National Park Service
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Natural Resource Stewardship and Science

Natural Resource Condition Assessment

Castillo de San Marcos and Fort Matanzas National Monuments, Florida

Natural Resource Report NPS/NRPC/WRD/NRR—2012/515

ON THE COVER
A view of the marsh from Fort Matanzas on left. Castillo de San Marcos NM sign and grounds on right.
Photograph by: Jessica L. Dorr, Conservation Management Institute, Virginia Tech

Natural Resource Condition Assessment

Castillo de San Marcos and Fort Matanzas National Monuments, Florida

Natural Resource Report NPS/NRPC/WRD/NRR—2012/515

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The National Park Service, Natural Resource Stewardship and Science office in Fort Collins, Colorado publishes a range of reports that address natural resource topics of interest and applicability to a broad audience in the National Park Service and others in natural resource management, including scientists, conservation and environmental constituencies, and the public.

The Natural Resource Report Series is used to disseminate high-priority, current natural resource management information with managerial application. The series targets a general, diverse audience, and may contain NPS policy considerations or address sensitive issues of management applicability.

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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 Castillo de San Marcos and Fort Matanzas National Monuments (NMs) 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 Castillo de San Marcos and Fort Matanzas National Monuments 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), *spatial* (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 Castillo de San Marcos NM is in the fair range (0.53; Table 3); Fort Matanzas NM is also in the fair range (0.65; 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 Castillo de San Marcos NM, fire dynamics, visitor use, climate, and geology and soils scored in the good range. Fire dynamics and climate are broad-scale assessment categories upon which Castillo de San Marcos NM has limited management influence. Consistent reporting and collaboration are essential for these categories. Visitor 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 and soil attributes are positive as well.

Landscape dynamics, human effects, and water quality are all in the fair range at Castillo de San Marcos NM. Landscape dynamics and human population, in this case, mirror each other. The landscape was rated within the monument and shows open space and small tree lots offer some benefits. Human effects are plentiful in this region and impervious surface coverage for Castillo de San Marcos NM and within the subbasin study area are high. Although dissolved oxygen was good in surrounding waters, other water quality indicators are in need of improvement.

Hydrology and biological integrity for Castillo de San Marcos NM are extremely limiting. This is more than likely due to the fact and this monument is an urban-centered park, focused on cultural resource management. Despite this, some improvements could be made, and are in process, for shoreline stabilization. Additionally, air quality received a poor rating in this assessment. The poor rating was a result of elevated ozone exposure, 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 Castillo de San Marcos NM has limited management influence.

For Fort Matanzas NM, landscape dynamics, fire dynamics, human effects, visitor use, climate, and geology and soils scored in the good range. Landscape, fire, human effects, and climate are broad-scale assessment categories upon which Fort Matanzas NM has limited management influence. Consistent reporting and collaboration are essential for these categories. Visitor 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.

Biological integrity received a fair rating for Fort Matanzas NM. The species assemblages present do not appear to reflect the more complete biotic communities observed in the surrounding area. This is perhaps due to the unique habitats present at the monument and may be due in part to a lack of comprehensive survey efforts. Other categories that scored in the fair range included hydrology and water quality. Hydrology improvements could be made, and are in process, for shoreline stabilization. Water quality will need coordination with other management organizations to improve. Collecting additional water quality data within park boundaries would allow better assessment of in-park resources.

The only category in this assessment to receive a poor rating was air quality. 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, human effects, and climate, air quality is a broad-scale assessment category upon which Fort Matanzas NM has limited management influence.

For both monuments, 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 National Monuments 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 Castillo de San Marcos 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).

<table>
<tr><th rowspan="2">Category</th><th rowspan="2">Condition Status</th><th rowspan="2">Score</th><th colspan="3">Data Quality</th></tr>
<tr><th>Thematic</th><th>Spatial</th><th>Temporal</th></tr>
<tr><td rowspan="2">Landscape dynamics total</td><td></td><td></td><td>0</td><td>3</td><td>0</td></tr>
<tr><td>Fair</td><td>0.39</td><td colspan="3">3 out of 9</td></tr>
<tr><td rowspan="2">Fire dynamics total</td><td></td><td></td><td>0</td><td>1</td><td>1</td></tr>
<tr><td>Good</td><td>0.84</td><td colspan="3">2 out of 3</td></tr>
<tr><td rowspan="2">Human effects total</td><td></td><td></td><td>1</td><td>2</td><td>2</td></tr>
<tr><td>Fair</td><td>0.34</td><td colspan="3">5 out of 6</td></tr>
<tr><td rowspan="2">Visitor use total</td><td></td><td></td><td>0</td><td>1</td><td>1</td></tr>
<tr><td>Good</td><td>0.84</td><td colspan="3">2 out of 3</td></tr>
<tr><td rowspan="2">Air quality total</td><td></td><td></td><td>3</td><td>1</td><td>3</td></tr>
<tr><td>Poor</td><td>0.17</td><td colspan="3">7 out of 9</td></tr>
<tr><td rowspan="2">Climate total</td><td></td><td></td><td>5</td><td>1</td><td>5</td></tr>
<tr><td>Good</td><td>0.70</td><td colspan="3">11 out of 15</td></tr>
<tr><td rowspan="2">Hydrology total</td><td></td><td></td><td>0</td><td>6</td><td>6</td></tr>
<tr><td>Poor</td><td>0.30</td><td colspan="3">12 out of 18</td></tr>
<tr><td rowspan="2">Water quality total</td><td></td><td></td><td>3</td><td>4</td><td>1</td></tr>
<tr><td>Fair</td><td>0.54</td><td colspan="3">8 out of 12</td></tr>
<tr><td rowspan="2">Soil total</td><td></td><td></td><td>3</td><td>3</td><td>3</td></tr>
<tr><td>Good</td><td>0.84</td><td colspan="3">9 out of 9</td></tr>
<tr><td rowspan="2">Biotic total</td><td></td><td></td><td>5</td><td>0</td><td>5</td></tr>
<tr><td>Poor</td><td>0.30</td><td colspan="3">10 out of 15</td></tr>
<tr><td rowspan="2">CASA overall</td><td></td><td></td><td>20</td><td>22</td><td>27</td></tr>
<tr><td>Fair</td><td>0.53</td><td colspan="3">69 out of 99</td></tr>
</table>

Table 4. Overall condition status summary for Fort Matanzas National Monument. Data quality was rated based on *thematic* (1 = best source; 0 = not the best source), *spatial* (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	0.84	3 out of 9		
Fire dynamics total			0	1	1
	Good	0.84	2 out of 3		
Human effects total			1	2	2
	Good	0.67	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
	Good	0.70	11 out of 15		
Hydrology total			0	6	6
	Fair	0.64	12 out of 18		
Water quality total			3	4	1
	Fair	0.54	8 out of 12		
Soil total			3	3	3
	Good	0.73	9 out of 9		
Biotic total			5	1	6
	Fair	0.45	12 out of 18		
FOMA overall			20	23	28
	Fair	0.65	71 out of 102		

This project provided a comprehensive amount of organized tabular data and many geospatial data layers and maps that will aid in the management of Castillo de San Marcos and Fort Matanzas NMs. 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.

Acknowledgements

This project would not have been possible without the help of personnel from Fort Matanzas 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

AICW	Atlantic Intracoastal Waterway
AQI	Air Quality Index
BBS	Breeding Bird Survey
BOD	Biological Oxygen Demand
BMP	Best Management Practice
CASA	Castillo de San Marcos National Monument
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
FOMA	Fort Matanzas 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
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
SGCN	Species of Greatest Conservation Need
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
UV	Ultraviolet

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1.0 Introduction

The goal of this assessment is to provide an overview of natural resource condition status to allow Castillo de San Marcos and Fort Matanzas National Monuments (NMs) 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 parks 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

Castillo de San Marcos and Fort Matanzas NMs are located in the Coastal Plain of northeastern Florida in St. Johns County (Figure 1). Castillo de San Marcos NM is within the city of St. Augustine and comprises about 20 acres along Matanzas Bay. Fort Matanzas NM is 14 miles south of St. Augustine on Anastasia and Rattlesnake Islands (Figure 1). Fort Matanzas is approximately 298 acres, the larger of the two monuments under joint management. The headquarters for both park units are located at Castillo de San Marcos NM in St. Augustine (National Park Service 2007b, 2008b).

2.1.2 Park Plans and Objectives

The purpose of Castillo de San Marcos is to preserve and protect the fortress and related cultural resources as described in the Historic Resources Study of March 1997, and to interpret their architectural, political, military, and social history. The monument's mission is to preserve and protect the oldest masonry fortification in the continental United States and its related cultural resources, and to foster public understanding of their historical, military, and architectural significance (National Park Service 2007b).

Fort Matanzas NM is in the process of completing a new General Management Plan (GMP). During this process, newsletters are released to the public and public meetings aid managers in the development of the plan. According to the August 2007 GMP Newsletter (National Park Service 2007c), the purpose of Fort Matanzas National Monument is:

- To preserve the masonry tower and its associated cultural landscapes and archeological resources.
- To provide an accurate historical perspective of what military life was like in Florida as it existed at this isolated outpost.
- To manage and care for all resources within the park for the benefit of future generations through a comprehensive program of preservation, interpretation, and education.
- To permit recreational opportunities on Rattlesnake Island and Anastasia Island that do not impair park resources.

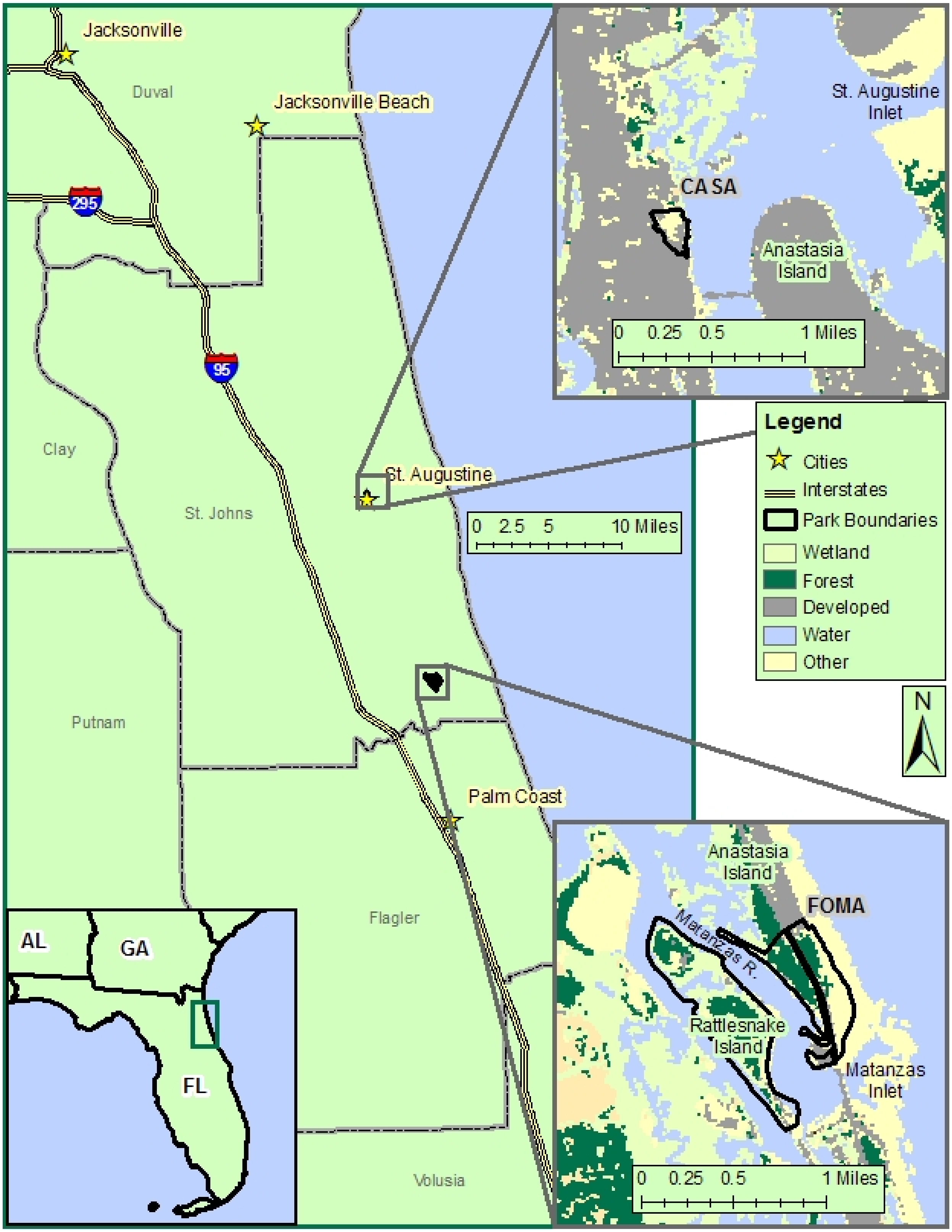

Figure 1. Castillo de San Marcos and Fort Matanzas National Monuments are located on the east coast of northern Florida.

2.1.3 Climate

The climate of the St. Augustine region of the Florida Coastal Plain is temperate, semitropical with hot, humid summers and mild winters. The average annual temperature of the area is 70.0 degrees Fahrenheit (°F), with a mean maximum temperature of 79.2 °F and mean minimum temperature of 60.9 °F (The Southeast Regional Climate Center 2008). The coolest month on average is January, at 56.7 °F and the warmest month is July, at 81.5 °F. Lowest and highest recorded temperatures were 10 °F in 1985 and 103 °F in 1986. The wettest month has historically been September with an average of 7.64 inches (The Southeast Regional Climate Center 2008). Major storms are somewhat of a concern as this area is brushed or hit by a tropical system every 3.63 years (Hurricane City 2008).

2.1.4 Geology, Landforms, and Soils

The Coastal Plain region in northeastern Florida is composed of undeformed sedimentary rock layers whose ages range from the Late Cretaceous to the present Holocene sediments of the coast. Florida and southern Georgia were not part of the same geologic platform as the Coastal Plain from Central Georgia and further north. Ordovician to Devonian sedimentary "basement rocks” occur more than 3,500 feet beneath the Coastal Plain sediments in northeast Florida (Lane 1994). During all of Late Cretaceous and early Paleogene time, Florida looked much like the Grand Bahama Bank does today: a marine platform mostly covered by shallow seas with scattered small, low islands. The sediments that accumulated in those shallow waters formed the carbonate deposits that underlie much of Florida (Frazier 2007). Starting in Miocene times, the Appalachian Mountains were uplifted and eroding sediments began to cover the carbonate rocks below. Periodic high sea levels during the Pleistocene allowed strong longshore currents to carry thick accumulations of sandy marine sediment south to cover Florida’s carbonate platform (Lane 1994). In addition to recent alluvium, organic and marine deposits make up some of the most recent 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 Castillo de San Marcos and Fort Matanzas NMs is a Holocene-aged deposit of organic, marine, and human-altered origin.

Castillo de San Marcos NM is primarily an urban-based park with little natural vegetation. The main grounds are a rolling grassy area with a few trees (National Park Service 2007b). Maintenance of grounds includes regular mowing, trimming, fertilizing, and removal of invasive species and storm damaged vegetation. There are no naturally occurring ecosystems since the area has been highly altered by human activity (National Park Service 2007b). Based on a classification that is explained further in 3.1.1 Landscape Dynamics section, we found developed open space to be 12.2 acres. The only natural vegetation class at Castillo de San Marcos NM is mixed forest at 1.5 acres.

The majority of Fort Matanzas NM acreage is in evergreen forest, while wetlands compose a close second of the land area. The GMP Newsletter (National Park Service 2007c) states that the monument contains dunes, marsh, and maritime forest that are nearly undisturbed. We found a total of 121 acres of evergreen forest and 72 acres of wetlands.

According to Soil Survey Geographic (SSURGO) from the USDA Natural Resources Conservation Service (2006b), Castillo de San Marcos NM is composed primarily of *St. Augustine-Urban land complex*. There is a miniscule (<0.01%) section of *Pellicer silty clay loam, frequently flooded* that falls within the monument boundary. Fort Matanzas NM is composed of *St. Augustine fine sand, clayey substratum* (25.7%); *Pellicer silty clay loam, frequently flooded* (15.8%); *Fripp-Satellite complex* (13.0%); *Satellite fine sand* (12.7%); *Moultrie fine sand, frequently flooded* (12.5%); and *Beaches* (8.6%) (National Park Service 2006b). Additional information on these soils can be found in 3.5.1 Geology and Soils section.

2.1.5 Surface Water and Wetlands

Castillo de San Marcos NM is located just south of the St. Augustine inlet on the Matanzas River. The Matanzas River is a part of the Atlantic Intracoastal Waterway (AICW) and is actually a saltwater estuary about 20 miles in length and flows about eight miles past the Matanzas inlet. Fort Matanzas NM lies on the southern tip of Anastasia Island on the Matanzas inlet and the northern third of Rattlesnake Island. The two islands that compose Fort Matanzas NM are separated by the Matanzas River (AICW, Figure 2). The Matanzas River is home to extensive salt marshes, estuarine lagoons, oyster bars, mangrove tidal wetlands, and marine environments (National Park Service 2007b). These communities not only support a wide range of aquatic plants and animals but are of great aesthetic importance. All of Castillo de San Marcos and Fort Matanzas NMs and these surrounding waterways are in the Daytona-St. Augustine, Florida subbasin, hydrologic unit code (HUC) 03080201.

Figure 2. Water resources and hydrologic unit boundary at Castillo de San Marcos and Fort Matanzas National Monuments.

As mentioned previously, we found 72 acres of wetlands within the Fort Matanzas NM boundary. 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 Castillo de San Marcos and Fort Matanzas NM has a rich history stretching back to Native American occupation and early European colonization. Juan Ponce de León laid claim to North America for the Spanish in 1513 when he discovered Florida. Several failed attempts at colonizing led the Spanish King, Philip II, to put a moratorium on colonization of Florida in 1561. When the French began their own colonization effort, Pedro Menéndez de Avilés was sent to reestablish Spanish claims to this area. He succeeded and St. Augustine became the oldest permanent European settlement in the continental United States, founded in 1565 by the Spanish. England took control of Florida and St. Augustine in 1763, but the Spanish won the area back in 1784. Then in 1821 Spain gave ownership of Florida to the United States, making it an American territory (National Park Service 1997, 2007b).

The total population for year 2000 in the St. Augustine subdivision of St. Johns County was 59,415, while the 1990 total was 49,229. More recent data for St. Augustine was not available, so we looked at the Jacksonville, Florida Metropolitan Statistical Area (MSA). The 2007 population estimate for the Jacksonville, Florida MSA was 1.3 million people, ranking 40th out of 363 MSAs nationwide (U.S. Census Bureau 2009c). St. Johns County grew from 83,829 to 175,446 individuals between 1990 and 2007, a 109% increase. The U.S. Census Bureau (2009a) reported an even higher population increase in nearby Flagler County of 208%, from 28,701 in 1990 to 49,832 in 2007.

The Northern Coastal Basin Surface Water Improvement and Management Plan (Haydt and Frazel Inc. 2003) reports that the basin is approximately 23% residential, commercial, and industrial lands. Wetlands, wetland forest, and open water cover more than 29% of the area; upland forest, agriculture, and open/range lands comprise more than 41%; and open water covers nearly 7%. Increases have been noted in coastal residential development in St. Augustine and St. Augustine Beach. Traditionally, the western edge of the Tolomato/Matanzas River planning unit has been used for agriculture and silviculture. Commercial shellfishing has also been a traditional use of resources in northern St. Johns County. Urban areas are expanding in these regions at an increasing rate (Haydt and Frazel Inc. 2003).

2.2.2 Site History

The Spanish built the Castillo de San Marcos between 1672 and 1695 to guard the colonial town to St. Augustine and insure the safety of sea routes for ships departing to Spain. This fort is the oldest in-tact European fortification in the continental United States. When England took control of Florida in 1763, the fort was under control of the British for 21 years, but the Castillo was never taken by military force. In 1784, the fort was back under Spanish control until the United States purchased Florida in 1821. The fort was then known as Fort Marion, after General Francis Marion, of the American Revolutionary War. Both the Confederate forces (January 1861 to March 1862) and United Sates occupied Fort Marion during the Civil War. In the late 19th century, Fort Marion was used as a prison for Native Americans in the Cheyenne, Kiowa, Camanche, Caddo, and Arapaho tribes (National Park Service 2007b).

Fort Marion became a National Monument on October 15, 1924 and, like many of the forts during this time, was run the War Department. The National Park Service took over on June 10, 1933, and Congress changed the name to Castillo de San Marcos National Monument on June 5, 1942, bringing the fort full circle back to its historical name (National Park Service 2007b).

In the mean time, Fort Matanzas, a smaller and more remote fort situated 14 miles south of the Castillo, was also making history doing its part to protect the Matanzas River Inlet, the back door to St. Augustine. Fort Matanzas construction began soon after 1740, when the British blockaded the St. Augustine Inlet for 39 days and the importance of maintaining the Matanzas Inlet was realized by the Spanish. The fort was near completion in 1742 when 12 British ships were driven off by cannon fire from Fort Matanzas. Fort Matanzas also became a National Monument on October 15, 1924, was originally administered by the War Department, and was transferred to the National Park Service in 1933 (National Park Service 2007c).

2.3 Unique and Significant Park Resources and Designations

2.3.1 Unique Resources

There are several significant historical park resources at Castillo de San Marcos NM. The monument stands as a reminder of the battle of European powers for control of North America. Its design and historic structures preserve the architecture of that time-period. As mentioned previously, the fortification is the oldest of its type in the continental United States. It has a long history of occupation and was in use by Spain, England, the Confederate States of America, and the United States for parts of its history. In addition, it marks a period in US history when Native Americans were forced from their homelands since it was used as a prison for many prominent tribal leaders during this time (National Park Service 2007b). There are no unique resources of natural resource significance present at Castillo de San Marcos.

There are also several significant historical park resources at Fort Matanzas NM. These were outlined in the General Management Plan Newsletter (National Park Service 2007c) and include:

- The fort is the only example of a fortified watchtower of Spanish architecture in the continental United States.
- The fort is a completely intact component of the St. Augustine defense system constructed by the Spanish.
- The site commemorates the slaughter of over 200 French Huguenot soldiers by Spanish soldiers in 1565 – an event which marked the beginning of 235 years of Spanish dominance in Florida.
- The location provides a rare opportunity for visitors to experience an historic setting as it might have appeared hundreds of years ago.

Fort Matanzas NM also protects 298 acres of dunes, marsh, and maritime forest within a nearly undisturbed barrier island system. This monument is part of the Guana Tolomato Matanzas National Estuarine Research Reserve (GTM NERR). This reserve contains approximately 55,000 acres of county, state, and federal lands, providing protection for salt marsh and mangrove tidal wetlands, oyster bars, estuarine lagoons, upland habitat, and offshore seas (NOAA 2009).

2.3.2 Special Designations
Castillo de San Marcos NM has no special natural resource designations, however it was placed on the National Register of Historic Places in 1966 (National Park Service 1997). Ten structures within Castillo de San Marcos are listed on the National Register of Historic Places. Fort Matanzas NM is also listed on the National Register of Historic Places (2009). As mentioned previously, Fort Matanzas NM is part of the Guana Tolomato Matanzas National Estuarine Research Reserve (NOAA 2009).

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 Castillo de San Marcos and Fort Matanzas National Monuments 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 Castillo de San Marcos and Fort Matanzas NMs. Ecosystems do not often function within the small political boundaries in which regulating bodies are constrained. Castillo de San Marcos and Fort Matanzas NMs are relatively small monuments, so we chose to first look at the monuments 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 Daytona-St. Augustine, Florida subbasin, hydrologic unit code (HUC) 03080201. The NHD geospatial layers do not further delineate this subbasin into specific watersheds. This study area covers coastal areas of St. Johns, Flagler, and Volusia Counties, Florida (Figure 3).

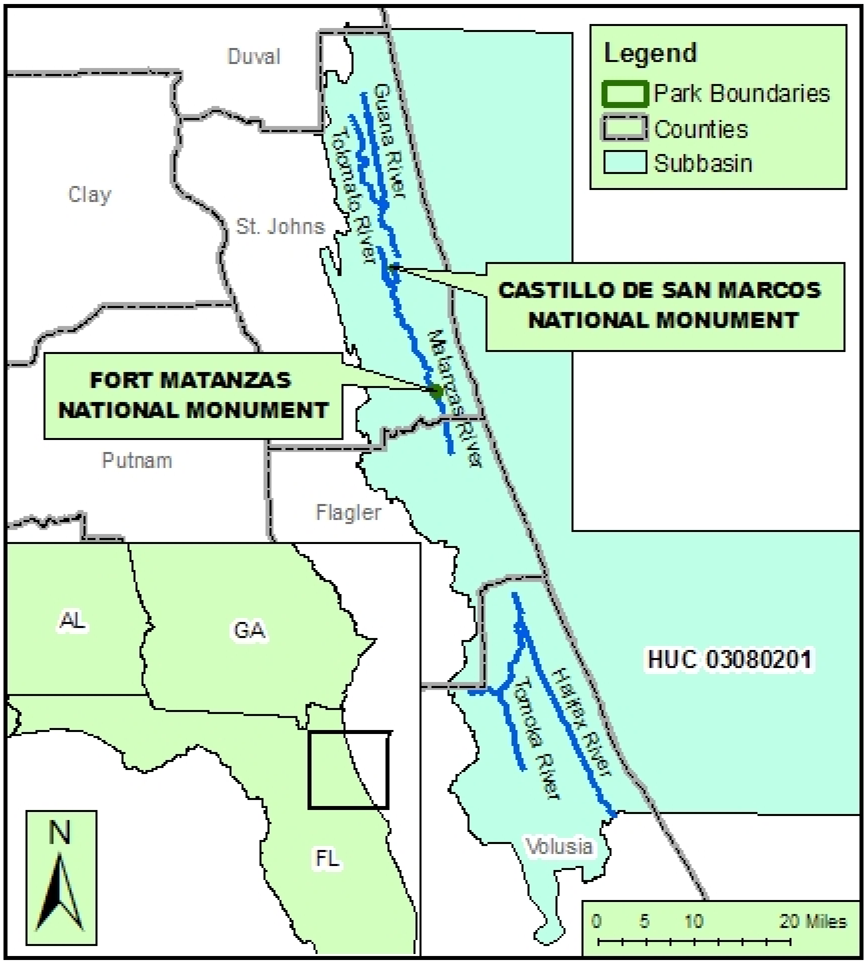

Figure 3. The subbasin study area examined for the Castillo de San Marcos and Fort Matanzas National Monuments Natural Resource Assessment.

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 Castillo de San Marcos and Fort Matanzas NM boundaries. Because the monuments contain a relatively small area, the spatial resolution of C-CAP for analysis within the park boundary was questionable. Consequently, we (Conservation Management Institute at Virginia Tech, CMI) also performed a more detailed classification using heads-up digitizing over 2004 digital orthophotos from the St. Johns River Water Management District (2004). 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 697,000 acres. Of this total acreage, 15.7% or 109,517 acres is Evergreen Forest. This is the highest represented class (after water) for the subbasin study area as well as Fort Matanzas NM (at 40.6% or 121.0 acres in the CMI classification, Table 4, Figure 4). Castillo de San Marcos NM is an urban-centered park, and its highest land cover class reflects that (Table 3, Figure 4). Developed Open Space is 12.2 acres or 60.7% of the detailed CMI classification for Castillo de San Marcos NM. The only natural vegetation class at Castillo de San Marcos NM is Mixed Forest at 1.5 acres or 7.5%. The subbasin study area is composed of only 0.3% Mixed Forest.

Table 3. Land cover (from CMI classification and 2001 NOAA C-CAP) totals and percent of total within Castillo de San Marcos National Monument (CASA) boundary and in the subbasin study area containing CASA. “CASA Acres (CMI)” are the number of acres of each cover type within CASA as delineated by the Conservation Management Institute at Virginia Tech (CMI). “CASA Acres (NOAA)” are the number of acres of each cover type within CASA 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 CASA or the subbasin study area.

Land Cover Classification	*CASA Acres (CMI)*	*CASA % (CMI)*	*CASA Acres (NOAA)*	*CASA % (NOAA)*	*Study Area Acres*	*Study Area %*
Developed Open Space	12.2	60.7	7.1	35.6	32643	4.7
Medium Intensity Developed	5.7	28.5	3.6	17.8	10774	1.5
Mixed Forest	1.5	7.5	0.0	0.0	2103	0.3
Bare Land	0.4	1.9	1.1	5.6	6804	1.0
Low Intensity Developed	0.2	1.0	7.1	35.6	56688	8.1
Unconsolidated Shore	0.1	0.5	0.0	0.0	4128	0.6
High Intensity Developed	0.0	0.0	0.7	3.3	4067	0.6
Scrub/Shrub	0.0	0.0	0.2	1.1	35046	5.0
Pasture/Hay	0.0	0.0	0.2	1.1	6685	1.0
Water	0.0	0.0	0.0	0.0	260989	37.5
Evergreen Forest	0.0	0.0	0.0	0.0	109517	15.7
Palustrine Forested Wetland	0.0	0.0	0.0	0.0	63460	9.1
Palustrine Scrub/Shrub Wetland	0.0	0.0	0.0	0.0	35659	5.1
Palustrine Emergent Wetland	0.0	0.0	0.0	0.0	29841	4.3
Estuarine Emergent Wetland	0.0	0.0	0.0	0.0	22732	3.3
Grassland	0.0	0.0	0.0	0.0	12879	1.8
Estuarine Scrub/Shrub Wetland	0.0	0.0	0.0	0.0	1269	0.2
Cultivated	0.0	0.0	0.0	0.0	759	0.1
Deciduous Forest	0.0	0.0	0.0	0.0	498	0.1
Estuarine Forested Wetland	0.0	0.0	0.0	0.0	112	0.0

Table 4. Land cover (from CMI classification and 2001 NOAA C-CAP) totals and percent of total within Fort Matanzas National Monument (FOMA) boundary and in the subbasin study area containing FOMA. "FOMA Acres (CMI)" are the number of acres of each cover type within FOMA as delineated by the Conservation Management Institute at Virginia Tech (CMI). "FOMA Acres (NOAA)" are the number of acres of each cover type within FOMA 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 FOMA or the subbasin study area.

Land Cover Classification	*FOMA Acres (CMI)*	*FOMA % (CMI)*	*FOMA Acres (NOAA)*	*FOMA % (NOAA)*	*Study Area Acres*	*Study Area %*
Evergreen Forest	121.0	40.6	38.0	12.7	109517	15.7
Estuarine Emergent Wetland	44.2	14.8	49.6	16.6	22732	3.3
Water	42.0	14.1	41.4	13.8	260989	37.5
Unconsolidated Shore	25.5	8.6	11.8	3.9	4128	0.6
Estuarine Scrub/Shrub Wetland	17.2	5.8	0.0	0.0	1269	0.2
Scrub/Shrub	14.9	5.0	25.1	8.4	35046	5.0
Bare Land	13.8	4.6	54.9	18.3	6804	1.0
Palustrine Emergent Wetland	10.5	3.5	11.3	3.8	29841	4.3
Grassland	4.1	1.4	5.1	1.7	12879	1.8
Low Intensity Developed	3.0	1.0	12.9	4.3	56688	8.1
Developed Open Space	1.1	0.4	0.7	0.2	32643	4.7
Medium Intensity Developed	0.6	0.2	9.3	3.1	10774	1.5
Palustrine Forested Wetland	0.0	0.0	25.4	8.5	63460	9.1
Palustrine Scrub/Shrub Wetland	0.0	0.0	6.7	2.2	35659	5.1
High Intensity Developed	0.0	0.0	3.6	1.2	4067	0.6
Estuarine Forested Wetland	0.0	0.0	2.4	0.8	112	0.0
Mixed Forest	0.0	0.0	0.9	0.3	2103	0.3
Deciduous Forest	0.0	0.0	0.4	0.1	498	0.1
Pasture/Hay	0.0	0.0	0.0	0.0	6685	1.0
Cultivated	0.0	0.0	0.0	0.0	759	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 Castillo de San Marcos NM is protecting a minor amount of the Mixed Forest within the protected areas in the subbasin; but a high percentage (7.5%) or relative make-up compared to the other protected areas (0.4%, Table 5). Fort Matanzas NM is also protecting a minor amount of the Evergreen Forest and Estuarine Emergent Wetland within the protected areas. However, Fort Matanzas NM is protecting a greater relative make-up of Evergreen Forest (40.6%) as compared to other protected land in the study area (21.1%). Fort Matanzas NM is also protecting Estuarine Emergent Wetland at a higher relative make-up (14.8%) as compared to the subbasin protected lands (9.8%, Table 6).

There is a long list of conservation areas within the subbasin study area that we included in this examination (Table 7). Chief among them is a group of protected areas that compose the Guana Tolomato Matanzas National Estuarine Research Reserve (GTM NERR). Fort Matanzas NM along with 11 other county and state properties are part of this approximately 55,000 acre collection of protected lands (NOAA 2009).

When all wetland types are combined, Fort Matanzas NM holds a marginal 0.15% (71.9 acres) of the total protected wetlands. However, we must take into consideration the small size of this monument and the relative make-up of natural vegetation communities within the monument. In addition, this monument is part of a large contiguous network of conservation lands which provide protection for salt marsh and mangrove tidal wetlands, oyster bars, estuarine lagoons, upland habitat and offshore seas (NOAA 2009).

There is an additional 106,298 acres of wetlands in the study area that are not owned and under direct protection by a conservation organization. These areas are under development pressure and permits can be acquired to alter these wetlands. With that in mind, Fort Matanzas NM and other conservation areas may play a larger role in the protection of Florida coastal natural areas as population and development pressures increase.

Table 5. Comparison of cover types (from CMI classification and 2001 NOAA C-CAP) within Castillo de San Marcos National Monument boundary, subbasin study area, and other protected areas within the subbasin. "CASA Acres (CMI)" are the number of acres of each cover type within CASA 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 CASA, study area, or conservation areas.

Land Cover Classification	*CASA Acres (CMI)*	*CASA % (CMI)*	*Study Area Acres*	*Study Area %*	*Conservation Acres (NOAA)*	*Conservation % (NOAA)*
Developed Open Space	12.2	60.7	32643	4.7	176.6	0.1
Medium Intensity Developed	5.7	28.5	10774	1.5	91.6	0.1
Mixed Forest	1.5	7.5	2103	0.3	444.1	0.4
Bare Land	0.4	1.9	6804	1.0	1790.9	1.4
Low Intensity Developed	0.2	1.0	56688	8.1	625.6	0.5
Unconsolidated Shore	0.1	0.5	4128	0.6	610.2	0.5
Water	0.0	0.0	260989	37.5	38032.5	30.0
Evergreen Forest	0.0	0.0	109517	15.7	26690.4	21.1
Palustrine Forested Wetland	0.0	0.0	63460	9.1	17771.6	14.0
Palustrine Scrub/Shrub Wetland	0.0	0.0	35659	5.1	5994.3	4.7
Scrub/Shrub	0.0	0.0	35046	5.0	7664.4	6.1
Palustrine Emergent Wetland	0.0	0.0	29841	4.3	10252.6	8.1
Estuarine Emergent Wetland	0.0	0.0	22732	3.3	12370.7	9.8
Grassland	0.0	0.0	12879	1.8	3383.4	2.7
Pasture/Hay	0.0	0.0	6685	1.0	223.5	0.2
High Intensity Developed	0.0	0.0	4067	0.6	22.9	0.0
Estuarine Scrub/Shrub Wetland	0.0	0.0	1269	0.2	324.0	0.3
Cultivated	0.0	0.0	759	0.1	58.7	0.0
Deciduous Forest	0.0	0.0	498	0.1	76.9	0.1
Estuarine Forested Wetland	0.0	0.0	112	0.0	62.3	0.0
Total	20.0	100.0	696653	100.0	126667.3	100.0

Table 6. Comparison of cover types (from CMI classification and 2001 NOAA C-CAP) within Fort Matanzas National Monument boundary, subbasin study area, and other protected areas within the subbasin. "FOMA Acres (CMI)" are the number of acres of each cover type within FOMA 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 FOMA, study area, or conservation areas.

Land Cover Classification	*FOMA Acres (CMI)*	*FOMA % (CMI)*	*Study Area Acres*	*Study Area %*	*Conservation Acres (NOAA)*	*Conservation % (NOAA)*
Evergreen Forest	121.0	40.6	109517	15.7	26690.4	21.1
Estuarine Emergent Wetland	44.2	14.8	22732	3.3	12370.7	9.8
Water	42.0	14.1	260989	37.5	38032.5	30.0
Unconsolidated Shore	25.5	8.6	4128	0.6	610.2	0.5
Estuarine Scrub/Shrub Wetland	17.2	5.8	1269	0.2	324.0	0.3
Scrub/Shrub	14.9	5.0	35046	5.0	7664.4	6.1
Bare Land	13.8	4.6	6804	1.0	1790.9	1.4
Palustrine Emergent Wetland	10.5	3.5	29841	4.3	10252.6	8.1
Grassland	4.1	1.4	12879	1.8	3383.4	2.7
Low Intensity Developed	3.0	1.0	56688	8.1	625.6	0.5
Developed Open Space	1.1	0.4	32643	4.7	176.6	0.1
Medium Intensity Developed	0.6	0.2	10774	1.5	91.6	0.1
Palustrine Forested Wetland	0.0	0.0	63460	9.1	17771.6	14.0
Palustrine Scrub/Shrub Wetland	0.0	0.0	35659	5.1	5994.3	4.7
Pasture/Hay	0.0	0.0	6685	1.0	223.5	0.2
High Intensity Developed	0.0	0.0	4067	0.6	22.9	0.0
Mixed Forest	0.0	0.0	2103	0.3	444.1	0.4
Cultivated	0.0	0.0	759	0.1	58.7	0.0
Deciduous Forest	0.0	0.0	498	0.1	76.9	0.1
Estuarine Forested Wetland	0.0	0.0	112	0.0	62.3	0.0
Total	297.9	100.0	696653	100.0	126667.3	100.0

Table 7. Protected areas surrounding Castillo de San Marcos and Fort Matanzas National Monuments, within the subbasin study area.

