fewer occurrences) or because of some factor(s) such as very steep declines making it especially vulnerable to extirpation from the state or province.

S2: Imperiled
Imperiled in the state or province because of rarity due to very restricted range, very few populations (often 20 or fewer), steep declines, or other factors making it very vulnerable to extirpation from the state or province.

S3: Vulnerable
Vulnerable in the state or province due to a restricted range, relatively few populations (often 80 or fewer), recent and widespread declines, or other factors making it vulnerable to extirpation.

S4: Apparently Secure
Uncommon but not rare; some cause for long-term concern due to declines or other factors.

S5: Secure
Common, widespread, and abundant in the state or province.

SC Comprehensive Wildlife Conservation Strategy (South Carolina Department of Natural Resources 2005) listings for endangered, threatened, or of concern species

Federal Status (From US Fish and Wildlife Service):
E: Listed as endangered. The most critically imperiled species. A species that may become extinct or disappear from a significant part of its range if not immediately protected.

T: Listed as threatened. The next most critical level of threatened species. A species that may become endangered if not protected.

E(S/A) or T(S/A): Listed as endangered or threatened because of similarity of appearance.

State Status:
E: State Endangered

T: State Threatened

SC: Of Concern, State

Appendix F: Plant species documented for Fort Sumter National Monument.
These species have been cross referenced to NatureServe's global and state rankings (NatureServe 2008). No plant species were listed as endangered or threatened. See reference or Appendix E for explanation of abbreviations.

Scientific Name	*Common Name(s)*	*Park Status*	*Abundance*	*Nativity*	*Weedy?*	*Management Priority*	*Global Rank*	*State Rank*
Acalypha gracilens	slender copperleaf, slender threeseed mercury	Present	Unknown	Native	No	No		
Achillea millefolium	bloodwort, carpenter's weed, common yarrow	Present	Unknown	Non-Native	No	No		
Aeschynomene indica	Indian jointvetch	Present	Unknown	Native	No	Yes	G5	SNR
Allium vineale	wild garlic	Present	Unknown	Non-Native	No	No		
Alternanthera philoxeroides	alligator weed, alligatorweed, pig weed	Present	Unknown	Non-Native	Yes	No		
Ambrosia artemisiifolia	annual ragweed, common ragweed, low ragweed	Present	Unknown	Native	No	No		
Ampelopsis arborea	peppervine	Present	Unknown	Native	No	No		
Andropogon glomeratus	bushy bluestem	Present	Unknown	Native	No	No		
Andropogon gyrans var. gyrans	elliott bluestem, Elliott's bluestem	Present	Unknown	Native	No	No		
Andropogon ternaries	splitbeard bluestem	Present	Unknown	Native	No	No		
Andropogon virginicus	broomsedge, broomsedge bluestem, yellow bluestem	Present	Unknown	Native	No	No		
Arenaria serpyllifolia	thymeleaf sandwort	Present	Unknown	Non-Native	No	No		
Artemisia vulgaris	common wormwood, mugwort	Present	Unknown	Non-Native	No	No		
Asparagus officinalis	asparagus, garden asparagus, garden-asparagus	Present	Unknown	Non-Native	No	No		
Aster dumosus	rice button aster	Present	Unknown	Native	No	No		
Atriplex cristata	crested saltbush	Present	Unknown	Native	No	No		
Atriplex patula	halberd-leaf orache, spear saltbush, spear saltweed	Present	Unknown	Native	No	No		

Scientific Name	Common Name(s)	Park Status	Abundance	Nativity	Weedy?	Management Priority	Global Rank	State Rank
Atriplex prostrata	hastate orache, triangle orache	Present	Unknown	Native	No	No		
Baccharis halimifolia	eastern baccharis	Present	Unknown	Native	No	No		
Bidens bipinnata	Spanish needles, spanish-needles	Present	Unknown	Native	No	No		
Bignonia capreolata	cross vine, crossvine	Present	Unknown	Native	No	No		
Borrichia frutescens	bushy seaoxeye, bushy seaside tansy	Present	Unknown	Native	No	No		
Briza minor	little quakinggrass	Present	Unknown	Non-Native	No	No		
Bromus catharticus	rescue brome, rescue grass	Present	Unknown	Non-Native	No	No		
Buglossoides arvensis	corn gromwell, corn-gromwell, field gromwell	Present	Unknown	Non-Native	No	No		
Cakile edentula	American searocket	Present	Unknown	Native	No	Yes	G5	SNR
Callicarpa americana	American beautyberry	Present	Unknown	Native	No	No		
Camellia japonica	camellia	Present	Unknown	Non-Native	No	No		
Camellia sasanqua	Sasanqua camellia	Present	Unknown	Non-Native	No	No		
Campsis radicans	common trumpetcreeper, cow-itch, trumpet creeper	Present	Unknown	Native	No	No		
Canna X generalis	canna lily	Present	Unknown	Non-Native	No	No		
Cardamine hirsuta	hairy bittercress	Present	Unknown	Non-Native	No	No		
Cardamine pensylvanica	Pennsylvania bittercress, Quaker bittercress	Present	Unknown	Native	No	No		
Carphephorus odoratissimus	vanillaleaf	Present	Unknown	Native	No	No		
Carya illinoinensis	pecan	Present	Unknown	Native	No	No		
Celtis laevigata	sugar berry, sugar hackberry, sugarberry	Present	Unknown	Native	No	No		
Cenchrus longispinus	burgrass, field sandbur, innocent-weed, longspine sandbur	Present	Unknown	Native	No	No		
Cenchrus tribuloides	sanddune sandbur	Present	Unknown	Native	No	No		

Scientific Name	Common Name(s)	Park Status	Abundance	Nativity	Weedy?	Management Priority	Global Rank	State Rank
Centella erecta	erect centella	Present	Unknown	Native	No	No		
Centrosema virginianum	butterflypea, spurred butterfly pea	Present	Unknown	Native	No	No		
Cerastium fontanum	common chickweed, common mouse-ear chickweed	Present	Unknown	Non-Native	No	No		
Chaerophyllum tainturieri	chervil, hairy-fruit chervil, hairyfruit chervil	Present	Unknown	Native	No	No		
Chamaesyce nutans	eyebane, nodding spurge, spotted sandmat, spotted spurge	Present	Unknown	Native	No	No		
Chamaesyce polygonifolia	seaside sandmat, seaside spurge	Present	Unknown	Native	No	No		
Chasmanthium laxum	slender woodoats, spike uniola	Present	Unknown	Native	No	No		
Chenopodium album	common lambsquarters, lambsquarters goosefoot	Present	Unknown	Native	No	No		
Chenopodium ambrosioides	Mexican tea, Mexican-tea	Present	Unknown	Non-Native	No	No		
Cirsium nuttallii	Nuttall's thistle	Present	Unknown	Native	No	No		
Citrullus lanatus var. lanatus	watermelon, wild watermelon	Present	Unknown	Non-Native	No	No		
Clitoria mariana	Atlantic pigeonwings, pidgeonwings	Present	Unknown	Native	No	No		
Conoclinium coelestinum	blue mistflower	Present	Unknown	Native	No	No		
Conyza bonariensis	asthmaweed, flaxleaved fleabane, hairy fleabane	Present	Unknown	Non-Native	No	No		
Conyza canadensis	Canadian horseweed, horseweed, horseweed fleabane	Present	Unknown	Native	No	No		
Conyza canadensis var. pusilla	Canadian horseweed	Present	Unknown	Native	No	No		
Coreopsis basalis	goldenmane tickseed	Present	Unknown	Native	No	No		
Coronopus didymus	lesser swinecress	Present	Unknown	Non-Native	No	No		

Scientific Name	Common Name(s)	Park Status	Abundance	Nativity	Weedy?	Management Priority	Global Rank	State Rank
Crotalaria spectabilis	showy crotalaria, showy rattlebox	Present	Unknown	Non-Native	No	No		
Croton glandulosus	vente conmigo	Present	Unknown	Native	No	No		
Croton punctatus	gulf croton	Present	Unknown	Native	No	No		
Croton willdenowii	two-fruit rushfoil, Willdenow's croton	Present	Unknown	Native	No	No		
Cynodon dactylon	Bermudagrass	Present	Unknown	Non-Native	No	No		
Cyperus croceus	Baldwin's flatsedge	Present	Unknown	Native	No	No		
Cyperus echinatus	globe flatsedge	Present	Unknown	Native	No	No		
Cyperus esculentus var. leptostachyus	chufa flatsedge, yellow nutgrass, yellow nutsedge	Present	Unknown	Native	No	No		
Cyperus polystachyos	manyspike flatsedge	Present	Unknown	Native	No	No		
Cyperus pseudovegetus	marsh flatsedge	Present	Unknown	Native	No	No		
Cyperus retrorsus	pine barren flatsedge	Present	Unknown	Native	No	No		
Cyperus strigosus	stawcolored flatsedge, strawcolor nutgrass	Present	Unknown	Native	No	No		
Daucus carota	bird's nest, Queen Anne's lace, wild carrot	Present	Unknown	Non-Native	No	No		
Descurainia pinnata	green tansymustard, pinnate tansy mustard, pinnate tansymustard, tansymustard, western tansymustard	Present	Unknown	Native	No	No		
Desmodium incanum	tickclover, zarzabacoa comun	Present	Unknown	Native	No	No		
Dichanthelium commutatum	variable panicgrass	Present	Unknown	Native	No	No		
Dichanthelium scabriusculum	woolly rosette grass	Present	Unknown	Native	No	No		
Dichondra carolinensis	Carolina ponysfoot, grass ponyfoot	Present	Unknown	Native	No	No		
Digitaria sanguinalis	Crabgrass, hairy crab grass, hairy crabgrass, large crabgrass	Present	Unknown	Native	No	No		

Scientific Name	Common Name(s)	Park Status	Abundance	Nativity	Weedy?	Management Priority	Global Rank	State Rank
Digitaria violascens	violet crabgrass	Present	Unknown	Non-Native	No	No		
Diodia teres	poor joe, poorjoe, rough buttonweed	Present	Unknown	Native	No	No		
Diodia virginiana	Virginia buttonweed	Present	Unknown	Native	No	No		
Diospyros virginiana	common persimmon, eastern persimmon, Persimmon	Present	Unknown	Native	No	No		
Distichlis spicata	desert saltgrass, inland saltgrass, marsh spikegrass	Present	Unknown	Native	No	No		
Elaeagnus pungens	thorny elaeagnus, thorny olive	Present	Unknown	Non-Native	Yes	No		
Eleocharis flavescens	yellow spikerush	Present	Unknown	Native	No	No		
Elephantopus carolinianus	Carolina elephantsfoot, leafy elephantfoot	Present	Unknown	Native	No	No		
Elephantopus nudatus	naked elephantfoot, smooth elephantsfoot	Present	Unknown	Native	No	No		
Eleusine indica	crowsfoot grass, goose grass, goosegrass, Indian goose grass, Indian goosegrass, manienie ali'I, silver crabgrass, wiregrass	Present	Unknown	Non-Native	No	No		
Elymus virginicus	Virginia wild rye, Virginia wildrye	Present	Unknown	Native	No	No		
Erechtites hieraciifolia	American burnweed	Present	Unknown	Native	No	No		
Erigeron philadelphicus	Philadelphia daisy, Philadelphia fleabane	Present	Unknown	Native	No	No		
Erigeron quercifolius	oakleaf fleabane	Present	Unknown	Native	No	No		
Erigeron strigosus	Daisy Fleabane, prairie fleabane, rough fleabane	Present	Unknown	Native	No	No		
Eupatorium capillifolium	dogfennel	Present	Unknown	Native	No	No		
Euphorbia heterophylla	Mexican fireplant, painted euphorbia	Present	Unknown	Native	Yes	No		