Protected Area	***Management***	***Primary Owner***	***Acres***
Addison Blockhouse Historic State Park	FL Dept. of Environmental Protection, Div. of Rec and Parks	Trustees of the Internal Improvement Trust Fund	6
Anastasia State Park	FL Dept. of Environmental Protection, Div. of Rec and Parks	Trustees of the Internal Improvement Trust Fund	1644
Betty Steflik Memorial Preserve	Flagler County	Flagler County	321
Bings Landing	Flagler County	Flagler County	12
Bulow Creek State Park	FL Dept. of Environmental Protection, Div. of Rec and Parks	Trustees of the Internal Improvement Trust Fund	5528
Bulow Plantation Ruins Historic State Park	FL Dept. of Environmental Protection, Div. of Rec and Parks	Trustees of the Internal Improvement Trust Fund	151
Canopy Shores Park	St. Johns County	St. Johns County	37
*Deep Creek State Forest (GTM NERR)	FL Dept. Agriculture and Consumer Services, Div. of Forestry	Trustees of the Internal Improvement Trust Fund	380
Doris Leeper Spruce Creek Preserve	Volusia County	Trustees of the Internal Improvement Trust Fund	2263
*Faver-Dykes State Park (GTM NERR)	FL Dept. of Environmental Protection, Div. of Rec and Parks	Trustees of the Internal Improvement Trust Fund	6046
Fort Mose Historic State Park	FL Dept. of Environmental Protection, Div. of Recreation and Parks	Trustees of the Internal Improvement Trust Fund	41
Gamble Place	City of Port Orange	City of Daytona Museum of Arts and Sciences	144
Gamble Rogers Memorial State Recreation Area at Flagler Beach	FL Dept. of Environmental Protection, Div. of Rec and Parks	Trustees of the Internal Improvement Trust Fund	134
Graham Swamp Conservation Area	Flagler County	St. Johns River Water Management District	3199
*GTMNERR - Guana River Site (GTM NERR)	FL Dept. of Environmental Protection, Office of Coastal and Aquatic Managed Areas	Trustees of the Internal Improvement Trust Fund	2649
Guana River Marsh Sanctuary	Florida Audubon Society, Inc.	Florida Audubon Society, Inc.	6
*Guana River Wildlife Management Area (GTM NERR)	FL Fish and Wildlife Conservation Commission	Trustees of the Internal Improvement Trust Fund	9815
*Guana Tolomato Matanzas National Estuarine Research Reserve (GTM NERR)	FL Dept. of Environmental Protection, Office of Coastal and Aquatic Managed Areas	Trustees of the Internal Improvement Trust Fund	64487
Hand Avenue Mitigation	Volusia County	Volusia County	65
Herschel King Senior Park	Flagler County	Flagler County	20
Larson Tract	St. Johns County	Trustees of the Internal Improvement Trust Fund	14
Lehigh Greenway	Flagler County	Trustees of the Internal Improvement Trust Fund	191
Lighthouse Point Park	Volusia County	Trustees of the Internal Improvement Trust Fund	55
Longleaf Pine Preserve	Volusia County	Volusia County	12286

Protected Area	***Management***	***Primary Owner***	***Acres***
Mandel Parcel	US Dept. of the Interior, National Park Service	Trustees of the Internal Improvement Trust Fund	1
Margaret Buschman Parcel	St. Johns River Water Management District	St. Johns River Water Management District	23
Matanzas State Forest	FL Dept. Agriculture and Consumer Services, Div. of Forestry	Trustees of the Internal Improvement Trust Fund	4700
Mercer Conservation Easement	US Dept. of the Interior, National Park Service	Private Individual(s)	7
*Moses Creek Conservation Area (GTM NERR)	St. Johns River Water Management District	St. Johns River Water Management District	2173
New Smyrna Sugar Mill Ruins Historic Site	Volusia County	Trustees of the Internal Improvement Trust Fund	17
North Peninsula State Park	FL Dept. of Environmental Protection, Div. of Rec and Parks	Trustees of the Internal Improvement Trust Fund	564
*Pellicer Creek Corridor Conservation Area (GTM NERR)	St. Johns River Water Management District	St. Johns River Water Management District	3163
Ponce Preserve	Town of Ponce Inlet	Town of Ponce Inlet	82
Port Orange City Forest	City of Port Orange	City of Port Orange	8642
*Princess Place Preserve (GTM NERR)	Flagler County	Flagler County	1503
*River to Sea Preserve at Marineland (GTM NERR)	Flagler County	Flagler County	85
*Roberts Property (GTM NERR)	FL Dept. of Environmental Protection, Office of Coastal and Aquatic Managed Areas	Trustees of the Internal Improvement Trust Fund	186
Southeast Intracoastal Waterway Park	St. Johns County	St. Johns County	114
Spruce Creek Park	Volusia County	Volusia County	21
*Stokes Landing Conservation Area (GTM NERR)	St. Johns River Water Management District	St. Johns River Water Management District	286
Three Chimneys	Ormond Beach Historical Trust Inc.	Trustees of the Internal Improvement Trust Fund	8
Tiger Bay State Forest	FL Dept. Agriculture and Consumer Services, Div. of Forestry	Trustees of the Internal Improvement Trust Fund	27396
Tocoi Junction Conservation Area	St. Johns County	St. Johns County	19
Tomoka State Park	FL Dept. of Environmental Protection, Div. of Recreation and Parks	Trustees of the Internal Improvement Trust Fund	1620
Twelve Mile Swamp Conservation Area	St. Johns River Water Management District	St. Johns River Water Management District	20711
Vaill Point Park	St. Johns County	St. Johns County	24
Varn Park	Flagler County	Flagler County	8
*Washington Oaks Gardens State Park (GTM NERR)	FL Dept. of Environmental Protection, Div. of Rec and Parks	Trustees of the Internal Improvement Trust Fund	426
Wiregrass Prairie Preserve	Volusia County	Volusia County	1433

*Property is part of the Guana Tolomato Matanzas National Estuarine Research Reserve (GTM NERR)

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). Castillo de San Marcos NM is composed of 62.1% "semi-natural vegetation," 30.2% "unnatural vegetation," and a marginal 7.6% "natural vegetation" (Table 8, Figure 5). This is in stark contrast to the subbasin study area, where "natural vegetation" dominates the landscape at 73.7%. As mentioned before, Castillo de San Marcos is a chiefly urban-centered park so this difference is not surprising. On the other hand, "natural vegetation" dominates the relative land area of Fort Matanzas NM (Table 8, Figure 5). Only 1.6% of this monument is in "unnatural vegetation," while its subbasin study area is composed of 16.8% "unnatural vegetation."

Table 8. Comparison of natural, semi-natural, and unnatural vegetation (reclassified from CMI classification and 2001 NOAA C-CAP) at Castillo de San Marcos National Monument, Fort Matanzas National Monument, and in the subbasin study area. "CASA Acres" and "FOMA Acres" are the number of acres of each vegetation type within CASA or FOMA 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 CASA, FOMA, or the subbasin study area.

Vegetation Classification	*CASA Acres*	*CASA %*	*FOMA Acres*	*FOMA %*	*Study Area Acres*	*Study Area %*
Natural Vegetation	1.5	7.6	212.0	97.8	313115.6	73.7
Semi-natural Vegetation	12.2	62.1	1.1	0.5	40086.9	9.4
Unnatural Vegetation	5.9	30.2	3.6	1.6	71529.5	16.8

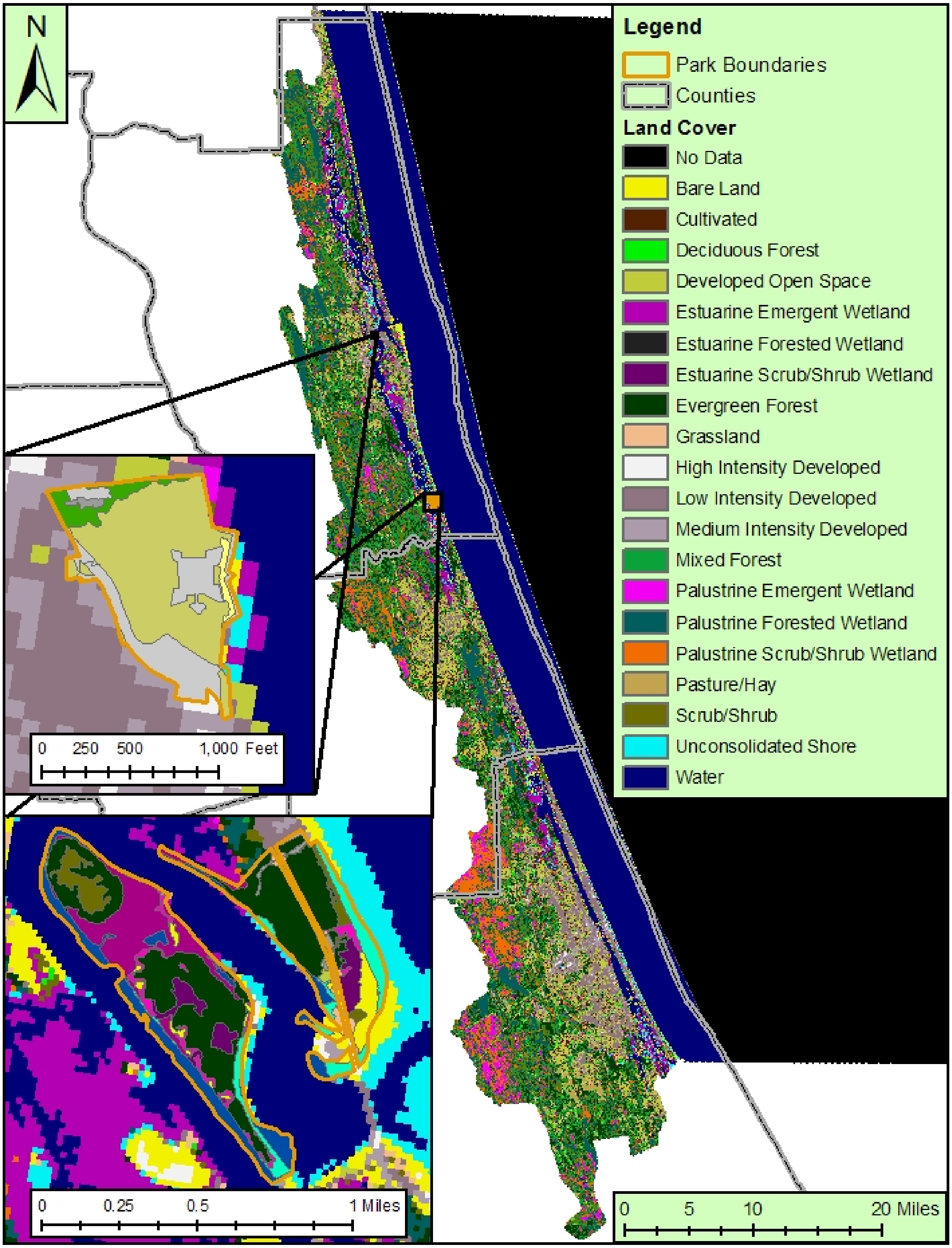

Figure 4. Land cover (from CMI classification in detailed insets and 2001 NOAA C-CAP) at Castillo de San Marcos NM, Fort Matanzas NM, and in the subbasin study area.

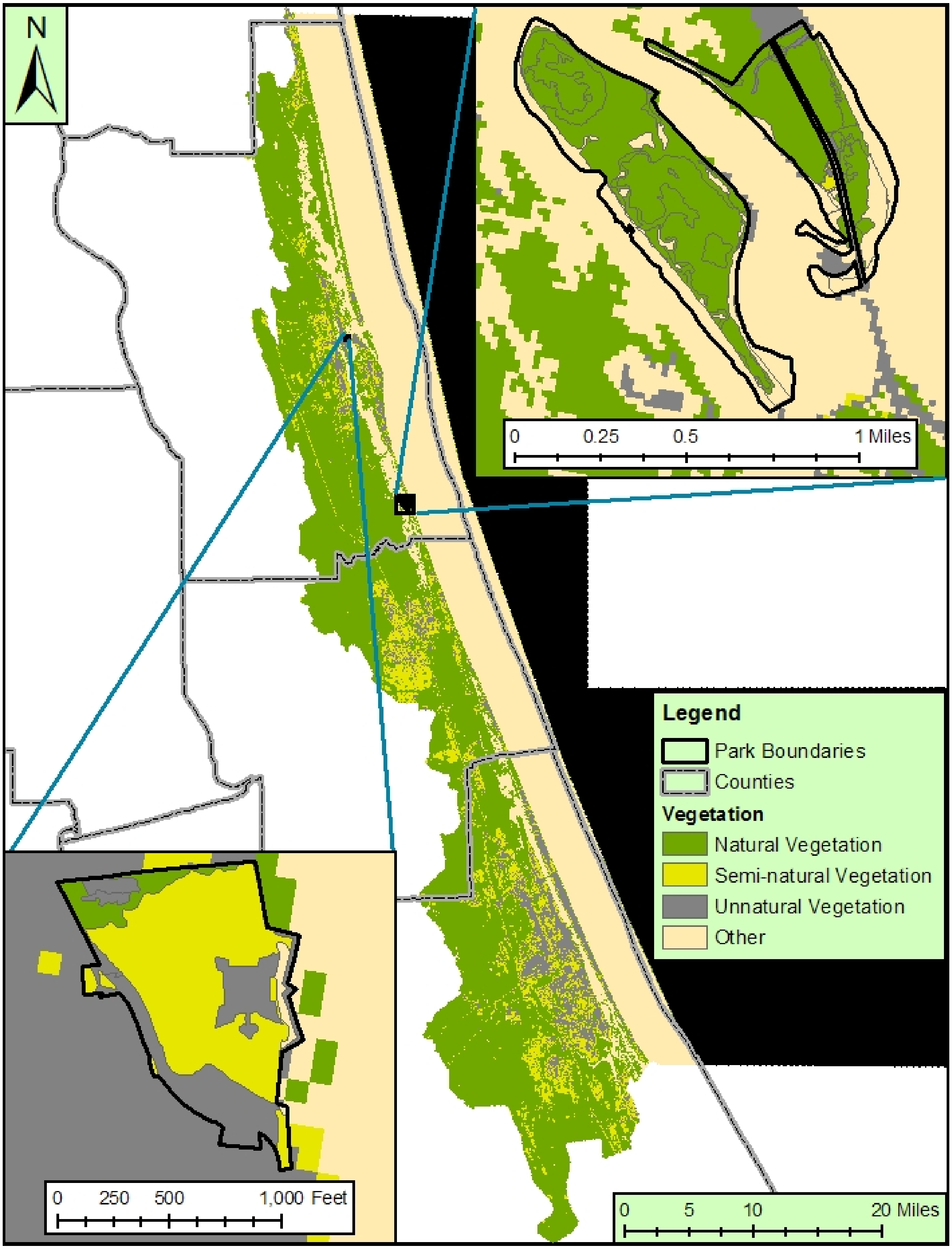

Figure 5. Vegetation reclass (from CMI classification in detailed insets and 2001 NOAA C-CAP) for Castillo de San Marcos NM, Fort Matanzas NM, and in the subbasin study area.

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 an 11% increase from 1996 to 2001 in developed areas within the study area. These changes will directly impact Castillo de San Marcos and Fort Matanzas NMs 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 Castillo de San Marcos and Fort Matanzas National Monuments.

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	16581	2.4	35659	5.1	115.06
Grassland	7692	1.1	12879	1.8	67.43
Palustrine Emergent Wetland	20820	3.0	29841	4.3	43.33
Bare Land	4956	0.7	6804	1.0	37.30
Estuarine Forested Wetland	90	0.0	112	0.0	23.89
Pasture/Hay	5646	0.8	6685	1.0	18.39
Developed Open Space	28515	4.1	32643	4.7	14.48
Low Intensity Developed	51279	7.4	56688	8.1	10.55
Medium Intensity Developed	9914	1.4	10774	1.5	8.67
High Intensity Developed	3751	0.5	4067	0.6	8.42
Deciduous Forest	466	0.1	498	0.1	6.97
Cultivated	713	0.1	759	0.1	6.59
Unconsolidated Shore	3895	0.6	4128	0.6	6.00
Mixed Forest	2011	0.3	2103	0.3	4.54
Estuarine Emergent Wetland	22165	3.2	22732	3.3	2.56
Estuarine Scrub/Shrub Wetland	1244	0.2	1269	0.2	1.98
Water	261062	37.5	260989	37.5	-0.03
Scrub/Shrub	36403	5.2	35046	5.0	-3.73
Evergreen Forest	121095	17.4	109517	15.7	-9.56
Palustrine Forested Wetland	98354	14.1	63460	9.1	-35.48

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. National Park Service has a service-wide vegetation mapping initiative (National Park Service 2008e). Current plans will have final maps available for Castillo de San

Marcos and Fort Matanzas NMs 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 subbasin study area condition status for Castillo de San Marcos NM is fair because this monument is protecting a smaller percentage of forest cover types than the subbasin study area (Table 10). Developed open space and general developed areas compose the largest land cover class at Castillo de San Marcos NM. The open space and small tree lots offer some benefits. Fort Matanzas NM is good for comparison to the subbasin because the monument is protecting a larger relative area of evergreen forest than the subbasin study area. This monument is also protecting a large percentage of wetlands (Table 11). Compared to other conservation areas, Castillo de San Marco NM is protecting a higher relative make-up of mixed forest, but no wetland or evergreen forest (the 2 highest land cover classes in conservation areas), so this monument received a fair status for this category (Table 10). On the other hand, Fort Matanzas NM is in the good range compared to other conservation areas because it is protecting a greater relative area of evergreen forest and estuarine emergent wetland (Table 11). Castillo de San Marcos NM is protecting a marginal 7.6% natural vegetation, so it is rated poor for comparison to the subbasin study area (Table 10). Natural and semi-natural vegetation make up the bulk of the relative land area of Fort Matanzas NM, so vegetation comparison to subbasin study area received a good condition status (Table 11).

Table 10. Landscape dynamics condition status summary within Castillo de San Marcos National Monument. Data quality was rated based on *thematic* (1 = best source; 0 = not the best source), *spatial* (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
	Fair	0.5	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
	Fair	0.39	3 out of 9		

Table 11. Landscape dynamics condition status summary within Fort Matanzas National Monument. Data quality was rated based on *thematic* (1 = best source; 0 = not the best source), *spatial* (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
	Good	0.84	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	0.84	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	***Management***	***Phone number***
Addison Blockhouse Historic State Park	FL Dept. of Environmental Protection, Div. of Recreation and Parks	386-676-4075
Anastasia State Park	FL Dept. of Environmental Protection, Div. of Recreation and Parks	904-461-2000
Betty Steflik Memorial Preserve	Flagler County	386-446-7658
Bings Landing	Flagler County	386-446-7658
Bulow Creek State Park	FL Dept. of Environmental Protection, Div. of Recreation and Parks	386-676-4040
Bulow Plantation Ruins Historic State Park	FL Dept. of Environmental Protection, Div. of Recreation and Parks	386-676-4075
Canopy Shores Park	St. Johns County	904-209-0326
*Deep Creek State Forest (GTM NERR)	FL Dept. Agriculture and Consumer Services, Div. of Forestry	904-825-5082
Doris Leeper Spruce Creek Preserve	Volusia County	386-740-5261 (2092)
*Faver-Dykes State Park (GTM NERR)	FL Dept. of Environmental Protection, Div. of Recreation and Parks	904-794-0997
Fort Mose Historic State Park	FL Dept. of Environmental Protection, Div. of Recreation and Parks	904-461-2000
Gamble Place	City of Port Orange	386-985-5047
Gamble Rogers Memorial State Recreation Area at Flagler Beach	FL Dept. of Environmental Protection, Div. of Recreation and Parks	386-517-2086
Graham Swamp Conservation Area	Flagler County	386-446-7658
*GTMNERR - Guana River Site (GTM NERR)	FL Dept. of Environmental Protection, Office of Coastal and Aquatic Managed Areas	904-823-4500
Guana River Marsh Sanctuary	Florida Audubon Society, Inc.	407-539-5700

Protected Area	*Management*	*Phone number*
*Guana River Wildlife Management Area (GTM NERR)	FL Fish and Wildlife Conservation Commission	904-825-6877
*Guana Tolomato Matanzas National Estuarine Research Reserve (GTM NERR)	FL Dept. of Environmental Protection, Office of Coastal and Aquatic Managed Areas	904-823-4500
Hand Avenue Mitigation	Volusia County	386-740-5261 (2092)
Herschel King Senior Park	Flagler County	386-313-4185
Larson Tract	St. Johns County	904-209-0792
Lehigh Greenway	Flagler County	386-437-7474
Lighthouse Point Park	Volusia County	386-736-5953
Longleaf Pine Preserve	Volusia County	386-740-5261 (2092)
Mandel Parcel	US Dept. of the Interior, National Park Service	904-829-6506 (221)
Margaret Buschman Parcel	St. Johns River Water Management District	386-329-4404
Matanzas State Forest	FL Dept. Agriculture and Consumer Services, Div. of Forestry	904-824-4564
Mercer Conservation Easement	US Dept. of the Interior, National Park Service	904-829-6506 (221)
*Moses Creek Conservation Area (GTM NERR)	St. Johns River Water Management District	904-529-2380
New Smyrna Sugar Mill Ruins Historic Site	Volusia County	386-736-5953
North Peninsula State Park	FL Dept. of Environmental Protection, Div. of Recreation and Parks	386-517-2086
*Pellicer Creek Corridor Conservation Area (GTM NERR)	St. Johns River Water Management District	386-329-4883
Ponce Preserve	Town of Ponce Inlet	386-322-6711 (345)
Port Orange City Forest	City of Port Orange	386-506-5750
*Princess Place Preserve (GTM NERR)	Flagler County	386-446-7658
River to Sea Preserve at Marineland (GTM NERR)	Flagler County	386-446-7658
*Roberts Property (GTM NERR)	FL Dept. of Environmental Protection, Office of Coastal and Aquatic Managed Areas	904-823-4500
Southeast Intracoastal Waterway Park	St. Johns County	904-209-0324
Spruce Creek Park	Volusia County	386-736-5953
*Stokes Landing Conservation Area (GTM NERR)	St. Johns River Water Management District	904-529-2380
Three Chimneys	Ormond Beach Historical Trust Inc.	386-677-7005
Tiger Bay State Forest	FL Dept. Agriculture and Consumer Services, Div. of Forestry	386-226-0250
Tocoi Junction Conservation Area	St. Johns County	904-209-0792
Tomoka State Park	FL Dept. of Environmental Protection, Div. of Recreation and Parks	386-676-4075
Twelve Mile Swamp Conservation Area	St. Johns River Water Management District	904-529-2380
Vaill Point Park	St. Johns County	904-209-0326
Varn Park	Flagler County	386-313-4185
*Washington Oaks Gardens State Park (GTM NERR)	FL Dept. of Environmental Protection, Div. of Recreation and Parks	386-446-6780
Wiregrass Prairie Preserve	Volusia County	386-740-5261 (2092)

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 Castillo de San Marcos and Fort Matanzas NM. There have been 7 fires recorded at Castillo de San Marcos NM since 1972 (Table 13). There have been no fires recorded at Fort Matanzas NM. Due to incomplete data, it is difficult to estimate the size and scope of the fires, although the most recent fire incident at Castillo de San Marcos NM covered only a fraction of an acre. There have been four fires within 20 miles of Castillo de San Marcos and Fort Matanzas NM reported by the Geospatial Multi-Agency Coordination Group (GeoMAC 2008) since 2000 (Figure 6).

Table 13. Wildfires reported at Castillo de San Marcos 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
226660	Wilema	2222	NPS land under NPS protection	8/25/1993	N/A	N/A	NPS
226661	Gnatcatche	2	Support actions by NPS resources	6/12/1993	N/A	N/A	FWS
226662	Squaw Peak	1	Support actions by NPS resources	7/30/1994	N/A	N/A	USFS
226663	Chamberlain	2	Support actions by NPS resources	8/7/1994	N/A	N/A	USFS
226664	Bitter Nez	3	Support actions by NPS resources	8/15/1994	N/A	N/A	USFS
226665	Fomanogo	1	NPS land under NPS protection	5/7/1995	N/A	N/A	NPS
226666	Kaboom	2	NPS land under NPS protection	5/20/1995	0.1	Natural	NPS

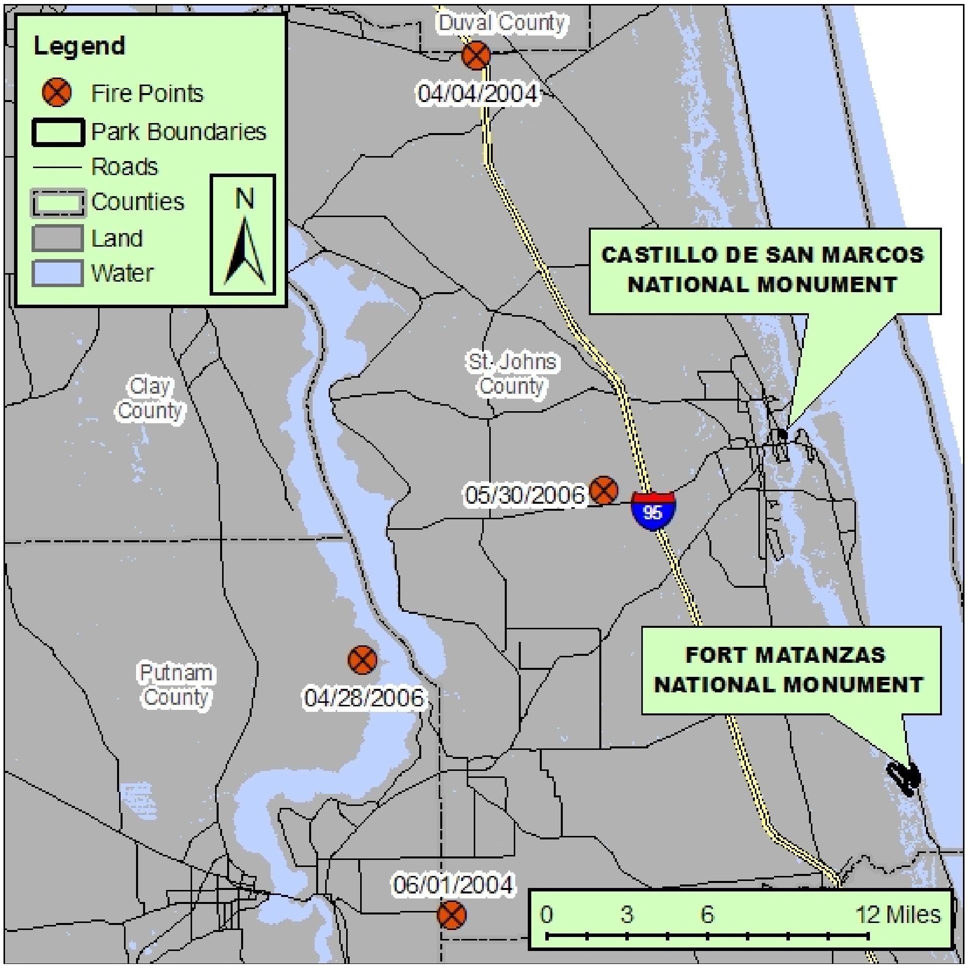

Figure 6. Wildfire sites and the dates they occurred, from 2000 to 2007 (GeoMAC 2008), within 20 miles of Castillo de San Marcos and Fort Matanzas National Monuments.

According to a simulated historical fire severity model (USDA Forest Service 2006), low severity fires accounted for a majority of fire occurrences on essentially all of the acreage at Castillo de San Marcos NM. Low severity fires accounted for a majority of fire occurrences on roughly half of the Rattlesnake Island portion of Fort Matanzas NM (Figure 7). Replacement severity fires accounted for a majority of fires on roughly half of Rattlesnake Island and nearly all fire occurrences on Anastasia Island (Figure 9). 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. Castillo de San Marcos NM is rated entirely as urban or agriculture and therefore does not have a qualifying fire regime condition class. The majority of the Rattlesnake Island portion of Fort Matanzas NM is in the Fire Regime Condition Class II, meaning there is moderate departure from historic vegetation, and the majority of the Anastasia Island portion of Fort Matanzas NM is in the Fire Regime Condition Class III, meaning there is high departure from historic vegetation (Figure 10). 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 Castillo de San Marcos and Fort Matanzas NM boundaries.

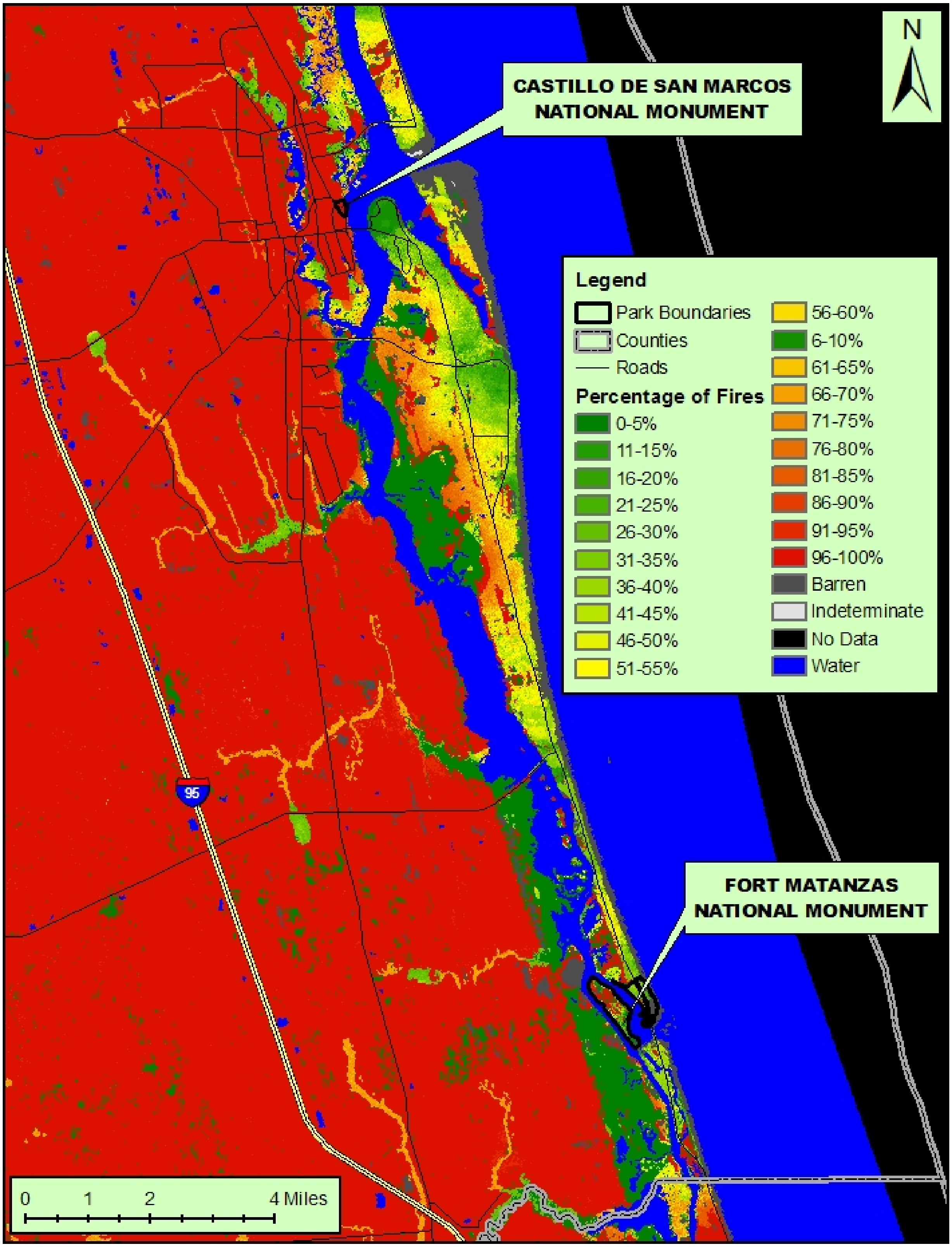

Figure 7. Simulated historical percent of low severity fires according to LANDFIRE (USDA Forest Service 2006) in the region of Castillo de San Marcos and Fort Matanzas National Monuments.

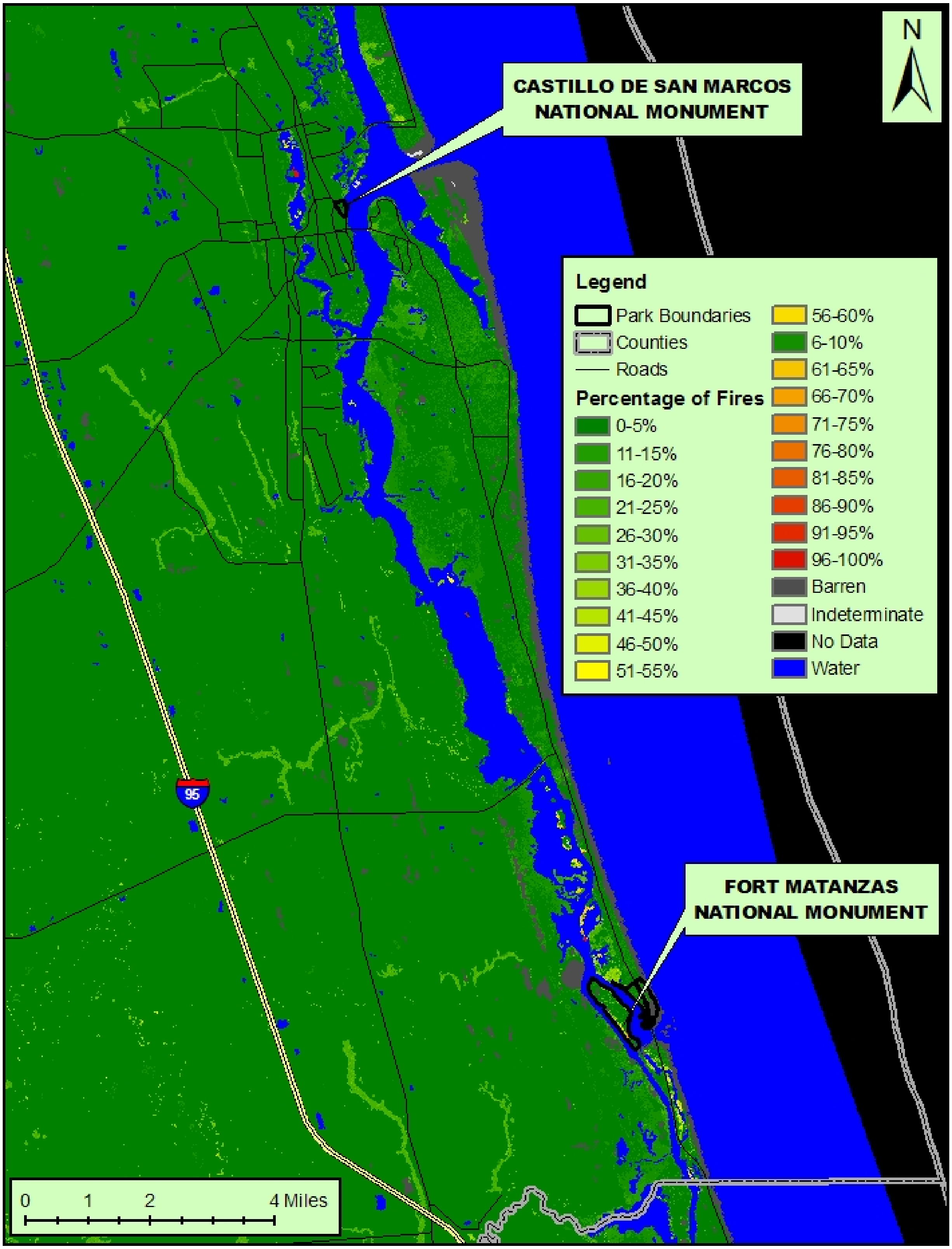

Figure 8. Simulated historical percent of mixed severity fires according to LANDFIRE (USDA Forest Service 2006) in the region of Castillo de San Marcos and Fort Matanzas National Monuments.

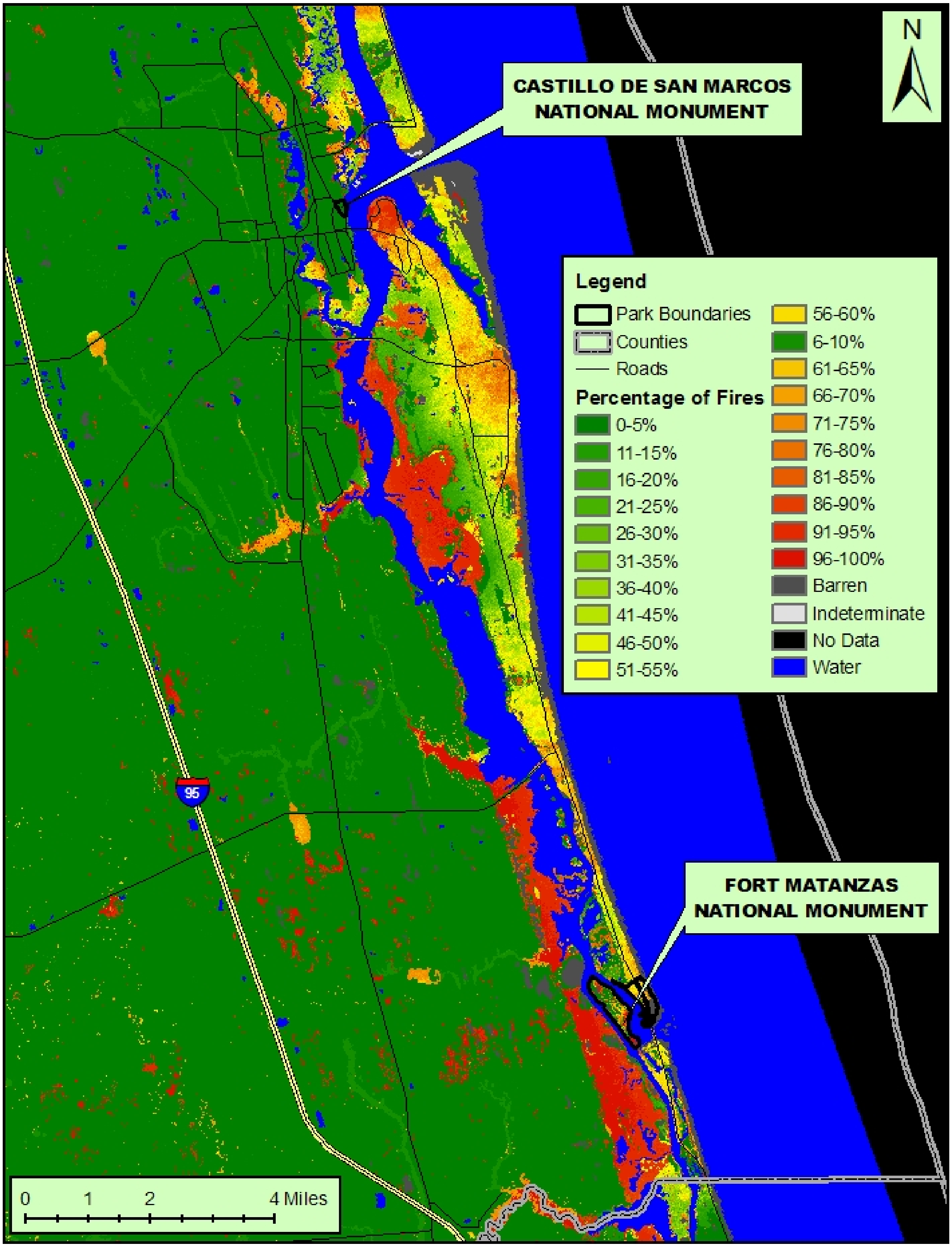

Figure 9. Simulated historical percent of replacement severity fires according to LANDFIRE (USDA Forest Service 2006) in the region of Castillo de San Marcos and Fort Matanzas National Monuments.

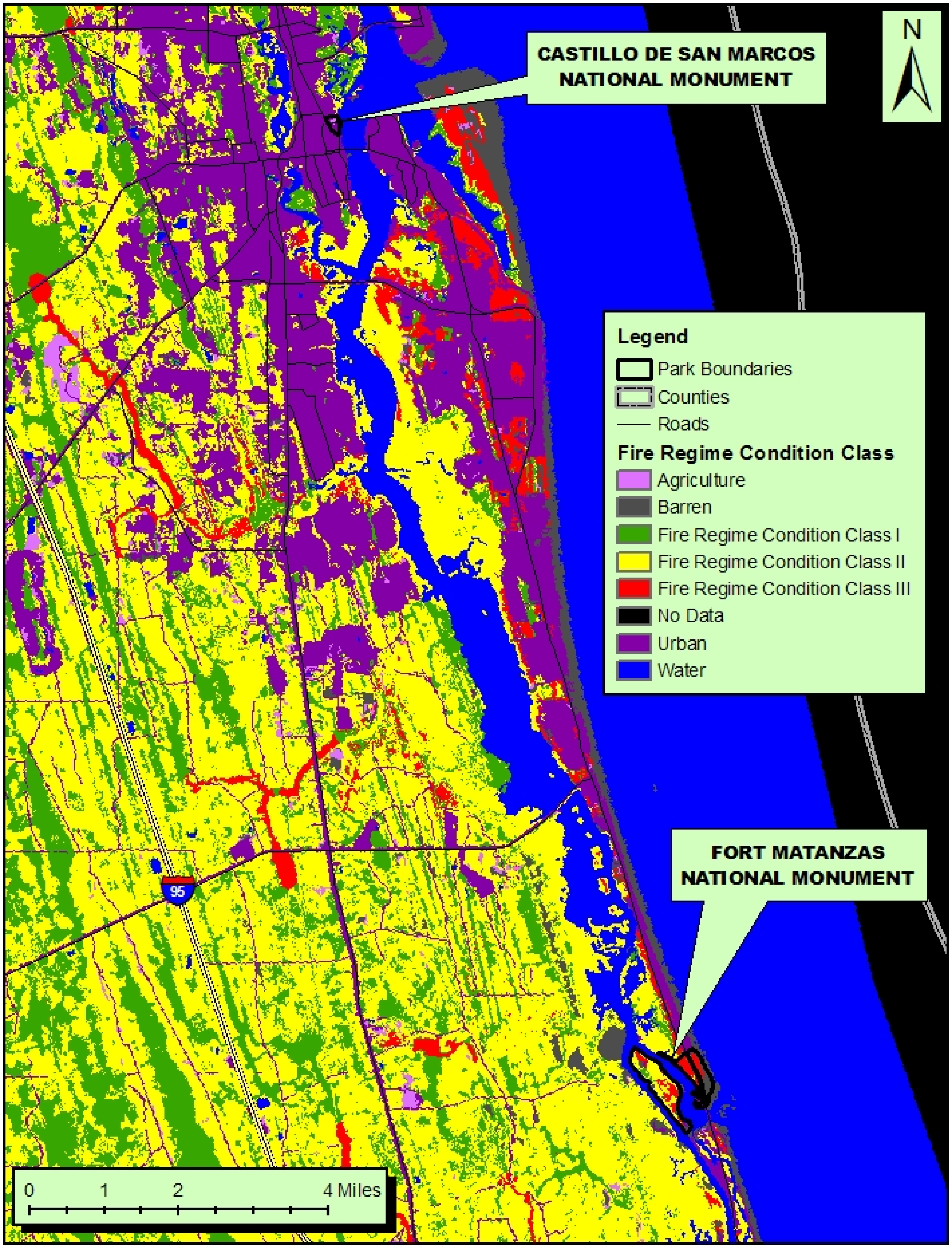

Figure 10. Departure between current vegetation condition and reference vegetation condition according to LANDFIRE (USDA Forest Service 2006) in the region of Castillo de San Marcos and Fort Matanzas National Monuments.