Scientific Name	Common Name(s)	Park Status	Abundance	Nativity	Weedy?	Management Priority	Global Rank	State Rank
Eustachys petraea	pinewoods fingergrass	Present	Unknown	Native	No	No		
Euthamia tenuifolia	slender goldentop	Present	Unknown	Native	No	No		
Fimbristylis thermalis	hot springs fimbry	Present	Unknown	Native	No	No		
Gaillardia pulchella	firewheel, Indian blanket, Indianblanket, rosering gaillardia	Present	Unknown	Native	No	No		
Galactia volubilis	downy milkpea	Present	Unknown	Native	No	No		
Galium tinctorium	dye bedstraw, stiff marsh bedstraw	Present	Unknown	Native	No	No		
Gamochaeta falcata	narrowleaf purple everlasting	Present	Unknown	Native	No	No		
Gamochaeta pensylvanica	Pennsylvania everlasting	Present	Unknown	Native	No	No		
Gamochaeta purpurea	spoon-leaf purple everlasting	Present	Unknown	Native	No	No		
Geranium carolinianum	Carolina crane's-bill, Carolina geranium	Present	Unknown	Native	No	No		
Heterotheca subaxillaris	camphorweed, golden aster	Present	Unknown	Non-Native	No	No		
Hydrocotyle bonariensis	largeleaf pennywort	Present	Unknown	Native	No	No		
Hydrocotyle umbellata	manyflower marshpennywort, umbrella pennyroyal	Present	Unknown	Native	No	No		
Hydrocotyle verticillata	whorled marsh pennywort, whorled pennyroyal	Present	Unknown	Native	No	No		
Hypericum gentianoides	orangegrass, pinweed st. johnswort	Present	Unknown	Native	No	No		
Hypericum hypericoides	St. Andrew's cross	Present	Unknown	Native	No	No		
Hypochaeris brasiliensis	Brazilian catsear	Present	Unknown	Non-Native	No	No		
Hypochaeris glabra	smooth catsear	Present	Unknown	Non-Native	No	No		
Ilex vomitoria	yaupon	Present	Unknown	Native	No	No		
Ipomoea carnea ssp. fistulosa	gloria de la manana, shrubby morningglory	Present	Unknown	Non-Native	No	No		

Scientific Name	Common Name(s)	Park Status	Abundance	Nativity	Weedy?	Management Priority	Global Rank	State Rank
Ipomoea imperati	beach morning-glory, beach morningglory	Present	Unknown	Native	No	No		
Ipomoea lacunosa	pitted morningglory, white morninglory, whitestar	Present	Unknown	Native	No	No		
Ipomoea pandurata	bigroot morningglory, man-of-the-earth	Present	Unknown	Native	No	No		
Ipomoea sagittata	saltmarsh morning-glory, saltmarsh morningglory	Present	Unknown	Native	No	No		
Iva frutescens	bigleaf sumpweed, Jesuit's bark	Present	Unknown	Native	No	No		
Iva imbricata	seacoast marshelder	Present	Unknown	Native	No	No		
Juncus roemerianus	needlegrass rush	Present	Unknown	Native	No	No		
Juniperus virginiana var. silicicola	coast juniper, coastal redcedar, southern red-cedar	Present	Unknown	Native	No	No		
Kyllinga brevifolia	shortleaf spikesedge	Present	Unknown	Native	No	No		
Lamium amplexicaule	common henbit, giraffehead, henbit, henbit deadnettle	Present	Unknown	Non-Native	No	No		
Lantana camara	lantana, largeleaf lantana	Present	Unknown	Native	No	No		
Lechea mucronata	hairy pinweed	Present	Unknown	Native	No	No		
Lepidium virginicum	peppergrass, poorman pepperweed, poorman's pepper	Present	Unknown	Native	No	No		
Ligustrum sinense	Chinese privet, common chinese privet	Present	Unknown	Non-Native	Yes	No		
Lolium perenne	italian ryegrass, perennial rye grass, perennial ryegrass	Present	Unknown	Non-Native	No	No		
Lonicera japonica	Chinese honeysuckle, Japanese honeysuckle	Present	Unknown	Non-Native	Yes	No		
Ludwigia maritima	seaside primrose-willow	Present	Unknown	Native	No	No		
Medicago lupulina	black medic, black	Present	Unknown	Non-Native	No	No		

Scientific Name	Common Name(s)	Park Status	Abundance	Nativity	Weedy?	Management Priority	Global Rank	State Rank
	medic clover, black medick							
Medicago polymorpha	bur clover, burclover, California burclover, toothed medick	Present	Unknown	Non-Native	No	No		
Melia azedarach	chinaberry, Chinaberry tree, Indian lilac	Present	Unknown	Non-Native	Yes	No		
Melilotus alba	white sweetclover	Present	Unknown	Non-Native	No	No		
Melilotus officinalis	yellow sweet-clover, yellow sweetclover	Present	Unknown	Non-Native	No	No		
Melothria pendula	drooping melonnettle, Guadeloupe cucumber	Present	Unknown	Native	No	No		
Mentha X gentilis	red mint	Present	Unknown	Non-Native	No	No		
Modiola caroliniana	Carolina bristlemallow, Carolina modiola	Present	Unknown	Native	No	No		
Mollugo verticillata	carpetweed, green carpetweed	Present	Unknown	Native	No	No		
Morella cerifera	wax myrtle, waxmyrtle	Present	Unknown	Native	No	No		
Morus rubra	red mulberry	Present	Unknown	Native	No	No		
Muhlenbergia capillaris var. trichopodes	cutover muhly	Present	Unknown	Native	No	No		
Nerium oleander	oleander	Present	Unknown	Non-Native	No	No		
Nothoscordum bivalve	crowpoison	Present	Unknown	Native	No	No		
Nuttallanthus canadensis	Canada toadflax, oldfield toadflax, oldfield-toadflax	Present	Unknown	Native	No	No		
Oenothera biennis	common evening primrose, common evening-primrose, common eveningprimrose, evening primrose (common), hoary eveningprimrose, king's-cureall	Present	Unknown	Native	No	No		

Scientific Name	Common Name(s)	Park Status	Abundance	Nativity	Weedy?	Management Priority	Global Rank	State Rank
Oenothera drummondii	beach evening-primrose, beach eveningprimrose	Present	Unknown	Native	No	No		
Oenothera fruticosa	narrowleaf evening-primrose	Present	Unknown	Native	No	No		
Oenothera humifusa	seabeach evening-primrose	Present	Unknown	Native	No	No		
Oenothera laciniata	cut-leaf evening-primrose	Present	Unknown	Native	Yes	No		
Oenothera speciosa	pinkladies, Showy evening primrose	Present	Unknown	Native	No	No		
Oldenlandia corymbosa	flat-top mille graines, flattop mille graines	Present	Unknown	Native	No	No		
Opuntia humifusa	devil's-tongue, pricklypear	Present	Unknown	Native	No	No		
Opuntia pusilla	cockspur pricklypear	Present	Unknown	Native	No	No		
Ornithogalum umbellatum	Pyrenees Star of Bethlehem, sleepydick, Star-of-Bethlehem	Present	Unknown	Native	No	No		
Oxalis rubra	Oxalis rubra, windowbox woodsorrel	Present	Unknown	Non-Native	No	No		
Oxalis stricta	common yellow oxalis, erect woodsorrel, sheep sorrel, sourgrass, toad sorrel, upright yellow wood-sorrel, upright yellow woodsorrel, yellow woodsorrel	Present	Unknown	Native	No	No		
Panicum amarum	bitter panicgrass, bitter panicum	Present	Unknown	Native	No	No		
Panicum dichotomiflorum	fall panic, fall panicgrass, fall panicum, western witchgrass	Present	Unknown	Native	No	No		
Parthenocissus quinquefolia	American ivy, fiveleaved ivy, Virginia creeper, woodbine	Present	Unknown	Native	No	No		
Paspalum dilatatum	dallas grass, water grass	Present	Unknown	Non-Native	No	No		

Scientific Name	Common Name(s)	Park Status	Abundance	Nativity	Weedy?	Management Priority	Global Rank	State Rank
Paspalum notatum	Bahia grass, bahiagrass	Present	Unknown	Non-Native	No	No		
Paspalum notatum var. saurae	bahiagrass	Present	Unknown	Non-Native	No	No		
Persea borbonia	redbay	Present	Unknown	Native	No	No		
Phlox drummondii	annual phlox, drummond phlox	Present	Unknown	Native	No	No		
Phyla nodiflora	frog fruit, sawtooth fogfruit, turkey tangle	Present	Unknown	Native	No	No		
Physalis walteri	Walter's groundcherry	Present	Unknown	Native	No	No		
Phytolacca americana	American pokeweed, common pokeweed, inkberry, pigeonberry, poke, pokeberry, pokeweed	Present	Unknown	Native	No	No		
Pinus taeda	loblolly pine	Present	Unknown	Native	No	No		
Pittosporum tobira	Japanese cheesewood	Present	Unknown	Non-Native	No	No		
Plantago aristata	bottlebrush Indianwheat, largebracted plantain	Present	Unknown	Native	No	No		
Plantago lanceolata	buckhorn plantain, English plantain, lanceleaf Indianwheat	Present	Unknown	Non-Native	No	No		
Plantago virginica	paleseed Indianwheat, Virginia plantain	Present	Unknown	Native	No	No		
Pleopeltis polypodioides ssp. polypodioides	resurrection fern	Present	Unknown	Native	No	No		
Pluchea carolinensis	cure for all	Present	Unknown	Native	No	No		
Poa annua	annual blue grass, annual bluegrass, walkgrass	Present	Unknown	Non-Native	No	No		
Polycarpon tetraphyllum	fourleaf manyseed	Present	Unknown	Non-Native	No	No		
Polygonum persicaria	lady's-thumb, ladysthumb smartweed, smartweed	Present	Unknown	Unknown	No	No		

Scientific Name	Common Name(s)	Park Status	Abundance	Nativity	Weedy?	Management Priority	Global Rank	State Rank
Polygonum punctatum	dotted smartweed	Present	Unknown	Native	No	No		
Polygonum virginianum	jumpseed, Virginia smartweed	Present	Unknown	Native	No	No		
Populus alba	white poplar	Present	Unknown	Non-Native	No	No		
Populus heterophylla	swamp cottonwood	Present	Unknown	Native	No	No		
Portulaca oleracea	common purslane, duckweed, garden purslane, little hogweed	Present	Unknown	Native	No	No		
Portulaca pilosa	chisme, kiss me quick, kiss-me-quick	Present	Unknown	Native	No	No		
Prunus angustifolia	Chickasaw plum	Present	Unknown	Native	No	No		
Prunus caroliniana	Carolina laurelcherry	Present	Unknown	Native	No	No		
Prunus serotina	black cherry, black chokecherry	Present	Unknown	Native	No	No		
Pseudognaphalium obtusifolium ssp. obtusifolium	rabbittobacco	Present	Unknown	Native	No	No		
Pteris vittata	Chinese brake, ladder brake	Present	Unknown	Native	No	No		
Ptilimnium capillaceum	herbwilliam, threadleaf mockbishopweed	Present	Unknown	Native	No	No		
Pyrrhopappus carolinianus	Carolina desert-chicory, Carolina false dandelion	Present	Unknown	Native	No	No		
Quercus chapmanii	Chapman oak	Present	Unknown	Native	No	No		
Quercus geminata	sand live oak	Present	Unknown	Native	No	No		
Quercus nigra	water oak	Present	Unknown	Native	No	No		
Quercus virginiana	live oak	Present	Unknown	Native	No	No		
Rhus copallinum	flameleaf sumac	Present	Unknown	Native	No	No		
Richardia scabra	rough Mexican clover	Present	Unknown	Native	No	No		
Rubus argutus	prickly Florida blackberry, sawtooth blackberry	Present	Unknown	Native	No	No		
Rubus trivialis	southern dewberry	Present	Unknown	Native	No	No		

Scientific Name	Common Name(s)	Park Status	Abundance	Nativity	Weedy?	Management Priority	Global Rank	State Rank
Rumex conglomeratus	clustered dock, sharp dock	Present	Unknown	Non-Native	No	No		
Rumex crispus	Curley dock, curly dock, narrowleaf dock, sour dock	Present	Unknown	Non-Native	No	No		
Rumex hastatulus	heartwing dock, heartwing sorrel	Present	Unknown	Native	No	No		
Rumex verticillatus	swamp dock	Present	Unknown	Native	No	No		
Sabal palmetto	cabbage palm, cabbage palmetto	Present	Unknown	Native	No	No		
Sabatia stellaris	rose of Plymouth	Present	Unknown	Native	No	No		
Sagina decumbens	beach pearlwort, trailing pearlwort	Present	Unknown	Native	No	No		
Salicornia virginica	Virginia glasswort	Present	Unknown	Native	No	No		
Salsola kali	prickly Russian thistle, Russian thistle, tumbleweed	Present	Unknown	Non-Native	No	No		
Salvia lyrata	lyreleaf sage	Present	Unknown	Native	No	No		
Sanicula canadensis	Canada sanicle, Canadian blacksnakeroot	Present	Unknown	Native	No	No		
Schoenoplectus robustus	sturdy bulrush	Present	Unknown	Native	No	No		
Senecio vulgaris	common groundsel, old-man-in-the-Spring	Present	Unknown	Non-Native	No	No		
Senna obtusifolia	Java-bean, sicklepod	Present	Unknown	Native	No	No		
Sesbania punicea	rattelbox, rattlebox	Present	Unknown	Non-Native	No	No		
Sesuvium portulacastrum	shoreline seapurslane	Present	Unknown	Native	No	No		
Setaria corrugata	coastal bristlegrass	Present	Unknown	Native	No	No		
Sida rhombifolia	arrowleaf sida, cuban jute, Cuban-jute	Present	Unknown	Native	No	No		
Sideroxylon lycioides	buckthorn bully	Present	Unknown	Native	No	No		
Sideroxylon tenax	tough bully	Present	Unknown	Native	No	Yes	G3?	SNR
Smilax auriculata	earleaf greenbrier	Present	Unknown	Native	No	No		

Scientific Name	Common Name(s)	Park Status	Abundance	Nativity	Weedy?	Management Priority	Global Rank	State Rank
Smilax bona-nox	saw greenbrier	Present	Unknown	Native	No	No		
Smilax laurifolia	laurel greenbrier	Present	Unknown	Native	No	No		
Solanum carolinense	apple of Sodom, bull nettle, Carolina horsenettle, devil's tomato, horsenettle, sand briar	Present	Unknown	Native	No	No		
Solanum pseudogracile	glowing nightshade	Present	Unknown	Native	No	No		
Solanum ptychanthum	black nightshade, eastern black nightshade, nightshade	Present	Unknown	Native	No	No		
Solanum rostratum	buffalobur, buffalobur nightshade, Colorado bur	Present	Unknown	Native	No	No		
Solidago odora	anisescented goldenrod, fragrant goldenrod	Present	Unknown	Native	No	No		
Solidago rugosa	wrinkleleaf goldenrod	Present	Unknown	Native	No	No		
Solidago sempervirens	seaside goldenrod	Present	Unknown	Native	No	No		
Solidago stricta	wand goldenrod	Present	Unknown	Native	No	No		
Sonchus asper	perennial sowthistle, prickly sowthistle, spiny sowthistle	Present	Unknown	Non-Native	No	No		
Sonchus oleraceus	annual sowthistle, common sow-thistle, common sowthistle	Present	Unknown	Non-Native	No	No		
Sorghum halepense	Johnson grass	Present	Unknown	Non-Native	Yes	No		
Spartina alterniflora	Atlantic cordgrass, saltmarsh cordgrass, smooth cordgrass	Present	Unknown	Native	No	No		
Spartina patens	marshhay cordgrass, salt meadow cordgrass, saltmeadow cordgrass	Present	Unknown	Native	No	No		
Sphenopholis nitida	shiny wedgescale	Present	Unknown	Native	No	No		
Sporobolus indicus var. indicus	smut grass	Present	Unknown	Native	No	No		

Scientific Name	Common Name(s)	Park Status	Abundance	Nativity	Weedy?	Management Priority	Global Rank	State Rank
Sporobolus virginicus	seashore dropseed	Present	Unknown	Native	No	No		
Stachys floridana	Florida betony, Florida hedgenettle	Present	Unknown	Native	No	No		
Stachys hyssopifolia	hyssopleaf hedgenettle	Present	Unknown	Native	No	No		
Stellaria media	chickweed, common chickweed, nodding chickweed	Present	Unknown	Non-Native	No	No		
Stenotaphrum secundatum	St. Augustine grass, St. Augustinegrass	Present	Unknown	Native	No	No		
Strophostyles helvula	trailing fuzzybean, trailing wild-bean, Trailing wildbean	Present	Unknown	Native	No	No		
Suaeda linearis	annual seepweed	Present	Unknown	Native	No	No		
Symphyotrichum dumosum	rice button aster	Present	Unknown	Native	No	No		
Symphyotrichum pilosum var. pilosum	hairy white oldfield aster	Present	Unknown	Native	No	No		
Symphyotrichum subulatum	eastern annual saltmarsh aster	Present	Unknown	Native	No	No		
Symphyotrichum tenuifolium	perennial saltmarsh aster	Present	Unknown	Native	No	No		
Tamarix gallica	French tamarisk, saltcedar, tamarisk, tamarix	Present	Unknown	Non-Native	No	No		
Taraxacum laevigatum	red-seed dandelion, rock dandelion, rock dandylion	Present	Unknown	Non-Native	No	No		
Taraxacum officinale	blowball, common dandelion, dandelion, faceclock	Present	Unknown	Native	No	No		
Teucrium canadense	American germander, Canada germander, wood sage	Present	Unknown	Native	No	No		
Tillandsia usneoides	Spanish moss	Present	Unknown	Native	No	No		
Tradescantia ohiensis	bluejacket, Ohio spiderwort	Present	Unknown	Native	No	No		
Trifolium dubium	hop clover, smallhop	Present	Unknown	Non-Native	No	No		

Scientific Name	Common Name(s)	Park Status	Abundance	Nativity	Weedy?	Management Priority	Global Rank	State Rank
	clover, suckling clover							
Trifolium repens	Dutch clover, ladino clover, white clover	Present	Unknown	Non-Native	No	No		
Triodanis perfoliata	clasping bellwort, clasping Venus' looking-glass	Present	Unknown	Native	No	No		
Triplasis purpurea	purple sand grass, purple sandgrass	Present	Unknown	Native	No	No		
Typha latifolia	broadleaf cattail, cattail, cattail (common), common cattail	Present	Unknown	Native	No	No		
Uniola paniculata	seaoats	Present	Unknown	Native	No	No		
Verbena bonariensis	pretty verbena, purpletop vervain	Present	Unknown	Non-Native	No	No		
Verbena brasiliensis	Brazilian vervain	Present	Unknown	Non-Native	No	No		
Veronica arvensis	common speedwell, corn speedwell, rock speedwell	Present	Unknown	Non-Native	No	No		
Veronica peregrina	neckweed, purslane speedwell	Present	Unknown	Native	No	No		
Vicia angustifolia	garden vetch	Present	Unknown	Non-Native	No	No		
Vicia hirsuta	tiny vetch	Present	Unknown	Non-Native	No	No		
Vicia sativa ssp. nigra	common vetch, garden vetch, slimleaf vetch, vetch	Present	Unknown	Non-Native	No	No		
Vitex agnus-castus	chaste tree, lilac chastetree	Present	Unknown	Non-Native	No	No		
Vitis aestivalis	summer grape	Present	Unknown	Native	No	No		
Vulpia octoflora var. octoflora	eight-flower six-weeks grass, sixweeks fescue	Present	Unknown	Native	No	No		
Wisteria sinensis	Chinese wisteria	Present	Unknown	Non-Native	Yes	No		
Youngia japonica	oriental false hawksbeard	Present	Unknown	Non-Native	No	No		
Yucca aloifolia	aloe yucca	Present	Unknown	Native	No	No		
Yucca filamentosa	Adam's needle	Present	Unknown	Native	No	No		
Zanthoxylum clava-	Hercules' club,	Present	Unknown	Native	No	No		

Scientific Name	*Common Name(s)*	*Park Status*	*Abundance*	*Nativity*	*Weedy?*	*Management Priority*	*Global Rank*	*State Rank*
herculis	hercules-club, hercules-club pricklyash							
Zephyranthes atamasca	Atamasco lily	Present	Unknown	Native	No	No		

Appendix G: Plant species documented for Charles Pinckney National Historic Site.
These species have been cross referenced to NatureServe's global and state rankings (NatureServe 2008). No plant species were listed as endangered or threatened. See reference or Appendix E for explanation of abbreviations.

Scientific Name	*Common Name(s)*	*Park Status*	*Abundance*	*Nativity*	*Cultivation*	*Weedy?*	*Global Rank*	*State Rank*
Sanicula canadensis	Canada sanicle, Canadian blacksnakeroot	Present	Unknown	Native	n/a	No		
Sabal palmetto	cabbage palm, cabbage palmetto	Present	Unknown	Native	n/a	No		
Baccharis halimifolia	eastern baccharis	Present	Unknown	Native	n/a	No		
Bidens bipinnata	Spanish needles, spanish-needles	Present	Unknown	Native	n/a	No		
Conoclinium coelestinum	blue mistflower	Present	Unknown	Native	n/a	No		
Conyza canadensis	Canadian horseweed, horseweed, horseweed fleabane	Present	Unknown	Native	n/a	No		
Elephantopus carolinianus	Carolina elephantsfoot, leafy elephantfoot	Present	Unknown	Native	n/a	No		
Erigeron quercifolius	oakleaf fleabane	Present	Unknown	Native	n/a	No		
Eupatorium capillifolium	dogfennel	Present	Unknown	Native	n/a	No		
Melanthera nivea	snow squarestem	Present	Unknown	Native	n/a	No		
Pseudognaphalium obtusifolium	rabbittobacco	Present	Unknown	Native	n/a	No		
Pyrrhopappus carolinianus	Carolina desert chicory, Carolina false-dandelion	Present	Unknown	Native	n/a	No		
Solidago odora	anisescented goldenrod, fragrant goldenrod	Present	Unknown	Native	n/a	No		
Symphyotrichum dumosum	rice button aster	Present	Unknown	Native	n/a	No		
Verbesina occidentalis	yellow crownbeard	Present	Unknown	Native	n/a	No		
Tillandsia usneoides	Spanish moss	Present	Unknown	Native	n/a	No		
Lepidium virginicum	peppergrass, poorman pepperweed, Virginia pepperweed	Present	Unknown	Native	n/a	No		
Chenopodium ambrosioides	Mexican tea, Mexican-tea	Present	Unknown	Non-Native	Unknown	Yes		
Cornus florida	flowering dogwood	Present	Unknown	Native	n/a	No		
Pennisetum glaucum	pearl millet, pearl-millet, yellow bristlegrass	Present	Unknown	Non-Native	Unknown	No		
Setaria corrugata	coastal bristlegrass	Present	Unknown	Native	n/a	No		