3.1.2.b Resource threats and stressors:
Fuel types (Figure 11) and fuel loads are an existing threat and stressor that should be monitored at Castillo de San Marcos and Fort Matanzas NMs. 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 Castillo de San Marcos and Fort Matanzas NMs. With a current vegetation map, we could more thoroughly assess the role of fire in the vegetation communities.

3.1.2.d Condition status summary
Fire and fuel dynamics received a good condition status for both monuments because there were very few recorded fires at the monuments or in the region (Table 14). If fires were to occur a large portion of both monuments and the region are predicted to be low severity. In addition, the majority of Fort Matanzas NM and the surrounding region exhibits moderate departure from historic vegetation, placing it in Fire Regime Condition Class II.

Table 14. Fire condition status summary for Castillo de San Marcos and Fort Matanzas National Monuments. Data quality was rated based on *thematic* (1 = best source; 0 = not the best source), *spatial* (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*
Fire dynamics Total		0	1	1
	Good	2 out of 3		

3.1.2.e Recommendations to park managers:
Castillo de San Marcos and Fort Matanzas NM should continue to record fire occurrence information with the National Wildfire Coordinating Group. There have been only seven recorded fires, from 1993 to 1995. A formal fire management plan may also be an appropriate addition.

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 12).

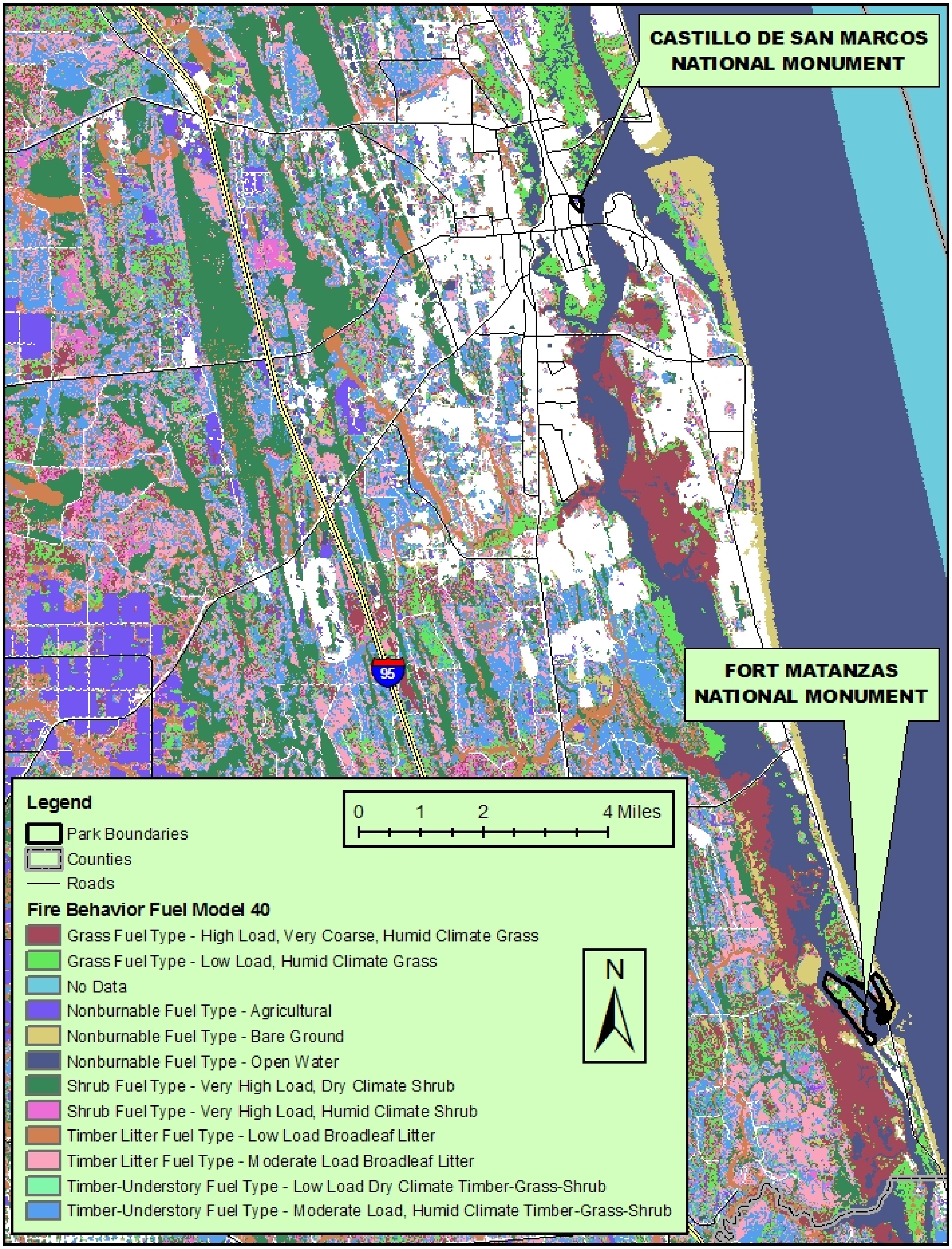

Figure 11. Wildfire fuel types according to LANDFIRE (USDA Forest Service 2006) in the region of Castillo de San Marcos and Fort Matanzas National Monuments.

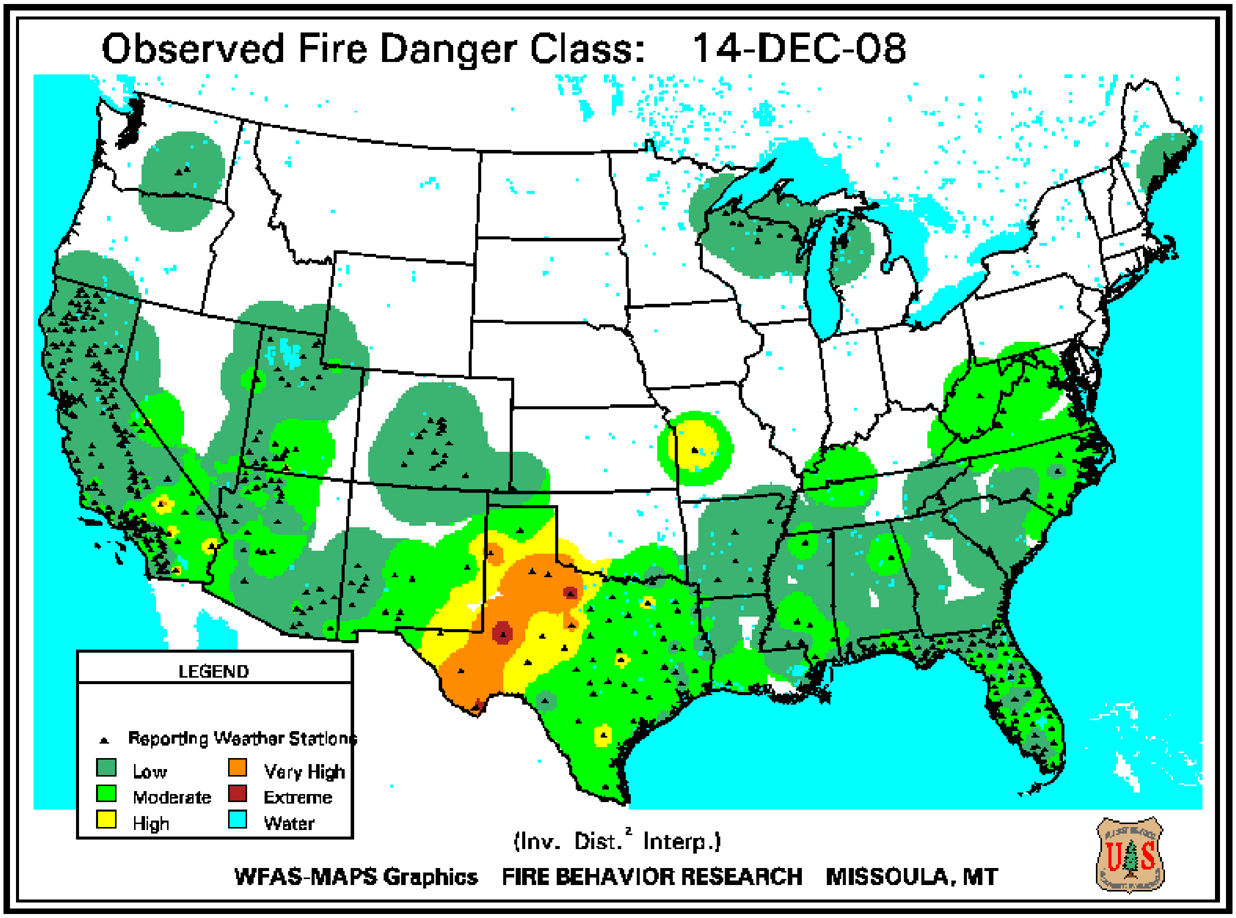

Figure 12. A recent observed fire danger class map for the United States (USDA Forest Service 2008).

3.2 Human Use

3.2.1 Non-point Source Human Effects

In the region of Castillo de San Marcos and Fort Matanzas NMs, human population and resulting development pressures are growing. This encroachment of human population and development is arguably the most important threat or stressor the monuments 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 Castillo de San Marcos and Fort Matanzas NM 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 Castillo de San Marcos and Fort Matanzas NM boundaries and in the broad, 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.

Castillo de San Marcos and Fort Matanzas NMs are situated in the city of St. Augustine, the county seat of St. Johns County, Florida. St. Johns County is part of the Jacksonville, Florida Metropolitan Statistical Area (MSA). The 2007 population estimate for the Jacksonville, Florida MSA was 1.3 million people, ranking 40th out of 363 MSAs nationwide (U.S. Census Bureau 2009c). Significant population increases from U.S. Census Bureau (U.S. Census Bureau 2009a) data were evident in this region, particularly in Flagler and St. Johns counties, the two fastest growing counties in the subbasin study area (Figure 13 and Figure 14). Flagler County experienced the most precipitous growth rate, with a 208% increase in population between 1990 and 2007. St. Johns County grew from 83,829 to 175,446 individuals between 1990 and 2007, a 109% increase. Volusia and Duval counties, the two remaining counties in the subbasin study area, each experienced more moderate population increases between 1990 and 2007. Volusia County population expanded nearly 35% while Duval County population increased by 26%.

Along with population change, a good indicator of human effects on natural resources is population density. Duval County totaled by far the highest population density in the study area in 2007 with 357 people/square km. Volusia County is the second highest with 135 people/square km, while St. Johns and Flagler have respective population densities of 83 and 60 people/square km (Figure 15).

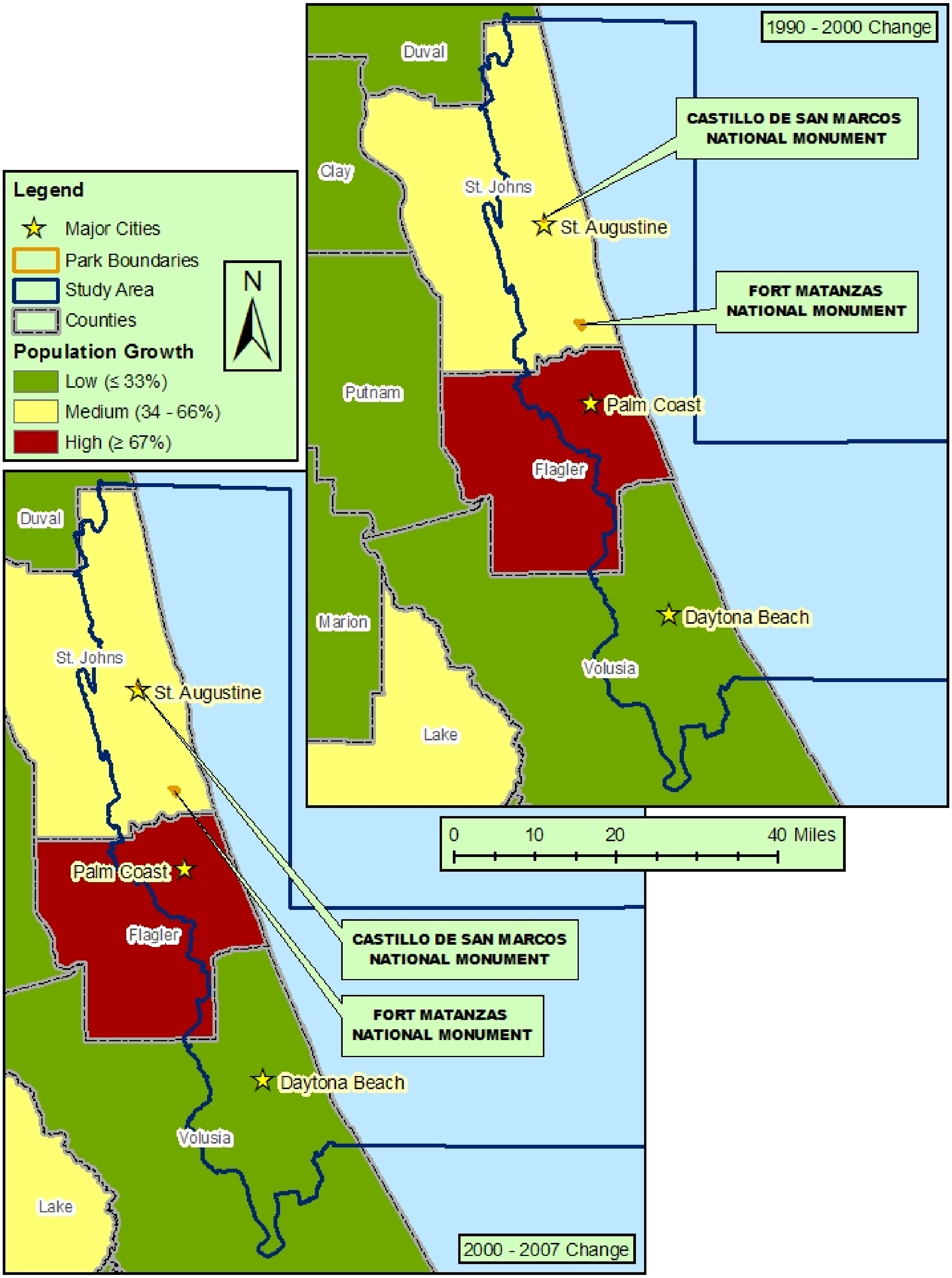

Figure 13. Human population change in counties surrounding Castillo de San Marcos and Fort Matanzas National Monuments, 1990 – 2000 and 2000 – 2007 (U.S. Census Bureau 2008).

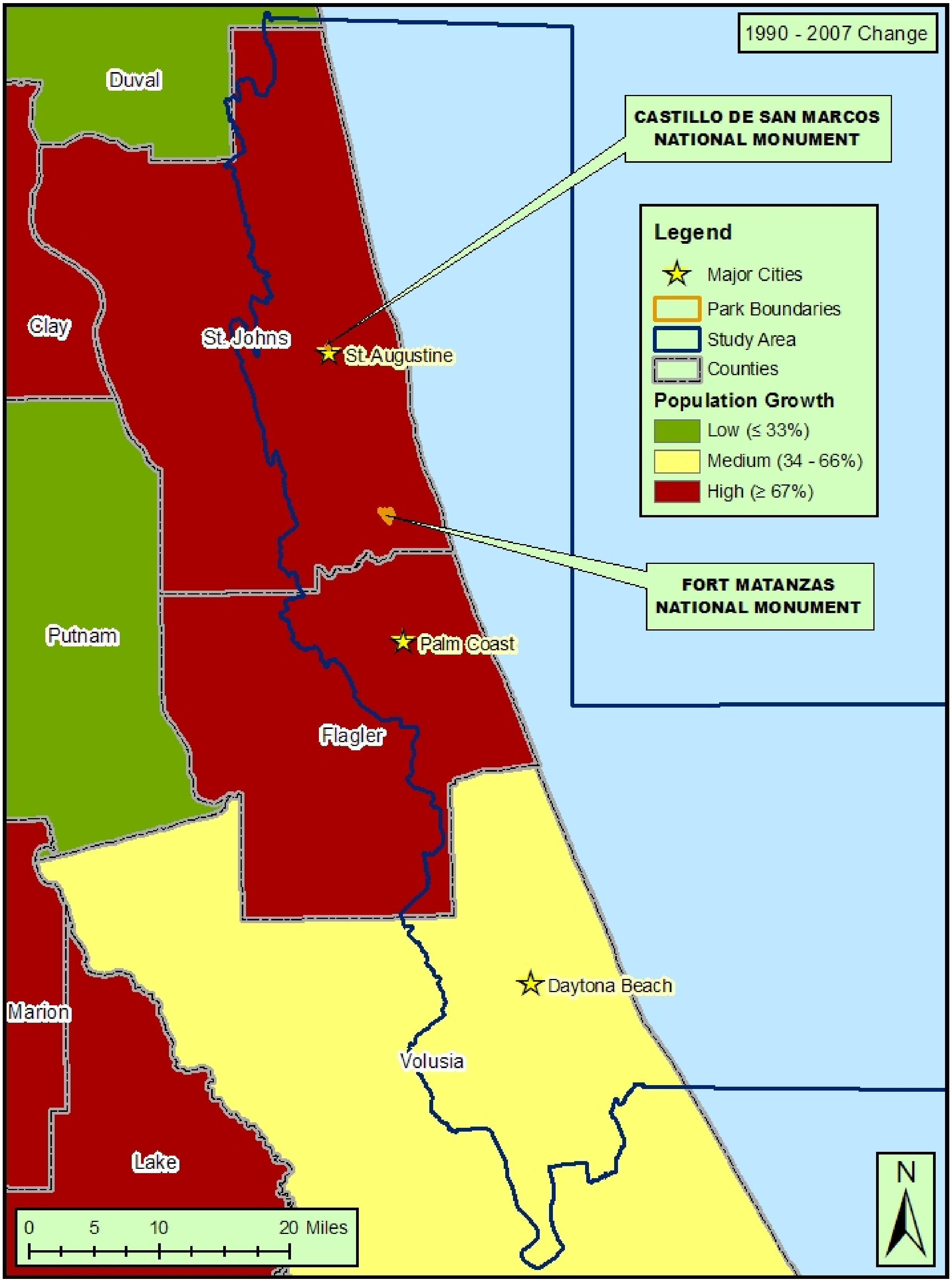

Figure 14. Human population change in counties surrounding Castillo de San Marcos and Fort Matanzas National Monuments, 1990 – 2007 (U.S. Census Bureau 2008).

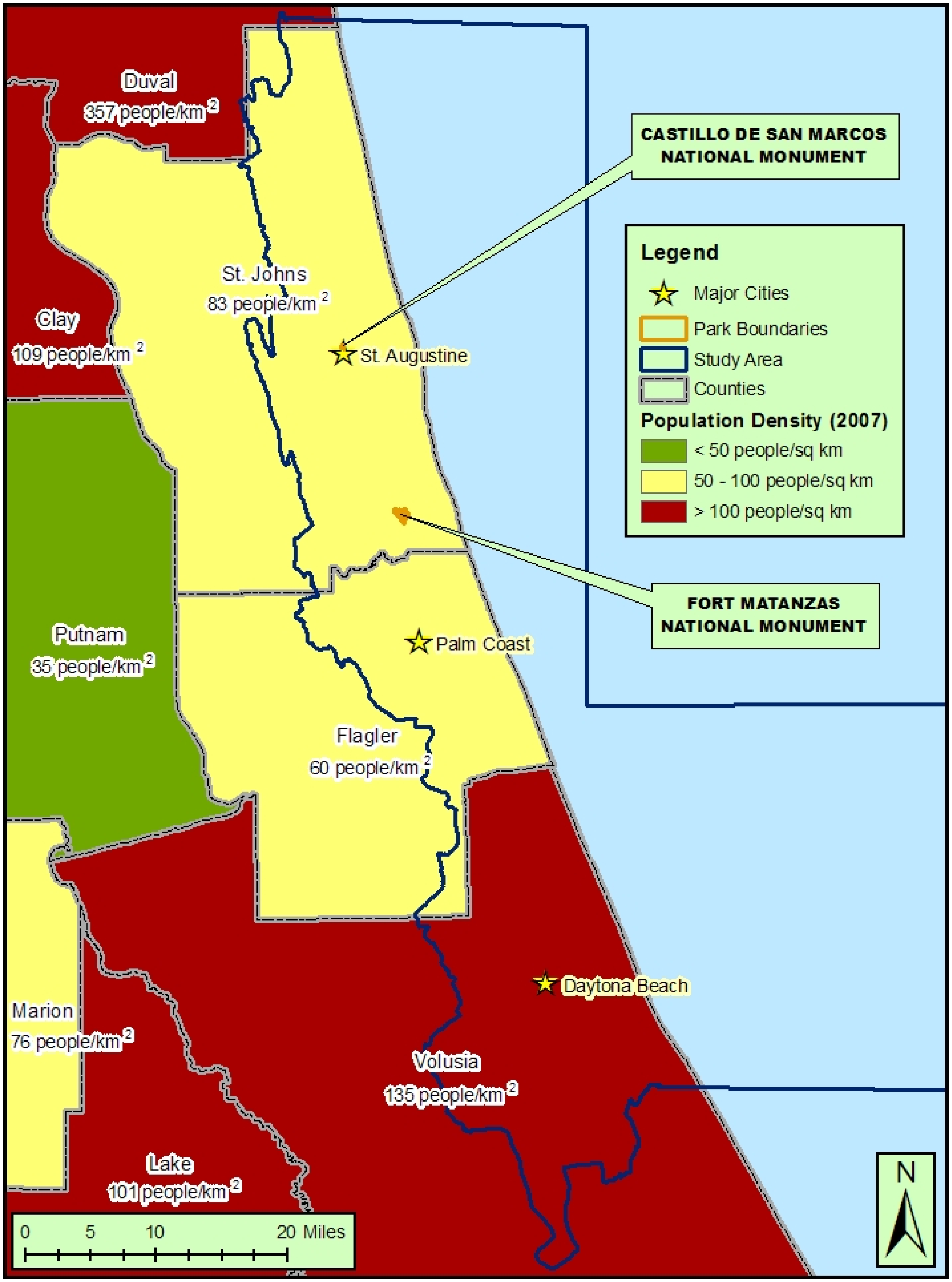

Figure 15. Human population density (people per square kilometer, 2007) for counties surrounding Castillo de San Marcos and Fort Matanzas National Monuments (U.S. Census Bureau 2008).

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 Castillo de San Marcos and Fort Matanzas NMs and within the subbasin study area (Table 16, Figure 16). The Daytona-St. Augustine (HUC 03080201) subbasin contains Castillo de San Marcos and Fort Matanzas NMs and has a fairly high amount of impervious surface (Table 16, Figure 16). It is not surprising that the highest concentration of impervious surface in the subbasin occur in urbanized areas surrounding the cities of St. Augustine, Palm Coast, and Daytona Beach. The subbasin study area exceeds the 10% impervious threshold, with 23.2% impervious cover, and was therefore classified as impacted. Castillo de San Marcos NM was classified as non-supporting due to nearly 76% impervious surface cover, while Fort Matanzas NM was classified as sensitive, with slightly more than 9% impervious surface cover.

Table 16. Impervious surface totals for Castillo de San Marcos and Fort Matanzas National Monuments 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*
Daytona-St. Augustine (03080201)	358339	108120	466459	23.2	Impacted streams
Castillo de San Marcos NM	5	15	20	75.5	Non-supporting streams
Fort Matanzas NM	271	28	300	9.4	Sensitive streams

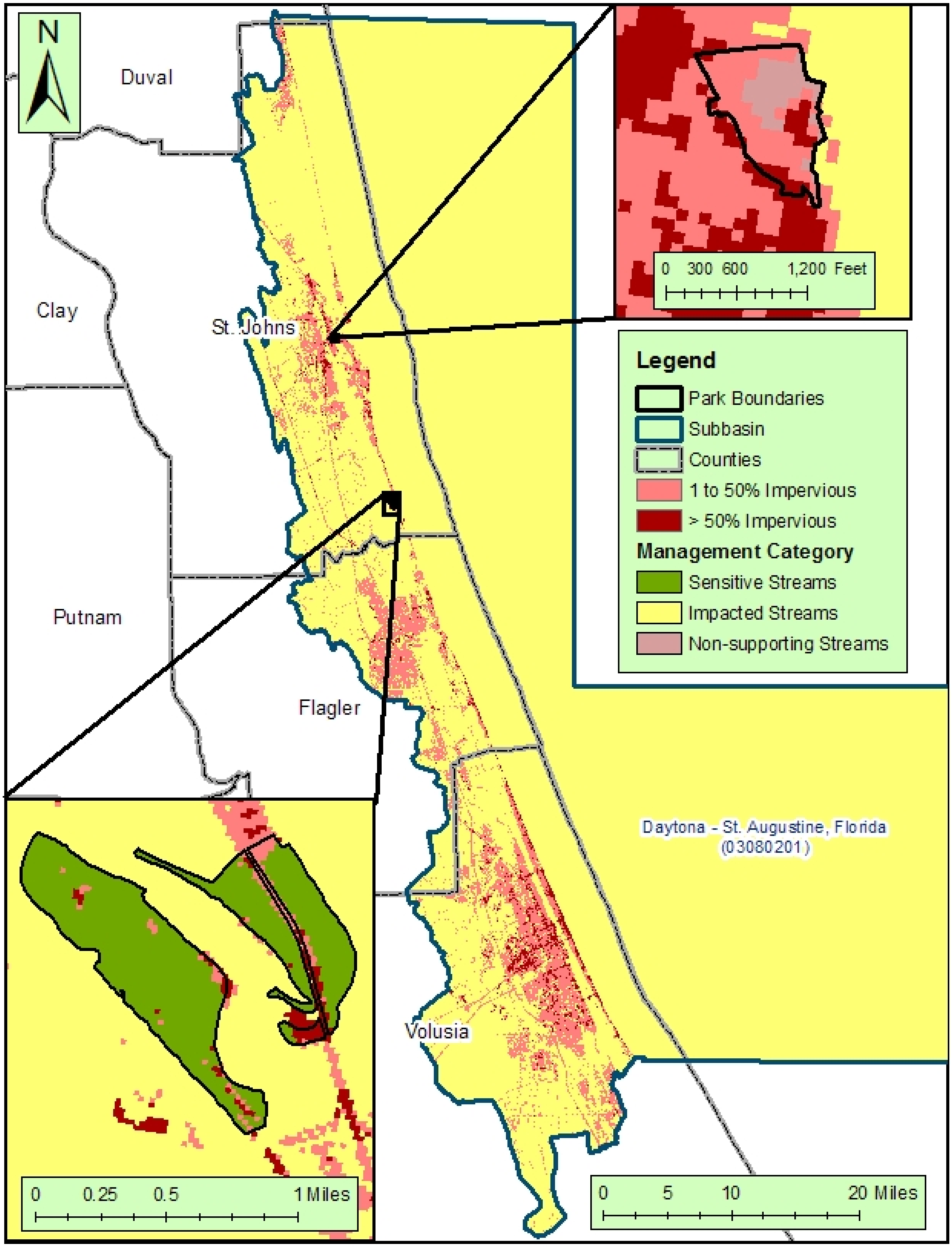

Figure 16. Impervious surface (from National Land Cover Database 2001) in the subbasin study area containing Castillo de San Marcos and Fort Matanzas National Monuments.

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 monument. 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 U.S. Census Bureau (2009b), two of the top five counties in Florida with the highest population change between 2000 and 2008 are in the subbasin study area. Flagler County ranks number one with an 83.1% population increase and St. Johns County ranks number three with a 47.4% population increase. Additionally, Flagler County and St. Johns County are expected to continue growing, with respective population increase projections of 28.3% and 20.3% from 2008 to 2013. Similarly, the number of households in these counties are projected to increase over the same five-year period: by 31.2% in Flagler County and by 19.8% in St. Johns County between 2008 and 2013 (St. Johns County Chamber of Commerce 2009).

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.

Broad, small-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 Castillo de San Marcos NM (20 acres) and Fort Matanzas NM (298 acres) are fairly small parks. When spatial scale was questionable, we gave thematic a zero for data quality (Table 17).

3.2.1.d Condition status summary
Human population condition status is in the fair range because St. Johns County is growing relatively fast and population density is fairly substantial for the region (Table 17, Table 18). Impervious surface coverage for Castillo de San Marcos NM was above the 26% cut-off so it is rated as poor for this category (Table 17). Fort Matanzas NM was below the 10% threshold so it received a good rating (Table 18). It is important to note that the subbasin containing the monuments fell in the fair (impacted streams) range, at 23.2% impervious cover. This may lead to greater impacts from outside the monument boundaries to streams and other resources within the monuments.

Table 17. Human effects condition status summary for Castillo de San Marcos National Monument. Data quality was rated based on *thematic* (1 = best source; 0 = not the best source), *spatial* (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
	Poor	0.17	2 out of 3		
Human effects total			1	2	2
	Fair	0.34	5 out of 6		

Table 18. Human effects condition status summary for Fort Matanzas National Monument. Data quality was rated based on *thematic* (1 = best source; 0 = not the best source), *spatial* (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
	Good	0.84	2 out of 3		
Human effects total			1	2	2
	Good	0.67	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 resources 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 2008c). 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 at Castillo de San Marcos NM was steadily on the rise and experienced a peak in visitation in 1992. For the past 20 years, however, visitor levels have been on an overall decline (Figure 17). The number of visitors per year at Fort Matanzas NM has also been steadily increasing, with a peak of over 1 million visitors in 2005. Unlike Castillo de San Marcos, however, Fort Matanzas NM has seen a steady increase in visitor levels over the past 20 years (Figure 18). Visitation to Castillo de San Marcos NM is relatively constant throughout the year, with peaks occurring in March, April, and July (Figure 19). Likewise, visitation to Fort Matanzas NM is relatively constant throughout the year, with peaks in July and August (Figure 20). Castillo de San Marcos NM was fifth out of 21 in the number of visitors to NPS Forts in 2007 (Table 19) and eighth out of 68 National Monuments visited in 2007. Fort Matanzas NM was second out of 21 in the number of visitors to NPS Forts in 2007 (Table 19) and third out of 68 National Monuments visited in 2007.

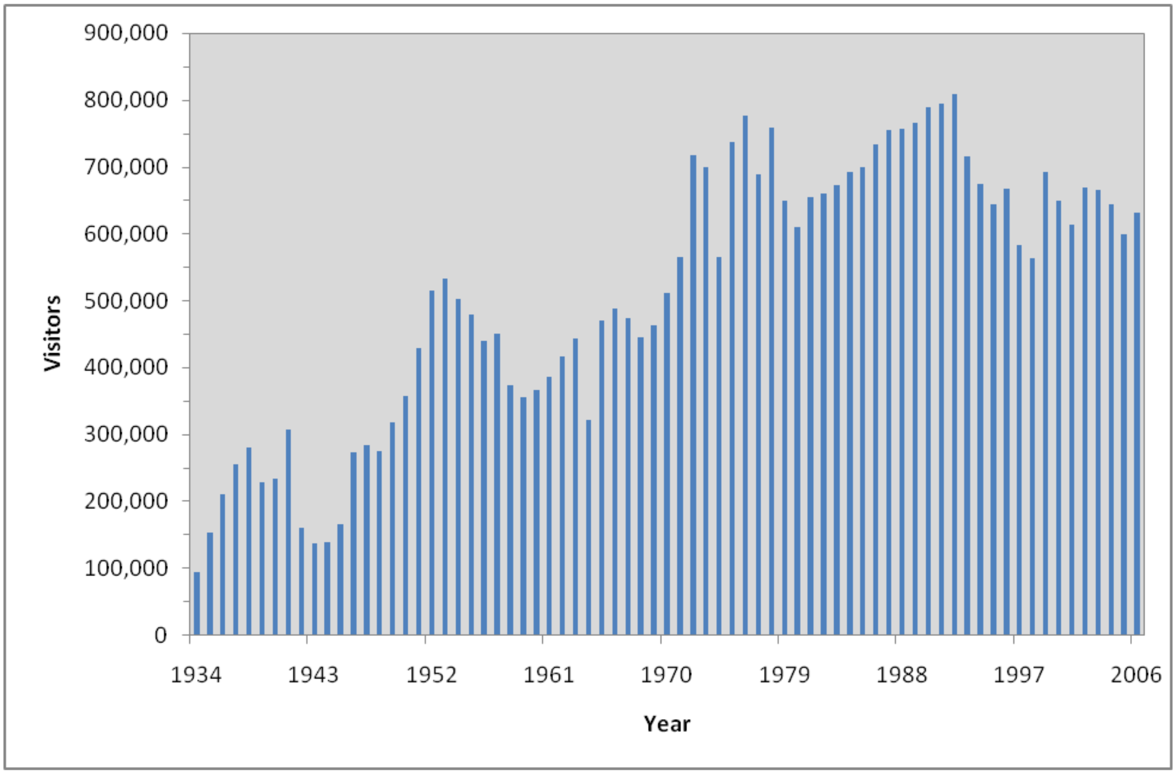

Figure 17. Number of visitors per year to Castillo de San Marcos National Monument from 1934 to 2007. Data from NPS (2008d).

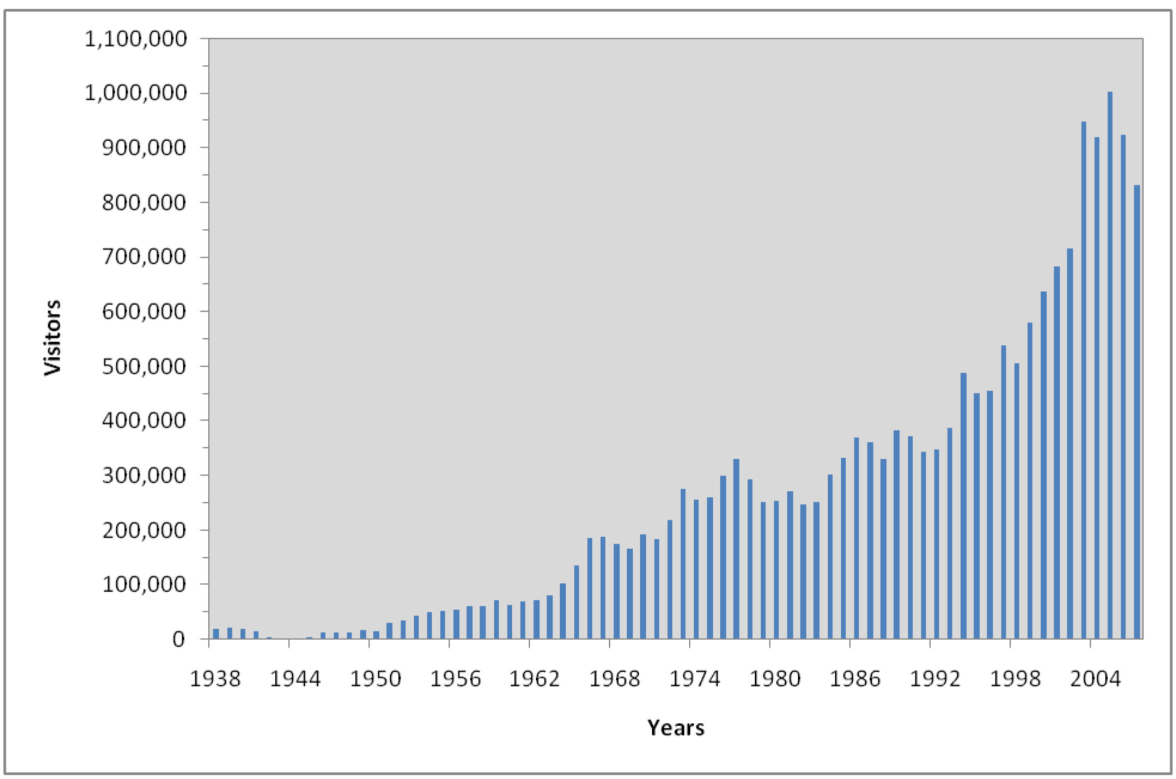

Figure 18. Number of visitors per year to Fort Matanzas National Monument from 1938 to 2007. Data from NPS (2008d).

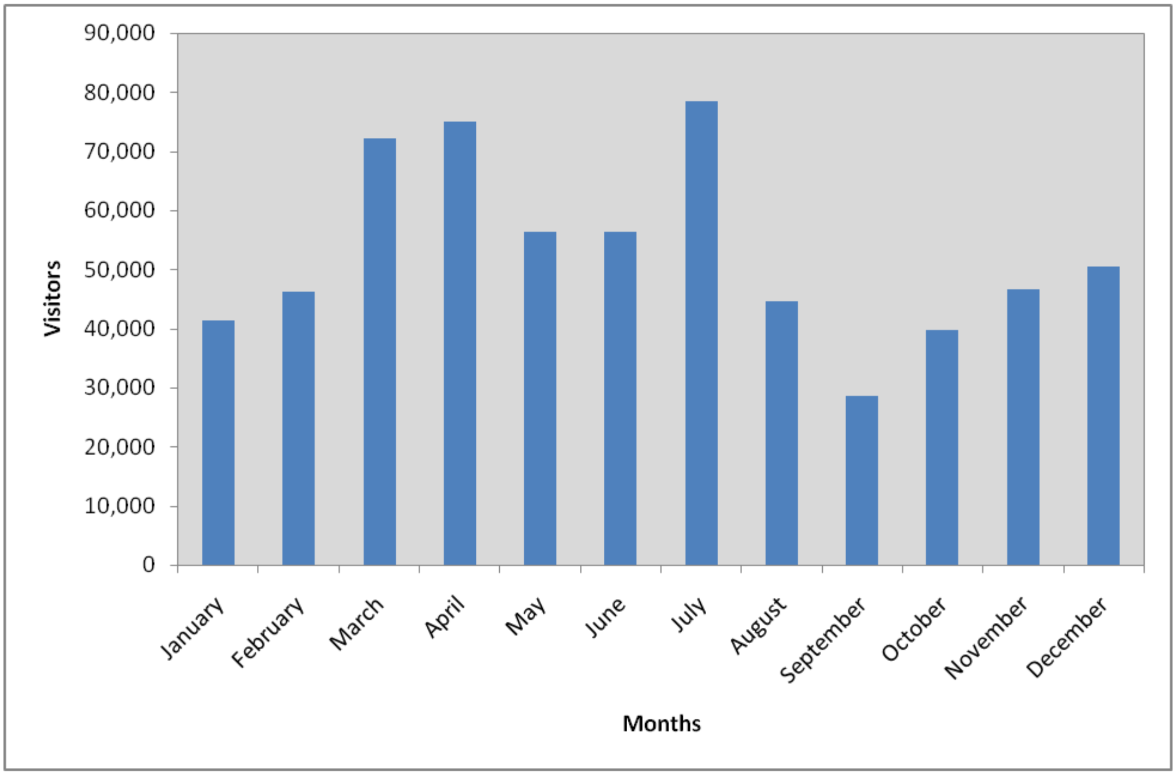

Figure 19. Average monthly visitors (from the past 10 years, 1998 – 2007) to Castillo de San Marcos National Monument. Data from NPS (2008d).