Scientific Name	*Common Name(s)*	*Park Status*	*Abundance*	*Nativity*	*Cultivation*	*Weedy?*	*Global Rank*	*State Rank*
Setaria parviflora	knotroot bristlegrass, marsh bristle grass, yellow bristlegrass	Present	Unknown	Native	n/a	No		
Vulpia octoflora var. octoflora	eight-flower six-weeks grass, sixweeks fescue	Present	Unknown	Native	n/a	No		
Acalypha gracilens	slender copperleaf, slender threeseed mercury	Present	Unknown	Native	n/a	No		
Cnidoscolus stimulosus	finger rot	Present	Unknown	Native	n/a	No		
Triadica sebifera	tallowtree	Present	Unknown	Non-Native	Unknown	Yes		
Albizia julibrissin	mimosa, powderpuff tree, silk tree	Present	Unknown	Non-Native	Unknown	Yes		
Crotalaria spectabilis	showy crotalaria, showy rattlebox	Present	Unknown	Non-Native	Unknown	No		
Medicago lupulina	black medic, black medic clover, black medick	Present	Unknown	Non-Native	Unknown	No		
Senna obtusifolia	Java-bean, sicklepod	Present	Unknown	Native	n/a	No		
Sesbania punicea	rattelbox, rattlebox	Present	Unknown	Non-Native	Not cultivated	No		
Strophostyles helvula	trailing fuzzybean, trailing wild-bean, Trailing wildbean	Present	Unknown	Native	n/a	No		
Trifolium repens	Dutch clover, ladino clover, white clover	Present	Unknown	Non-Native	Unknown	No		
Fagus grandifolia	American beech	Present	Unknown	Native	n/a	No		
Quercus nigra	water oak	Present	Unknown	Native	n/a	No		
Quercus virginiana	live oak	Present	Unknown	Native	n/a	No		
Sabatia stellaris	rose of Plymouth	Present	Unknown	Native	n/a	No		
Oxalis rubra	Oxalis rubra, windowbox woodsorrel	Present	Unknown	Non-Native	Unknown	No		
Liquidambar styraciflua	sweetgum	Present	Unknown	Native	n/a	No		
Platanus occidentalis	American sycamore, sycamore	Present	Unknown	Native	n/a	No		
Carya illinoinensis	pecan	Present	Unknown	Native	n/a	No		
Juglans regia	English walnut	Present	Unknown	Non-Native	Cultivated	No		
Juncus roemerianus	needlegrass rush	Present	Unknown	Native	n/a	No		
Callicarpa americana	American beautyberry	Present	Unknown	Native	n/a	No		
Verbena bonariensis	pretty verbena, purpletop vervain	Present	Unknown	Non-Native	Unknown	No		
Sisyrinchium rosulatum	annual blue-eyed grass, annual blueeyed grass	Present	Unknown	Native	n/a	No		
Asimina parviflora	smallflower pawpaw	Present	Unknown	Native	n/a	No		

Scientific Name	*Common Name(s)*	*Park Status*	*Abundance*	*Nativity*	*Cultivation*	*Weedy?*	*Global Rank*	*State Rank*
Magnolia grandiflora	southern magnolia	Present	Unknown	Native	n/a	No		
Modiola caroliniana	Carolina bristlemallow, Carolina modiola	Present	Unknown	Native	n/a	No		
Sida rhombifolia	arrowleaf sida, cuban jute, Cuban-jute	Present	Unknown	Native	n/a	No		
Morella cerifera	wax myrtle, waxmyrtle	Present	Unknown	Native	n/a	No		
Oenothera drummondii	beach evening-primrose, beach eveningprimrose	Present	Unknown	Native	n/a	No		
Juniperus virginiana	eastern redcedar, red cedar juniper	Present	Unknown	Native	n/a	No		
Pinus taeda	loblolly pine	Present	Unknown	Native	n/a	No		
Saururus cernuus	lizard's tail, lizards tail	Present	Unknown	Native	n/a	No		
Polygonum punctatum	dotted smartweed	Present	Unknown	Native	n/a	No		
Polygonum virginianum	jumpseed, Virginia smartweed	Present	Unknown	Native	n/a	No		
Woodwardia areolata	chainfern, netted chainfern	Present	Unknown	Native	n/a	No		
Vitis aestivalis	summer grape	Present	Unknown	Native	n/a	No		
Vitis rotundifolia	muscadine, muscadine grape	Present	Unknown	Native	n/a	No		
Duchesnea indica	India mockstrawberry, Indian strawberry	Present	Unknown	Non-Native	Unknown	No		
Prunus caroliniana	Carolina laurelcherry	Present	Unknown	Native	n/a	No		
Prunus serotina	black cherry, black chokecherry	Present	Unknown	Native	n/a	No		
Diodia teres	poor joe, poorjoe, rough buttonweed	Present	Unknown	Native	n/a	No		
Diodia virginiana	Virginia buttonweed	Present	Unknown	Native	n/a	No		
Richardia brasiliensis	tropical Mexican clover	Present	Unknown	Native	n/a	No		
Acer rubrum	red maple	Present	Unknown	Native	n/a	No		
Catalpa speciosa	northern catalpa	Present	Unknown	Non-Native	Unknown	No		
Ligustrum japonicum	Japanese privet	Present	Unknown	Non-Native	Unknown	Yes		
Ligustrum sinense	Chinese privet, common chinese privet	Present	Unknown	Non-Native	Unknown	Yes		
Ipomoea carnea ssp. fistulosa	gloria de la manana, shrubby morningglory	Present	Unknown	Non-Native	Unknown	No		
Physalis walteri	Walter's groundcherry	Present	Unknown	Native	n/a	No		
Solanum pseudogracile	glowing nightshade	Present	Unknown	Native	n/a	No		
Camellia japonica	camellia	Probably Present	NA	Non-Native	Cultivated	No		
Camellia reticulata		Probably	NA	Non-Native	Cultivated	No		

Scientific Name	*Common Name(s)*	*Park Status*	*Abundance*	*Nativity*	*Cultivation*	*Weedy?*	*Global Rank*	*State Rank*
Camellia sasanqua	Sasanqua camellia	Present Probably Present	NA	Non-Native	Cultivated	No		
Passiflora lutea	passionflower, yellow passionflower	Present	Unknown	Native	n/a	No		

Appendix H: Fish species documented for Fort Sumter National Monument.
These species have been cross referenced to the SC Comprehensive Wildlife Conservation Strategy prioriy species, and listings for endangered, threatened, or of concern (South Carolina Department of Natural Resources 2005); and NatureServe's global and state rankings (NatureServe 2008). See reference or Appendix E for explanation of abbreviations.

Scientific Name	*Common Name(s)*	*Park Status*	*Abundance*	*Residency*	*Nativity*	*Cultivation*	*SC priority species*	*Global Rank*	*State Rank*	*Federal Status*	*State Status*
Ancylopsetta ommata	--	Probably Present	n/a	n/a	Native	n/a					
Anguilla rostrata	American eel	Probably Present	n/a	n/a	Native	n/a	Yes	G5	SNR		
Alosa sapidissima	American shad	Probably Present	n/a	n/a	Native	n/a	Yes	G5	S5		
Chloroscombrus chrysurus	Atlantic bumper	Probably Present	n/a	n/a	Native	n/a	Yes				
Micropogonias undulatus	Atlantic croaker	Probably Present	n/a	n/a	Native	n/a	Yes	G5			
Trichiurus lepturus	Atlantic cutlassfish	Probably Present	n/a	n/a	Native	n/a	Yes				
Rhinobatos lentiginosus	Atlantic guitarfish	Probably Present	n/a	n/a	Native	n/a	Yes				
Brevoortia tyrannus	Atlantic menhaden, bugfish, bunker, fatback, menhaden	Probably Present	n/a	n/a	Native	n/a	Yes				
Selene setapinnis	Atlantic moonfish	Probably Present	n/a	n/a	Native	n/a	Yes				
Strongylura marina	Atlantic needlefish, silver gar	Probably Present	n/a	n/a	Native	n/a	Yes				
Rhizoprionodon terraenovae	Atlantic sharpnose shark	Probably Present	n/a	n/a	Native	n/a					
Menidia menidia	Atlantic silverside	Probably Present	n/a	n/a	Native	n/a	Yes				
Chaetodipterus faber	Atlantic spadefish	Probably Present	n/a	n/a	Native	n/a	Yes				
Scomberomorus maculatus	Atlantic Spanish mackerel,	Probably Present	n/a	n/a	Native	n/a	Yes				

Scientific Name	*Common Name(s)*	*Park Status*	*Abundance*	*Residency*	*Nativity*	*Cultivation*	*SC priority species*	*Global Rank*	*State Rank*	*Federal Status*	*State Status*
	Spanish mackerel										
Dasyatis sabina	Atlantic stingray	Probably Present	n/a	n/a	Native	n/a	Yes				
Opisthonema oglinum	Atlantic thread herring	Probably Present	n/a	n/a	Native	n/a	Yes				
Larimus fasciatus	banded drum	Probably Present	n/a	n/a	Native	n/a	Yes				
Seriola zonata	banded rubberfish, banded rudderfish	Probably Present	n/a	n/a	Native	n/a					
Centropristis ocyurus	bank sea bass	Probably Present	n/a	n/a	Native	n/a					
Anchoa mitchilli	bay anchovy	Probably Present	n/a	n/a	Native	n/a	Yes				
Citharichthys spilopterus	bay whiff	Probably Present	n/a	n/a	Native	n/a	Yes				
Serranus subligarius	belted sandfish	Probably Present	n/a	n/a	Native	n/a	Yes				
Prionotus tribulus	bighead searobin	Probably Present	n/a	n/a	Native	n/a	Yes				
Pogonias cromis	black drum	Probably Present	n/a	n/a	Native	n/a	Yes				
Mugil cephalus	black mullet, gray mullet, striped mullet	Probably Present	n/a	n/a	Native	n/a	Yes	G5			
Centropristis striata	black sea bass	Probably Present	n/a	n/a	Native	n/a	Yes				
Symphurus plagiusa	blackcheek tonguefish	Probably Present	n/a	n/a	Native	n/a	Yes				
Synagrops bellus	blackmouth bass, blackmouth cardinalfish	Probably Present	n/a	n/a	Native	n/a					
Caranx crysos	blue runner	Probably Present	n/a	n/a	Native	n/a	Yes				
Alosa aestivalis	blueback herring,	Probably	n/a	n/a	Native	n/a	Yes	G3	S3		SC

Scientific Name	Common Name(s)	Park Status	Abundance	Residency	Nativity	Cultivation	SC priority species	Global Rank	State Rank	Federal Status	State Status
	blueback shad	Present									
Pomatomus saltatrix	bluefish	Probably Present	n/a	n/a	Native	n/a	Yes				
Enneacanthus gloriosus	bluespotted sunfish	Probably Present	n/a	n/a	Native	n/a					
Hemicaranx amblyrhynchus	bluntnose jack	Probably Present	n/a	n/a	Native	n/a					
Sphyrna tiburo	bonnethead, shovelhead	Probably Present	n/a	n/a	Native	n/a	Yes				
Scophthalmus aquosus	brill, sand dab, spotted flounder, windowpane	Probably Present	n/a	n/a	Native	n/a	Yes				
Paralichthys squamilentus	broad flounder	Probably Present	n/a	n/a	Native	n/a	Yes				
Anchoa hepsetus	broad-striped anchovy, striped anchovy	Probably Present	n/a	n/a	Native	n/a	Yes				
Syngnathus springeri	bull pipefish	Probably Present	n/a	n/a	Native	n/a	Yes				
Chilomycterus schoepfii	burrfish, porcupinefish, striped burrfish	Probably Present	n/a	n/a	Native	n/a					
Peprilus triacanthus	butterfish	Probably Present	n/a	n/a	Native	n/a	Yes				
Syngnathus louisianae	chain pipefish	Probably Present	n/a	n/a	Native	n/a	Yes				
Raja eglanteria	clearnose skate	Probably Present	n/a	n/a	Native	n/a	Yes				
Prionotus carolinus	common searobin, northern searobin	Probably Present	n/a	n/a	Native	n/a					
Rhinoptera bonasus	cownose ray	Probably Present	n/a	n/a	Native	n/a	Yes				
Caranx hippos	crevalle jack	Probably Present	n/a	n/a	Native	n/a	Yes	G5			
Ctenogobius boleosoma	darter goby	Probably Present	n/a	n/a	Native	n/a	Yes				