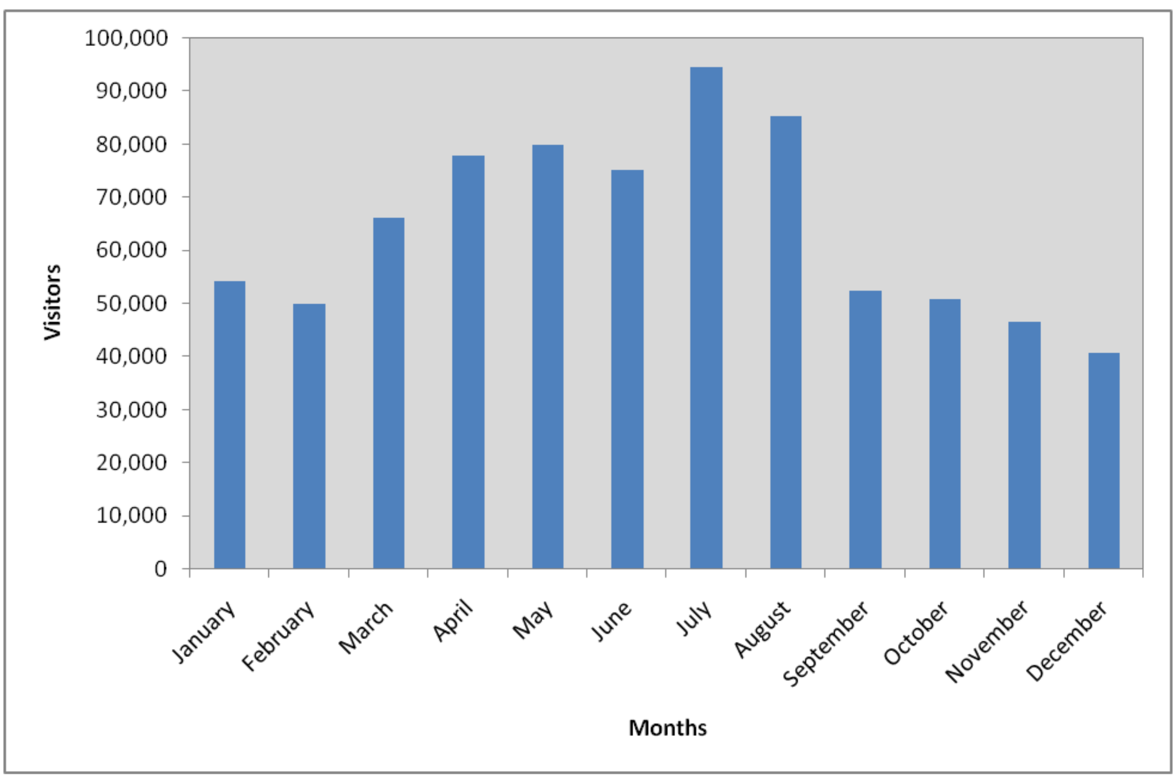

Figure 20. Average monthly visitors (from the past 10 years, 1998 – 2007) to Fort Matanzas National Monument. Data from NPS (2008d).

Table 19. Number of National Park Service Fort visitors in 2007 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 Castillo de San Marcos and Fort Matanzas NMs. With that said, visitor use statistics and current data do not indicate that this is a large threat to natural resources within the parks' 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. On-the-ground surveys of visitor impacts and trail spatial data would help quantify the effects of visitor use on the natural resources. These data were not available (Table 20 and Table 21).

3.2.2.d Condition status summary:
Visitor use is in the good range for condition status at both monuments because 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 (Table 20 and Table 21).

Table 20. Visitor use condition status summary for Castillo de San Marcos National Monument. Data quality was rated based on *thematic* (1 = best source; 0 = not the best source), *spatial* (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*
Visitor use total		0	1	1
	Good	2 out of 3		

Table 21. Visitor use condition status summary for Fort Matanzas National Monument. Data quality was rated based on *thematic* (1 = best source; 0 = not the best source), *spatial* (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*
Visitor use total		0	1	1
	Good	2 out of 3		

3.2.2.d 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 the 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 22), 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 22. 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 2007a). Based on certain criteria, these categories are given a score of "good," "moderate," or "significant concern." Although Castillo de San Marcos and Fort Matanzas NMs 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:

Florida's state environmental agency operates twelve air quality monitoring sites in Duval County, ranging between 40 and 100 km from Castillo de San Marcos and Fort Matanzas NMs. They measure O_3, $PM_{2.5}$, PM_{10}, SO_2, and CO. Table 23 and Figure 21 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 23. Air quality index in 2007 at monitoring sites near Castillo de San Marcos and Fort Matanzas National Monuments. 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
120310032	Bennett St.	FL	Duval	Jacksonville	30.356111	-81.635556				12		
120310053	Buckman St.	FL	Duval	Jacksonville	30.352222	-81.628333			64			
120310081	Cedar Bay Rd.	FL	Duval	Jacksonville	30.422222	-81.621111				28		
120310097	Fort Caroline Rd.	FL	Duval	Jacksonville	30.367222	-81.594167				16		
120310089	Georgia St.	FL	Duval	Jacksonville	30.328889	-81.639722			65			
120310077	Lanier St.	FL	Duval	Jacksonville	30.477500	-81.587500	104					
120310080	LaSalle St.	FL	Duval	Jacksonville	30.308889	-81.652500				7	16	
120310098	Mandarin Rd.	FL	Duval	Jacksonville	30.135556	-81.634167		82				
120310099	Merrill Rd.	FL	Duval	Jacksonville	30.355833	-81.548056		88				
120310084	Rosselle and Copeland	FL	Duval	Jacksonville	30.320278	-81.687778			62		24	
120310083	South McDuff Ave.	FL	Duval	Jacksonville	30.305000	-81.705556					20	
120310100	William Davis Parkway	FL	Duval	Jacksonville	30.261000	-81.454000	129					

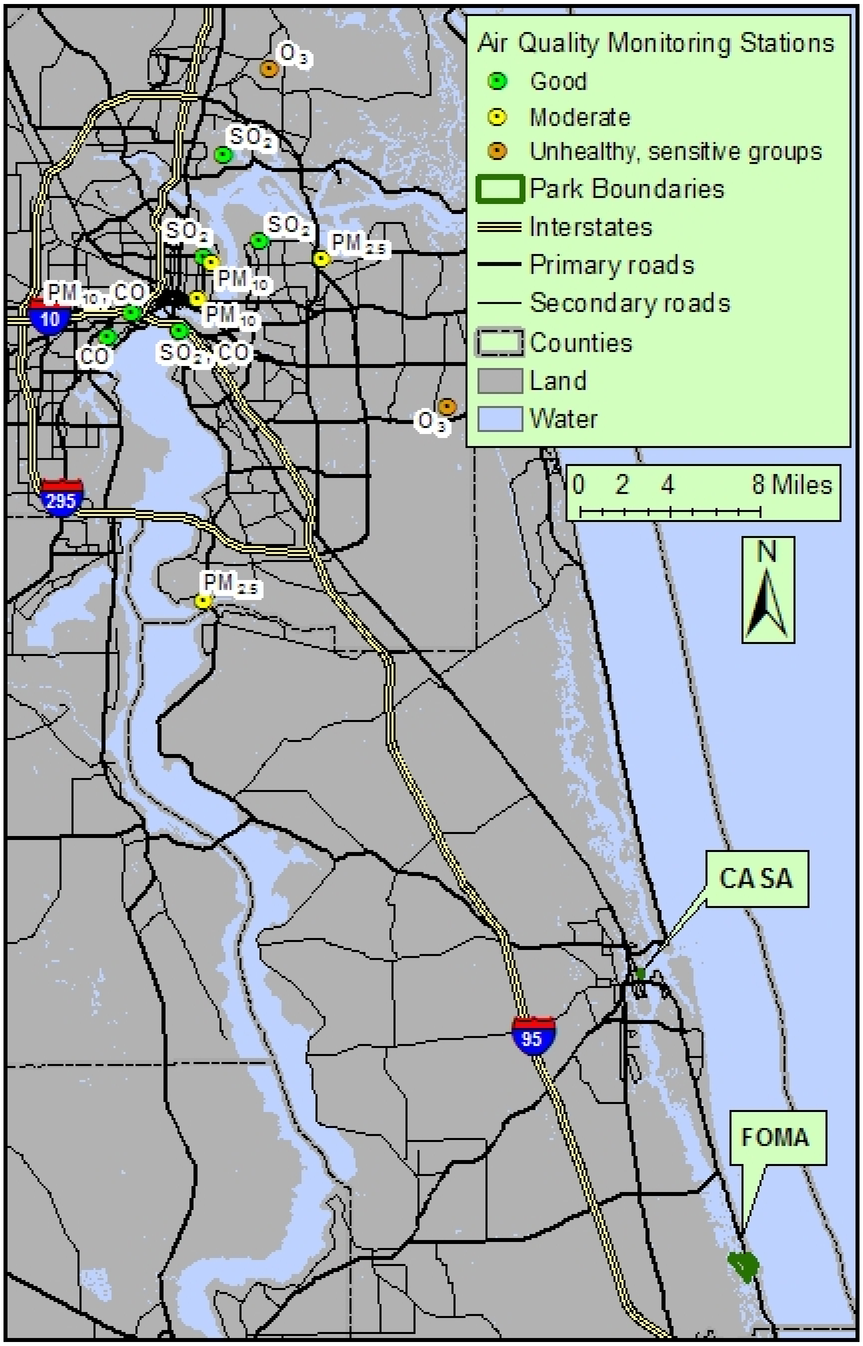

Figure 21. Air quality monitoring sites near Castillo de San Marcos and Fort Matanzas National Monuments. Green indicates "good" air quality, yellow indicates "moderate," and orange indicates "unhealthy for sensitive groups" at these sites in 2007.

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 23 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 22 and Figure 23. 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 are from the Lanier Road site (Figure 22). Ozone exceedances have been consistently around 4 for the last few years with a noticeable spike in 2006. The EPA standard for 8-hour ozone is based on the 4th highest measurement in a year. The measurements have stayed consistently around the standard of 0.075 ppm.

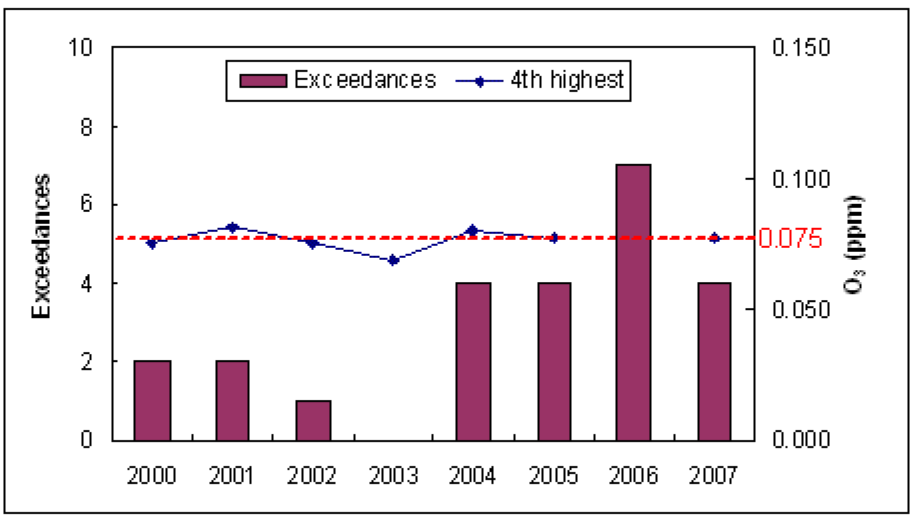

Figure 22. Eight-hour ozone for Castillo de San Marcos and Fort Matanzas National Monuments.

The $PM_{2.5}$ measurements shown in Figure 23 are from the Merrill Road site. $PM_{2.5}$ exceedances have not been an issue until recently in 2007 when 6 occurred. 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 35 micrograms per cubic meter, compared to the standard of 35.

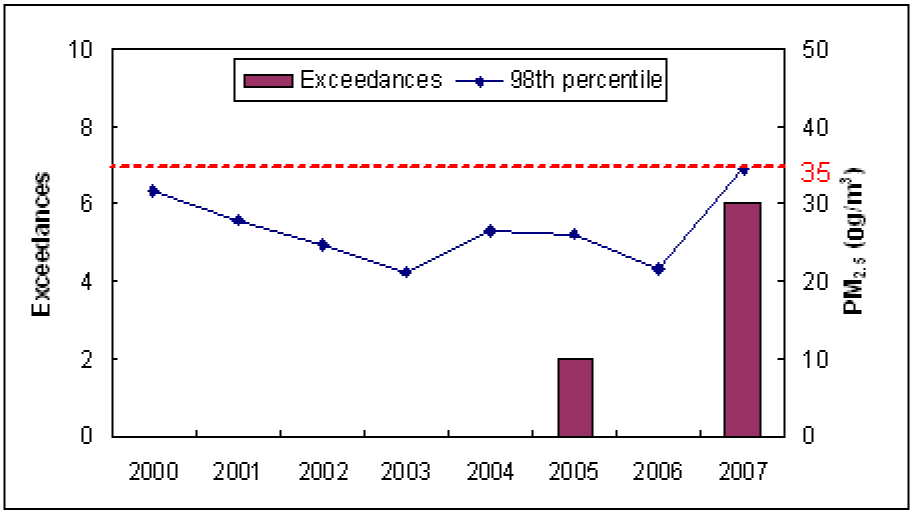

Figure 23. 24-hour $PM_{2.5}$ for Castillo de San Marcos and Fort Matanzas National Monuments.

Air quality forecast:
The location nearest Castillo de San Marcos and Fort Matanzas National Monuments with a daily air quality forecast is in Jacksonville, FL, which is approximately 60 km to the northwest of Castillo de San Marcos NM and 90 km to the northwest of Fort Matanzas NM. The AQI forecast (AirNow 2008c) is provided for both ozone (O_3) and fine particulate matter ($PM_{2.5}$). The Jacksonville forecast is a reasonable indicator for the monuments, but because of the moderate distance between the locations and the comparatively urban setting in Jacksonville, the forecast may not always apply.

Ozone (O_3):
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 24 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 24. Air Resources Division ozone air quality condition classifications and corresponding condition status. The 5-year average ozone concentration at Castillo de San Marcos NM was 79.67 ppb; Fort Matanzas NM was 72.40 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 indicated that there are no ozone-sensitive species present at Castillo de San Marcos NM, but identified five plant species present at Fort Matanzas NM that are sensitive to ozone (National Park Service 2004). This risk assessment indicated that the risk of injury to plants is low at Castillo de San Marcos NM because of the regular occurrence of mild to severe drought, which inhibits ozone uptake by plants, during periods of elevated ozone levels. Similarly, the risk of injury to plants is low at Fort Matanzas NM due to low levels of ozone exposure coupled with soil moisture conditions which inhibit the uptake of ozone. Although none are present as Castillo de San Marcos NM, the 2004 report also identifies two bioindicator species that can be monitored at Fort Matanzas 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 25 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 25. 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 Castillo de San Marcos NM is estimated at 2.75 kg/ha/yr, and total wet sulfur deposition is estimated at 3.99 kg/ha/yr. Total wet nitrogen deposition at Fort Matanzas NM is estimated at 2.83 kg/ha/yr, and total wet sulfur deposition is estimated at 4.14 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 40^{th} and 60^{th} 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 26, 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 26. Air Resources Division visibility condition classifications and corresponding condition status. The current Group 50 deviation at Castillo de San Marcos and Fort Matanzas NMs is 12.20 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 Castillo de San Marcos and Fort Matanzas NMs takes into account ozone concentration, wet

atmospheric deposition, and visibility. The 5-year (2003 – 2007) average ozone concentrations for Castillo de San Marcos and Fort Matanzas NMs were 79.67 ppb and 72.40 ppb, respectively. As a result, Castillo de San Marcos received a "significant concern" or "poor" ozone condition rating; Fort Matanzas received a "moderate" or "fair" ozone condition rating (Table 24). 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 "significant concern" for Castillo de San Marcos NM and "moderate" for Fort Matanzas NM.

Atmospheric deposition at Castillo de San Marcos NM is classified as a "significant concern" or "poor" condition status (Table 25). Although wet nitrogen deposition, estimated at 2.75 kg/ha/yr, fell within the "moderate concern" or "fair" condition status, the wet sulfur deposition, estimated at 3.99 kg/ha/yr, was high enough to warrant an overall "significant concern" classification for wet atmospheric deposition. Likewise, Fort Matanzas NM is classified as a "significant concern" or "poor" condition status due to elevated wet sulfur deposition, estimated at 4.14 kg/ha/yr, despite the "moderate" or "fair" condition status of wet nitrogen deposition, estimated at 2.83 kg/ha/yr. There is no current information to indicate whether ecosystems at Castillo de San Marcos and Fort Matanzas NMs are sensitive to nitrogen or sulfur deposition, but deposition is elevated. Nitrogen deposition, in particular, may affect the integrity of vegetation communities at Castillo de San Marcos and Fort Matanzas NMs because excess nitrogen has been found to encourage growth of invasive plant species at the expense of native species.

The visibility condition at Castillo de San Marcos and Fort Matanzas NMs is classified as a "significant concern" because the current Group 50 visibility at both parks is 12.20 dv above estimated Group 50 natural conditions (Table 26).

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 2007a). 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 monuments' 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 monuments could lead to an increase in vehicle traffic and its associated emissions that could impact the monuments' air quality.

3.3.1.c Critical knowledge or data gaps:
An air monitoring site on the monuments' property would provide the best information about their 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 monuments. The spatial component of data quality received a zero for atmospheric deposition and visibility because the available data could be more local

(Table 27 and Table 28). There are, however, monitoring stations for ozone within close proximity to the monuments 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 Castillo de San Marcos and Fort Matanzas NMs is poor overall (Table 27 and Table 28). As previously discussed, a 2004 risk assessment determined that the ozone threat to vegetation at Castillo de San Marcos and Fort Matanzas NMs 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 2004).

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 27. Air quality condition status summary for Castillo de San Marcos National Monument. Data quality was rated based on *thematic* (1 = best source; 0 = not the best source), *spatial* (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
	Poor	0.17	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	0.17	7 out of 9		

Table 28. Air quality condition status summary for Fort Matanzas National Monument. Data quality was rated based on *thematic* (1 = best source; 0 = not the best source), *spatial* (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.	Florida Department of Environmental Protection - Division of Air Resource Management	http://www.dep.state.fl.us/Air/default.htm

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 Castillo de San Marcos and Fort Matanzas NMs. This information can be used to provide some forward-looking insight into potential direct and indirect impacts a changing climate might have on their natural resources.

3.3.2.a Current condition:
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) to assess temperature change for Castillo de San Marcos and Fort Matanzas NMs. 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). St. Augustine, Florida 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. In an effort to obtain the most comprehensive climate data possible, we obtained data from two separate data collection sites within close proximity to Castillo de San Marcos and Fort Matanzas NMs and combined them in our analysis (The Southeast Regional Climate Center 2008). These sites were St Augustine WFOY, FL (087826) and St Augustine, FL (087812).

We used the “monthly average temperature” option to examine annual temperature trends as well as seasonally for Winter (December – February), Spring (March – May), Summer (June – August), and Fall (September – November) seasons. The range of dates for which the combined data were available was 1901 – 2007. It should be noted, however, that data there are data gaps which prevent precise climate analysis. Instances of incomplete data are noted beneath each figure.

The mean annual temperature for St. Augustine, Florida has increased approximately 0.01 degrees Fahrenheit per decade (mean = 69.97 °F) from 1901 to 2007 (Figure 24). This observed trend was similar for all four seasons (Figure 25 through Figure 28). Although the most potentially biologically significant increase was observed during the winter and summer seasons, temperatures in St. Augustine are fairly constant and increasing at a relatively negligible rate.

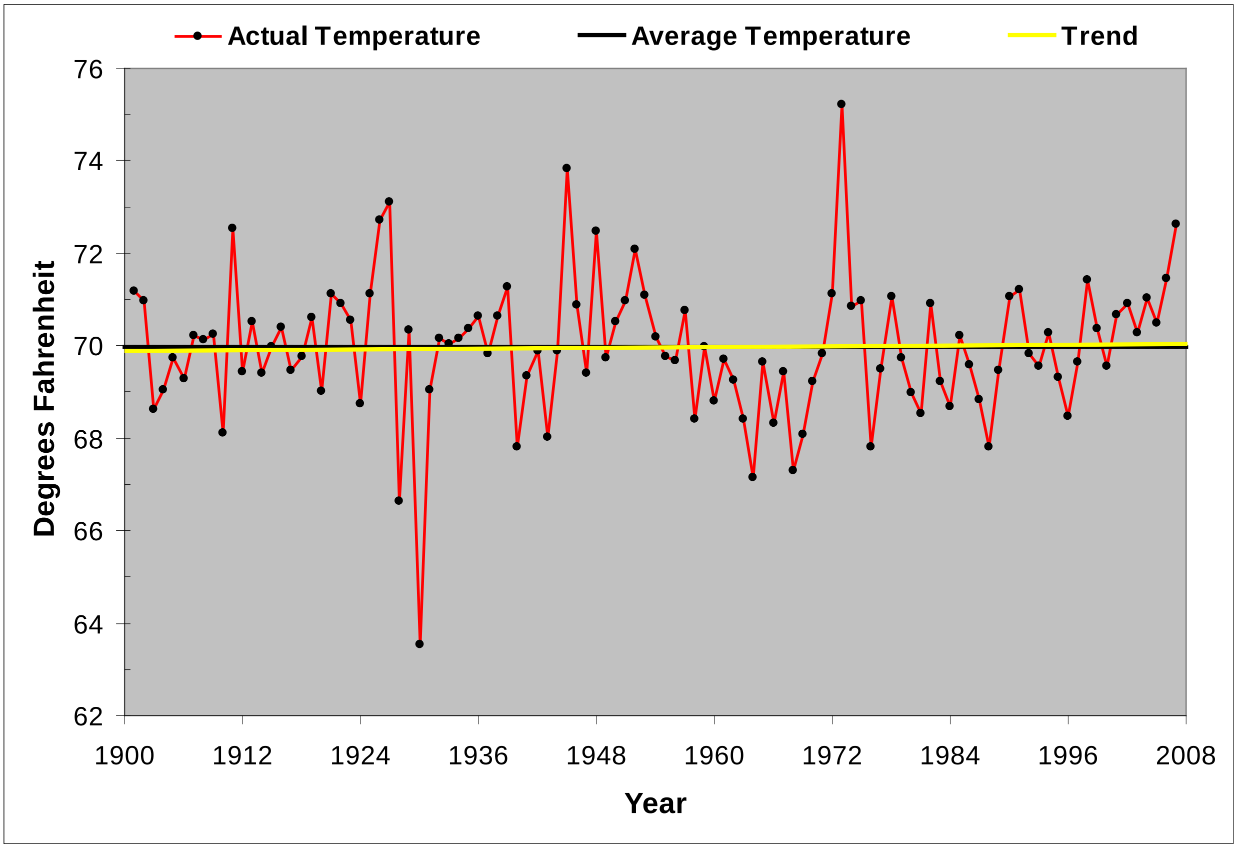

Figure 24. Annual temperature for St. Augustine, FL from 1901 to 2007. The mean annual temperature is 69.97 °F. The trend is 0.01 °F per decade.

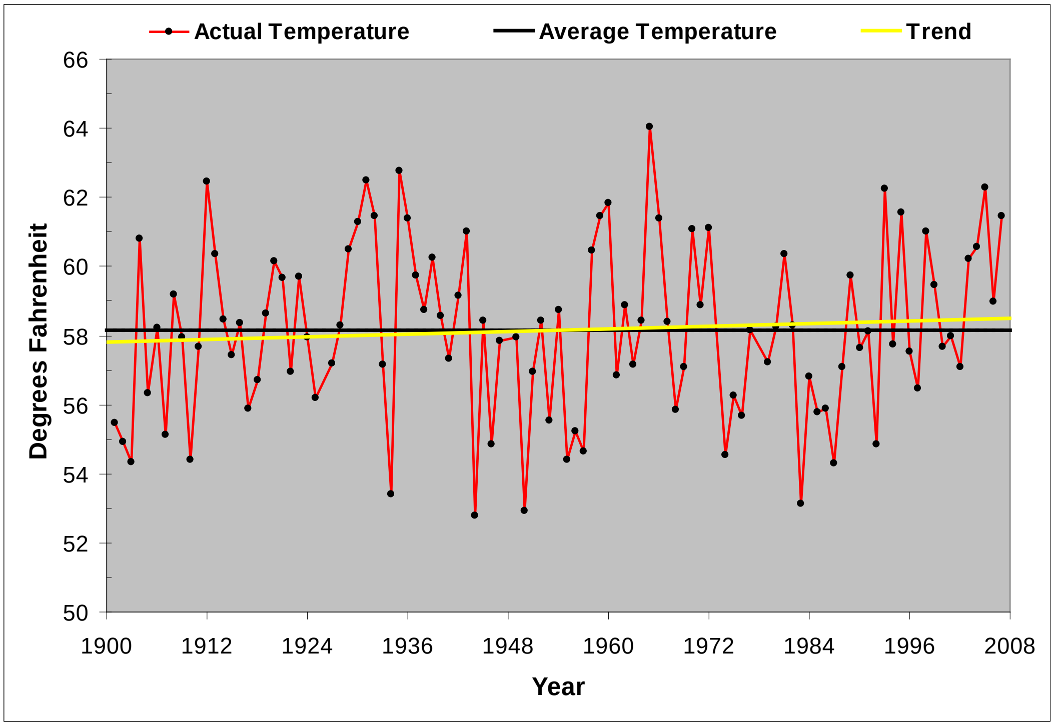

Figure 25. Winter temperature for St. Augustine, FL from 1901 to 2007. The mean temperature was 58.16 °F. The trend is 0.06 °F per decade. Data for 1926, 1948, 1973, and 1978 is incomplete and has been omitted from this figure.

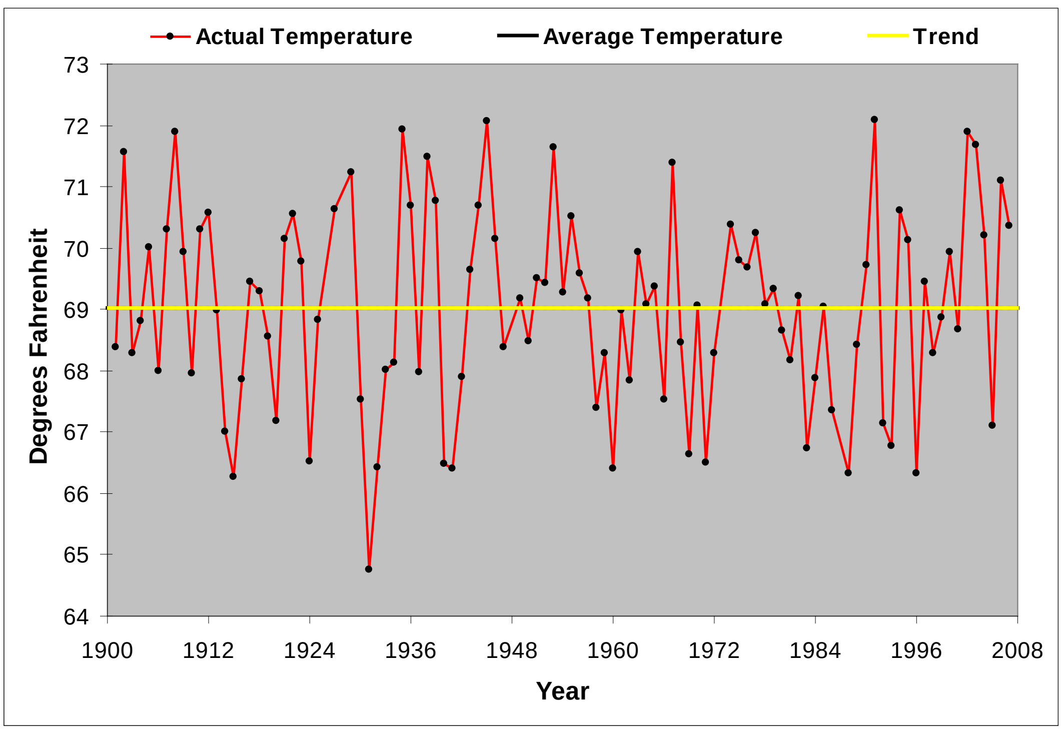

Figure 26. Spring temperature for St. Augustine, FL from 1901 to 2007. The mean temperature was 69.02 °F. The trend is 0.001 °F per decade. Data for 1926, 1928, 1948, 1973, and 1987 is incomplete and has been omitted from this figure.

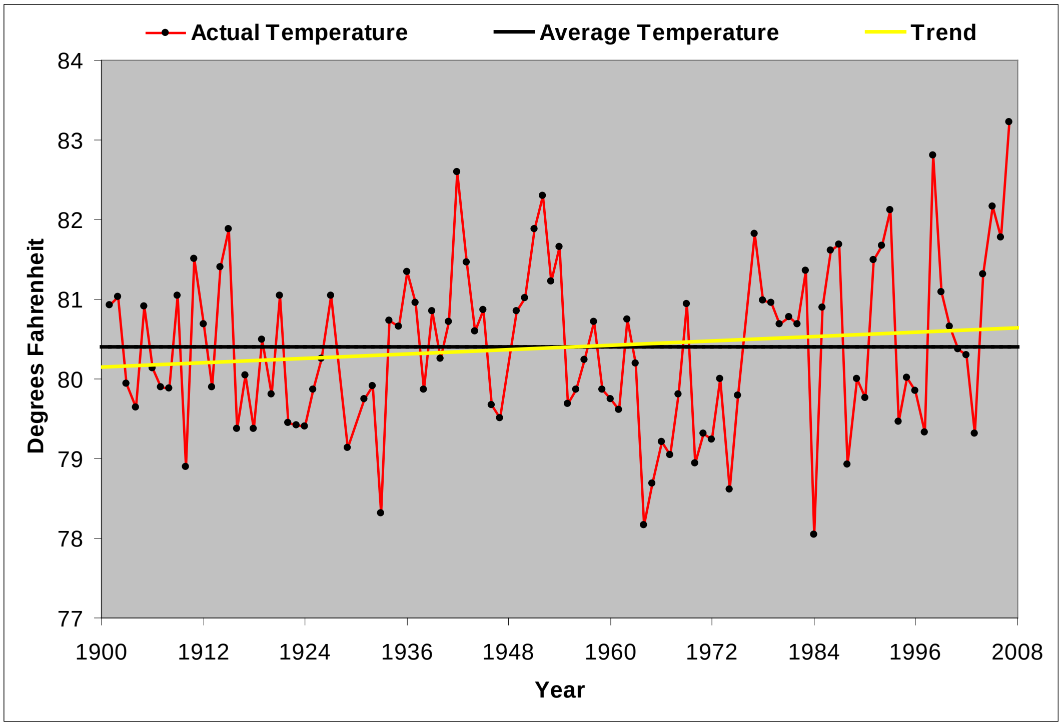

Figure 27. Summer temperature for St. Augustine, FL from 1901 to 2007. The mean temperature was 80.40 °F. The trend is 0.05 °F per decade. Data for 1928, 1930, 1948, and 1976 is incomplete and has been omitted from this figure.

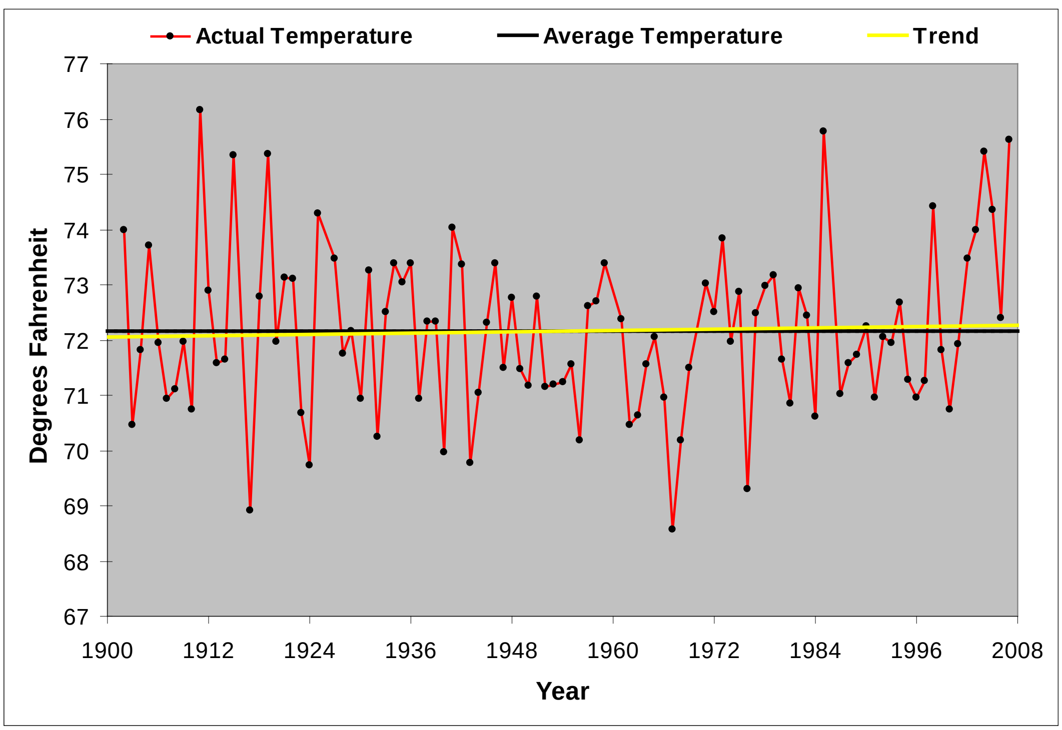

Figure 28. The fall temperature for St. Augustine, FL from 1901 to 2007. The mean temperature was 72.16 °F. The trend is 0.02 °F per decade. Data for 1901, 1916, 1926, 1960, 1970, and 1986 is incomplete and has been omitted from this figure.

Precipitation:
Similar analyses were conducted for precipitation using data collected at St. Augustine, FL. The annual precipitation at St. Augustine shows great variation through time and has an increasing trend of approximately 0.41 inches per decade (Figure 29).

We also examined precipitation seasonally (as described in temperature above) for winter, spring, summer, and fall from 1901 – 2007 (Figure 30 through Figure 33).

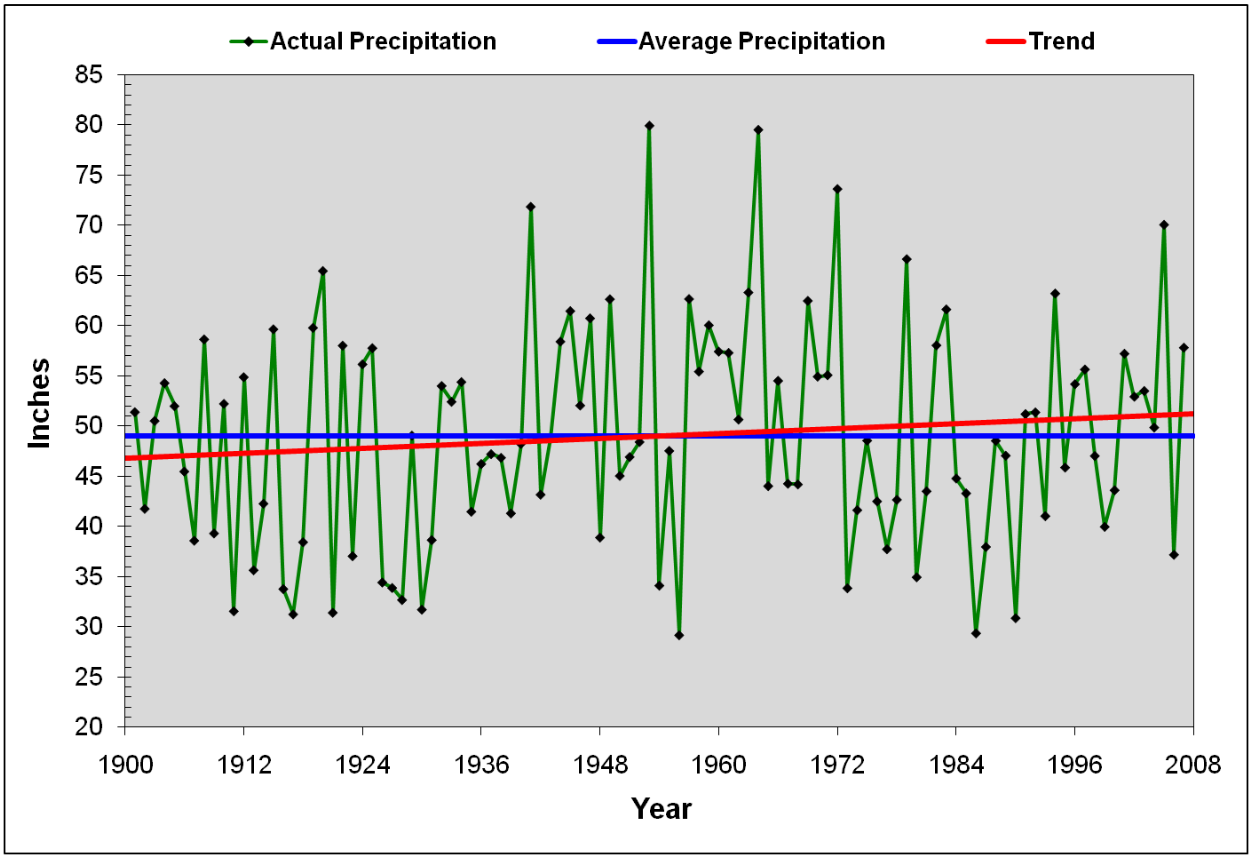

Figure 29. Annual precipitation for St. Augustine, FL from 1901 to 2007. The mean annual precipitation is 49.02 inches with an increasing trend of 0.41 inches per decade.

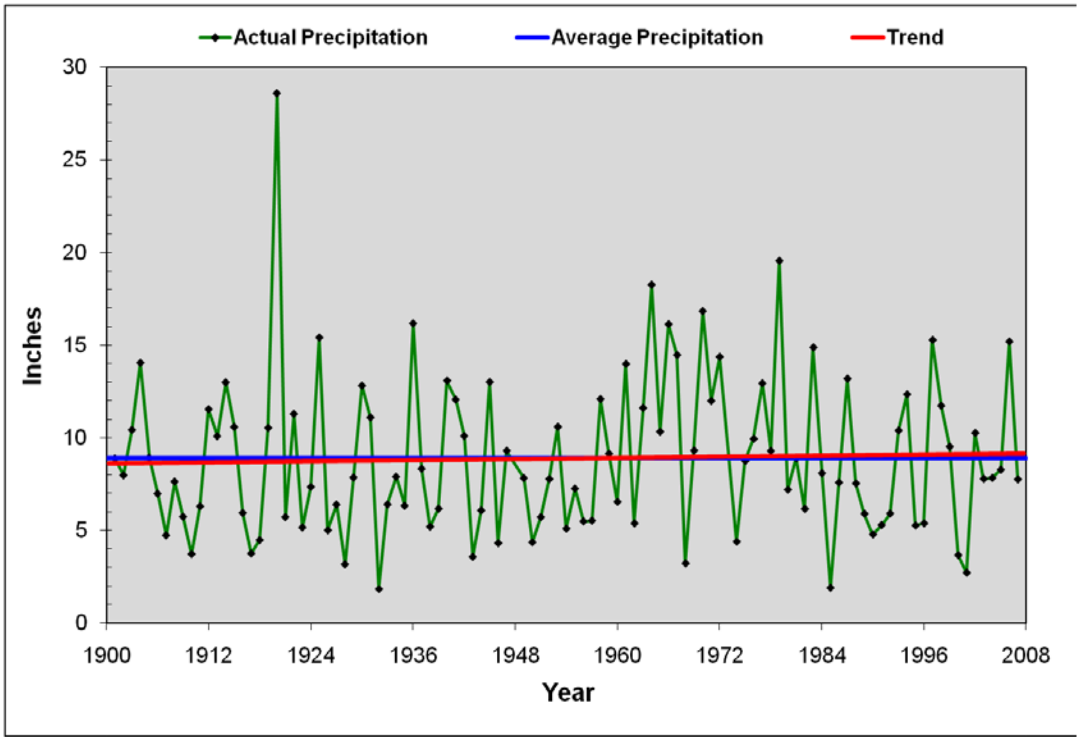

Figure 30. The winter precipitation for St. Augustine, FL from 1901 to 2007. The mean precipitation is 8.89 inches with an increasing trend of 0.05 inches per decade. Data for 1948 and 1973 is incomplete and has been omitted from this figure.

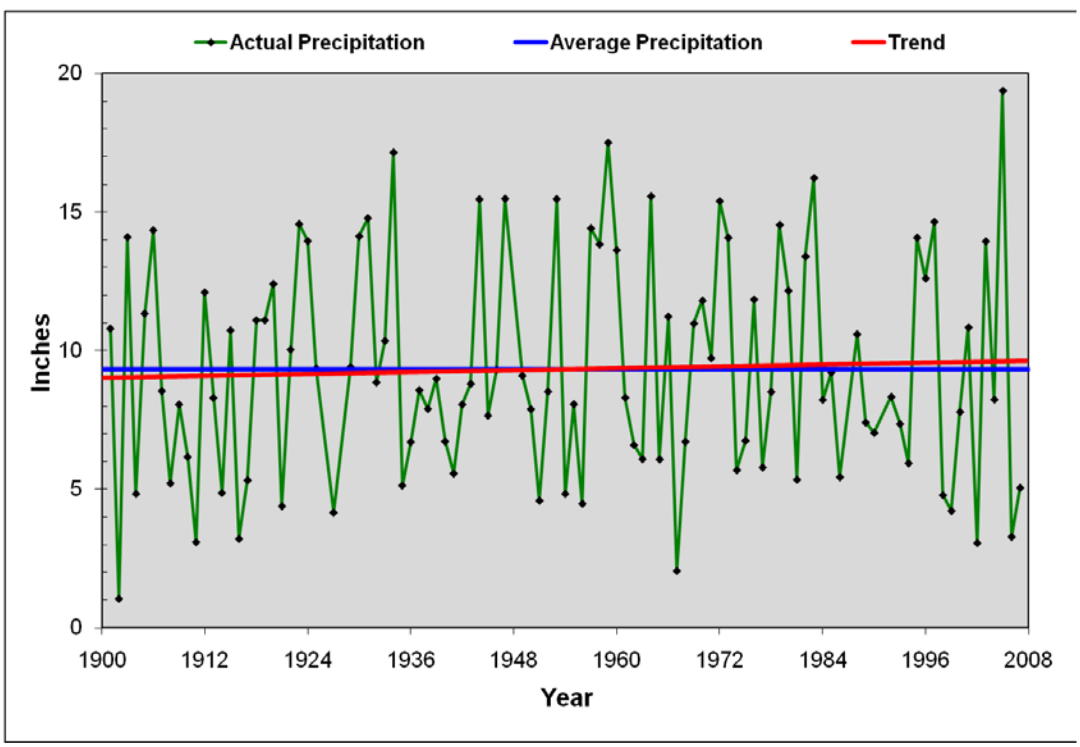

Figure 31. The spring precipitation for St. Augustine, FL from 1901 to 2007. The mean precipitation is 9.33 inches with an increasing trend of 0.06 inches per decade. Data for 1926, 1928, 1948, 1987 and 1991 is incomplete and has been omitted from this figure.

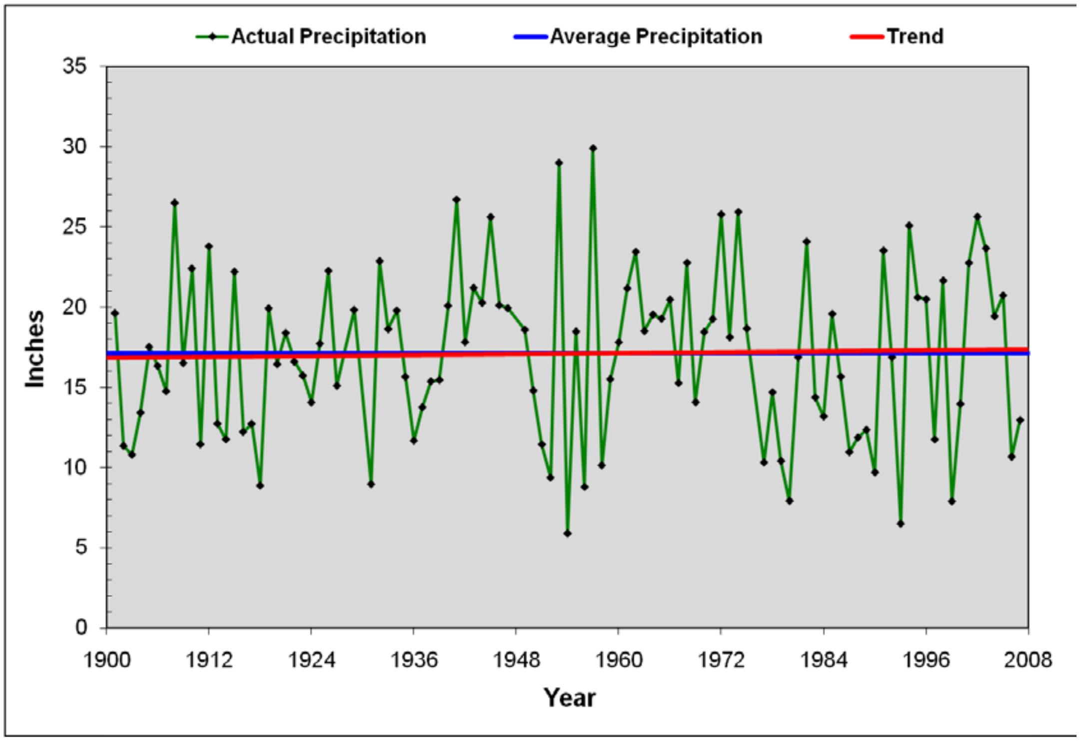

Figure 32. The summer precipitation for St. Augustine, FL from 1901 to 2007. The mean precipitation is 17.09 inches with an increasing trend of 0.05 inches per decade. Data for 1928, 1930, 1948 and 1976 is incomplete and has been omitted from this figure.

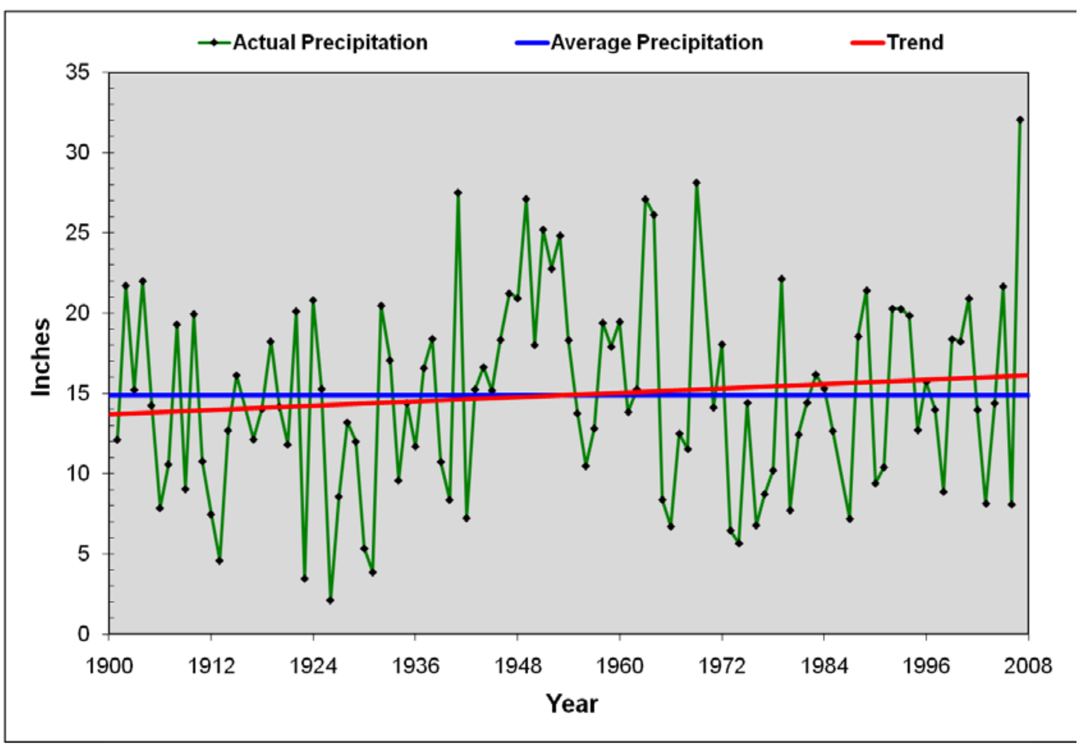

Figure 33. The fall precipitation for St. Augustine, FL from 1901 to 2007. The mean precipitation is 14.89 inches with an increasing trend of 0.23 inches per decade. Data for 1916, 1970 and 1986 is incomplete and has been omitted from this figure.

Overall, St. Augustine is receiving an increasing amount of precipitation. While this trend is relatively slight, St. Augustine is experiencing the highest increase in precipitation during the fall season. This is interesting given the observed increase in temperatures for the same seasonal period. Taken together, it is reasonable to assume that increasing temperatures and increasing precipitation will moderate one another and result in stable water availability. This may also prevent severe drought conditions or excessive moisture that could impact biotic resources, particularly during extremes.

Moisture:
We also summarized information on drought severity using monthly data from NOAA for coastal Florida from 1896-2007 (Figure 34). 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 1900 to 2007 then determined the proportion of months in each class for each 9-year period for ease of comparison (Figure 34).

Table 30. Classification used for Palmer Drought Severity Index (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

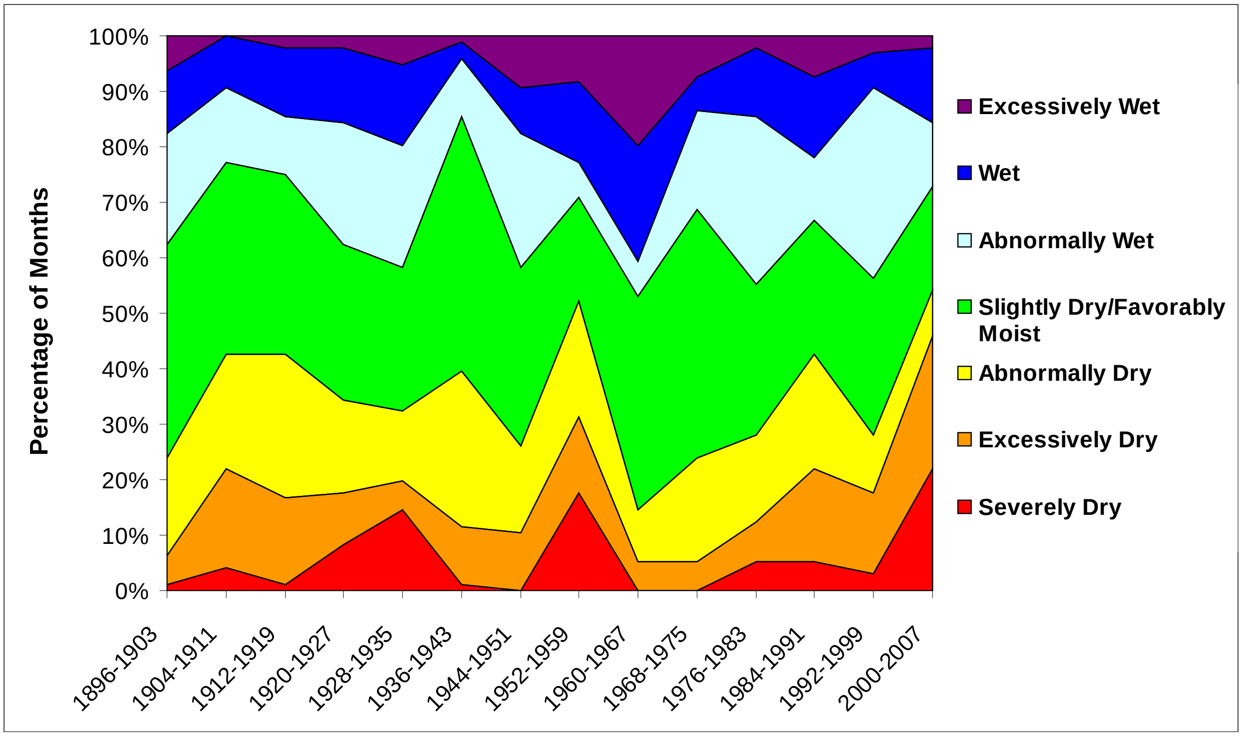

Figure 34. PDSI values for St. Augustine, FL in 8-year blocks from 1896 – 2007.

The data indicate a clear increase in the proportion of months classified as "excessively dry" or "severely dry" since 1975. The red 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 increasing precipitation may provide a stabilized environment able to tolerate periodic instances of saturation or drought conditions.

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 Castillo de San Marcos and Fort Matanzas NMs by using monthly mean temperature data for nearby weather collection stations in St. Augustine, Florida. Monthly temperature was available from 1901-2007 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 degrees days for each month were summed to determine the approximate number of growing degree days per year. In an attempt to compensate for gaps in the temperature data, the growing degree days were computed for the first three months of the year rather than for the entire year. These values were plotted against time (year) to illustrate the long-term trends in the numbers of growing degree days at Castillo de San Marcos and Fort Matanzas NMs (Figure 35).

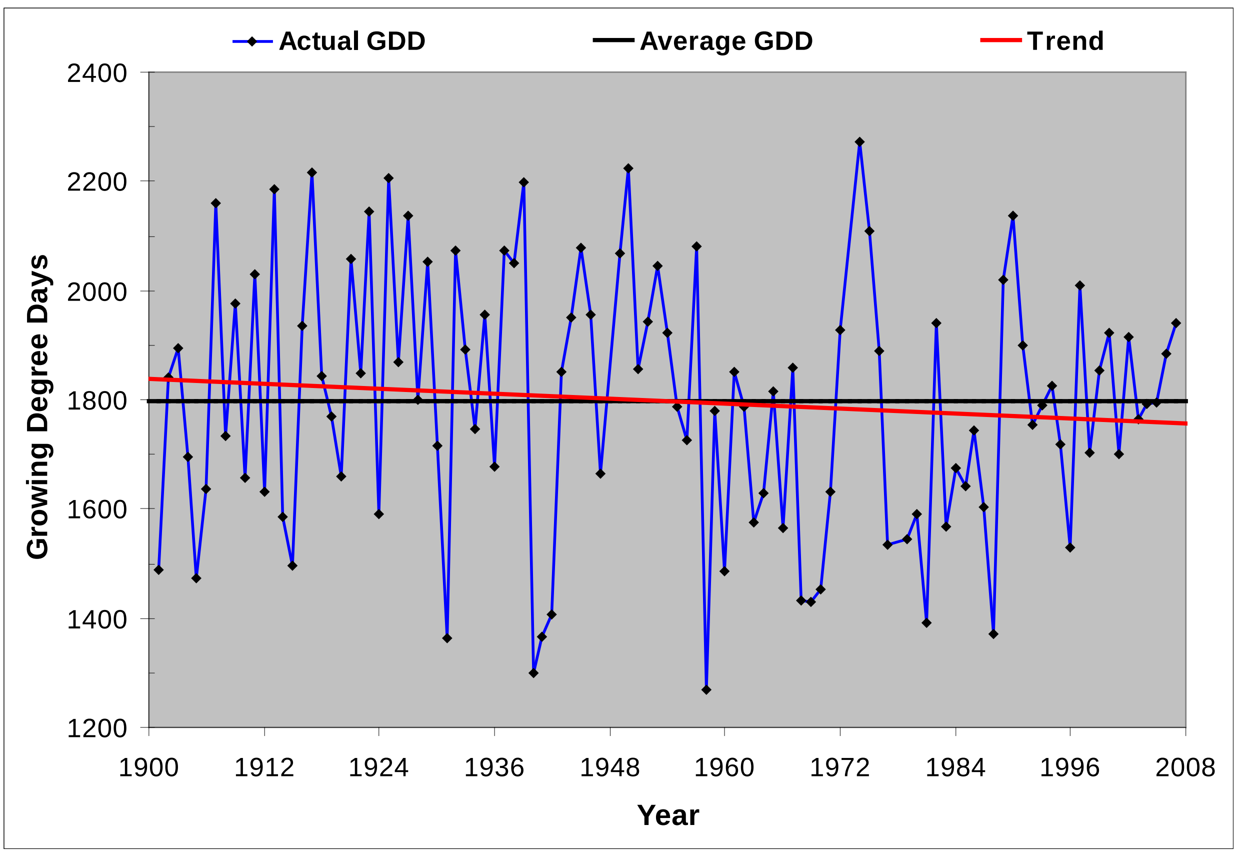

Figure 35. The total growing degree days from January – March for St. Augustine, FL from 1901 – 2007. The three month mean growing degree total is 1797.11 (black line). The red trend line indicates a decreasing trend (R^2=0.01). Data for 1948, 1973, and 1978 is incomplete and has been excluded from this figure.

Over the long-term span of available data, we observed a decrease in the number of growing degree days during the first three months of the year. While this may indicate a decrease in the growing season through time, Figure 35 also illustrates that conditions are variable and cyclical. To better understand 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 36).

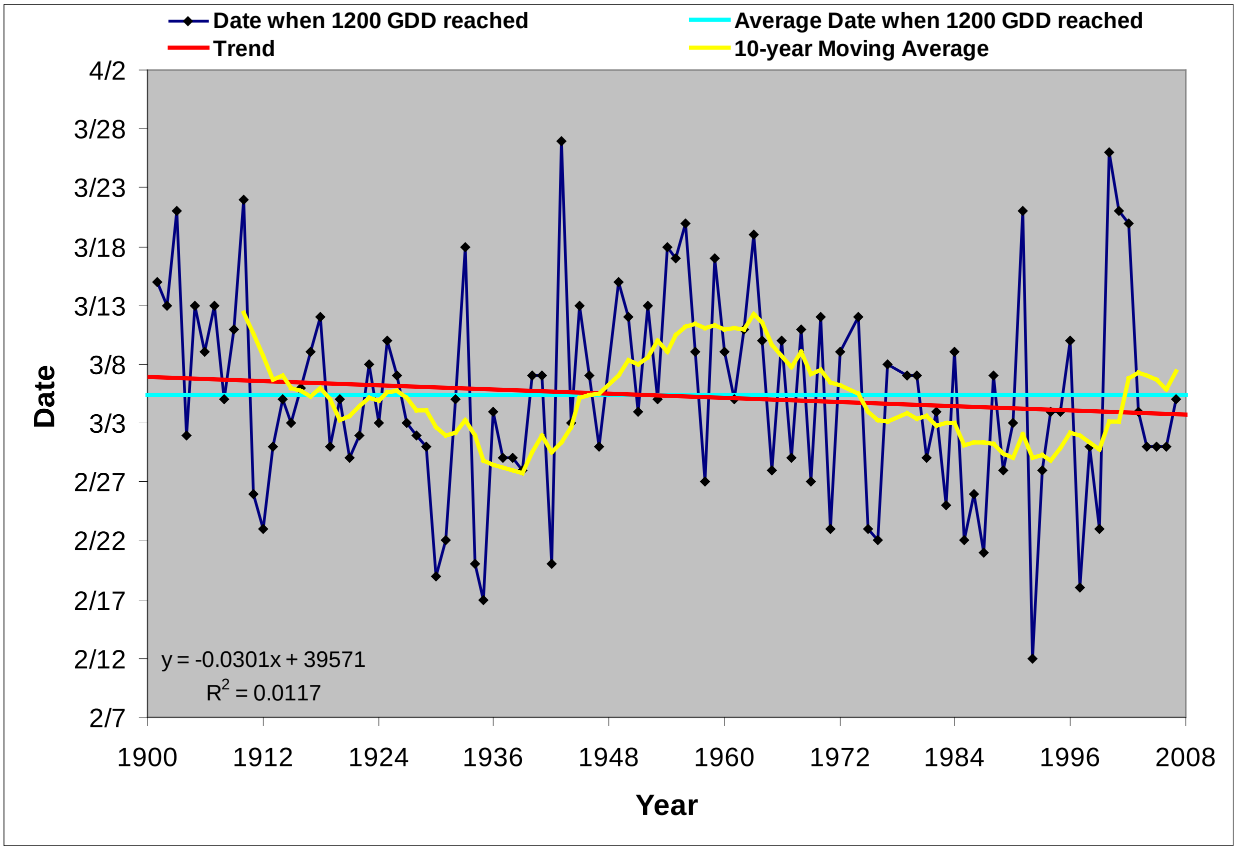

Figure 36. The approximate date in St. Augustine, FL when 1200 GDD has been reached for each year (1901 – 2007). The average date is March 5. The decreasing trend (-0.30 days per decade) indicates that this date is arriving earlier each year. Data for 1948, 1973, and 1978 is incomplete and has been excluded from this figure.

This illustrates that the phenology of Castillo de San Marcos and Fort Matanzas NMs 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 = 0.012). 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 from 1851 to 2007, which was loaded into a GIS. We then selected all storms that occurred within 100 nautical miles (nm) of the Castillo de San Marcos and Fort Matanzas NM boundaries to assess those storms which were most likely to have an impact on the ecosystems and processes associated with the park.

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 Castillo de San Marcos and Fort Matanzas

NMs 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 Castillo de San Marcos or Fort Matanzas NMs.

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).

		Typical Characteristics of Hurricanes by Category			
Scale Number (Category)	*Wind Speed (mph)*	*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 Castillo de San Marcos and Fort Matanzas NMs. We observed the data in terms of monthly occurrence as well as yearly occurrence. Figure 37 through Figure 39 illustrate various combinations of storm activity during the annual monthly cycles, while Figure 40 through Figure 42 illustrate various combinations of storm activity broken down decennially to adequately facilitate illustration and interpretation.

The majority of all storm activity within 100nm of Castillo de San Marcos and Fort Matanzas NMs occurs later in the year, between the months of August and October, with September experiencing the most (Figure 37). 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 Castillo de San Marcos and Fort Matanzas NMs than do major storms (Figure 38).

Dissecting the data further, we were able to illustrate the frequency of each storm category and the potential impacts on Castillo de San Marcos and Fort Matanzas NMs. 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 39).

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 Castillo de San Marcos and Fort Matanzas NMs. When all storm categories are combined, the data show that storm activity is on a relative decline (Figure 40). The graphic also illustrates that although the trend is declining, storm activity peaks an average of every twenty years since the 1940 –

1949 decennial block. Based on these data alone, storm activity should peak in the 2000 – 2009 decennial block and continue the historic downward trend in the following decade.

When the annual data is split into major and minor storms, it is evident that Castillo de San Marcos and Fort Matanzas NMs are threatened more by minor storms than major storms (Figure 41). The graph illustrates that while minor storm activity generally appears to be decreasing, the monuments have experienced a peak every twenty years since the 1940 – 1949 decennial block. According to the trends, minor storms should peak in the 2000 – 2009 decennial block and continue to decline in the following decade. The data also suggests that Castillo de San Marcos and Fort Matanzas NM may expect a major storm event in the coming years. The trends for major storm indicate that activity peaks every thirty to forty years, with the last peak occurring in the 1960 – 1969 decennial block.

Splitting the annual data into its primary components permits the observation of each storm category and its trends since 1851 (Figure 42). Castillo de San Marcos and Fort Matanzas NMs have historically been affected most by Tropical Storms, followed by a secondary influence from Cat 1 hurricanes. The data also illustrates that the monuments are experiencing an increasing trend in Tropical Depressions and Cat 4 hurricanes, while experiencing fewer storms in other categories.

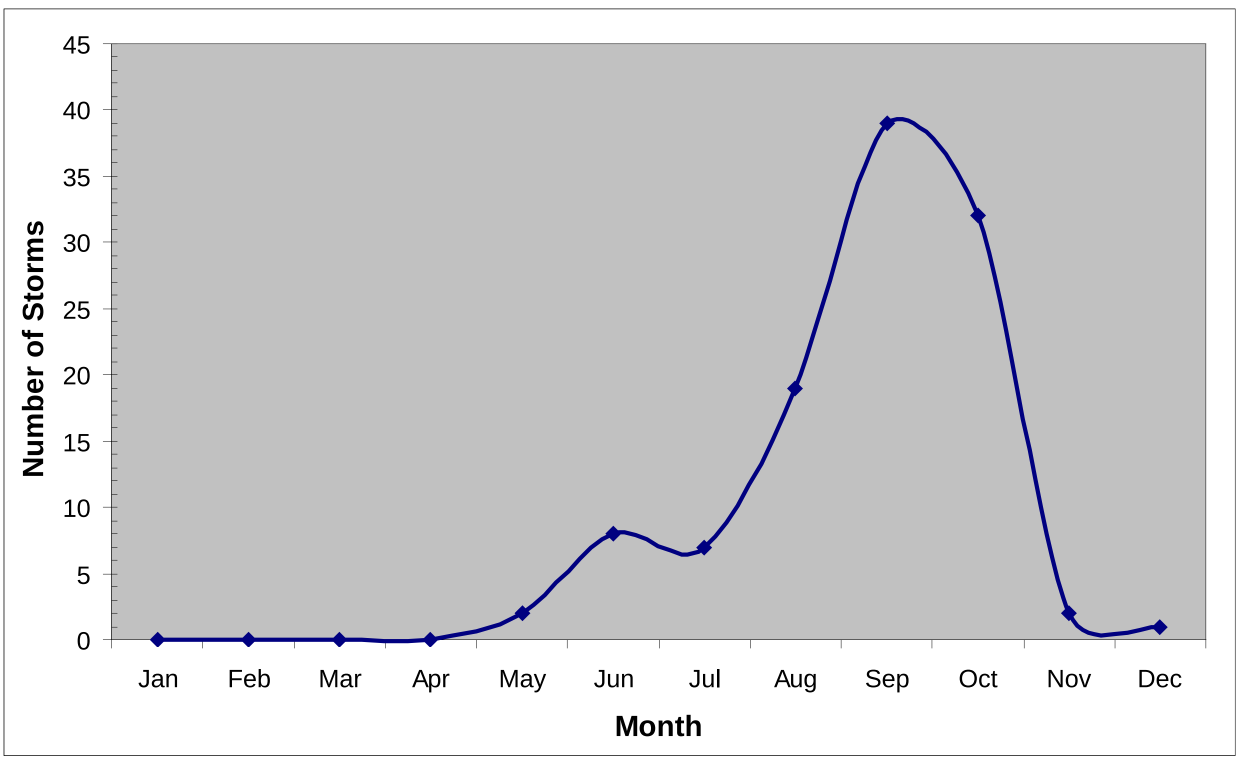

Figure 37. Total number of all storms per month (1851 – 2007) occurring within 100 nautical miles of Castillo de San Marcos and Fort Matanzas National Monuments.

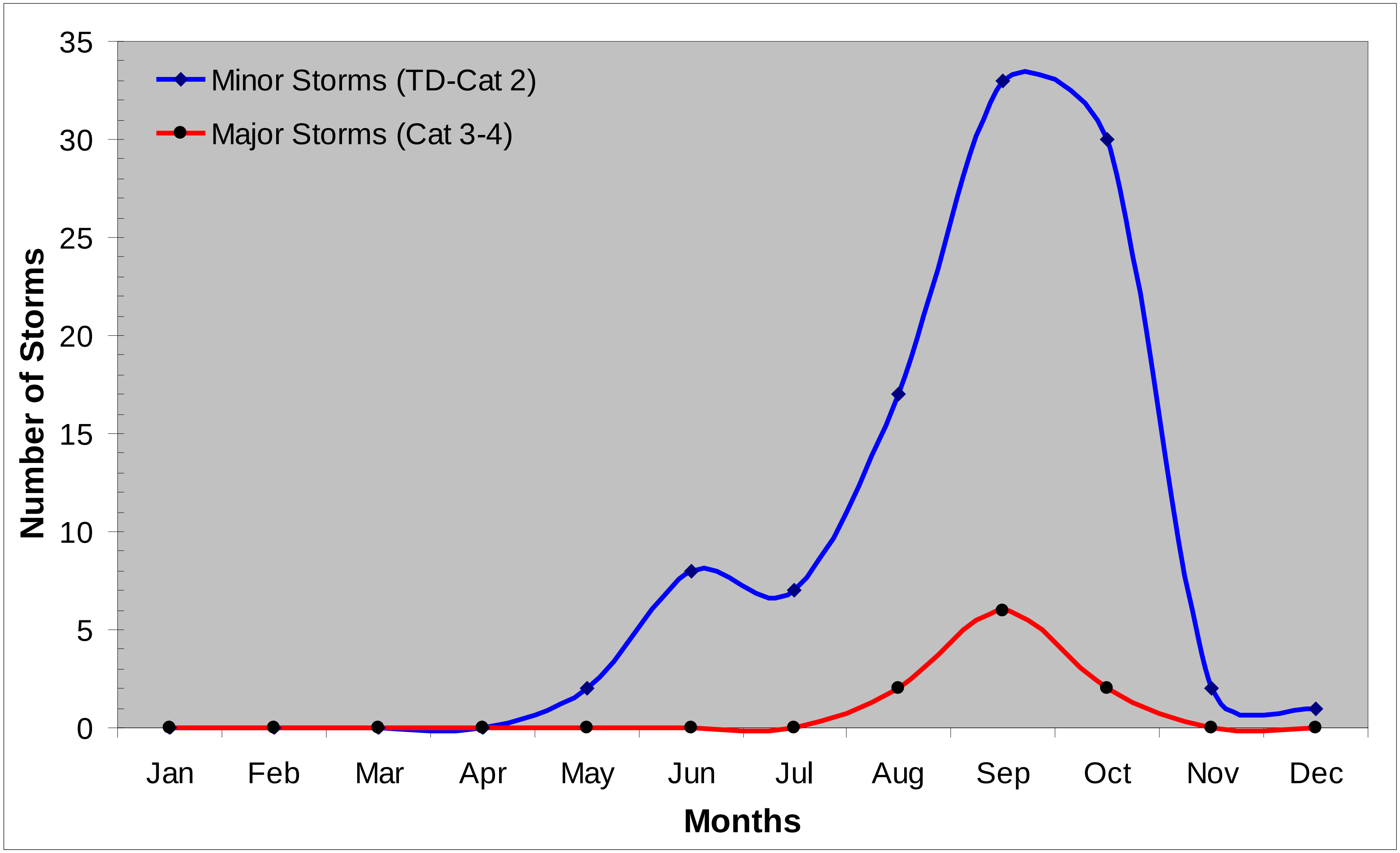

Figure 38. Total number of major and minor storms per month (1851 – 2007) occurring within 100 nautical miles of Castillo de San Marcos and Fort Matanzas National Monuments.

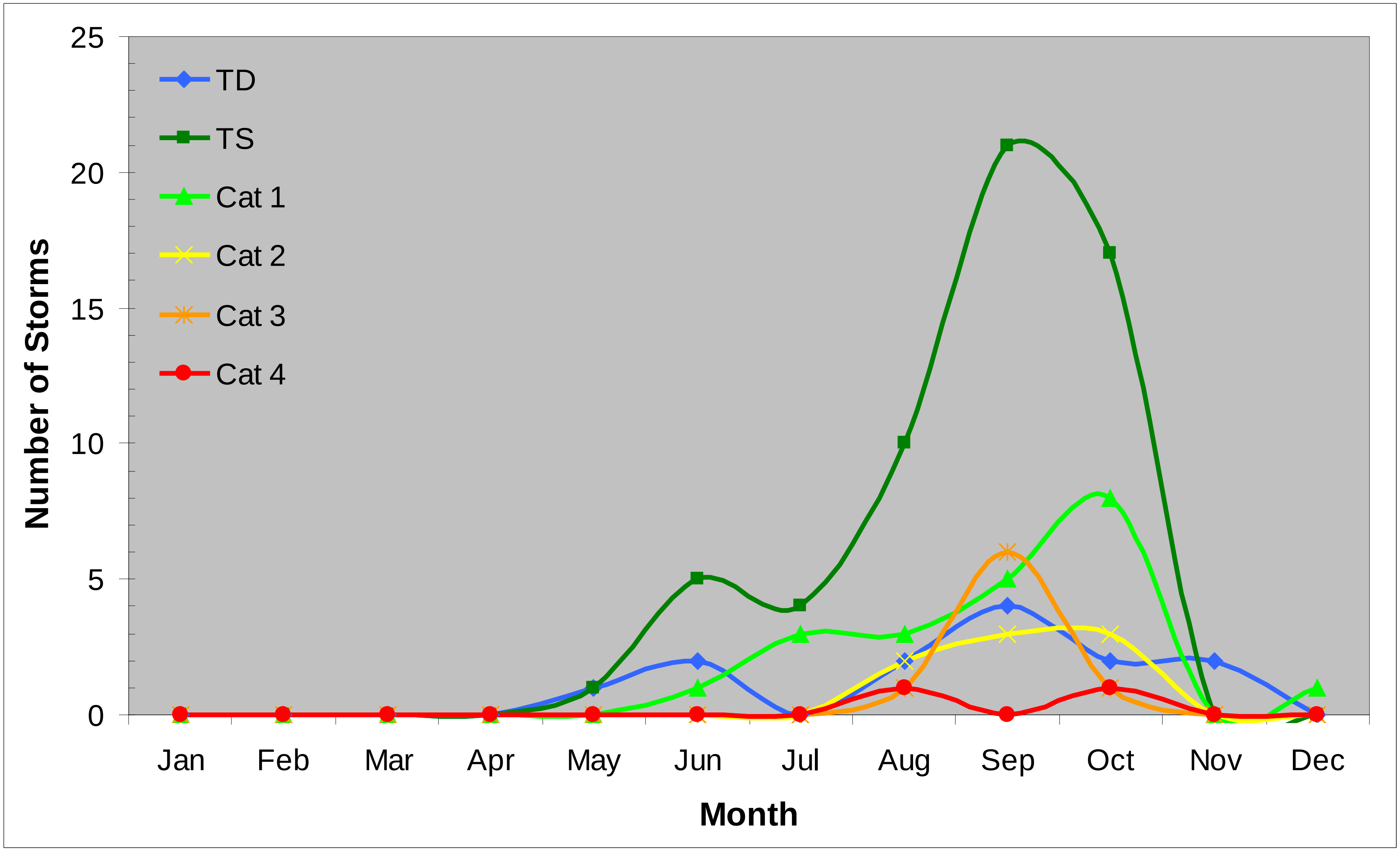

Figure 39. Total number of storms by category per month (1851 – 2007) occurring within 100 nautical miles of Castillo de San Marcos and Fort Matanzas National Monuments. Tropical depressions (TD) have 38 mph sustained wind speeds or less, tropical storms (TS) have 39 to 73 mph wind speeds, and the remaining hurricane categories (1 – 4) are from Saffir/Simpson Hurricane Scale (Table 31).

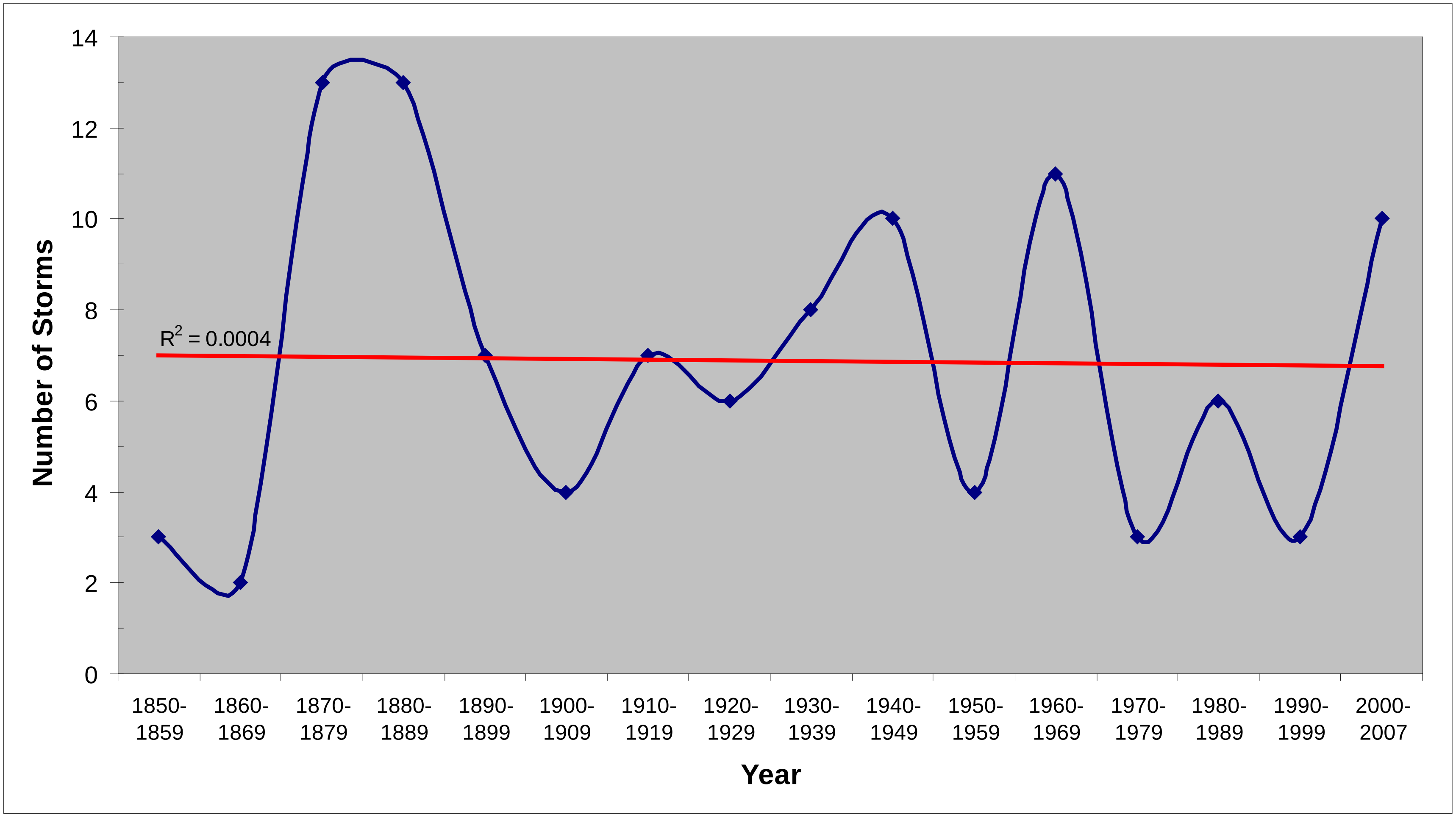

Figure 40. Total number of all storms per decade (1851 – 2007) occurring within 100 nautical miles of Castillo de San Marcos and Fort Matanzas National Monuments.