Scientific Name	Common Name(s)	Park Status	Abundance	Residency	Nativity	Cultivation	SC priority species	Global Rank	State Rank	Federal Status	State Status
Coryphaena hippurus	dolphinfish	Probably Present	n/a	n/a	Native	n/a					
Gambusia holbrooki	eastern mosquitofish	Probably Present	n/a	n/a	Native	n/a					
Ctenogobius smaragdus	emerald goby	Probably Present	n/a	n/a	Native	n/a	Yes				
Hypsoblennius hentz	feather blenny	Probably Present	n/a	n/a	Native	n/a	Yes				
Trachinotus carolinus	Florida pompano	Probably Present	n/a	n/a	Native	n/a	Yes				
Paralichthys dentatus	fluke, summer flounder	Probably Present	n/a	n/a	Native	n/a	Yes				
Hypsoblennius ionthas	freckled blenny	Probably Present	n/a	n/a	Native	n/a	Yes				
Etropus crossotus	fringed flounder	Probably Present	n/a	n/a	Native	n/a	Yes				
Bagre marinus	gafftopsail catfish	Probably Present	n/a	n/a	Native	n/a	Yes				
Notemigonus crysoleucas	golden shiner	Probably Present	n/a	n/a	Native	n/a					
Lutjanus griseus	gray snapper	Probably Present	n/a	n/a	Native	n/a	Yes				
Cynoscion regalis	gray trout, sea trout, weakfish	Probably Present	n/a	n/a	Native	n/a	Yes				
Microgobius thalassinus	green goby	Probably Present	n/a	n/a	Native	n/a	Yes				
Paralichthys albigutta	Gulf flounder	Probably Present	n/a	n/a	Native	n/a	Yes				
Menticirrhus littoralis	Gulf kingfish	Probably Present	n/a	n/a	Native	n/a	Yes	GNR			
Menticirrhus saxatilis	Gulf minkfish, northern kingfish	Probably Present	n/a	n/a	Native	n/a	Yes	GNR			
Syngnathus scovelli	Gulf pipefish	Probably Present	n/a	n/a	Native	n/a	Yes				
Ariopsis felis	hardhead catfish	Probably Present	n/a	n/a	Native	n/a	Yes	G5			
Peprilus paru	harvestfish,	Probably	n/a	n/a	Native	n/a	Yes				

Scientific Name	Common Name(s)	Park Status	Abundance	Residency	Nativity	Cultivation	SC priority species	Global Rank	State Rank	Federal Status	State Status
	northern harvestfish, northern harvestfish	Present									
Gobionellus oceanicus	highfin goby, sharptail goby, slim goby	Probably Present	n/a	n/a	Native	n/a	Yes				
Trinectes maculatus	hogchoker	Probably Present	n/a	n/a	Native	n/a	Yes				
Caranx latus	horse-eye jack	Probably Present	n/a	n/a	Native	n/a	Yes				
Menidia beryllina	inland silverside, tidewater silverside	Probably Present	n/a	n/a	Native	n/a	Yes				
Synodus foetens	inshore lizardfish	Probably Present	n/a	n/a	Native	n/a	Yes				
Menticirrhus americanus	jewsharp drummer, southern kingfish	Probably Present	n/a	n/a	Native	n/a	Yes	GNR			
Scomberomorus cavalla	king mackerel	Probably Present	n/a	n/a	Native	n/a	Yes				
Elops saurus	ladyfish	Probably Present	n/a	n/a	Native	n/a	Yes				
Prionotus scitulus	leopard searobin	Probably Present	n/a	n/a	Native	n/a	Yes				
Lepisosteus osseus	longnose gar	Probably Present	n/a	n/a	Native	n/a					
Selene vomer	lookdown	Probably Present	n/a	n/a	Native	n/a	Yes				
Ctenogobius stigmaticus	marked goby	Probably Present	n/a	n/a	Native	n/a					
Gambusia affinis	mosquitofish, western mosquitofish	Probably Present	n/a	n/a	Native	n/a					
Fundulus heteroclitus	mummichog	Probably Present	n/a	n/a	Native	n/a	Yes	G5			
Gobiosoma bosc	naked goby	Probably	n/a	n/a	Native	n/a	Yes				

Scientific Name	Common Name(s)	Park Status	Abundance	Residency	Nativity	Cultivation	SC priority species	Global Rank	State Rank	Federal Status	State Status
		Present									
Membras vagrans	Neotropical silversides	Probably Present	n/a	n/a	Native	n/a					
Syngnathus fuscus	northern pipefish	Probably Present	n/a	n/a	Native	n/a	Yes				
Sphoeroides maculatus	northern puffer	Probably Present	n/a	n/a	Native	n/a	Yes				
Astroscopus guttatus	northern stargazer	Probably Present	n/a	n/a	Native	n/a	Yes				
Cantherhines pullus	orangespotted filefish	Probably Present	n/a	n/a	Native	n/a					
Opsanus tau	oyster toadfish	Probably Present	n/a	n/a	Native	n/a	Yes				
Trachinotus falcatus	permit	Probably Present	n/a	n/a	Native	n/a	Yes				
Orthopristis chrysoptera	pigfish	Probably Present	n/a	n/a	Native	n/a	Yes				
Lagodon rhomboides	pinfish	Probably Present	n/a	n/a	Native	n/a	Yes				
Aphredoderus sayanus	pirate perch	Probably Present	n/a	n/a	Native	n/a					
Stephanolepis hispida	planehead filefish	Probably Present	n/a	n/a	Native	n/a	Yes				
Stenotomus chrysops	porgy, scup	Probably Present	n/a	n/a	Native	n/a					
Pagrus pagrus	red porgy	Probably Present	n/a	n/a	Native	n/a					
Muraena retifera	reticulate moray	Probably Present	n/a	n/a	Native	n/a					
Centropristis philadelphica	rock sea bass	Probably Present	n/a	n/a	Native	n/a	Yes				
Morone saxatilis	rockfish, striped bass	Probably Present	n/a	n/a	Native	n/a	Moderate	G5	SNR		
Membras martinica	rough silverside	Probably Present	n/a	n/a	Native	n/a	Yes				
Poecilia latipinna	sailfin molly	Probably Present	n/a	n/a	Native	n/a	Yes	G5	SNR		

Scientific Name	Common Name(s)	Park Status	Abundance	Residency	Nativity	Cultivation	SC priority species	Global Rank	State Rank	Federal Status	State Status
Sphyrna lewini	scalloped hammerhead	Probably Present	n/a	n/a	Native	n/a	Yes				
Echeneis naucrates	sharksucker	Probably Present	n/a	n/a	Native	n/a	Yes				
Archosargus probatocephalus	sheepshead	Probably Present	n/a	n/a	Native	n/a	Yes	G5			
Cyprinodon variegatus	sheepshead minnow, sheepshead pupfish	Probably Present	n/a	n/a	Native	n/a	Yes				
Pristigenys alta	short bigeye	Probably Present	n/a	n/a	Native	n/a					
Chlorophthalmus agassizi	shortnose greeneye	Probably Present	n/a	n/a	Native	n/a					
Acipenser brevirostrum	shortnose sturgeon	Probably Present	n/a	n/a	Native	n/a	Yes	G3	S3	E	E
Eucinostomus gula	silver jenny	Probably Present	n/a	n/a	Native	n/a	Yes				
Eucinostomus argenteus	Silver mojarra	Probably Present	n/a	n/a	Native	n/a					
Mugil curema	silver mullet, white mullet	Probably Present	n/a	n/a	Native	n/a	Yes				
Bairdiella chrysoura	silver perch	Probably Present	n/a	n/a	Native	n/a	Yes				
Gobiesox strumosus	skilletfish	Probably Present	n/a	n/a	Native	n/a	Yes				
Etropus microstomus	smallmouth flounder	Probably Present	n/a	n/a	Native	n/a					
Pristis pectinata	smalltooth sawfish, wide sawfish	Probably Present	n/a	n/a	Native	n/a					
Lagocephalus laevigatus	smooth puffer	Probably Present	n/a	n/a	Native	n/a	Yes				
Myliobatis goodei	southern eagle ray	Probably Present	n/a	n/a	Native	n/a					
Paralichthys lethostigma	southern flounder	Probably Present	n/a	n/a	Native	n/a	Yes				

Scientific Name	Common Name(s)	Park Status	Abundance	Residency	Nativity	Cultivation	SC priority species	Global Rank	State Rank	Federal Status	State Status
Astroscopus y-graecum	southern stargazer	Probably Present	n/a	n/a	Native	n/a	Yes				
Myrophis punctatus	speckled worm eel	Probably Present	n/a	n/a	Native	n/a	Yes				
Leiostomus xanthurus	spot	Probably Present	n/a	n/a	Native	n/a	Yes	G5			
Fundulus luciae	spotfin killifish	Probably Present	n/a	n/a	Native	n/a	Yes				
Diplodus holbrookii	spottail pinfish	Probably Present	n/a	n/a	Native	n/a					
Cynoscion nebulosus	spotted seatrout	Probably Present	n/a	n/a	Native	n/a	Yes				
Stellifer lanceolatus	star drum	Probably Present	n/a	n/a	Native	n/a	Yes				
Antennarius striatus	striated frogfish	Probably Present	n/a	n/a	Native	n/a					
Ophidion marginatum	striped cusk-eel	Probably Present	n/a	n/a	Native	n/a	Yes				
Fundulus majalis	striped killifish	Probably Present	n/a	n/a	Native	n/a	Yes	G5			
Eugerres plumieri	striped mojarra	Probably Present	n/a	n/a	Native	n/a					
Prionotus evolans	striped searobin	Probably Present	n/a	n/a	Native	n/a	Yes				
Dorosoma petenense	threadfin shad	Probably Present	n/a	n/a	Native	n/a					
Galeocerdo cuvier	tiger shark	Probably Present	n/a	n/a	Native	n/a	Yes				
Rhomboplites aurorubens	vermilion snapper	Probably Present	n/a	n/a	Native	n/a					
Ameiurus catus	white bullhead, white catfish	Probably Present	n/a	n/a	Native	n/a	Moderate	G5	SNR		
Haemulon plumierii	white grunt	Probably Present	n/a	n/a	Native	n/a					
Thunnus albacares	yellowfin tuna	Probably Present	n/a	n/a	Native	n/a					

Appendix I: Fish species documented for Charles Pinckney National Historic Site.
These species have been cross referenced to the SC Comprehensive Wildlife Conservation Strategy prioriy species, and listings for endangered, threatened, or of concern (South Carolina Department of Natural Resources 2005); and NatureServe's global and state rankings (NatureServe 2008). See reference or Appendix E for explanation of abbreviations.

Scientific Name	*Common Name(s)*	*Park Status*	*Abundance*	*Residency*	*Nativity*	*SC priority Species*	*Global Rank*	*State Rank*	*Federal Status*	*State Status*
Menidia beryllina	inland silverside, tidewater silverside	Present	Unknown	Unknown	Native	Yes				
Fundulus heteroclitus	mummichog	Present	Unknown	Unknown	Native	Yes	G5			
Leiostomus xanthurus	spot	Present	Unknown	Unknown	Native	Yes	G5			

Appendix J: Amphibian species documented for Fort Sumter National Monument.
These species have been cross referenced to the SC Comprehensive Wildlife Conservation Strategy prioriy species, and listings for endangered, threatened, or of concern (South Carolina Department of Natural Resources 2005); and NatureServe's global and state rankings (NatureServe 2008). See reference or Appendix E for explanation of abbreviations.

Scientific Name	***Common Name(s)***	***Park Status***	***Abundance***	***Residency***	***Nativity***	***SC priority species***	***Global Rank***	***State Rank***	***Federal Status***	***State Status***
Bufo terrestris	Southern Toad	Present in Park	Unknown	Unknown	Native					
Hyla cinerea	Green Tree Frog	Present in Park	Unknown	Unknown	Native					
Gastrophryne carolinensis	Eastern Narrow-mouthed Toad	Present in Park	Unknown	Unknown	Native					
Scaphiopus holbrookii	Eastern Spadefoot	Present in Park	Unknown	Unknown	Native					
Bufo quercicus	Oak toad	Found near vicinity	Unknown	Unknown	Native					
Hyla cinerea	Green treefrog	Found near vicinity	Unknown	Unknown	Native					
Hyla squirella	Squirrel treefrog	Found near vicinity	Unknown	Unknown	Native					
Plethodon glutinosus	Slimy salamander	Found near vicinity	Unknown	Unknown	Native					

Appendix K: Amphibian species documented for Charles Pinckney National Historic Site.
These species have been cross referenced to the SC Comprehensive Wildlife Conservation Strategy prioriy species, and listings for endangered, threatened, or of concern (South Carolina Department of Natural Resources 2005); and NatureServe's global and state rankings (NatureServe 2008). See reference or Appendix E for explanation of abbreviations.