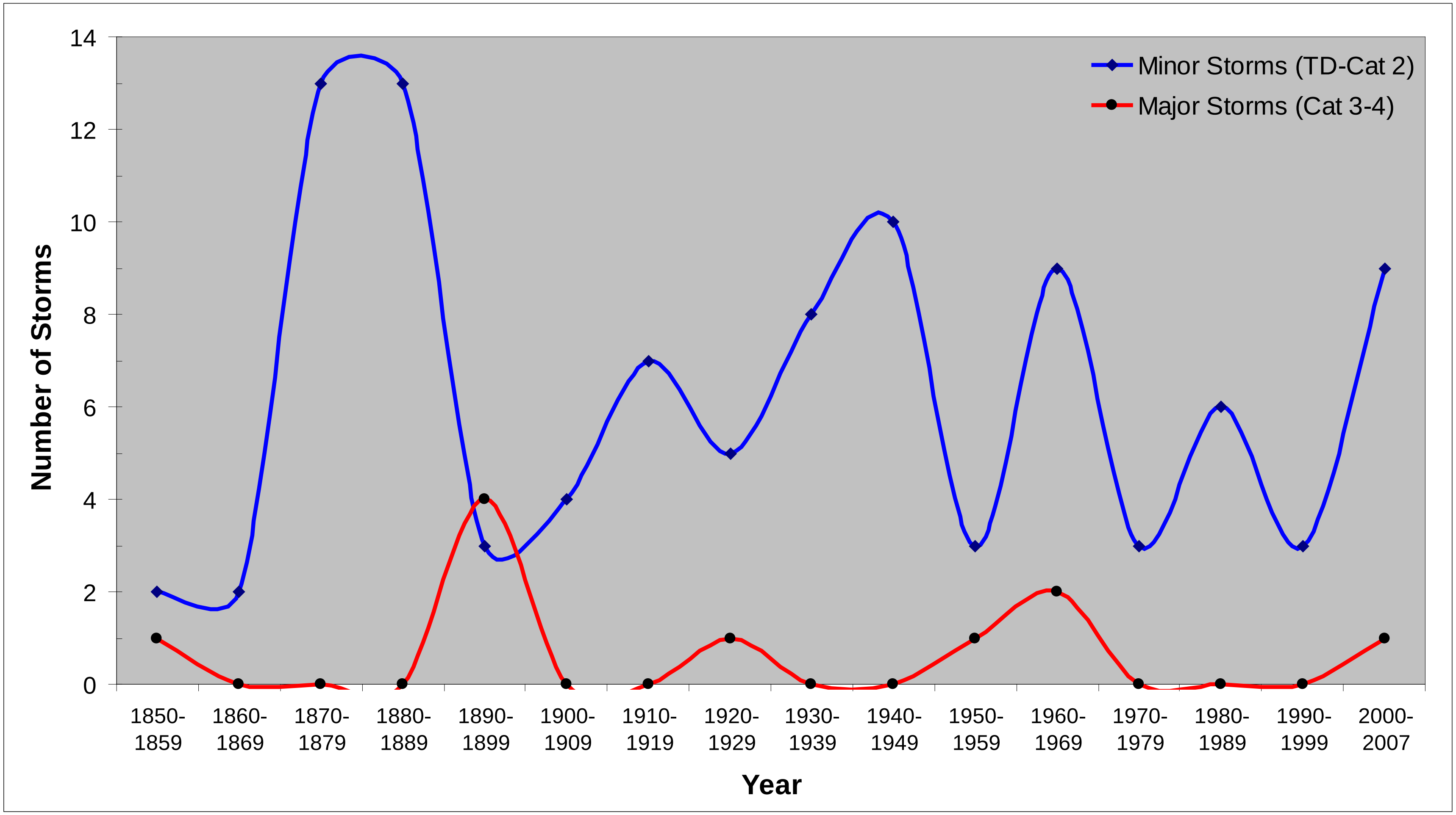

Figure 41. Total number of major and minor storms per decade (1851 – 2007) occurring within 100 nautical miles of Castillo de San Marcos and Fort Matanzas National Monuments.

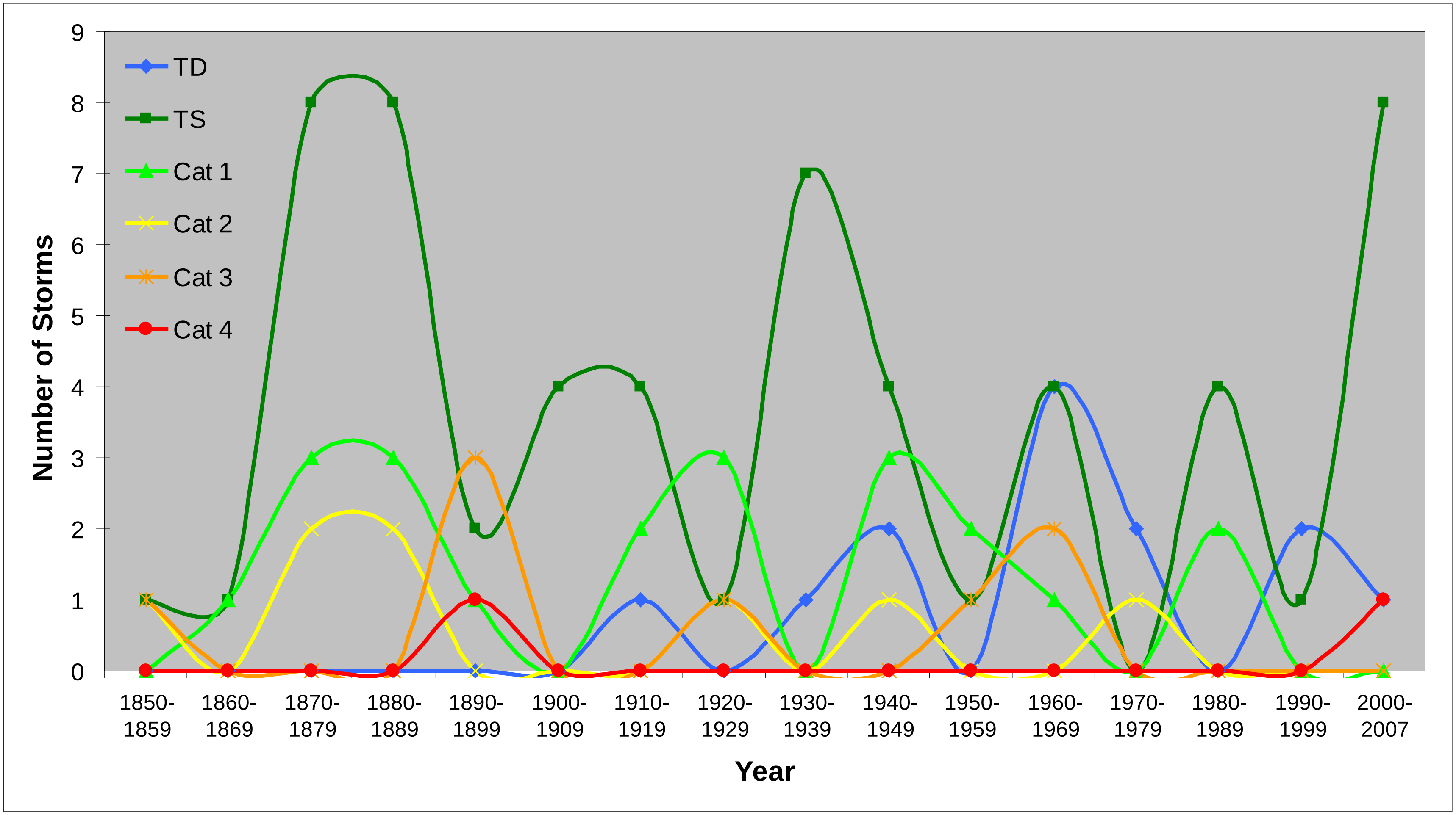

Figure 42. Total number of storms by category per decade (1851 – 2007) occurring within 100 nautical miles of Castillo de San Marcos and Fort Matanzas National Monuments. Tropical depressions (TD) have 38 mph sustained wind speeds or less, tropical storms (TS) have 39 to 73 mph wind speeds, and the remaining 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 marsh at Fort Matanzas NM.

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 Castillo de San Marcos and Fort Matanzas NMs, 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 St. Augustine, Florida and Castillo de San Marcos NM is within the city. It is also unlikely that the climate at Fort Matanzas NM varies much from this data, but without basic climate variable information taken on-site, this remains an 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 St. Augustine.

It would be advisable for the park 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 park 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 Castillo de San Marcos and Fort Matanzas NMs because temperatures are fairly constant and increasing at a relatively negligible rate (Table 32). The condition status was also good for precipitation due to an increasing trend (Table 32). The moisture condition status was fair because the increase in the proportion of months classified as "excessively dry" or "severely 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 good condition status because storm activity is on a relative decline and the majority of the storms that do hit are relatively minor (Table 32).

Table 32. Climate condition status summary for Castillo de San Marcos and Fort Matanzas National Monuments. 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
	Good	0.84		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
	Good	0.84		3 out of 3	
Climate total			5	1	5
	Good	0.70		11 out of 15	

3.3.2.e Recommendations to park managers:
Simple measures to monitor the climate changes at Castillo de San Marcos and Fort Matanzas NMs 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 Castillo de San Marcos and Fort Matanzas NM are wide and varied. The unique interaction of coastal water processes in conjunction with the Matanzas River estuary and arrangement of wetlands make for a complicated array of hydrologic function. We examined these 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 monuments. Castillo de San Marcos NM is concerned with erosion pertaining to its seawall stabilization (Parsons 2007). Fort Matanzas NM is also concerned about shoreline stabilization along the Intracoastal Waterway and has recently finished some parts of a project to slow erosion (National Park Service 2006a).

3.4.1.a Current condition:
There are 0.80 acres of wetlands at Castillo de San Marcos NM and 170 acres of wetlands at Fort Matanzas NM 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 Florida, 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:
All of Castillo de San Marcos and Fort Matanzas NM wetlands are highly rated for surface water detention (Table 33, Figure 43). 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 Castillo de San Marcos and Fort Matanzas National Monuments.

NWI Correlation	*CASA Acres*	*% of CASA Wetlands*	*FOMA Acres*	*% of FOMA Wetlands*
High	0.80	100.00	170.0	100.00
	0.80	100.00	170.0	100.00

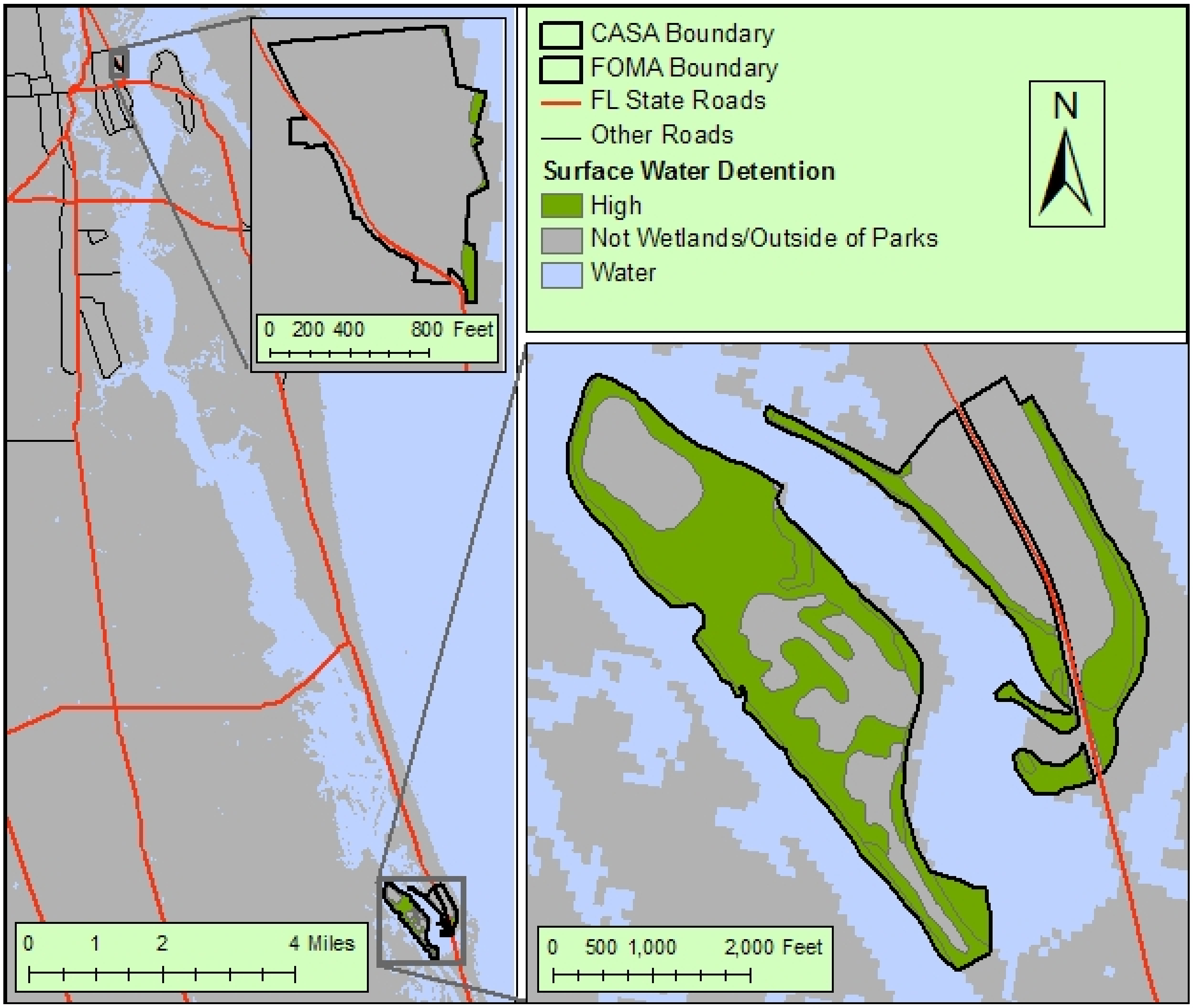

Figure 43. Surface water detention correlation to National Wetland Inventory classification within Castillo de San Marcos and Fort Matanzas National Monuments.

Coastal Storm Surge Detention:
Table 34 and Figure 44 illustrate that only 4% of Castillo de San Marcos NM wetlands are capable of offering high levels of coastal storm surge detention, while 93% of Fort Matanzas NM wetlands offer 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 Castillo de San Marcos and Fort Matanzas National Monuments.

NWI Correlation	*CASA Acres*	*% of CASA Wetlands*	*FOMA Acres*	*% of FOMA Wetlands*
High	0.03	4.08	158.4	93.19
Not Correlated/Poor	0.76	95.92	11.6	6.81
	0.80	100.00	170.0	100.00

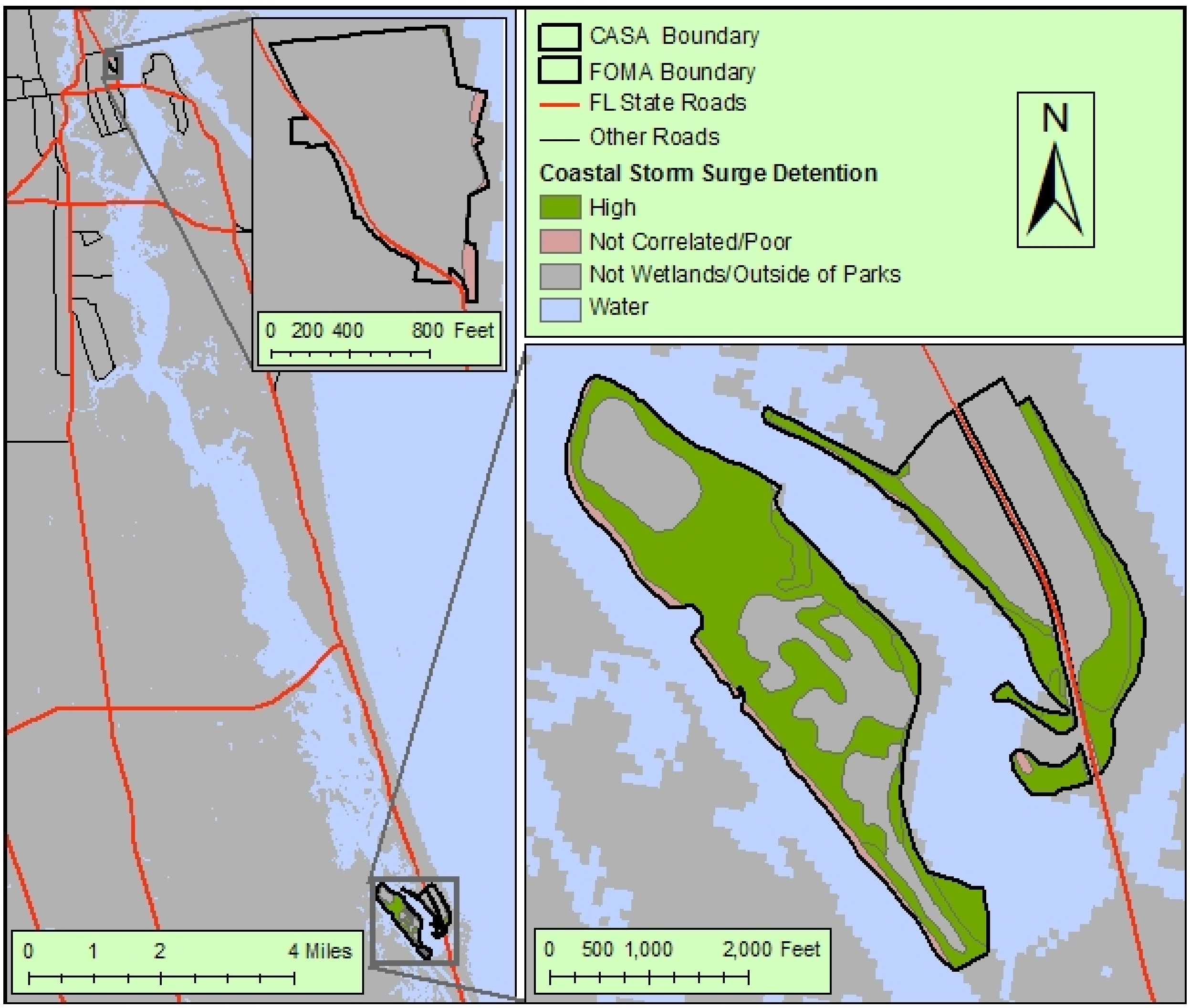

Figure 44. Coastal storm surge detention correlation to National Wetland Inventory classification within Castillo de San Marcos and Fort Matanzas National Monuments.

Streamflow Maintenance:
The location of Castillo de San Marcos and Fort Matanzas NMs, on the coast, precludes them from offering much in the way of streamflow maintenance (Table 35, Figure 45). Headwater wetlands, far upstream from the monuments, operate to increase streamflow (Tiner 2003a).

Table 35. Streamflow maintenance correlation to National Wetland Inventory classification within Castillo de San Marcos and Fort Matanzas National Monuments.

NWI Correlation	*CASA Acres*	*% of CASA Wetlands*	*FOMA Acres*	*% of FOMA Wetlands*
Not Correlated /Poor	0.80	100.00	170.0	100.00
	0.80	100.00	170.0	100.00

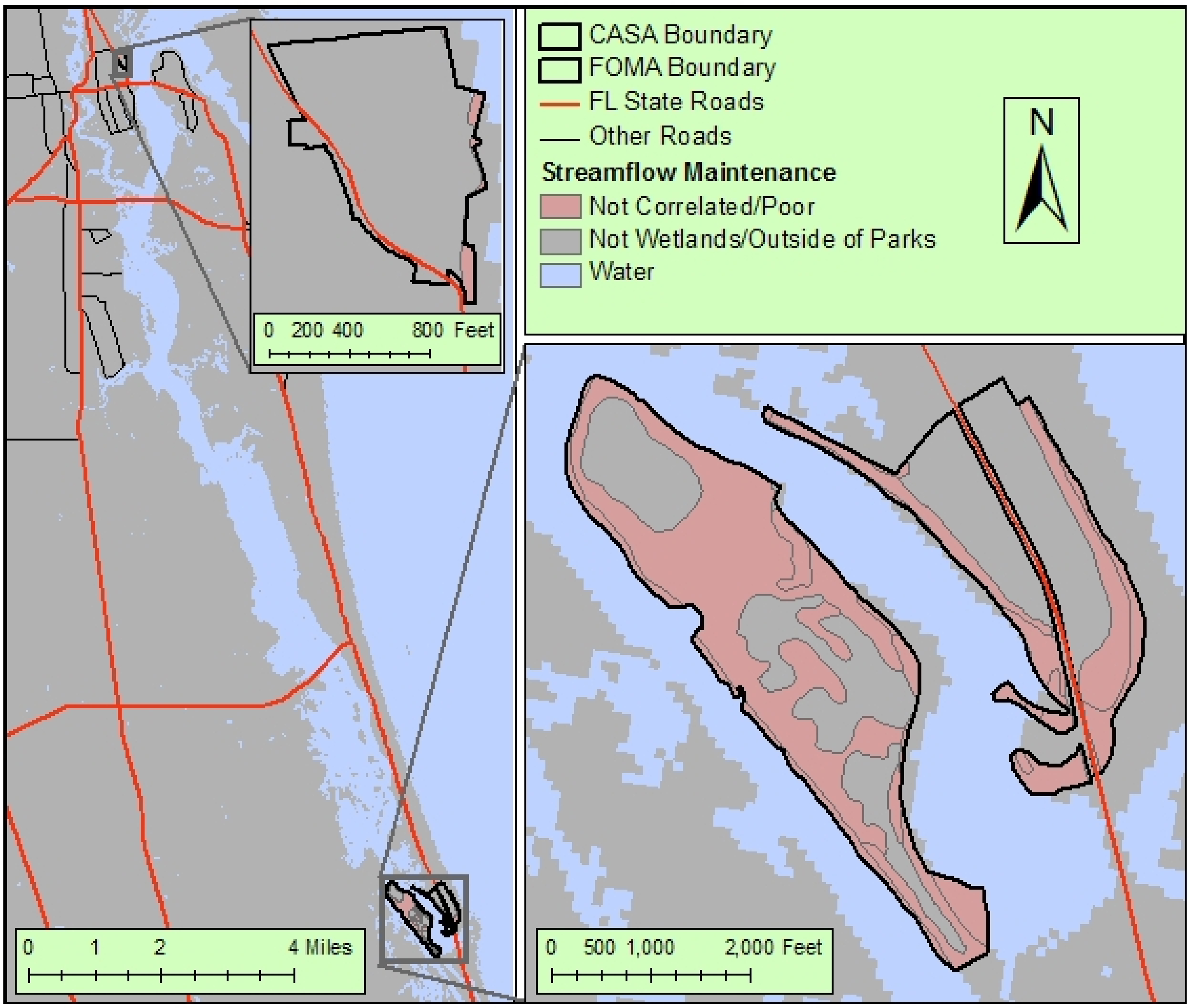

Figure 45. Streamflow maintenance correlation to National Wetland Inventory classification within Castillo de San Marcos and Fort Matanzas National Monuments.

Nutrient Transformation:

Nutrient transformation occurs most readily in permanently flooded wetlands whereas temporarily flooded wetlands have only moderate potential (Tiner 2003a). Four percent of the wetlands at Castillo de San Marcos NM and 22% of wetlands at Fort Matanzas NM are highly correlated to this function (Table 36, Figure 46). 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 Castillo de San Marcos and Fort Matanzas National Monuments.

NWI Correlation	*CASA Acres*	*% of CASA Wetlands*	*FOMA Acres*	*% of FOMA Wetlands*
High	0.03	4.08	36.7	21.59
Not Correlated /Poor	0.76	95.92	133.3	78.41
	0.80	100.00	170.0	100.00

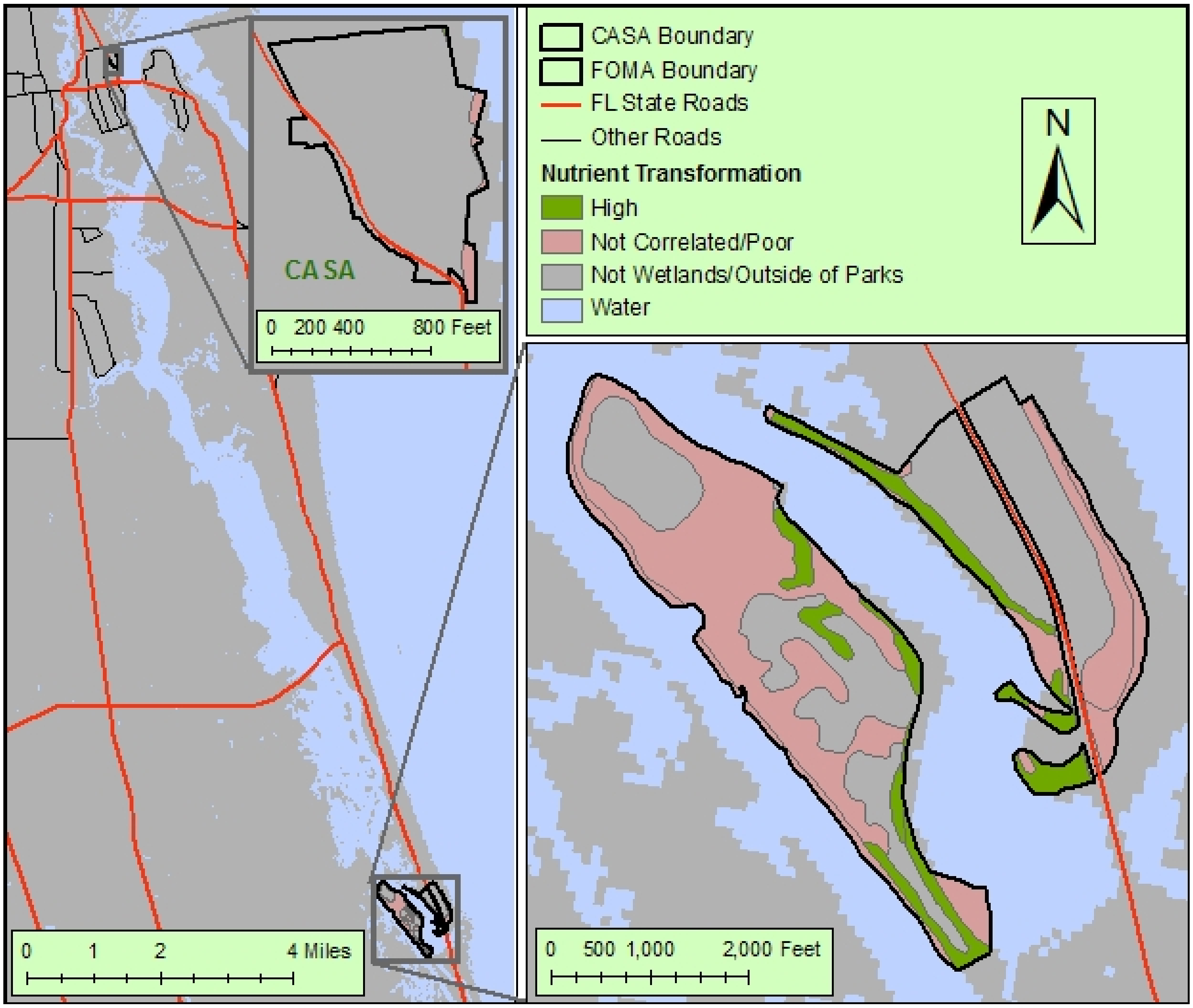

Figure 46. Nutrient transformation correlation to National Wetland Inventory classification within Castillo de San Marcos and Fort Matanzas National Monuments.

Sediment and Other Particulate Retention:

There is a low correlation of wetlands at Castillo de San Marcos NM (4%) and a significantly higher correlation of wetlands at Fort Matanzas NM (79%) with the retention of sediments and other particulates (Table 37, Figure 47). Water quality is supported through this wetland function (Tiner 2003a). Maintenance of healthy native vegetation is an important way to ensure that sediment and particulate retention is maximized.

Table 37. Sediment and other particulate retention correlation to National Wetland Inventory classification within Castillo de San Marcos and Fort Matanzas National Monuments.

NWI Correlation	*CASA Acres*	*% of CASA Wetlands*	*FOMA Acres*	*% of FOMA Wetlands*
High	0.03	4.08	134.3	78.97
Moderate	0.00	0.00	24.2	14.22
Not Correlated /Poor	0.76	95.92	11.6	6.81
	0.80	100.00	170.0	100.00

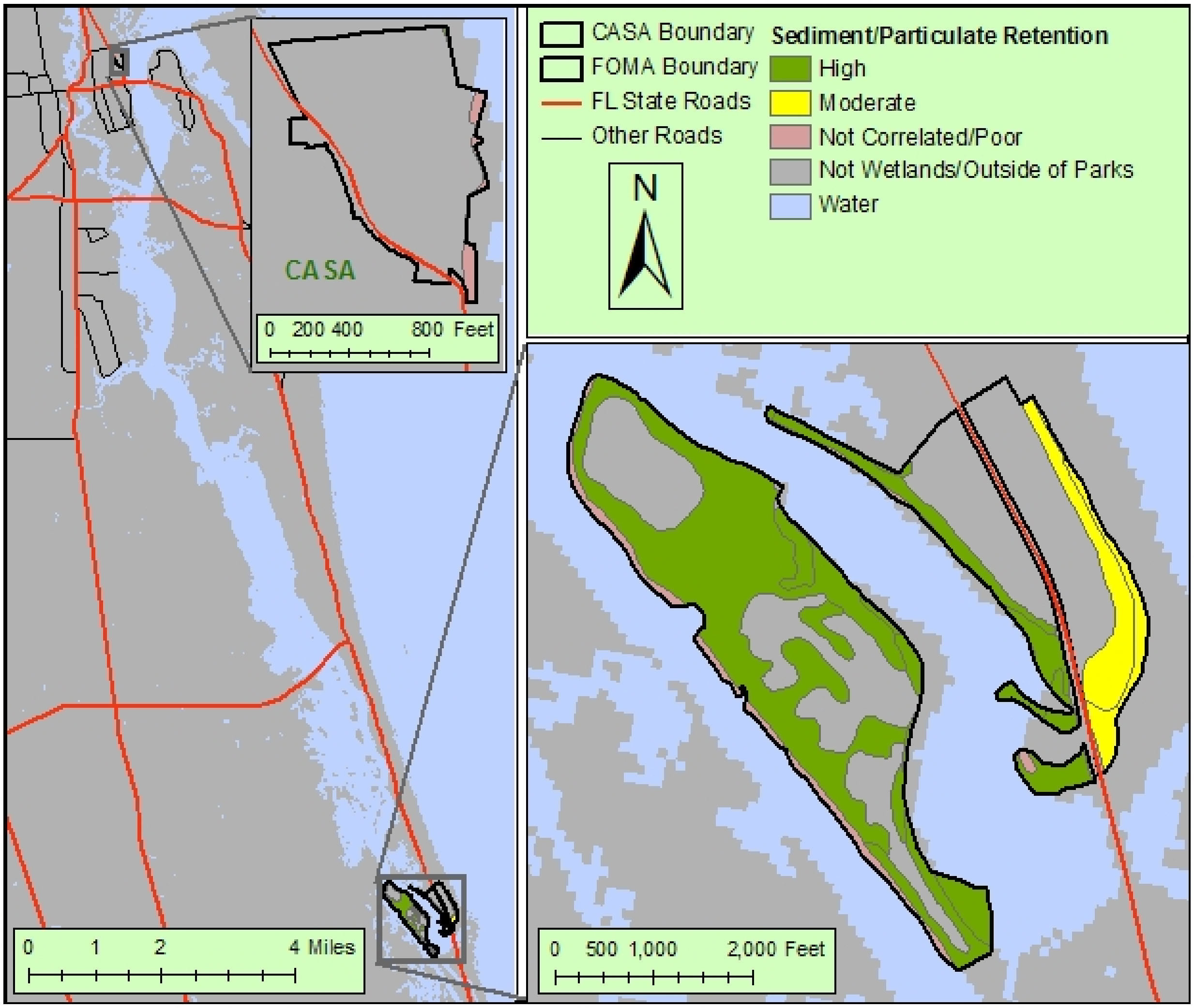

Figure 47. Sediment and other particulate retention correlation to National Wetland Inventory classification within Castillo de San Marcos and Fort Matanzas National Monuments.

Shoreline Stabilization:
Shoreline stabilization is an important function for Castillo de San Marcos and Fort Matanzas NMs. Both monuments are undergoing projects to assure shoreline stabilization (National Park Service 2006a, Parsons 2007).

Castillo de San Marcos NM has ongoing issues with erosion due to the failing seawall. An environmental assessment was performed in 2007 with a comment period in fall 2007. They plan to rehabilitate the seawall. This is an important project to protect the landscape and historic structures of the monument (Parsons 2007).

Fort Matanzas NM recently finished the boat dock replacement on the Rattlesnake Island portion of the proposed shoreline stabilization and boat dock replacement (National Park Service 2006a, 2008a). Stabilization of rubble mound groins, dikes, concrete capped bulkhead, and seawall are also proposed to prevent erosion along Rattlesnake and Anastasia Islands (National Park Service 2006a). The erosion has been shown to be caused by waves, currents, and human dredging and filling. The primary cause, however, is boat wakes in the Intracoastal Waterway (Price 2006).

In agreement with current plans, NWI correlations (Tiner 2003a) show a low level of shoreline stabilization functionality within all of the wetlands of Castillo de San Marcos NM. Shoreline stabilization functionality at Fort Matanzas NM, however, is relatively high as a whole (Table 38, Figure 48). Fort Matanzas NM does show some level of shoreline stabilization issues along the immediate shoreline. Although hard to distinguish in the map (Figure 48), there is a buffer of not correlated/poor along the Matanzas River (Intracoastal Waterway) between the two islands.

Table 38. Shoreline stabilization correlation to National Wetland Inventory classification within Castillo de San Marcos and Fort Matanzas National Monuments.

NWI Correlation	*CASA Acres*	*% of CASA Wetlands*	*FOMA Acres*	*% of FOMA Wetlands*
High	0.03	4.08	134.3	78.97
Not Correlated /Poor	0.76	95.92	35.8	21.03
	0.80	100.00	170.0	100.00

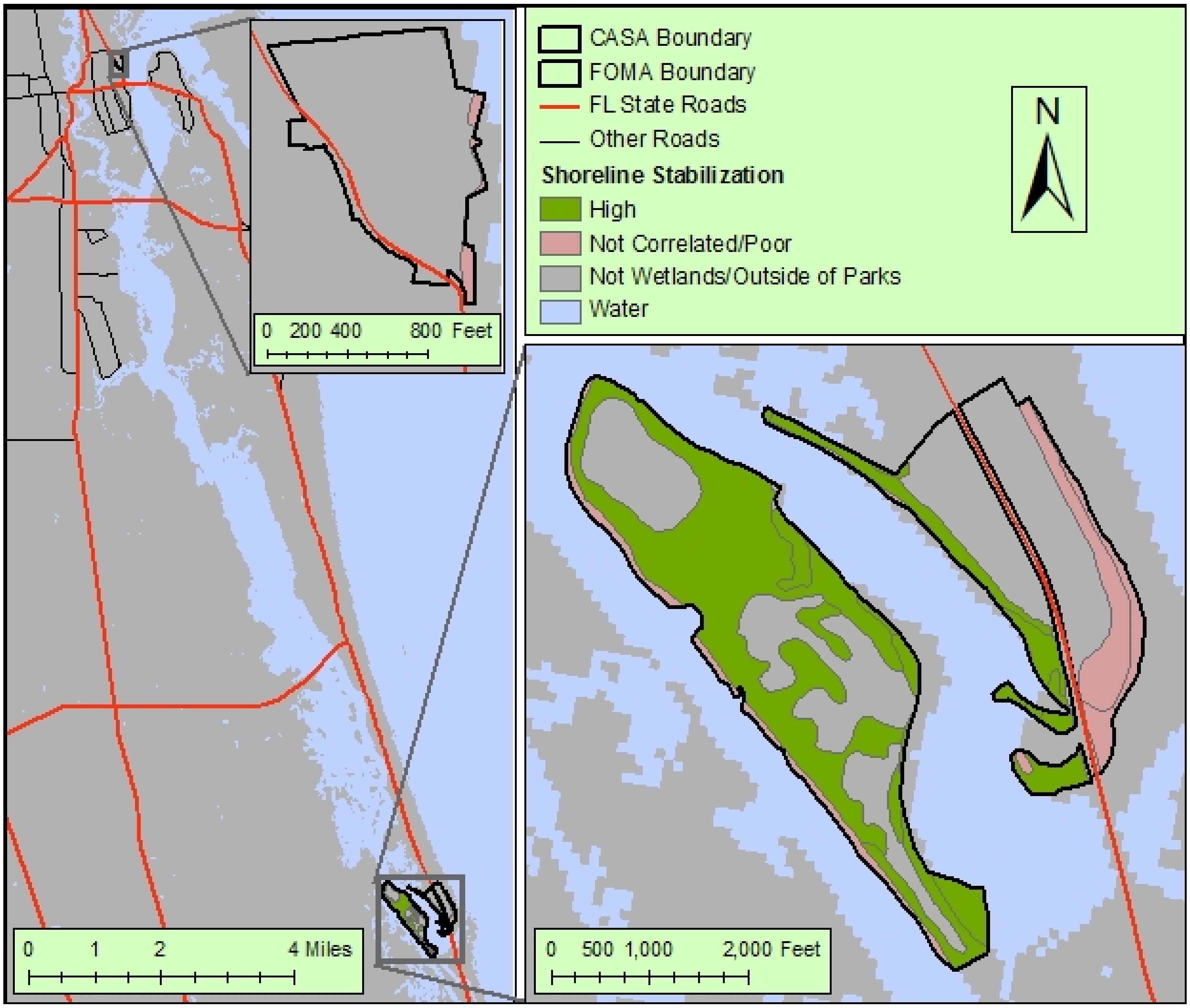

Figure 48. Shoreline stabilization correlation to National Wetland Inventory classification within Castillo de San Marcos and Fort Matanzas National Monuments.

3.4.1.b Resource threats and stressors:
Sea level rise and flooding are a real concern at Castillo de San Marcos and Fort Matanzas NMs. 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 Castillo de San Marcos NM (Figure 49) and Fort Matanzas NM (Figure 50). In a 2-foot surge, the area of water associated with Castillo de San Marcos NM increased from 4 to 6 acres, or 22% to 28% of Castillo de San Marcos NM total area. The area of water at Fort Matanzas NM in a 2-foot surge increased from 26 to 59 acres, or 9% to 20% of Fort Matanzas NM total area. In a 4-foot surge, the area of water at Castillo de San Marcos NM increased to 9 acres, leaving approximately 42% of Castillo de San Marcos NM under water. The area of water at Fort

Matanzas NM in a 4-foot surge increased to 124 acres, leaving approximately 41% of Fort Matanzas NM under water. The Federal Emergency Management Agency (2008) also shows Castillo de San Marcos and Fort Matanzas NMs under a hazardous flood area (Figure 51).

Another important threat and stressor mentioned under shoreline stabilization is the threat of increased erosion from boat wakes. The Matanzas River (Intracoastal Waterway) separating Rattlesnake and Anastasia Islands is a popular recreational boat area. This is another case of recreation and visitation to parks possibly leading to the two parts of the NPS mission working against each other (3.2.2 Visitor and Recreation Use).

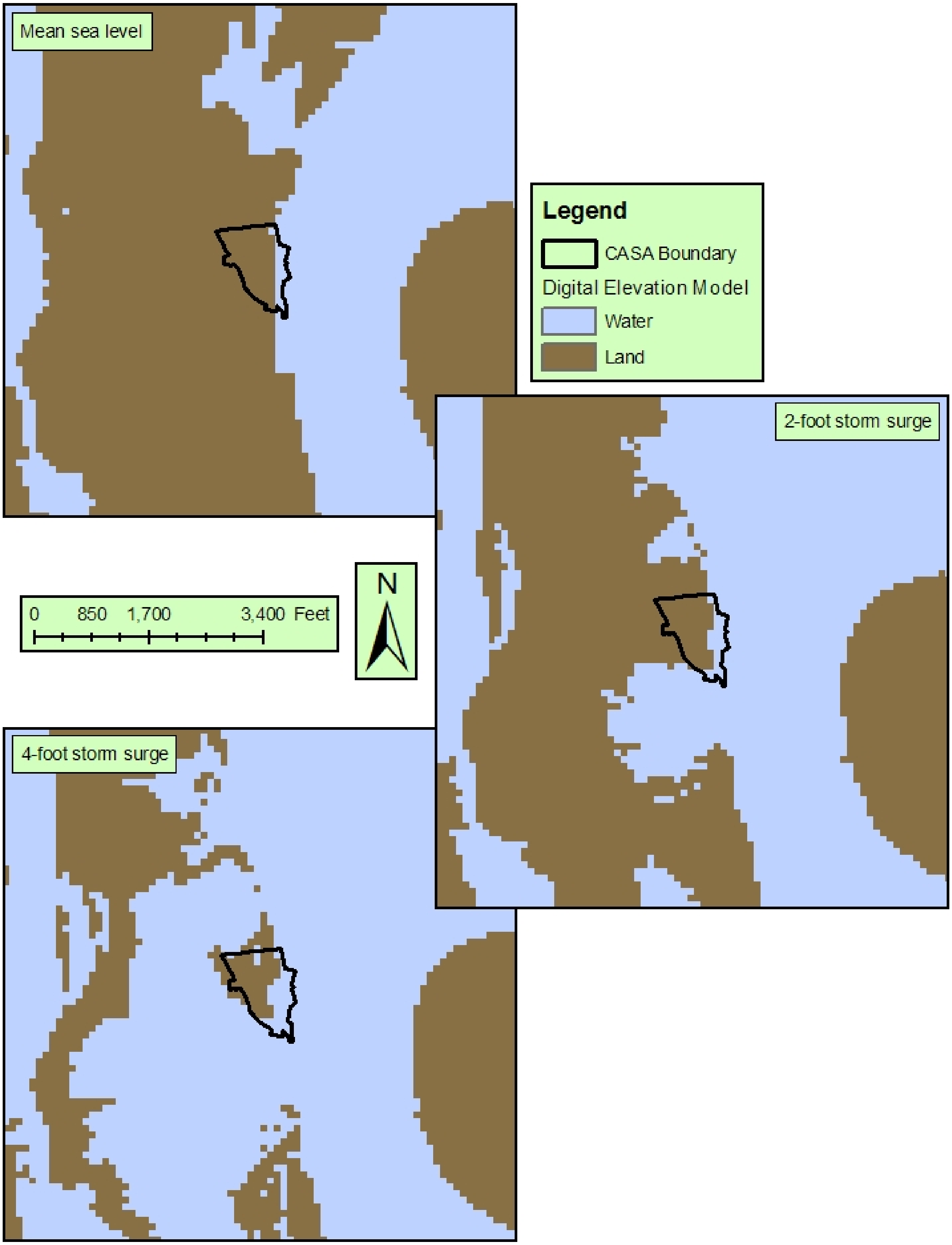

Figure 49. Digital elevation model (DEM) of the Castillo de San Marcos National Monument region showing mean sea level, and approximate two foot, and four foot storm surge.