Scientific Name	***Common Name(s)***	***Park Status***	***Abundance***	***Residency***	***Nativity***	***SC priority species***	***Global Rank***	***State Rank***	***Federal Status***	***State Status***
Bufo terrestris	Southern Toad	Present	Unknown	Unknown	Native					
Rana sphenocephala	Southern Leopard Frog	Present	Unknown	Unknown	Native					
Plethodon glutinosus	Slimy Salamander	Present	Unknown	Unknown	Native					
Bufo quercicus	Oak toad	Found near vicinity	Unknown	Unknown	Native					
Gastrophryne carolinensis	Eastern narrowmouth toad	Present	Unknown	Unknown	Native					
Hyla cinerea	Green treefrog	Found near vicinity	Unknown	Unknown	Native					
Hyla squirella	Squirrel treefrog	Found near vicinity	Unknown	Unknown	Native					
Scaphiopus holbrookii	Eastern spadefoot toad	Present	Unknown	Unknown	Native					

Appendix L: Reptile species documented for Fort Sumter National Monument.
These species have been cross referenced to the SC Comprehensive Wildlife Conservation Strategy prioriy species, and listings for endangered, threatened, or of concern (South Carolina Department of Natural Resources 2005); and NatureServe's global and state rankings (NatureServe 2008). See reference or Appendix E for explanation of abbreviations.

Scientific Name	***Common Name(s)***	***Park Status***	***Abundance***	***Residency***	***Nativity***	***SC priority species***	***Global Rank***	***State Rank***	***Federal Status***	***State Status***
Coluber constrictor	Eastern racer	Present in Park	Unknown	Unknown	Native					
Elaphe obsoleta	Eastern rat snake	Present in Park	Unknown	Unknown	Native					
Anolis carolinensis	Green anole	Present in Park	Unknown	Unknown	Native					
Cnemidophorus sexlineatus	Six-lined racerunner	Present in Park	Unknown	Unknown	Native					
Agkistrodon contortrix	Copperhead	Found near vicinity	n/a	Unknown						
Alligator mississippiensis	Alligator	Found near vicinity	n/a	Unknown		Yes	G5	S5	E (S/A)	
Caretta caretta	Loggerhead	Found near vicinity	n/a	Unknown		Yes	G3	S3	E	E
Carphophis amoenus	Worm snake	Found near vicinity	n/a	Unknown						
Cemophora coccinea	Scarlet snake	Found near vicinity	n/a	Unknown						
Crotalus adamanteus	Eastern diamondback rattlesnake	Found near vicinity	n/a	Unknown		Yes				
Crotalus horridus	Canebrake rattlesnake	Found near vicinity	n/a	Unknown						
Diadophis punctatus	Ringneck snake	Found near vicinity	n/a	Unknown						
Elaphe guttata	Corn snake	Found near vicinity	n/a	Unknown						
Eumeces fasciatus	Five-lined skink	Found near vicinity	n/a	Unknown						
Eumeces inexpectatus	Southeastern five-lined skink	Found near vicinity	n/a	Unknown						
Eumeces laticeps	Broadhead skink	Found near vicinity	n/a	Unknown						
Heterodon platirhinos	Eastern hognose snake	Found near	n/a	Unknown						

Scientific Name	*Common Name(s)*	*Park Status*	*Abundance*	*Residency*	*Nativity*	*SC priority species*	*Global Rank*	*State Rank*	*Federal Status*	*State Status*
		vicinity								
Heterodon simus	Southern hognose snake	Found near vicinity	n/a	Unknown		Yes	G2	S?		SC
Lampropeltis calligaster	Mole kingsnake	Found near vicinity	n/a	Unknown						
Lampropeltis getula	Eastern kingsnake	Found near vicinity	n/a	Unknown						
Lampropeltis triangulum	Scarlet kingsnake	Found near vicinity	n/a	Unknown						
Malaclemys terrapin	Diamondback terrapin	Found near vicinity	n/a	Unknown		Yes	G4	S?		
Masticophis flagellum	Coachwhip	Found near vicinity	n/a	Unknown						
Micrurus fulvius	Coral snake	Found near vicinity	n/a	Unknown		Yes	G5	S2		SC
Opheodrys aestivus	Rough green snake	Found near vicinity	n/a	Unknown						
Ophisaurus attenuatus	Slender glass lizard	Found near vicinity	n/a	Unknown		Yes	G5	S4		
Ophisaurus compressus	Island glass lizard	Found near vicinity	n/a	Unknown		Yes	G3G4	S1S2		SC
Ophisaurus mimicus	Mimic glass lizard	Found near vicinity	n/a	Unknown		Yes	G3	S?		SC
Ophisaurus ventralis	Eastern glass lizard	Found near vicinity	n/a	Unknown						
Pituophis melanoleucus	Pine snake	Found near vicinity	n/a	Unknown		Yes	G4	S3S4		SC
Rhadinaea flavilata	Pine woods snake	Found near vicinity	n/a	Unknown		Yes	G4	S?		SC
Sceloporus undulatus	Fence lizard	Found near vicinity	n/a	Unknown						
Scincella lateralis	Ground skink	Found near vicinity	n/a	Unknown						
Sistrurus miliarius	Pigmy rattlesnake	Found near vicinity	n/a	Unknown						
Storeria dekayi	Brown snake	Found near vicinity	n/a	Unknown						

Scientific Name	*Common Name(s)*	*Park Status*	*Abundance*	*Residency*	*Nativity*	*SC priority species*	*Global Rank*	*State Rank*	*Federal Status*	*State Status*
Storeria occipitomaculata	Redbelly snake	Found near vicinity	n/a	Unknown						
Tantilla coronata	Southeastern crowned snake	Found near vicinity	n/a	Unknown						
Terrapene carolina	Eastern box turtle	Found near vicinity	n/a	Unknown						
Thamnophis sauritus	Ribbon snake	Found near vicinity	n/a	Unknown						
Thamnophis sirtalis	Garter snake	Found near vicinity	n/a	Unknown						
Virginia striatula	Rough earth snake	Found near vicinity	n/a	Unknown						
Virginia valeriae	Smooth earth snake	Found near vicinity	n/a	Unknown						

Appendix M: Reptile species documented for Charles Pinckney National Historic Site.
These species have been cross referenced to the SC Comprehensive Wildlife Conservation Strategy prioriy species, and listings for endangered, threatened, or of concern (South Carolina Department of Natural Resources 2005); and NatureServe's global and state rankings (NatureServe 2008). See reference or Appendix E for explanation of abbreviations.

Scientific Name	*Common Name(s)*	*Park Status*	*Abundance*	*Residency*	*Nativity*	*SC priority species*	*Global Rank*	*State Rank*	*Federal Status*	*State Status*
Alligator mississippiensis	American alligator	Found near vicinity	Unknown			Yes	G5	S5	E(S/A)	
Coluber constrictor	Black racer	Found near vicinity	Unknown		Native					
Eumeces laticeps	Broadhead skink	Present	Unknown		Native					
Storeria dekayi	Brown snake	Found near vicinity	Unknown							
Crotalus horridus	Canebrake rattlesnake	Found near vicinity	Unknown							
Masticophis flagellum	Coachwhip	Found near vicinity	Unknown							
Agkistrodon contortrix	Copperhead	Found near vicinity	Unknown							
Micrurus fulvius	Coral snake	Found near vicinity	Unknown			Yes	G5	S2		SC
Elaphe guttata	Corn snake	Found near vicinity	Unknown							
Malaclemys terrapin	Diamondback terrapin	Found near vicinity	Unknown			Yes	G4	S?		
Terrapene carolina	Eastern box turtle	Found near vicinity	Unknown							
Crotalus adamanteus	Eastern diamondback rattlesnake	Found near vicinity	Unknown			Yes				
Ophisaurus ventralis	Eastern glass lizard	Found near vicinity	Unknown							
Heterodon platirhinos	Eastern hognose snake	Found near vicinity	Unknown							
Lampropeltis getula	Eastern kingsnake	Found near vicinity	Unknown							
Elaphe obsoleta	Eastern rat snake	Present	Unknown		Native					
Sceloporus undulatus	Fence lizard	Found near vicinity	Unknown							

Scientific Name	*Common Name(s)*	*Park Status*	*Abundance*	*Residency*	*Nativity*	*SC priority species*	*Global Rank*	*State Rank*	*Federal Status*	*State Status*
Eumeces fasciatus	Five-lined skink	Present	Unknown		Native					
Thamnophis sirtalis	Garter snake	Found near vicinity	Unknown							
Anolis carolinensis	Green Anole	Present	Unknown		Native					
Scincella lateralis	Ground skink	Present	Unknown		Native					
Ophisaurus compressus	Island glass lizard	Found near vicinity	Unknown			Yes	G3G4	S1S2		SC
Caretta caretta	Loggerhead	Found near vicinity	Unknown			Yes	G3	S3	E	E
Ophisaurus mimicus	Mimic glass lizard	Found near vicinity	Unknown			Yes	G3	S?		SC
Lampropeltis calligaster	Mole kingsnake	Found near vicinity	Unknown							
Sistrurus miliarius	Pigmy rattlesnake	Found near vicinity	Unknown							
Pituophis melanoleucus	Pine snake	Found near vicinity	Unknown			Yes	G4	S3S4		SC
Rhadinaea flavilata	Pine woods snake	Found near vicinity	Unknown			Yes	G4	S?		SC
Storeria occipitomaculata	Redbelly snake	Found near vicinity	Unknown							
Thamnophis sauritus	Ribbon snake	Found near vicinity	Unknown							
Diadophis punctatus	Ringneck snake	Found near vicinity	Unknown							
Virginia striatula	Rough earth snake	Found near vicinity	Unknown							
Opheodrys aestivus	Rough green snake	Found near vicinity	Unknown							
Lampropeltis triangulum	Scarlet kingsnake or milksnake	Found near vicinity	Unknown							
Cemophora coccinea	Scarlet snake	Found near vicinity	Unknown							
Cnemidophorus sexlineatus	Six-lined racerunner	Found near vicinity	Unknown		Native					

Scientific Name	*Common Name(s)*	*Park Status*	*Abundance*	*Residency*	*Nativity*	*SC priority species*	*Global Rank*	*State Rank*	*Federal Status*	*State Status*
Ophisaurus attenuatus	Slender glass lizard	Found near vicinity	Unknown			Yes	G5	S4		
Virginia valeriae	Smooth earth snake	Found near vicinity	Unknown							
Tantilla coronata	Southeastern crowned snake	Found near vicinity	Unknown							
Eumeces inexpectatus	Southeastern five-lined skink	Found near vicinity	Unknown							
Heterodon simus	Southern hognose snake	Found near vicinity	Unknown			Yes	G2	S?		SC
Carphophis amoenus	Worm snake	Found near vicinity	Unknown							

Appendix N: Bird species documented for Fort Sumter National Monument.
These species have been cross referenced to the SC Comprehensive Wildlife Conservation Strategy prioriy species, and listings for endangered, threatened, or of concern (South Carolina Department of Natural Resources 2005); and NatureServe's global and state rankings (NatureServe 2008). See reference or Appendix E for explanation of abbreviations. Bird species were also cross referenced to the Partners in Flight Priority Species (Partners in Flight 2005) and Audubon WatchList (National Audubon Society 2007).

Scientific Name	*Common Name(s)*	*Park Status*	*Abundance*	*Residency*	*Nativity*	*SC priority species*	*PIF priority*	*Audubon watchlist*	*Global Rank*	*State Rank*	*Federal Status*	*State Status*
Empidonax alnorum	Alder Flycatcher	Present	Rare	Migratory	Native							
Corvus brachyrhynchos	American Crow	Present	Rare	Resident	Native							
Carduelis tristis	American Goldfinch	Present	Uncommon	Resident	Native							
Falco sparverius	American Kestrel	Present	Uncommon	Breeder	Native	Highest	Yes		G5	S4		
Haematopus palliatus	American Oystercatcher	Present	Common	Breeder	Native	Highest			G5	SNR		SC
Anthus rubescens	American Pipit	Present	Common	Resident	Native							
Setophaga ruticilla	American Redstart	Present	Common	Migratory	Native							
Turdus migratorius	American Robin	Present	Common	Resident	Native							
Haliaeetus leucocephalus	Bald Eagle	Present	Occasional	Breeder	Native	High			G5	S2		E
Riparia riparia	Bank Swallow	Present	Uncommon	Migratory	Native							
Tyto alba	Barn Owl	Probably Present	n/a	n/a	Native	High			G5 S4			SC
Hirundo rustica	Barn Swallow	Present	Abundant	Breeder	Native							
Rynchops niger	Black Skimmer	Present	Abundant	Breeder	Native	Highest		Yes	G5	S4		SC
Coragyps atratus	Black Vulture	Present	Uncommon	Resident	Native							
Mniotilta varia	Black-and-white Warbler	Present	Uncommon	Resident	Native							
Pluvialis squatarola	Black-bellied Plover	Present	Common	Resident	Native							
Coccyzus erythropthalmus	Black-billed Cuckoo	Present	Occasional	Migratory	Native							
Himantopus mexicanus	Black-necked Stilt	Present	Occasional	Breeder	Native							
Dendroica striata	Blackpoll Warbler	Present	Rare	Migratory	Native							
Dendroica caerulescens	Black-throated Blue Warbler	Present	Common	Migratory	Native	High			G5	S4B		

Scientific Name	Common Name(s)	Park Status	Abundance	Residency	Nativity	SC priority species	PIF priority	Audubon watchlist	Global Rank	State Rank	Federal Status	State Status
Guiraca caerulea	Blue Grosbeak	Present	Uncommon	Migratory	Native							
Quiscalus major	Boat-tailed Grackle	Present	Abundant	Breeder	Native							
Larus philadelphia	Bonaparte's Gull	Present	Uncommon	Resident	Native							
Certhia americana	Brown Creeper	Present	Rare	Migratory	Native							
Pelecanus occidentalis	Brown Pelican	Present	Abundant	Breeder	Native	Highest			G4	S1S2		
Toxostoma rufum	Brown Thrasher	Present	Common	Breeder	Native							
Molothrus ater	Brown-headed Cowbird	Present	Common	Breeder	Native							
Bucephala albeola	Bufflehead	Present	Common	Resident	Native							
Dendroica tigrina	Cape May Warbler	Present	Uncommon	Migratory	Native							
Poecile carolinensis	Carolina Chickadee	Present	Rare	Breeder	Native							
Thryothorus ludovicianus	Carolina Wren	Present	Common	Breeder	Native							
Bombycilla cedrorum	Cedar Waxwing	Present	Common	Resident	Native							
Spizella passerina	Chipping Sparrow	Present	Unknown	Resident	Native							
Caprimulgus carolinensis	Chuck-will's-widow	Present	Rare	Breeder	Native							
Rallus longirostris	Clapper Rail	Present	Common	Breeder	Native			Yes				
Hirundo pyrrhonota	Cliff Swallow	Probably Present	n/a	n/a	Native							
Quiscalus quiscula	Common Grackle	Present	Common	Breeder	Native							
Columbina passerina	Common Ground-Dove	Present	Common	Breeder	Native	Highest			G5	SNR		T
Gavia immer	Common Loon	Present	Common	Resident	Native	Moderate			G5	SNRN		
Gallinula chloropus	Common Moorhen	Probably Present	n/a	n/a	Native							
Chordeiles minor	Common Nighthawk	Present	Uncommon	Breeder	Native							
Sterna hirundo	Common Tern	Present	Uncommon	Resident	Native							
Geothlypis trichas	Common Yellowthroat	Present	Abundant	Resident	Native							
Oporornis agilis	Connecticut Warbler	Present	Occasional	Migratory	Native							

Scientific Name	Common Name(s)	Park Status	Abundance	Residency	Nativity	SC priority species	PIF priority	Audubon watchlist	Global Rank	State Rank	Federal Status	State Status
Accipiter cooperii	Cooper's Hawk	Present	Uncommon	Resident	Native							
Junco hyemalis	Dark-eyed Junco	Present	Rare	Migratory	Native	Moderate			G5	SNRB,SNRN		
Spiza americana	Dickcissel	Probably Present	n/a	n/a	Native							
Phalacrocorax auritus	Double-crested Cormorant	Present	Abundant	Resident	Native							
Picoides pubescens	Downy Woodpecker	Present	Rare	Breeder	Native							
Calidris alpina	Dunlin	Present	Abundant	Resident	Native	Highest			G5	SNRN		
Sialia sialis	Eastern Bluebird	Present	Uncommon	Breeder	Native							
Sturnella magna	Eastern Meadowlark	Present	Rare	Migratory	Native	Highest			G5	SNR		
Sayornis phoebe	Eastern Phoebe	Present	Common	Resident	Native							
Megascops asio	Eastern Screech-Owl	Present	Uncommon	Resident	Native							
Pipilo erythrophthalmus	Eastern Towhee	Present	Rare	Breeder	Native							
Streptopelia decaocto	Eurasian Collared Dove	Present	Abundant	Breeder	Non-Native							
Sturnus vulgaris	European Starling	Present	Common	Breeder	Non-Native							
Coccothraustes vespertinus	Evening Grosbeak	Probably Present	n/a	n/a	Native							
Spizella pusilla	Field Sparrow	Present	Uncommon	Breeder	Native	Highest			G5	S5?		
Corvus ossifragus	Fish Crow	Present	Common	Breeder	Native							
Sterna forsteri	Forster's Tern	Present	Abundant	Resident	Native	High			G5	SNRN		
Passerella iliaca	Fox Sparrow	Present	Rare	Resident	Native							
Dumetella carolinensis	Gray Catbird	Present	Abundant	Breeder	Native							
Tyrannus dominicensis	Gray Kingbird	Present	Occasional	Breeder	Native	Moderate			G5	SNRB,SNRN		
Larus marinus	Great Black-backed Gull	Present	Common	Resident	Native							
Ardea herodias	Great Blue Heron	Present	Common	Breeder	Native	Moderate			G5	SNRB,SNRN		

Scientific Name	Common Name(s)	Park Status	Abundance	Residency	Nativity	SC priority species	PIF priority	Audubon watchlist	Global Rank	State Rank	Federal Status	State Status
Podiceps auritus	Great Cormorant	Present	Common	Resident	Native							
Ardea alba	Great Egret	Present	Common	Breeder	Native	Moderate			G5	SNRB,SNRN		
Tringa melanoleuca	Greater Yellowlegs	Present	Common	Resident	Native	Moderate			G5	SNRN		
Picoides villosus	Hairy Woodpecker	Present	Occasional	Migratory	Native							
Larus argentatus	Herring Gull	Present	Abundant	Resident	Native							
Lophodytes cucullatus	Hooded Merganser	Present	Uncommon	Resident	Native							
Wilsonia citrina	Hooded Warbler	Present	Occasional	Migratory	Native		Yes					
Eremophila alpestris	Horned Lark	Present	Occasional	Resident	Native							
Carpodacus mexicanus	House Finch	Present	Common	Breeder	Native							
Passer domesticus	House Sparrow	Present	Common	Breeder	Non-Native							
Troglodytes aedon	House Wren	Present	Rare	Migratory	Native							
Passerina cyanea	Indigo Bunting	Present	Uncommon	Breeder	Native							
Oporornis formosus	Kentucky Warbler	Present	Occasional	Migratory	Native	Highest			G5	S4		
Charadrius vociferus	Killdeer	Present	Common	Breeder	Native							
Rallus limicola	King Rail	Probably Present	n/a	n/a	Native	Highest		Yes	G4	SNR		
Larus atricilla	Laughing Gull	Present	Abundant	Resident	Native							
Empidonax minimus	Least Flycatcher	Present	Rare	Migratory	Native							
Calidris minutilla	Least Sandpiper	Present	Common	Resident	Native	Highest			G5	SNRN		
Sterna antillarum	Least Tern	Present	Abundant	Breeder	Native	Highest		Yes	G4	S3		T
Larus fuscus	Lesser Black-backed Gull	Present	Occasional	Resident	Native							
Aythya affinis	Lesser Scaup	Present	Abundant	Resident	Native	Highest			G5	SNRN		
Tringa flavipes	Lesser Yellowlegs	Present	Common	Resident	Native	Highest			G5	SNRN		
Melospiza lincolnii	Lincoln's Sparrow	Present	Occasional	Vagrant	Native							
Lanius ludovicianus	Loggerhead Shrike	Present	Rare	Resident	Native	Highest			G4	S3		SC

Scientific Name	Common Name(s)	Park Status	Abundance	Residency	Nativity	SC priority species	PIF priority	Audubon watchlist	Global Rank	State Rank	Federal Status	State Status
Numenius americanus	Long-billed Curlew	Probably Present	n/a	n/a	Native	Highest			G5	SNA		
Seiurus motacilla	Louisiana Waterthrush	Probably Present	n/a	n/a	Native	Moderate			G5	S4B		
Dendroica magnolia	Magnolia Warbler	Present	Rare	Migratory	Native							
Limosa fedoa	Marbled Godwit	Probably Present	n/a	n/a	Native	Highest			G5	SNRN		
Cistothorus palustris	Marsh Wren	Present	Common	Breeder	Native							
Falco columbarius	Merlin	Present	Occasional	Migratory	Native							
Zenaida macroura	Mourning Dove	Present	Abundant	Breeder	Native							
Oporornis philadelphia	Mourning Warbler	Present	Occasional	Migratory	Native							
Vermivora ruficapilla	Nashville Warbler	Present	Occasional	Migratory	Native							
Ammodramus nelsoni	Nelson's Sharp-tailed Sparrow	Probably Present	n/a	n/a	Native			Yes				
Cardinalis cardinalis	Northern Cardinal	Present	Abundant	Breeder	Native							
Morus bassanus	Northern Gannet	Present	Abundant	Resident	Native							
Circus cyaneus	Northern Harrier	Present	Rare	Resident	Native							
Mimus polyglottos	Northern Mockingbird	Present	Common	Breeder	Native							
Parula americana	Northern Parula	Present	Uncommon	Migratory	Native		Yes					
Stelgidopteryx serripennis	Northern Rough-winged Swallow	Present	Uncommon	Resident	Native							
Aegolius acadicus	Northern Saw-whet Owl	Probably Present	n/a	n/a	Native							
Seiurus noveboracensis	Northern Waterthrush	Present	Common	Migratory	Native							
Vermivora celata	Orange-crowned Warbler	Present	Uncommon	Resident	Native							
Pandion haliaetus	Osprey	Present	Common	Breeder	Native							
Seiurus aurocapillus	Ovenbird	Present	Uncommon	Migratory	Native							
Passerina ciris	Painted Bunting	Present	Common	Breeder	Native	Highest	Yes	Yes	G5	SNRB		
Dendroica palmarum	Palm Warbler	Present	Abundant	Resident	Native							