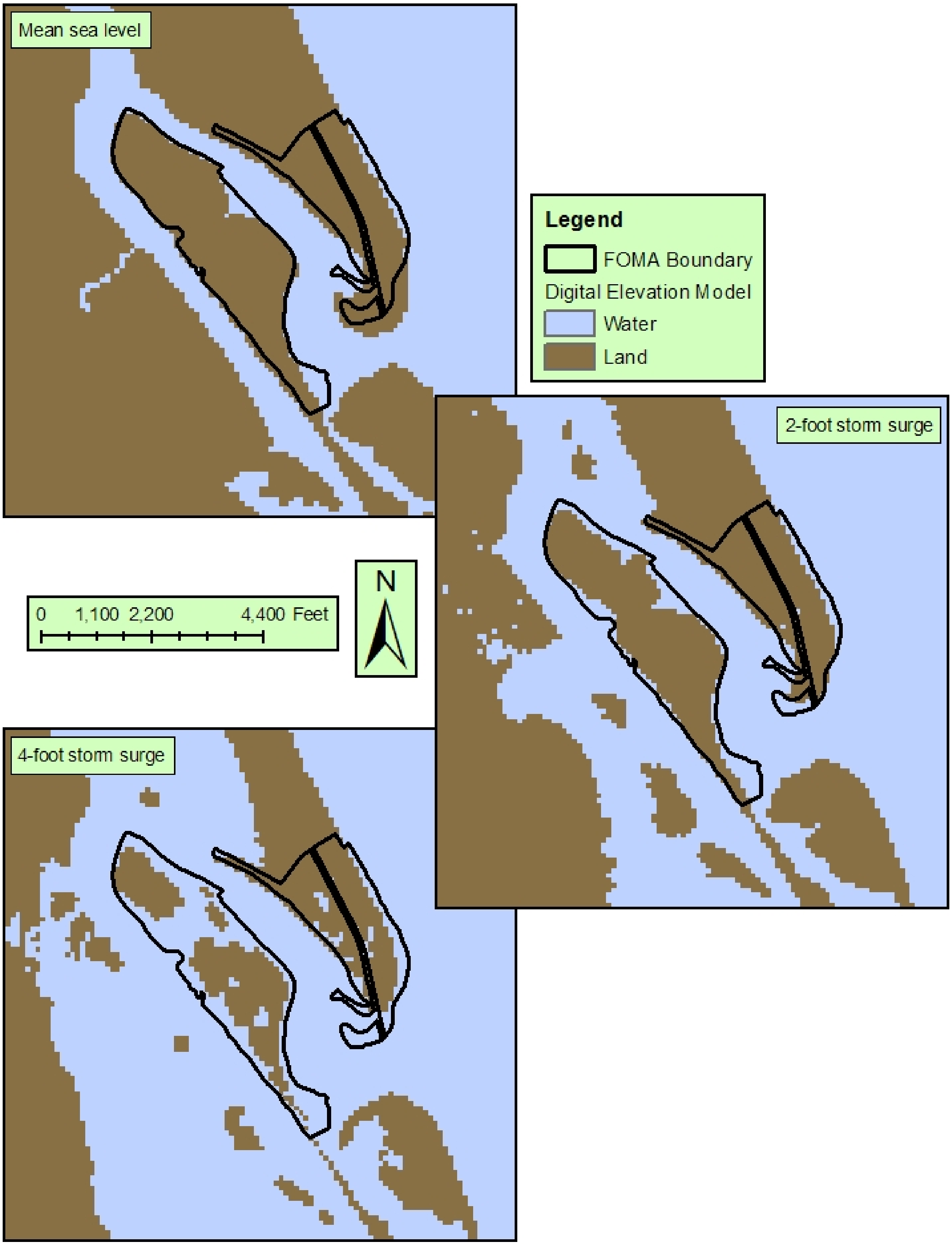

Figure 50. Digital elevation model (DEM) of the Fort Matanzas National Monument region showing mean sea level, and approximate two foot, and four foot storm surge.

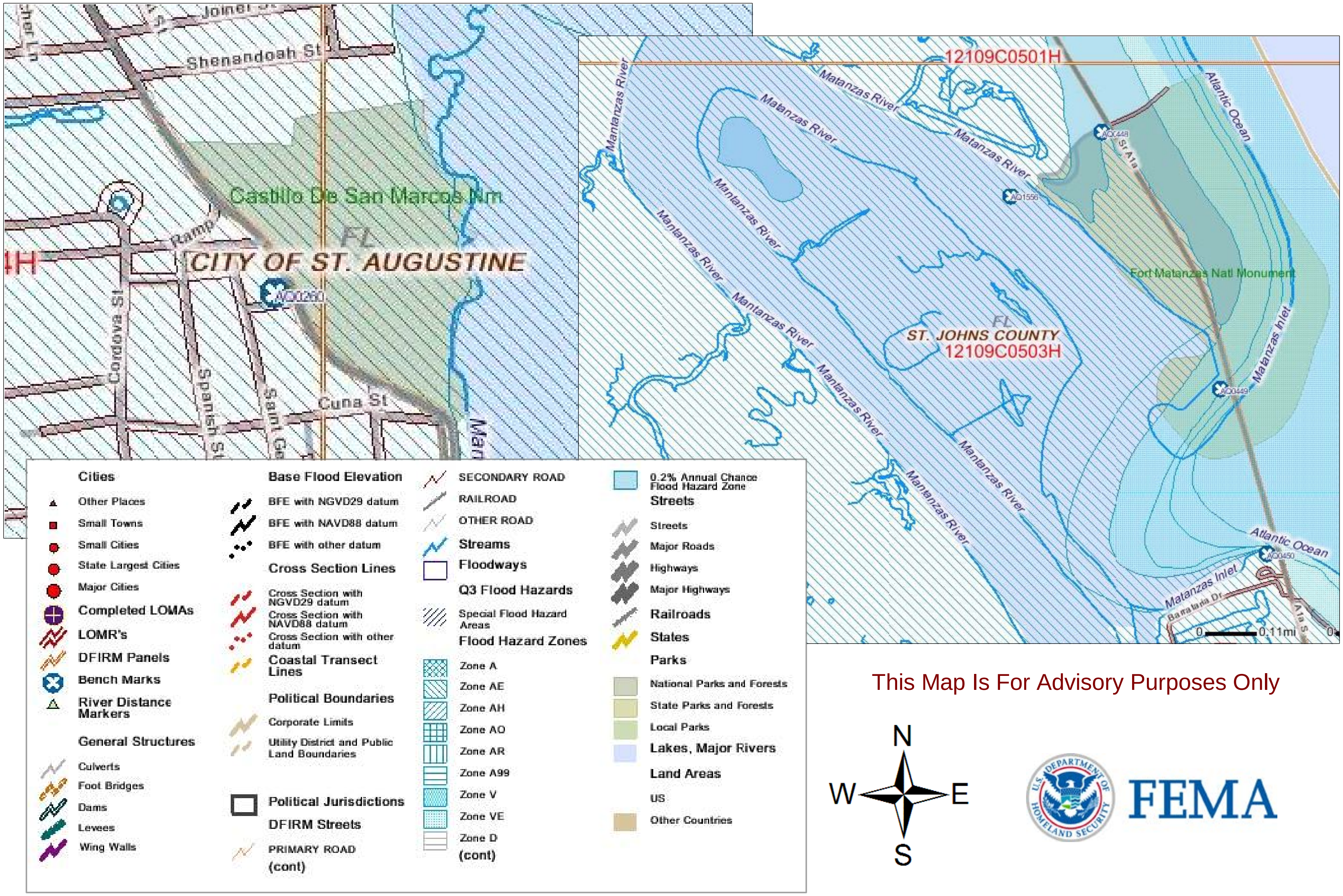

Figure 51. Federal Emergency Management Agency (FEMA, 2008) flood maps for the Castillo de San Marcos and Fort Matanzas National Monument region, showing all areas are under 100-year flood hazard in which base flood elevations have been determined (Zone AE).

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 Castillo de San Marcos and Fort Matanzas NMs, 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 Castillo de San Marcos NM (Table 39). 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. Surface water detention, coastal storm surge detention, and sediment and other particulate retention are all in the good range because the majority of Fort Matanzas NM wetlands were highly rated for these assessment categories (Table 40). Seventy-eight percent of Fort Matanzas NM wetlands are not correlated with nutrient transformation, thus giving this category a poor condition status (Table 40). The majority of Fort Matanzas NM wetlands are highly rated for shoreline stabilization. However, in agreement with recent projects and reports (National Park Service 2006a, Price 2006), the immediate shoreline, unconsolidated shore and bottom, shows no correlation to shoreline stabilization and is a concern. Consequently, shoreline stabilization is in the fair range for condition status (Table 40). In addition, the monuments' wetlands do not offer much in the way of streamflow maintenance because of their coastal location. Headwater wetlands, far upstream from the Castillo de San Marcos and Fort Matanzas NMs, operate to increase streamflow, so this category is not applicable (Table 39, Table 40).

Table 39. Hydrology condition status summary for Castillo de San Marcos National Monument. Data quality was rated based on *thematic* (1 = best source; 0 = not the best source), *spatial* (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 Fort Matanzas National Monument. Data quality was rated based on *thematic* (1 = best source; 0 = not the best source), *spatial* (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
	Good	0.84	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
	Good	0.84	2 out of 3		
Shoreline stabilization			0	1	1
	Fair	0.5	2 out of 3		
Hydrology total			0	6	6
	Fair	0.64	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. An additional proactive step would be to work with boat operators and other management entities to avoid continued shoreline erosion. Continuing to monitor and stabilize the shoreline is a positive management action that is already in process at both monuments.

3.4.2 Water Quality

Castillo de San Marcos and Fort Matanzas National Monuments lie within Florida's Daytona-St. Augustine subbasin, hydrologic unit code (HUC) 03080201 (Figure 52), that extends from southern Duval County south through Flagler and St. John's Counties to northern Volusia County. The Daytona-St. Augustine subbasin is also referred to as the Upper East Coast Watershed. This subbasin encompasses 692 square miles excluding estuarine areas (Florida Department of Environmental Protection 2009).

Surface waters cover about 36 percent of the basin area (158,939 acres) consisting of small rivers, streams, and marshes which form shallow bays and coastal lagoons all flowing east into the Atlantic Ocean (Florida Department of Environmental Protection 2009). The three inlets, St. Augustine, Matanzas, and Ponce de Leon connect the bays and coastal lagoons to the Atlantic, where they mix with tidal waters. The Atlantic Intracoastal Waterway (AICW) extends 15 miles north of the subbasin and runs south into the Tolomato River, which connects with the Guana River and flows into the Atlantic through the St. Augustine inlet. South of the St. Augustine inlet, the Matanzas River, a narrow bar-bounded estuary, flows into either the Atlantic via the Matanzas inlet or enters an extension of the AICW through an artificial canal into the Halifax River. The Halifax River continues south exiting the basin (Florida Department of Environmental Protection 2009) (Figure 52, Figure 53).

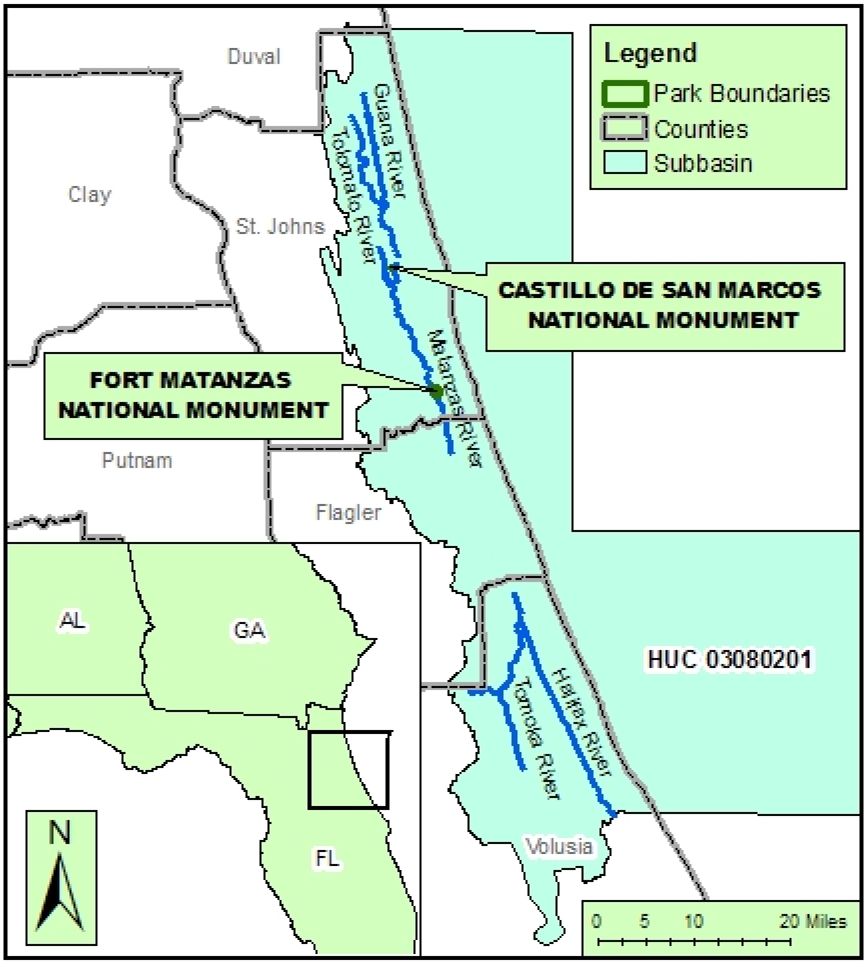

Figure 52. The Daytona-St. Augustine subbasin (HUC 03080201) that contains Castillo de San Marcos and Fort Matanzas National Monuments.

Castillo de San Marcos NM is located just south of the St. Augustine inlet on the Matanzas River. The Matanzas River is a part of the AICW and is actually a saltwater estuary about 20 miles in length and flows about eight miles past the Matanzas inlet. Fort Matanzas NM lies on the southern tip of Anastasia Island on the Matanzas inlet and the northern third of Rattlesnake Island. The two islands that compose Fort Matanzas NM are separated by the Matanzas River (AICW, Figure 53). The Matanzas River is home to extensive salt marshes, estuarine lagoons, oyster bars, mangrove tidal wetlands, and marine environments (National Park Service 2007b). These communities not only support a wide range of aquatic plants and animals, but are of great aesthetic importance.

Figure 53: Water resources and hydrologic unit at Castillo de San Marcos and Fort Matanzas National Monuments.

Florida's Water Quality Standards Program

Florida has designated five classes of water for the "present and future most beneficial uses" (Florida Department of Environmental Protection 2008). The classes are as follows:

Class I	Potable water supplies
Class II	Shellfish propagation or harvesting
Class III	Recreation, propagation, and maintenance of a healthy, well-balanced population of fish and wildlife
Class IV	Agricultural water supplies (large agricultural lands, located mainly around Lake Okeechobee)
Class V	Navigation, utility, and industrial use (there are no state waters currently in this class)

Water Quality Standards are assigned according to the classification of the surface water system (Table 41).

Table 41. Water quality standards from Florida 305(b) Rule 62-302.530 Criteria for Surface Water Quality Classification (Florida Department of Environmental Protection 2008)

Use Classification	*Bacteria (fecal coliform)*	*Dissolved Oxygen, DO*	*pH*
Class I	Monthly Ave not to exceed 200 MPN or MF, nor exceed 400 in 10% of samples, nor 800 in any one day	> 5 mg/L at all times	Not to vary more > 1 unit above or below natural background value, and fall between 6 and 8.5
Class II	MPN should not exceed median value of 14, with 10% not exceeding 43, nor exceed 800 on any one day	> 5 mg/L daily average; Not < 4 mg/L at all times	Coastal waters shall not vary > 1 unit above or below natural background value, open water shall not vary > 0.2 unit
Class III/ Fresh	Monthly Ave not to exceed 200 MPN or MF, nor exceed 400 in 10% of samples, nor 800 in any one day	> 5 mg/L at all times	Coastal waters or predominately freshwaters shall not vary > 1 unit above or below natural background value, open water shall not vary > 0.2 unit
Class III/ Marine	Monthly Ave not to exceed 200 MPN or MF, nor exceed 400 in 10% of samples, nor 800 in any one day	> 5 mg/L daily average; Not < 4 mg/L at all times	
Class IV	Not specified	> 4 mg/L daily average; Not < 3 mg/L at all times	Not to vary more than 1 unit above or below natural background value, and fall between 6 and 8.5
Class V	Not specified	> 0.3 50% of the times for flows greater than 250 cubic feet/sec; Not < 0.1 at all times	Not lower than 5.0 nor greater than 9.5 except certain swamp waters which may be as low as 4.5.

Generally, those in Class I have the most stringent water quality criteria and Class V are the least restrictive (Florida Department of Environmental Protection 2008).

The Florida Department of Environmental Protections (DEP) collects water quality data from stations located throughout the subbasin. The five stations closest to 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 54).

Table 42. Names and locations of the five closest water quality monitoring stations to Castillo de San Marcos with appropriate available water quality data. Data from U.S. Environmental Protection Agency STORET (U.S. Environmental Protection Agency 2008c). Distance estimated using the EPA EnviroMapper.

Station Name	*Station ID*	*Latitude*	*Longitude*	*Approximate distance from CASA*
St. Augustine Inlet @ Marker #2	27010131	29.90325	-81.2996	0.7 miles
Tolomato R S of Vilano Bch Brid	27010136	29.91494	-81.3028	1.2 miles
Matanzas R 1/2 Mi S of Bridge	27010139	29.88567	-81.3052	0.8 miles
San Sebastian R @ Hwy 1	27010141	29.89248	-81.3226	0.7 miles
San Sebastian River @ US 1	SSB	29.8819444	-81.3238889	1.3 miles

Table 43. Names and locations of the five closest water quality monitoring stations to Fort Matanzas with appropriate available water quality data. Data from U.S. Environmental Protection Agency STORET (U.S. Environmental Protection Agency 2008c). Distance estimated using the EPA EnviroMapper.

Station Name	*Station ID*	*Latitude*	*Longitude*	*Approximate distance from FOMA*
ICWW at Channel cut to Matanzas	27010098	29.70419	-81.2338	0.0 miles
Across from Fort Matanzas at creek mouth	88SEAS011	29.71683	-81.2395	0.1 miles
Up Creek from station 11	88SEAS012	29.71867	-81.2375	0.2 miles
CM 80A	88SEAS100	29.71917	-81.2463	0.1 miles
Mouth of 2^{nd} creek southwest of CM 81C	88SEAS189	29.71117	-81.244	0.1 miles

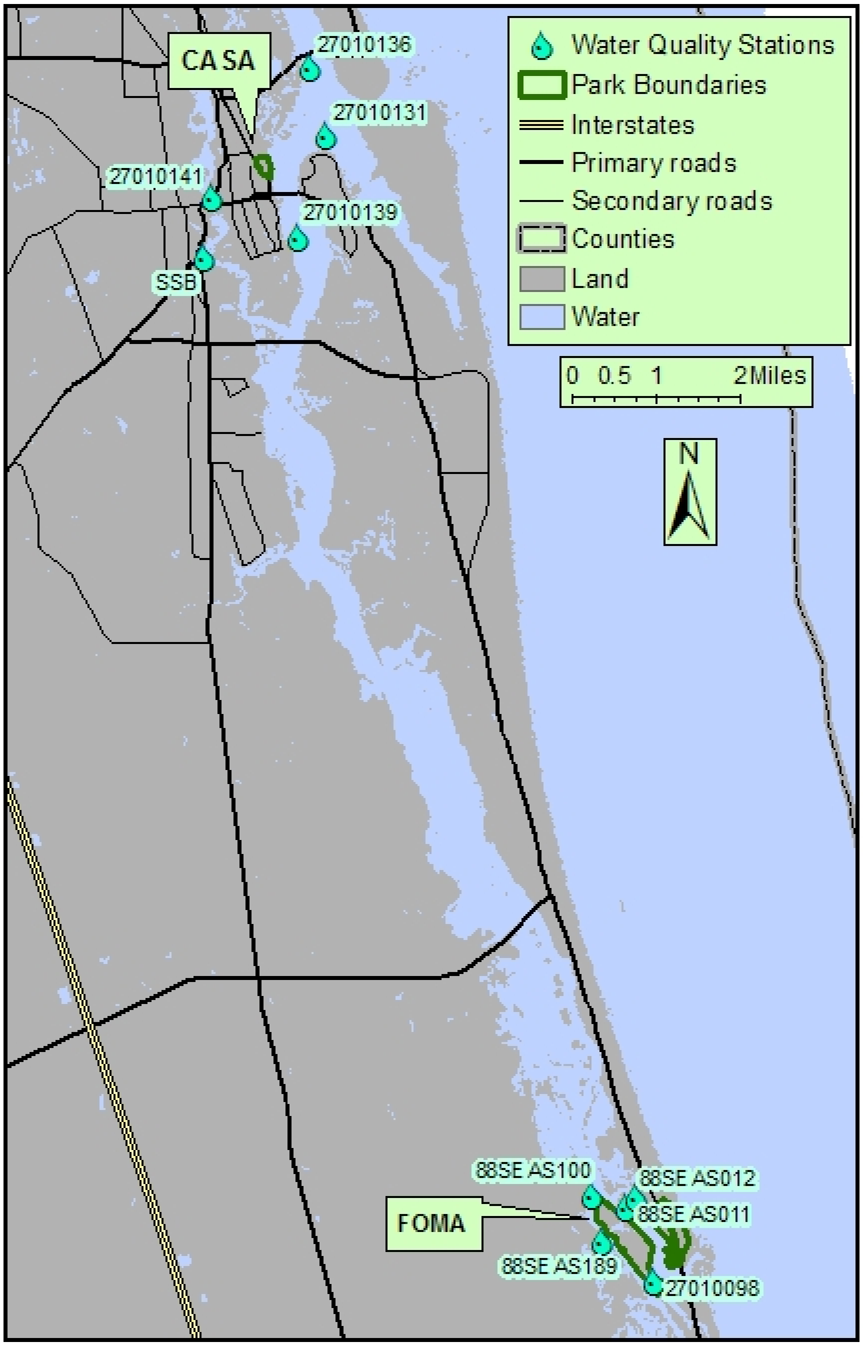

Figure 54. Location of the water quality monitoring stations used for the Castillo de San Marcos and Fort Matanzas National Monument Natural Resource Assessment.

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, usually 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 was reported by Florida DEP from January 8, 2004 to November 14, 2006. DO concentrations ranged from 2.4 to 10.7 mg/l and averaged 5.9 ± 2.3 mg/l. 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 or later 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. Florida water quality standards for DO are expressed in terms of daily averages, but some of the STORET data collected at Florida DEP monitoring stations near Castillo de San Marcos and Fort Matanzas NM during the last 5 years report DO levels as a single point value (i.e. reporting one single value per day). Consequently, direct comparison to daily average standards is problematic. Seventy-one percent (176 of 248) of the individual DO measurements reported exceeded the most restrictive standard of 5mg/liter for Class I waters. Ninety-eight percent (244 of 248) exceeded the Class III/Marine standard of 4mg/liter. Average DO values from all data reported are provided (Table 44 and Table 45).

Table 44. Dissolved oxygen levels and number of data points (*n*) from the stations closest to CASA. Averages taken from all values available in the past five years on the EPA STORET.

Station Name	*Station ID*	*Average DO (mg/L)*	*n*	*Lowest DO (mg/L)*
St. Augustine Inlet @ Marker #2	27010131	7.2	13	5
Tolomato R S of Vilano Bch Brid	27010136	7.2	13	4.6
Matanzas R 1/2 Mi S of Bridge	27010139	6.9	7	4.2
San Sebastian R @ Hwy 1	27010141	7.3	8	4.6
San Sebastian River @ US 1	SSB	6.1	47	3.4

Table 45. Dissolved oxygen levels and number of data points (*n*) from the stations closest to FOMA. Averages taken from all values available in the past five years on the EPA STORET.

Station Name	*Station ID*	*Average DO (mg/L)*	*n*	*Lowest DO (mg/L)*
ICWW at Channel cut to Matanzas	27010098	6.9	21	5.1
Across from Fort Matanzas at creek mouth	88SEAS011	5.5	72	2.4
Up Creek from station 11	88SEAS012	5.4	12	3.7
CM 80A	88SEAS100	5.7	82	2.4
Mouth of 2^{nd} creek southwest of CM 81C	88SEAS189	5.4	13	3.7

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).

Florida DEP does not have extensive water quality standards for nutrients. Criteria for Surface Water Quality Classifications (62-302.530) list a standard for Nitrate as N Class I waters as $\leq$ 10 mg/liter, or that concentration that exceeds the nutrient criteria (Florida Department of Environmental Protection 2008). The U.S. EPA's National Coastal Condition Report II (U.S. Environmental Protection Agency 2005) does establish some criteria for nutrient levels for U.S. coastal waters (Table 46) and classifies samples as "good," "fair," or "poor," based upon their nutrient concentrations.

Table 46. Water quality standards for nutrient concentrations as developed for the National Coastal Condition Report II (U.S. Environmental Protection Agency 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

The available STORET data does not list sufficient information to assess nutrient levels in and around the monuments based on relevant standards.

There are at least eight water bodies in HUC 03080201 with sections that are listed as impaired in part due to nutrient levels according to the 1998 Florida 303(d) listing (Table 47). It is unclear to what extent excessive nutrient levels contribute to the impairment or the constituent nutrients involved. Florida's 305(b) Rule 62-302.530 states that "In no case shall nutrient concentrations of a body of water be altered so as to cause an imbalance in natural populations of aquatic flora or fauna."

Table 47. Water bodies in HUC 03080201 listed as Impaired by Florida's 303(d) 1998 list.

Water body	*Type of water body*	*Cause of impairment*
Guana River	Stream/Creek River	Coliforms, DO
Halifax River	Stream/Creek River	Coliforms, Copper, Iron, Lead, Nutrients
ICWW	Coastal	DO
Matanzas River	Stream/Creek River	Coliforms, Nutrients
Mosquito Lagoon	Lagoon	Coliforms
Palm Coast	Coastal	Cadmium, Coliforms, DO, Lead, Nutrients, Selenium, Silver, Thallium
Pellicer Creek	Stream/Creek River	Coliforms, DO, Iron, Lead, Nutrients
Rose Bay	Bay	Coliforms, DO, Nutrients
Spruce Creek	Stream/Creek River	Coliforms, DO, Iron, Nutrients
Tomoka River	Stream/Creek River	Coliforms, DO, Iron, Lead, Nutrients
Unnamed Ditch	Ditch	DO, Nutrients
Guana River	Stream/Creek River	Coliforms, DO

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.

Florida water quality standards for fecal coliform are expressed in terms of monthly averages, median values or daily maximum values. Some of the STORET data collected at Florida DEP monitoring stations near Castillo de San Marcos and Fort Matanzas NMs during 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 monthly average standards is problematic, but all values reported fall well below the most restrictive monthly average and daily maximum standards. All values reported also meet the median standard of 14 MPN for Class II waters (shellfish propagation or harvesting waters) with the exception of one station where only one value was reported (Table 48 and Table 49).

Table 48. Fecal Coliform data from FL DEP monitoring stations near Castillo de San Marcos since 2004

Station Name	*Station ID*	*Average (#/100mL)*	*Median (#/100mL)*	*n*
St. Augustine Inlet @ Marker #2	27010131	3	2	12
Tolomato R S of Vilano Bch Brid	27010136	3	1.9	12
Matanzas R 1/2 Mi S of Bridge	27010139	17	9.5	4
San Sebastian R @ Hwy 1	27010141	17	17	1
Oyster Cr @ Dixie Hwy	27010156	3	2	5

Table 49. Fecal Coliform data from Florida DEP monitoring stations near Fort Matanzas since 2004.

Station Name	*Station ID*	*Average*	*Median*	*n*
ICWW at Channel cut to Matanzas	27010098*	9**	2**	22
Across from Fort Matanzas at creek mouth	88SEAS011	6*	1.5*	74
Up Creek from station 11	88SEAS012	9*	5*	13
CM 80A	88SEAS100	6*	2*	71
Mouth of 2nd creek southwest of CM 81C	88SEAS189	10*	5*	13

*MPN
** #/100mL

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 monuments' subbasin are scarce. Of the water bodies in HUC 03080201 listed as Impaired by Florida's 303(d) 1998 list, 50% (7 of 14) cite contaminants (metals) as contributing factors in their designation as impaired (Table 47).

3.4.2.b Resource threats and stressors:
While Florida Department of Health Division of Environmental Health does not list any hazardous waste sites proximate to the monuments, the northern-most corner of HUC 03080201 in Duval County does contain sites cited by the agency as containing chemicals found in environmental samples of air, soil and water with potential for harm to human health (Florida Department of Health 2008). Since the Matanzas River is a part of the Atlantic Intracoastal Waterway, potential impacts from boat traffic, like erosion from ship wake and other impacts of human/industrial use of the resource, may be a factor in the preservation of the water resources in the area.

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 Castillo de San Marcos and Fort Matanzas NMs (Table 50). Available data provides insight into water quality conditions in HUC 03080201 as a whole, but it is not clear as to what extent those conditions are reflected on a local scale. However, close proximity of the monitoring stations make it likely that the conditions assessed here are reflected in and around the monuments themselves (Table 50).

3.4.2.d Condition status summary
Available data do not indicate water quality problems due to low dissolved oxygen levels around Castillo de San Marcos and Fort Matanzas NMs. Overall condition status of the water resources at the monuments is assessed in the good range (Table 50) even though Table 47 cites a portion of the Intracoastal Waterway in HUC 03080201 as impaired due to DO levels. Clearly there have been water bodies in the subbasin where DO has been a problem, but the impaired area cited is located in the northern-most corner of the subbasin in Duval County in the vicinity of the reported hazardous waste site. Given that 98% data reported closer to Castillo de San Marcos and Fort Matanzas NMs exceeded the Class III/Marine standard for DO concentration, available data does not support a similar problem with low DO levels near the monuments.

The nutrients category is assessed between the fair and poor range (Table 50), but conclusions are less robust due to lack of appropriate data. The portion of the Matanzas River that is cited as impaired in Table 47 due to nutrient levels lies just north of Castillo de San Marcos NM and with no additional data it is assumed that water quality at this monument at least may be influenced by excess nutrient levels. Excess nutrient levels are also reported elsewhere in the subbasin.

Conclusions about fecal coliform levels in the monuments are similarly compromised by the fact that available data from stations near the monument boundaries cannot readily be compared with relevant standards. The portion of the Matanzas River north of Castillo de San Marcos NM is also cited as being impaired in part due to coliform levels. The proximity of Castillo de San Marcos NM to the impaired area may be an influence on fecal coliform levels near the monument. As a result overall Condition Status of water resources is assessed as fair for fecal coliform levels (Table 50). Excess fecal coliform levels are also reported elsewhere in the subbasin.

There is no direct indication of pollutant contaminants at Castillo de San Marcos and Fort Matanzas NMs, but documented problems in the subbasin have been attributed to nonpoint sources in the area, thus giving water quality a fair condition status assessment due to potential contaminant levels (Table 50).

Table 50. Water quality condition status summary within Castillo de San Marcos and Fort Matanzas National Monuments. 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***	***Midpoint***	***Data Quality***		
			Thematic	*Spatial*	*Temporal*
Dissolved oxygen			1	1	0
	Good	0.84	2 out of 3		
Nutrients (N/P)			0	1	0
	Fair/Poor	0.34	1 out of 3		
Fecal coliform bacteria			1	1	0
	Fair	0.5	2 out of 3		
Contaminants			1	1	1
	Fair	0.5	3 out of 3		
Water quality total			3	4	1
	Fair	0.54	8 out of 12		

3.3.2.e Recommendations to park managers:
We highlight the water quality specific recommendations in Table 51.

Table 51. Recommendations to improve water quality and monitoring at Castillo de San Marcos and Fort Matanzas National Monuments.

1. Work towards improved regional cooperation
2. Initiate regular water quality monitoring at CASA and FOMA
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 in northeastern Florida is composed of undeformed sedimentary rock layers whose ages range from the Late Cretaceous to the present Holocene sediments of the coast. Florida and southern Georgia were not part of the same geologic platform as the Coastal Plain from Central Georgia and further north. Ordovician to Devonian sedimentary "basement rocks" occur more than 3,500 feet beneath the Coastal Plain sediments in northeast Florida (Lane 1994). During all of Late Cretaceous and early Paleogene time, Florida looked much like the Grand Bahama Bank does today: a marine platform mostly covered by shallow seas with scattered small, low islands. The sediments that accumulated in those shallow waters formed the carbonate deposits that underlie much of Florida (Frazier 2007). Starting in Miocene times, the Appalachian Mountains were uplifted and eroding sediments began to cover the carbonate rocks below. Periodic high sea levels during the Pleistocene allowed strong longshore currents to carry thick accumulations of sandy marine sediment south to cover Florida's carbonate platform (Lane 1994). In addition to recent alluvium, organic and marine deposits make up some of the most recent 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 Castillo de San Marcos and Fort Matanzas NMs is a Holocene-aged deposit of organic, marine, and human-altered origin (Figure 55).

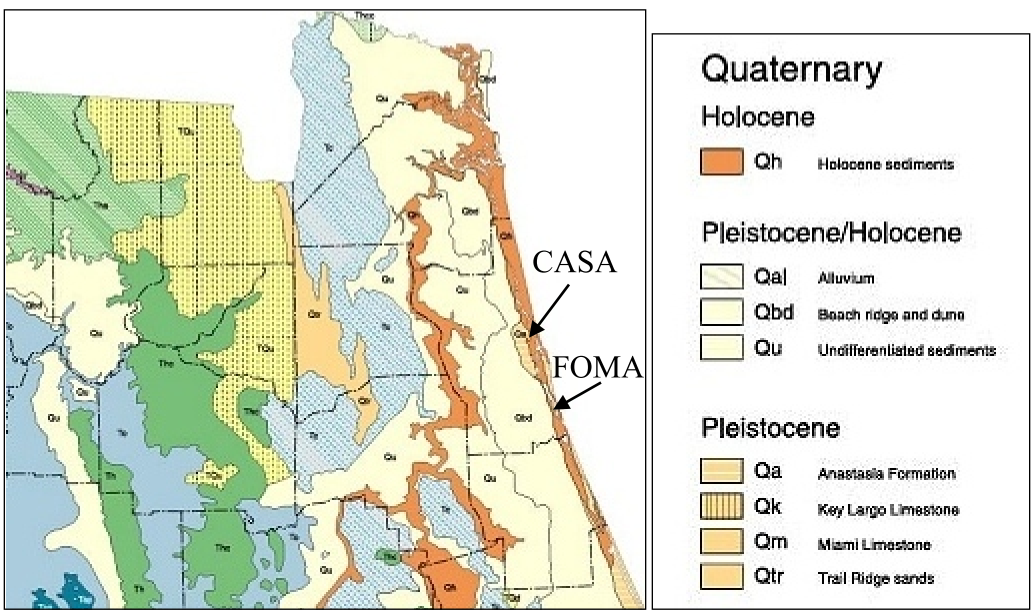

Figure 55. The surficial geology of northeast Florida (Scott et al. 2001).

Castillo de San Marcos NM is located within the city of Saint Augustine Florida and the majority of the 20 acres are maintained grass with a scattering of trees in an urban park-like setting (National Park Service 2007b). Fort Matanzas NM is part of Rattlesnake and Anastasia Islands, separated from the mainland by the Intracoastal Waterway and the Matanzas River. These islands consist of quartz sand with underlying coquina, a limestone of coarsely broken shells.

Figure 56. Castillo de San Marcos National Monument (Google 2008).

Figure 57. Fort Matanzas National Monument (Google 2008).

3.5.1.a Current condition:
We compared a 1917 soil survey (Table 52, Table 53, and Figure 58) to the current soil data from the Soil Survey Geographic Data Base (SSURGO) (Table 54, Table 55, and Figure 59) to see what changes had occurred. The SSURGO soil data for Castillo de San Marcos NM have a version date of December 7, 2006 and are available in GIS format (USDA Natural Resource Conservation Service 2006b). Current SSURGO data for Fort Matanzas were compiled by the National Park Service (2006b) but were originally created by the USDA Natural Resource Conservation Service (2006b). The 1917 soil survey (USDA Bureau of Soils 1917) was obtained from an on-line collection at University of Alabama. The 1917 soil data were aligned to digital raster graphics (DRG) topographic maps, using the georeferencing tools in ArcGIS (ESRI 2006). We surveyed Saint Augustine, Saint Augustine Beach, Matanzas Inlet, and Dinner Island NE 1:24,000 topographic maps that made up Castillo de San Marcos and Fort Matanzas NMs 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. No spoil areas were identified on these 1994 topographic maps for the areas in either monument, but are evident and well-vegetated on closer inspection of recent photos (Figure 57).

The soil survey program was near its inception in 1917. The 1917 soil data were obtained by reconnaissance survey methods using a limited set of soil series choices. The 1917 soil survey of Castillo de San Marcos NM (Figure 58) gave a soil classification of “Norfolk fine sand.” The Norfolk series includes soils with sandy surfaces and loamy subsoils with clay accumulation. Norfolk soils are now mapped on well drained, older, higher elevation, highly weathered Coastal Plain terraces much further inland. The area is currently mapped as “St. Augustine-Urban land complex” made up of a complex mixture of about 55% St. Augustine soils, about 35% buildings and pavements (Urban Land), and about 10% other soils. St. Augustine is a human-altered soil formerly composed of dredged sandy deposits and possibly leveled sand dunes and interdune swales. These soils have no subsoil accumulation of clay and are somewhat poorly drained. One soil that occurs on the ocean side next to the monument is Pellicer silty clay loam, a silty tidal marsh soil. “St. Augustine” and “Pellicer” soils were established long after the 1917 soil survey was completed. The change in soil mapping is due to an improvement in formerly inaccurate mapping and a closer inspection of the soils in the newer survey with additional choices of soil series for the soil mappers.