Scientific Name	Common Name(s)	Park Status	Abundance	Residency	Nativity	SC priority species	PIF priority	Audubon watchlist	Global Rank	State Rank	Federal Status	State Status
Calidris melanotos	Pectoral Sandpiper	Probably Present	n/a	n/a	Native	Moderate			G5	SNA		
Falco peregrinus	Peregrine Falcon	Present	Occasional	Migratory	Native	High			G4	SHB,SNRN		
Podilymbus podiceps	Pied-billed Grebe	Present	Rare	Resident	Native	Highest			G5	SNRB,SNRN		
Carduelis pinus	Pine Siskin	Probably Present	n/a	n/a	Native							
Dendroica pinus	Pine Warbler	Present	Uncommon	Migratory	Native							
Charadrius melodus	Piping Plover	Present	Occasional	Resident	Native			Yes				
Dendroica discolor	Prairie Warbler	Present	Common	Resident	Native	Highest	Yes	Yes	G5	SRB		
Protonotaria citrea	Prothonotary Warbler	Present	Common	Migratory	Native			Yes				
Carpodacus purpureus	Purple Finch	Probably Present	n/a	n/a	Native							
Porphyrula martinica	Purple Gallinule	Probably Present	n/a	n/a	Native	Highest			G5	S4		SC
Progne subis	Purple Martin	Present	Abundant	Breeder	Native							
Calidris maritima	Purple Sandpiper	Present	Uncommon	Resident	Native	Moderate			G5			
Calidris canutus	Red Knot	Present	Uncommon	Resident	Native	Highest		Yes	G4	SNRN		
Melanerpes carolinus	Red-bellied Woodpecker	Present	Uncommon	Breeder	Native							
Mergus serrator	Red-breasted Merganser	Present	Common	Unknown	Native							
Sitta canadensis	Red-breasted Nuthatch	Present	Occasional	Resident	Native							
Vireo olivaceus	Red-eyed Vireo	Present	Abundant	Migratory	Native							
Melanerpes erythrocephalus	Red-headed Woodpecker	Present	Occasional	Migratory	Native							
Podiceps grisegena	Red-necked Grebe	Probably Present	n/a	n/a	Native							
Buteo lineatus	Red-shouldered Hawk	Present	Rare	Migratory	Native							
Buteo jamaicensis	Red-tailed Hawk	Present	Uncommon	Breeder	Native							
Gavia stellata	Red-throated Loon	Present	Uncommon	Resident	Native							
Agelaius phoeniceus	Red-winged Blackbird	Present	Abundant	Breeder	Native							

Scientific Name	Common Name(s)	Park Status	Abundance	Residency	Nativity	SC priority species	PIF priority	Audubon watchlist	Global Rank	State Rank	Federal Status	State Status
Larus delawarensis	Ring-billed Gull	Present	Abundant	Resident	Native							
Columba livia	Rock Pigeon	Present	Common	Breeder	Non-Native							
Sterna maxima	Royal Tern	Present	Abundant	Breeder	Native	Highest			G5	SNRB,SNRN		
Regulus calendula	Ruby-crowned Kinglet	Present	Common	Resident	Native							
Archilochus colubris	Ruby-throated Hummingbird	Present	Common	Resident	Native							
Arenaria interpres	Ruddy Turnstone	Present	Common	Resident	Native							
Euphagus carolinus	Rusty Blackbird	Present	Uncommon	Resident	Native	Highest			G4	SNRN		
Ammodramus caudacutus	Saltmarsh Sharp-tailed Sparrow	Probably Present	n/a	n/a	Native			Yes	G4	SNRN		
Calidris alba	Sanderling	Present	Abundant	Resident	Native	Highest		Yes	G5	SNRN		
Sterna sandvicensis	Sandwich Tern	Present	Common	Breeder	Native	Highest			G5	SNR		
Passerculus sandwichensis	Savannah Sparrow	Present	Common	Resident	Native							
Piranga olivacea	Scarlet Tanager	Present	Occasional	Migratory	Native	Moderate			G5	SNRB		
Ammodramus maritimus	Seaside Sparrow	Probably Present	n/a	n/a	Native	Highest		Yes				
Cistothorus platensis	Sedge Wren	Present	Uncommon	Resident	Native							
Charadrius semipalmatus	Semipalmated Plover	Present	Abundant	Resident	Native	High			G5	SNRN		
Calidris pusilla	Semipalmated Sandpiper	Present	Common	Migratory	Native	Highest		Yes	G5	SNA		
Accipiter striatus	Sharp-shinned Hawk	Present	Uncommon	Resident	Native							
Molothrus bonariensis	Shiny Cowbird	Present	Uncommon	Breeder	Native							
Limnodromus griseus	Short-billed Dowitcher	Present	Abundant	Resident	Native	Highest			G5	SNRN		
Bubo virginianus	Short-eared Owl	Present	Uncommon	Breeder	Native							
Plectrophenax nivalis	Snow Bunting	Present	Occasional	Vagrant	Native							
Egretta thula	Snowy Egret	Present	Common	Breeder	Native	Highest			G5	SNRB,SNR		

Scientific Name	Common Name(s)	Park Status	Abundance	Residency	Nativity	SC priority species	PIF priority	Audubon watchlist	Global Rank	State Rank	Federal Status	State Status
										N		
Tringa solitaria	Solitary Sandpiper	Probably Present	n/a	n/a	Native	Highest			G5	SNA		
Vireo solitarius	Solitary Vireo	Present	Rare	Resident	Native							
Melospiza melodia	Song Sparrow	Present	Common	Resident	Native							
Porzana carolina	Sora	Present	Occasional	Migratory	Native							
Actitis macularia	Spotted Sandpiper	Probably Present	n/a	n/a	Native	High			G5	SNA		
Melanitta perspicillata	Surf Scoter	Present	Uncommon	Resident	Native							
Catharus ustulatus	Swainson's Thrush	Present	Uncommon	Migratory	Native							
Limnothlypis swainsonii	Swainson's Warbler	Present	Occasional	Migratory	Native	Highest	Yes		G4	S4		SC
Melospiza georgiana	Swamp Sparrow	Present	Abundant	Resident	Native							
Vermivora peregrina	Tennessee Warbler	Present	Occasional	Migratory	Native							
Tachycineta bicolor	Tree Swallow	Present	Abundant	Resident	Native							
Egretta tricolor	Tricolored Heron	Present	Common	Breeder	Native	Highest			G5	SNRB,SNRN		
Baeolophus bicolor	Tufted Titmouse	Present	Rare	Resident	Native							
Cathartes aura	Turkey Vulture	Present	Uncommon	Resident	Native							
Bartramia longicauda	Upland Sandpiper	Probably Present	n/a	n/a	Native							
Catharus fuscescens	Veery	Present	Uncommon	Migratory	Native							
Pooecetes gramineus	Vesper Sparrow	Present	Rare	Resident	Native							
Tyrannus verticalis	Western Kingbird	Probably Present	n/a	n/a	Native							
Calidris mauri	Western Sandpiper	Present	Common	Resident	Native	Highest		Yes	G5	SNRN		
Numenius phaeopus	Whimbrel	Present	Occasional	Resident	Native	Highest			G5	SNRN		
Caprimulgus vociferus	Whip-poor-will	Present	Rare	Resident	Native							
Eudocimus albus	White Ibis	Present	Abundant	Breeder	Native	Highest			G5	SNR		

Scientific Name	Common Name(s)	Park Status	Abundance	Residency	Nativity	SC priority species	PIF priority	Audubon watchlist	Global Rank	State Rank	Federal Status	State Status
Sitta carolinensis	White-breasted Nuthatch	Present	Rare	Resident	Native							
Zonotrichia leucophrys	White-crowned Sparrow	Present	Rare	Resident	Native							
Vireo griseus	White-eyed Vireo	Present	Common	Resident	Native							
Calidris fuscicollis	White-rumped Sandpiper	Present	Occasional	Migratory	Native	Moderate		Yes	G5	SNA		
Zonotrichia albicollis	White-throated Sparrow	Present	Abundant	Resident	Native							
Zenaida asiatica	White-winged Dove	Present	Occasional	Vagrant	Native							
Catoptrophorus semipalmatus	Willet	Present	Common	Resident	Native	Highest			G5	SNR		
Empidonax traillii	Willow Flycatcher	Present	Occasional	Migratory	Native							
Gallinago delicata	Wilson's Snipe	Present	Occasional	Migratory	Native	Highest						
Wilsonia pusilla	Wilson's Warbler	Present	Occasional	Migratory	Native							
Troglodytes troglodytes	Winter Wren	Present	Uncommon	Resident	Native							
Helmitheros vermivorus	Worm-eating Warbler	Present	Rare	Migratory	Native	Highest	Yes		G5	S4		
Dendroica petechia	Yellow Warbler	Present	Uncommon	Migratory	Native							
Empidonax flaviventris	Yellow-bellied Flycatcher	Present	Occasional	Migratory	Native							
Sphyrapicus varius	Yellow-bellied Sapsucker	Present	Occasional	Resident	Native							
Coccyzus americanus	Yellow-billed Cuckoo	Present	Rare	Migratory	Native							
Icteria virens	Yellow-breasted Chat	Present	Uncommon	Resident	Native							
Xanthocephalus xanthocephalus	Yellow-headed Blackbird	Present	Occasional	Vagrant	Native							
Dendroica coronata	Yellow-rumped Warbler	Present	Abundant	Resident	Native							
Dendroica dominica	Yellow-throated Warbler	Present	Rare	Migratory	Native							

Appendix O: Mammal species documented for Fort Sumter National Monument.
These species have been cross referenced to the SC Comprehensive Wildlife Conservation Strategy prioriy species, and listings for endangered, threatened, or of concern (South Carolina Department of Natural Resources 2005); and NatureServe's global and state rankings (NatureServe 2008). See reference or Appendix E for explanation of abbreviations.

Scientific Name	***Common Name(s)***	***Park Status***	***Abundance***	***Residency***	***Nativity***	***SC priority species***	***Global Rank***	***State Rank***
Canis familiaris	domestic dog	Present	Uncommon	Vagrant	Non-Native			
Lontra canadensis	river otter	Present	Rare	Vagrant	Native			
Mustela vison	mink	Present	Uncommon	Vagrant	Native	High	G5	S5
Procyon lotor	raccoon	Present	Common	Breeder	Native			
Tadarida brasiliensis	Brazilian free-tailed bat	Present	Unknown	Unknown	Native			
Eptesicus fuscus	big brown bat	Present	Unknown	Unknown	Native			
Nycticeius humeralis	evening bat	Present	Unknown	Unknown	Native			
Pipistrellus subflavus	eastern pipistrelle	Present	Unknown	Unknown	Native			
Sciurus carolinensis	eastern gray squirrel	Present	Uncommon	Breeder	Native			

Appendix P: Mammal species documented for Charles Pinckney National Historic Site.
These species have been cross referenced to the SC Comprehensive Wildlife Conservation Strategy prioriy species, and listings for endangered, threatened, or of concern (South Carolina Department of Natural Resources 2005); and NatureServe's global and state rankings (NatureServe 2008). See reference or Appendix E for explanation of abbreviations.

Scientific Name	*Common Name(s)*	*Park Status*	*Abundance*	*Residency*	*Nativity*	*SC priority species*	*Global Rank*	*State Rank*	*Federal Status*	*State Status*
Odocoileus virginianus	white-tailed deer	Present	Rare	Vagrant	Native					
Canis familiaris	domestic dog (feral)	Present	Uncommon	Vagrant	Non-Native					
Vulpes vulpes	red fox	Present	Rare	Breeder	Native					
Felis catus	domestic cat (feral)	Present	Common	Breeder	Non-Native					
Procyon lotor	raccoon	Present	Common	Breeder	Native					
Tadarida brasiliensis	Brazilian free-tailed bat	Present	Unknown	Unknown	Native					
Eptesicus fuscus	big brown bat	Present	Unknown	Unknown	Native					
Lasiurus seminolus	Seminole bat	Present	Unknown	Unknown	Native					
Nycticeius humeralis	evening bat	Present	Unknown	Unknown	Native					
Pipistrellus subflavus	eastern pipistrelle	Present	Unknown	Unknown	Native					
Didelphis virginiana	Virginia opossum	Present	Common	Breeder	Native					
Scalopus aquaticus	Eastern mole	Present	Uncommon	Breeder	Native					
Sylvilagus floridanus	Eastern cottontail	Present	Common	Breeder	Native					
Mus musculus	house mouse	Present	Common	Breeder	Non-Native					
Sigmodon hispidus	hispid cotton rat	Present	Uncommon	Breeder	Native					
Sciurus carolinensis	Eastern gray squirrel	Present	Uncommon	Breeder	Native					

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