The 1917 soil survey of Fort Matanzas NM (Figure 58) gave a soil classification of “Coastal Beach” and “Tidal Marsh" soils, represented by the Transquaking series. The beaches are flooded twice daily by tides and are a miscellaneous land type because the sands shift and are not stabilized by vegetation. The dunes should have been recognized as a soil series if one was established in 1917. The coastline of Florida has certainly been altered significantly since 1917 by development, dredging and severe storm tides. The “Coastal Beach” areas of Anastasia Island have been altered by longshore current additions of sand on the south end, now called “Beaches.” The rest of the “Coastal Beach” on Anastasia Island are now mapped as “Fripp-Satellite complex” or “Satellite fine sand” (Figure 59). The “Fripp” soils are thick, older, well-vegetated sand dunes that are excessively drained. The “Satellite” soils are thick sandy soils on very low undulating dunes and swales that are somewhat poorly drained. The “Tidal Marsh” mapped in the extreme northwest section of the park is now mapped as “Satellite fine sand (Figure 59). “Fripp” and “Satellite” soils were established long after the 1917 soil survey was completed. The change in soil mapping is due to an improvement in formerly inaccurate mapping and a closer inspection of the soils in the newer survey with additional choices of soil series for the soil mappers.

Rattlesnake Island has been severely altered since 1917, mainly by dredging of the Intracoastal Waterway. The "Coastal Beach" map unit has been remapped as "Moultrie fine sand." "Moultrie" soils are thick sandy deposits flooded by tidal storms. They have a subsoil accumulation of aluminum-organic carbon complex minerals. The rest of Rattlesnake Island has either been dredged out (southwestern and southeastern edge), eroded away (southeastern edge), or covered with sandy dredged deposits since the 1917 survey (spoil piles mapped as "Moultrie fine sand" on the northern end or "St. Augustine fine sand, clayey substratum" in the island center is an area shown as open water in 1917). The 1917 base map is probably inaccurate in places as well (Compare Figure 57 and Figure 58). The "Moultrie fine sand" on the northern end is now almost certainly a dredged sand deposit. Revegetation by tree planting is evident in Figure 57. The area may have been mapped as "Moultrie" if the elevation is very low and has somewhat poor drainage. However, the vegetation being planted corresponds more with an upland soils than a "Tidal Marsh" map unit or a soil subject to inundation by storm tides (Moultrie).

The "St. Augustine fine sand, clayey substratum" mapped in the island center in 2006 is almost certainly a sandy dredged deposit placed over a clayey tidal marsh soils or a shallow clayey marine or alluvial estuary deposit. Both areas appear to have a geometric-shaped berm or dike around them to hold dredged sediment. The "Pellicer silty clay loam" mapped in the island center in 2006 is almost certainly a remnant of the original "Tidal Marsh" soils or a shallow clayey marine or alluvial estuary deposit that filled with sediment as sea level has risen. "St. Augustine," "Moultrie," and "Pellicer" soils were established long after the 1917 soil survey was completed. The change in soil mapping is due to drastic alteration of the soils by humans, an improvement in formerly inaccurate mapping, a better base map, and a closer inspection of the soils in the newer survey with additional choices of soil series for the soil mappers. The areas mapped as "Tidal Marsh" in 1917 are not accurately mapped. The "Transquaking" soil type identified in the 1917 survey is an organic soil from the upper East Coast in Maryland and is also not representative of the soils in the area. The "Pellicer" soil used in the 2006 soil survey provide a better description of the soil resources. "Pellicer" does not have thick organic sediment at the surface. The difference in "Tidal Marsh" soils between 1917 and 2006 reflect updated versions of the soil series concepts and improved soil survey detail and accuracy.

Table 52. Historic soil survey (1917) classification and approximate percent of total acreage for Castillo de San Marcos National Monument.

Soil Code	*Classification Name*	*Description*	*Extent w/in CASA*
Nf	Norfolk fine sand (Hammock phase)	The Norfolk series consists of very deep, well drained, moderately permeable soils on lower, middle, or upper coastal plains 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%

[1] http://www2.ftw.nrcs.usda.gov/osd/dat/N/NORFOLK.html

Table 53. Historic soil survey (1917) classification and approximate percent of total acreage for Fort Matanzas National Monument.

Soil Code	*Classification Name*	*Description*	*Extent w/in FOMA*
Cb	Coastal Beach	Beaches consist of long narrow strips of nearly level sand along the Atlantic Ocean. Seawater covers these areas twice daily during normal high tides. Beaches also include some small areas of low dunes that are adjacent to the beaches. This is not a soil but a miscellaneous land type, since it is not stabilized by vegetation.	≈ 50%
T	Tidal Marsh	The Transquaking series consists of very deep, very poorly drained soils flooded by tidal waters. Permeability is rapid in the organic deposits and slow in the mineral material. Parent material consists of organic deposits underlain by loamy mineral sediments. These soils are on coastal plains in brackish estuarine marshes along tidally influenced rivers and creeks with slopes ranging from 0 to 1 percent. (Transquaking soils were previously mapped as Tidal Marsh miscellaneous area. These soils become ultra acid when drained).(2)	≈ 50%

(2) http://www2.ftw.nrcs.usda.gov/osd/dat/T/TRANSQUAKING.html

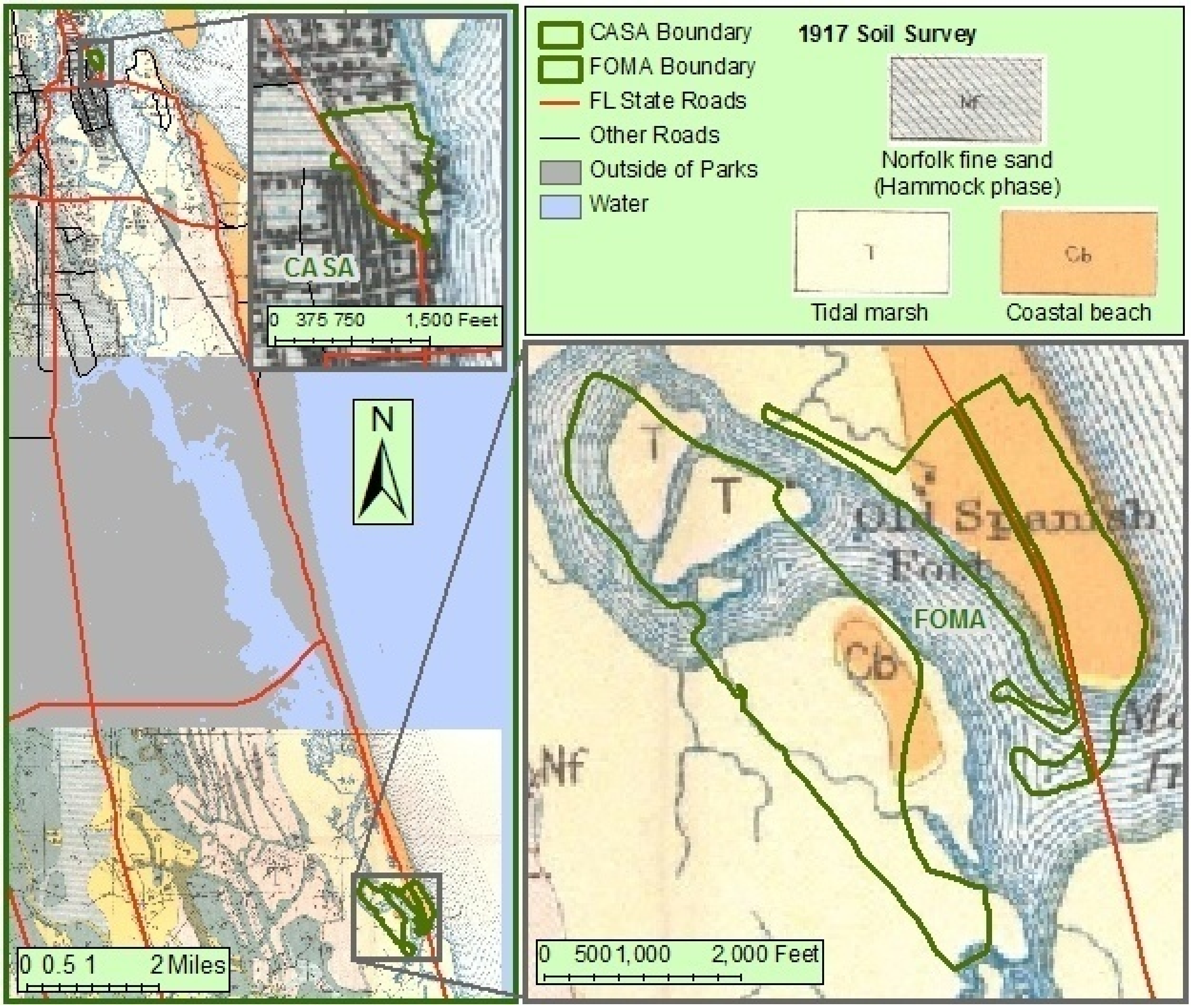

Figure 58. Extent of historic soil survey (1917) at Castillo de San Marcos and Fort Matanzas National Monuments.

In the 2006 soil survey, there is one soil for Castillo de San Marcos NM, the "St. Augustine-Urban land complex" (Table 54, Figure 59). There is a miniscule amount of "Pellicer silty clay loam, frequently flooded" on the ocean side next to the Fort.

In the 2006 soil survey, there are six soil classes for Fort Matanzas NM. These are "St. Augustine fine sand, clayey substratum," "Pellicer silty clay loam, frequently flooded," "Fripp-Satellite complex," "Satellite fine sand," "Moultrie fine sand, frequently flooded," and "Beaches" (Table 55, Figure 59). Tidal marsh soils such as "Pellicer" 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. "Pellicer" soils are not as clayey as "Bohicket" or "Capers." 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. The “Moultrie” soils have higher salinity than other sandy soils and have limitations for revegetation because of their flooding during storm tides.

There are no Prime Farmlands or soils of Statewide Importance in either monument. The only Highly Erodible Lands are at Fort Matanzas NM. These are the poorly vegetated dunes and dredged deposits in the “Moultrie fine sand”, “Beaches”, and “Fripp-Satellite complex.”

Table 54. Current soil survey (2006) classification, acreages, and percent of total acreage for Castillo de San Marcos National Monument.

Map Symbol	*Map Unit Name*	*Description*	*CASA Acres*	*CASA %*
51	St. Augustine [3]-Urban land complex	This map unit consists of nearly level, somewhat poorly drained St. Augustine soils that have been used for urban development. Most areas of this unit are located near developments along the Atlantic Coast and Intracoastal Waterway. Many areas are adjacent to tidal marshes and other low areas or bodies of water from which sandy soil material has been dredged.	20.0	100.0
	Total		20.0	100.0

[3] http://www2.ftw.nrcs.usda.gov/osd/dat/S/ST._AUGUSTINE.html

Table 55. Current soil survey (2006) classification, acreages, and percent of total acreage for Fort Matanzas National Monument.

Map Symbol	*Map Unit Name*	*Description*	*FOMA Acres*	*FOMA %*
45	St. Augustine[3] fine sand, clayey substratum	This is a somewhat poorly drained, nearly level soil on narrow to broad low flat areas, and low knolls adjacent to tidal salt marshes and estuaries along the Atlantic Coast and Intracoastal Waterway. It formed in marine sands mixed with shells and shell fragments and fragments of loamy or clayey material overlying loamy or clayey layers. This soil formed as the result of dredging operations in the Inland Waterway.	76.4	25.7
24	Pellicer[4] silty clay loam, frequently flooded	This is a very poorly drained, nearly level soil that is in low tidal marshes along stream estuaries near the Atlantic coast. Soil areas are wide and elongated in shape. Slopes are less than 1 percent. Typically, the surface layer is very dark brown silty clay loam about 10 inches thick. Between depths of 10 and 55 inches, the material is dark greenish gray clay loam. High sulfide content makes this soil subject to developing ultra-acid conditions if exposed to air.	47.2	15.8

Map Symbol	Map Unit Name	Description	FOMA Acres	FOMA %
31	Fripp[5]-Satellite[6] complex	In this map unit are excessively drained, rolling or hilly Fripp Soil on narrow relict beach dunes and somewhat poorly drained, nearly level Satellite soil in narrow swales between areas of the Fripp soil. These soils formed in thick sandy deposits of marine origin mixed with small amounts of shell and shell fragments.	38.6	13.0
29	Satellite[6] fine sand	This is a somewhat poorly drained, nearly level soil in narrow to broad swales between higher relict beach sand dunes, on low knolls adjacent to drainageways. Most of this soil is in the area between the Inland Waterway and Atlantic Ocean. Areas are generally elongated in shape. Slope ranges from 0 to 2 percent.	37.7	12.7
49	Moultrie[7] fine sand, frequently flooded	This very poorly drained, nearly level soil is in tidal marsh areas, generally in long narrow areas on the margins of the tidal marsh or on low islands in the tidal marsh. Slopes range from 0 to 1 percent. Typically, the surface layer is dark grayish brown fine sand about 2 inches thick.	37.3	12.5
99	Water		35.1	11.8
28	Beaches	Beaches consist of long narrow strips of nearly level sand along the Atlantic Ocean. Seawater covers these areas twice daily during normal high tides. Beaches also include some small areas of low dunes that are adjacent to the narrow strips that are overwashed by tidal waves.	25.5	8.6
	Total		298	100

[3] http://www2.ftw.nrcs.usda.gov/osd/dat/S/ST._AUGUSTINE.html (closest fit soil)
[4] http://www2.ftw.nrcs.usda.gov/osd/dat/P/PELLICER.html
[5] http://www2.ftw.nrcs.usda.gov/osd/dat/F/FRIPP.html
[6] http://www2.ftw.nrcs.usda.gov/osd/dat/S/SATELLITE.html
[7] http://www2.ftw.nrcs.usda.gov/osd/dat/M/MOULTRIE.html

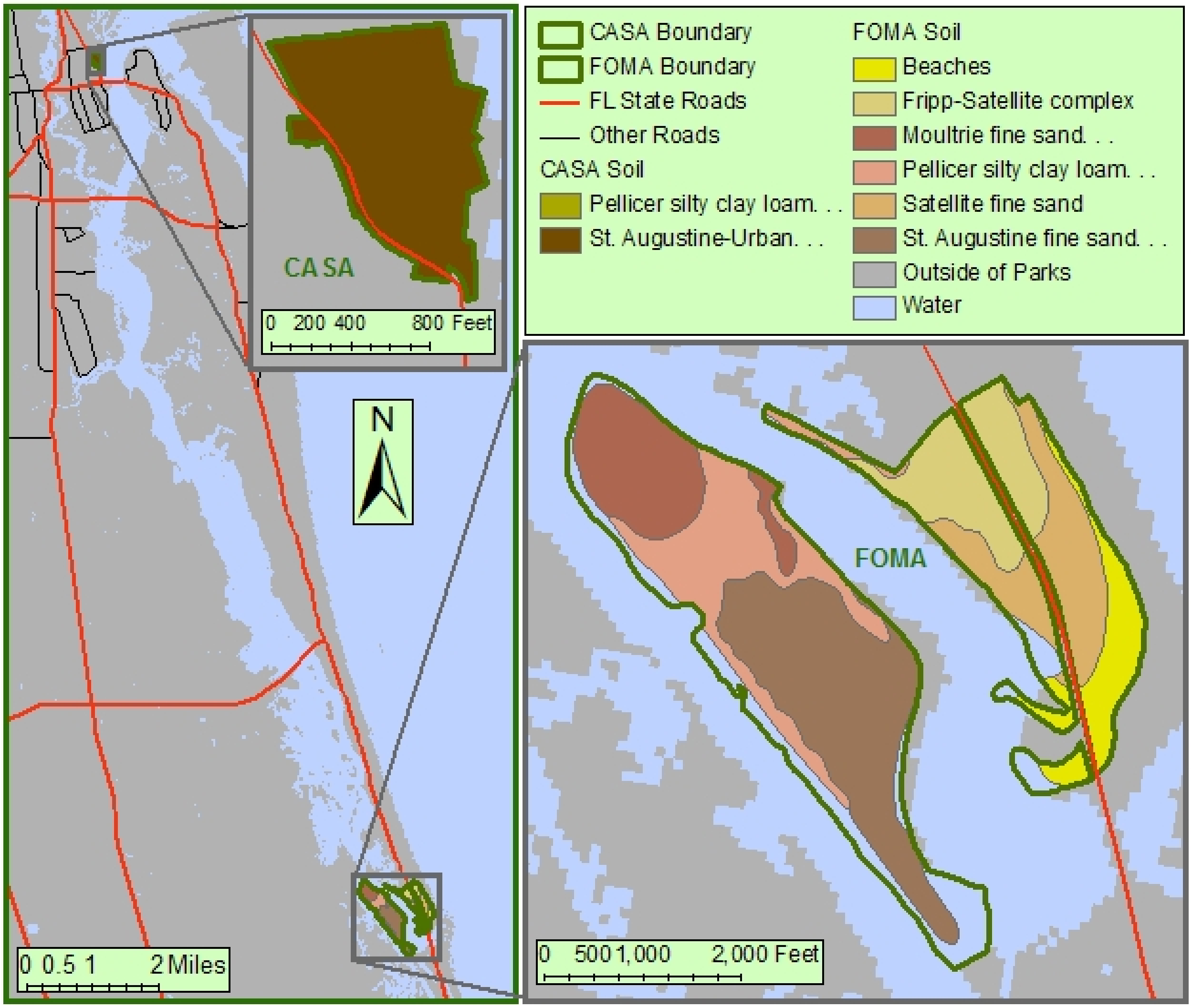

Figure 59. Extent of current soil survey (2006) at Castillo de San Marcos and Fort Matanzas National Monuments.

Several soil-based assessments can be assembled from current soil data using the soil database (USDA Natural Resource Conservation Service 2006a) 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 56, Figure 60, Appendix C); flooding frequency class (Table 57, Figure 61, other water features listed in Appendix C); drainage class (Table 58, Figure 62, Appendix C); hydric rating (Figure 63, Appendix C); soil features (Appendix C); and 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 56. Potential erosion hazard (off-road, off-trial) according to soil characteristics at Castillo de San Marcos and Fort Matanzas National Monuments. *Slight* means erosion is unlikely under ordinary climatic conditions.

Potential Erosion	*CASA Acres*	*% of CASA*	*FOMA Acres*	*% of FOMA*
Not rated	0.0	0.00	60.7	20.37
Slight	20.0	100.00	237.3	79.63
	20.0	100.00	298.0	100.00

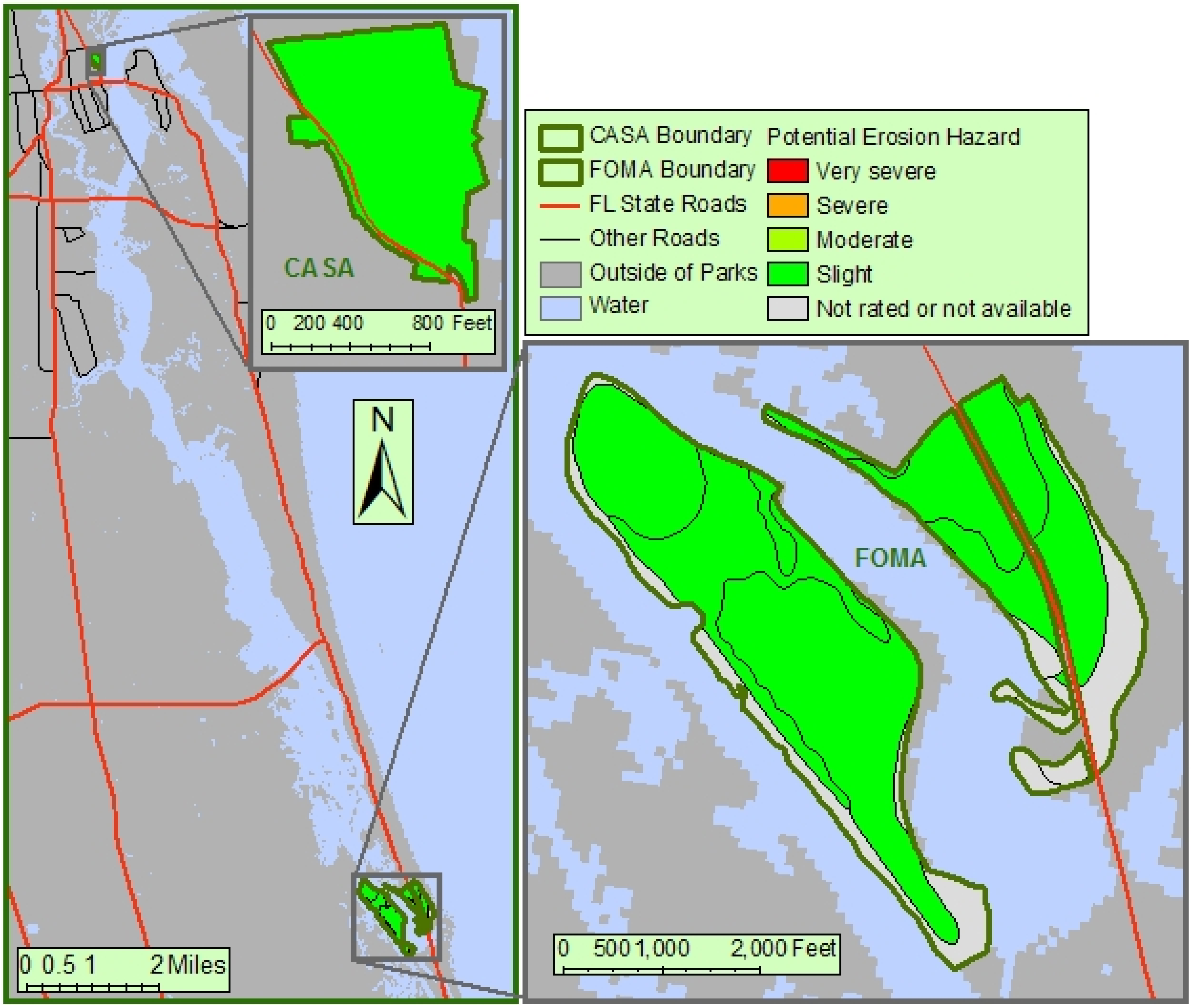

Figure 60. Potential erosion hazard (off-road, off-trial) according to soil characteristics at Castillo de San Marcos and Fort Matanzas National Monuments. *Slight* means erosion is unlikely under ordinary climatic conditions; *moderate* means that some erosion is likely and that erosion-control measures 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 57. Flooding frequency according to soil characteristics at Castillo de San Marcos and Fort Matanzas National Monuments. *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	*CASA Acres*	*% of CASA*	*FOMA Acres*	*% of FOMA*
None	0.0	0.00	111.5	37.41
Rare	20.0	100.00	76.4	25.63
Frequent	0.0	0.00	110.1	36.95
Very Frequent	0.0	0.00	0.0	0.00
	20.0	100.00	298.0	100.00

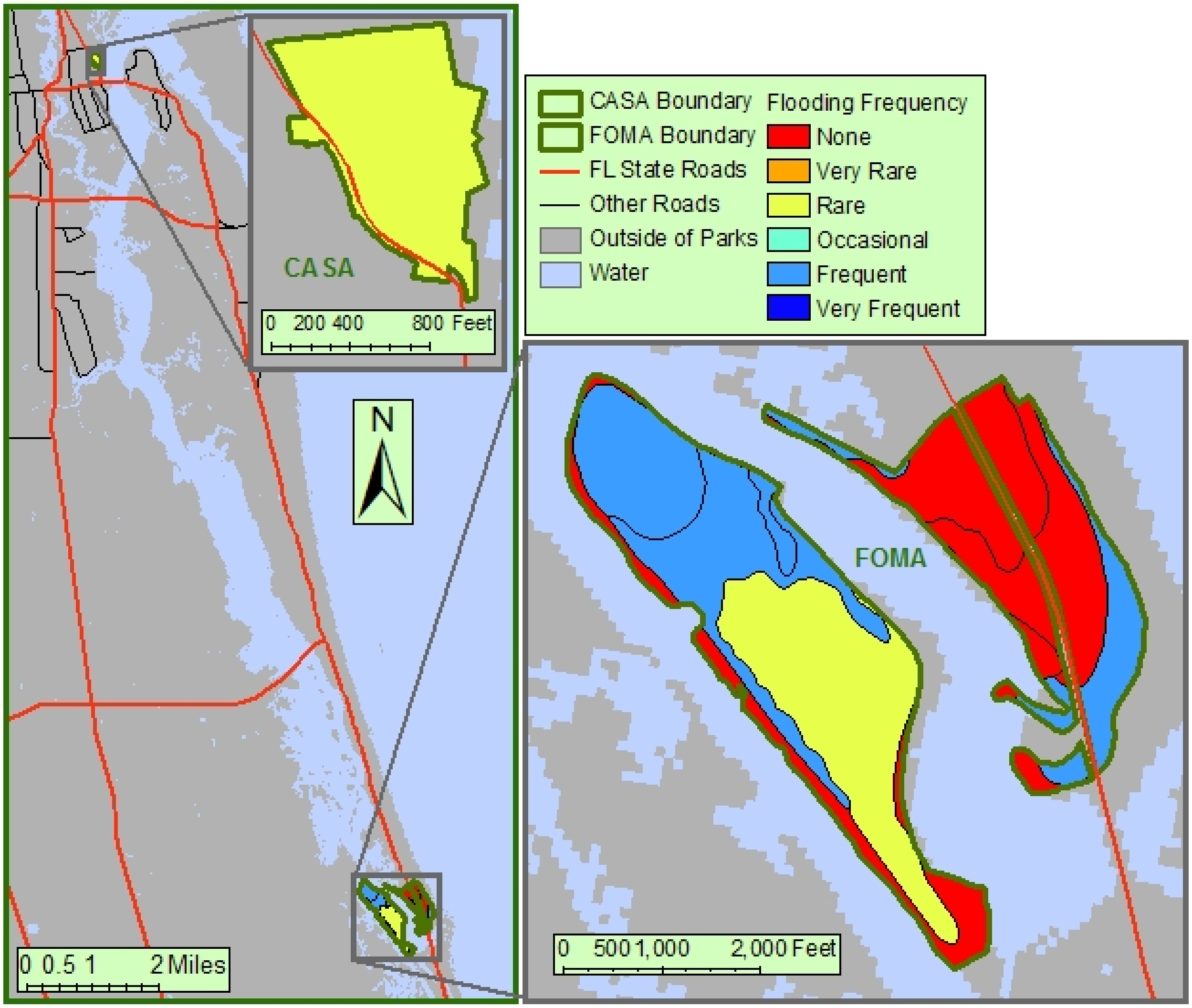

Figure 61. Flooding frequency according to soil characteristics at Castillo de San Marcos and Fort Matanzas National Monuments. *None* means flooding is not probable; *very rare* means flooding is very unlikely; *rare* means flooding is unlikely but possible under unusual weather conditions; *occasional* 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 58. Drainage classes according to soil characteristics at Castillo de San Marcos and Fort Matanzas National Monuments.

Drainage Class	*CASA Acres*	*% of CASA*	*FOMA Acres*	*% of FOMA*
Not rated	0.0	0.00	35.2	11.80
Excessively drained	0.0	0.00	38.6	12.96
Somewhat poorly drained	20.0	100.00	114.1	38.28
Poorly drained	0.0	0.00	25.6	8.59
Very poorly drained	0.0	0.00	84.6	28.38
	20.0	100.00	298.0	100.00

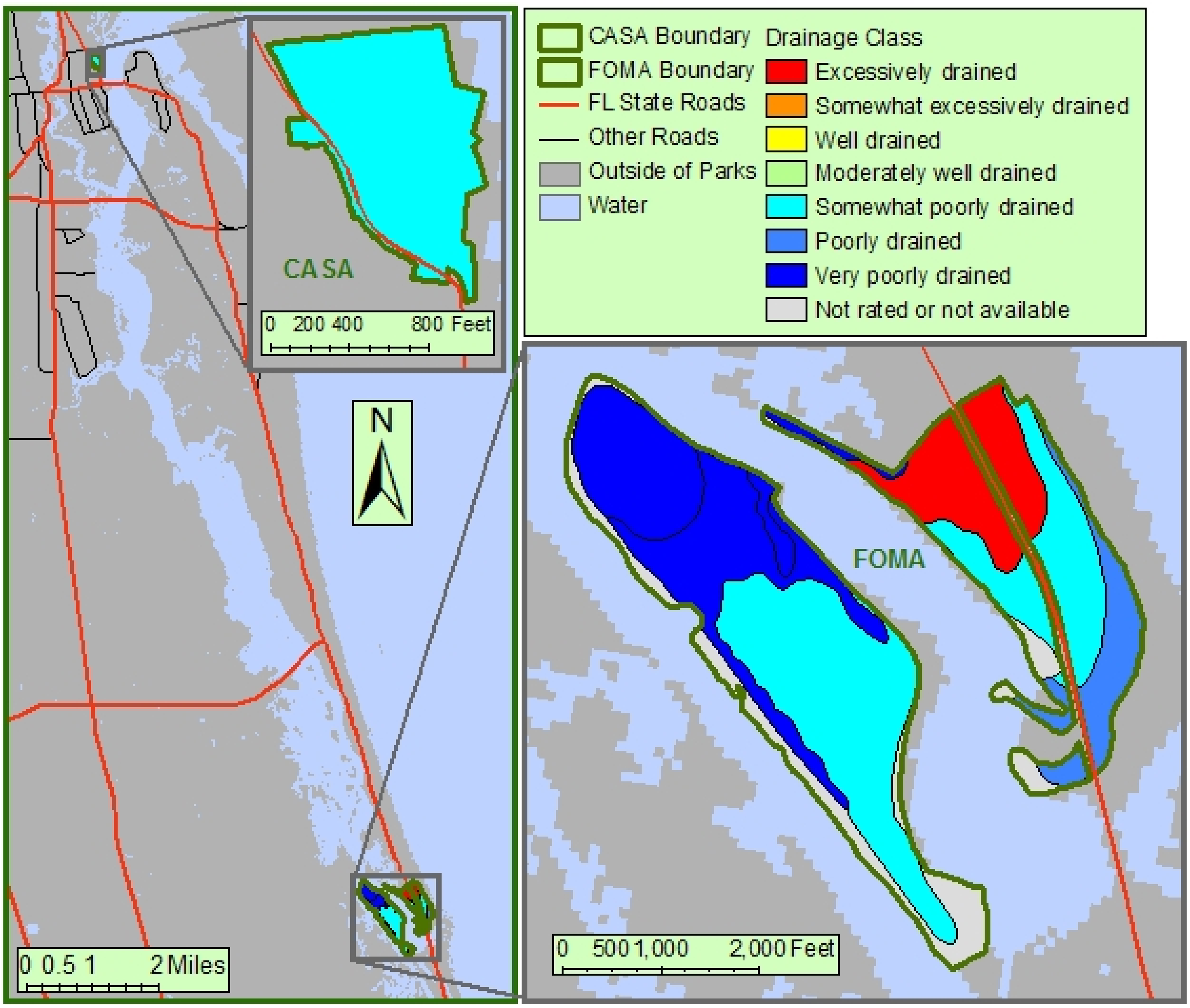

Figure 62. Drainage classes according to soil characteristics at Castillo de San Marcos and Fort Matanzas National Monuments.

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)

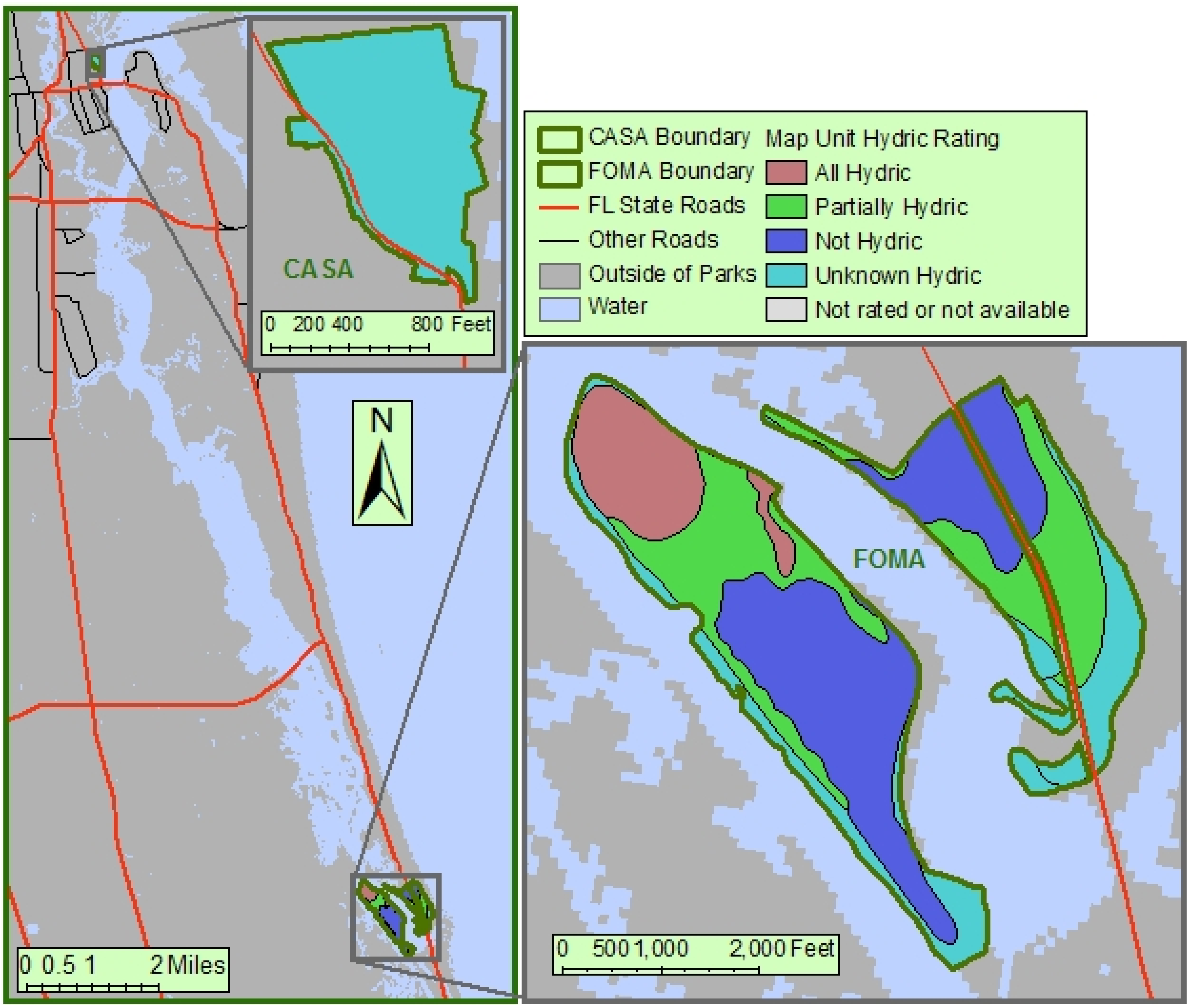

Figure 63. Hydric rating according to soil characteristics at Castillo de San Marcos and Fort Matanzas National Monuments.

3.5.1.b Resource threats and stressors:
Flooding from storm tides (Beaches and Moultrie), daily tides (Pellicer), and river flow (Moultrie soils) pose concerns. The Pellicer tidal marsh soils have high salinity and are subject to acidification if drained or oxidized. The dunes in the "Beaches" map unit and poorly vegetated sandy dredged deposits are subject to severe wind erosion if not properly vegetated. The southern tip of Anastasia Island appears to be growing seaward by accretion of sand from longshore currents. 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 shorelines along the western shore of Rattlesnake Island along the Intracoastal Waterway, and along the eastern shore on the Matanzas and Anastasia River. Some erosion of sands, or recent deposition of sands, is seen along the eastern side of Rattlesnake Island.

3.5.1.c Critical knowledge or data gaps:
Data quality is good in all cases (Table 59). Local scale, specific soil analysis to Castillo de San Marcos and Fort Matanzas NMs 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 1917 soil survey so soil change is in the good range for condition status in both monuments (Table 59 and Table 60). 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 59 and Table 60). All of Castillo de San Marcos NM soils have rare flooding frequency and the drainage class is somewhat poorly drained, so these categories received a good condition status (Table 59). Thirty-seven percent of Fort Matanzas NM has a frequent flooding frequency class while drainage class mirrored these findings with poor and very poorly drained characteristics in the same soils. Consequently, flooding frequency and drainage class were combined and received a fair condition status (Table 60).

Table 59. Soil condition status summary for Castillo de San Marcos 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			1	1	1
	Good	0.84	3 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		

Table 60. Soil condition status summary for Fort Matanzas 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			1	1	1
	Good	0.84	3 out of 3		
Potential erosion			1	1	1
	Good	0.84	3 out of 3		
Flooding frequency and drainage class			1	1	1
	Fair	0.5	3 out of 3		
Soil total			3	3	3
	Good	0.73	9 out of 9		

3.5.1.e Recommendations to park managers:
We recommend controlling wave erosion on the edges of Castillo de San Marcos NM. We also advise avoiding excavation in the tidal marsh as well as filling and building on the tidal marsh soils. These soils have the potential to produce ultra-acidic properties if exposed to the atmosphere. Tidal flooding and high salinity are a problem in the marsh areas. Park managers should plan for shoreline erosion and damage from storm tides. Storm tides may cause severe erosion in the Fort Matanzas NM area because the hydrology has been totally altered and is not natural. Many of the soils surrounding the Matanzas River are sandy and cannot withstand strong wave or wake action or storm surges without being eroded. Continuing to monitor and stabilize the shoreline is a positive management action that is already in process at both monuments. The dunes forming next to the new beach deposits should be vegetated rapidly to prevent wind erosion. The sandy dredged spoil that is poorly vegetated should be revegetated. Park egress during tropical storms should be planned for.

3.6 Biological Integrity

3.6.1 Focal Communities and At-risk Biota

The species of plants and animals found within the boundary of Castillo de San Marcos and Fort Matanzas NMs are the product of numerous habitat factors. The principal natural land cover classes found at the monument 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 Castillo de San Marcos NM include developed open space, medium intensity developed, and mixed forest (however mixed forest only comprises 1.5 acres). Approximately 90% of the monument is open space or developed. Natural resource management at Castillo de San Marcos NM is somewhat difficult due to the fact that the 20 acre site has “no free-flowing streams, wetlands, forests, or other naturally occurring ecosystems" and has been completely modified throughout history by human activities (National Park Service 2007b).

At Fort Matanzas NM, the most dominant vegetation communities are evergreen forest, estuarine emergent wetland, open water, unconsolidated shore, and estuarine scrub/shrub wetland (see Appendix A for a full description of the land cover classifications at Castillo de San Marcos and Fort Matanzas NMs).

The complete assemblage of species, plants and animals, at Castillo de San Marcos and Fort Matanzas NMs is a direct result of several different types of vegetation, land use, and hydrologic communities that occur within each park's boundaries. The most important natural community is the estuarine emergent wetland. However, the species assemblages observed at the monuments are certainly the product of other communities (natural or anthropogenic) around the monuments.

Ideally, an assessment of the biotic communities at Castillo de San Marcos and Fort Matanzas NMs would consist of the complete range of plants and animals known to occur within the monuments' 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 Castillo de San Marcos and Fort Matanzas National Monuments. There have been just a few investigations of animals and plants at these Monuments over the past 20-plus years (Table 61).

Table 61. List of available animal and plant surveys for Castillo de San Marcos and Fort Matanzas National Monuments.

Year	*Park*	*Community target for survey*	*Author(s)*
2005	CASA, FOMA	Reptiles and Amphibians	Tuberville, et al.
1999	FOMA	Reptiles and Amphibians	King and Krysko
2004	CASA, FOMA	Floristic surveys	Zomlefer and Giannasi

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 utilized this database to generate list of species (by-taxa) expected to occur within Castillo de San Marcos and Fort Matanzas NMs. These lists were reviewed and corrected as necessary and used in this project as current species lists.

Attempts at locating and utilizing appropriate reference datasets for comparison to Castillo de San Marcos and Fort Matanzas NMs 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 forest breeding birds and amphibians as communities of interest for that program. Relatively sound community information can be obtained for these groups and work at and around Castillo de San Marcos and Fort Matanzas NMs for these communities has been done relatively recently.

3.6.1.a Current Condition:

Avian communities, Castillo de San Marcos National Monument:

The bird community at Castillo de San Marcos NM is reported to contain 84 species either listed as "present" or "probably present," 19 species are listed as confirmed "breeder." These species are associated with all the habitats at Castillo de San Marcos NM. Due to the limited data available on breeding birds at Castillo de San Marcos 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 – 2007 (Figure 64). We selected six routes for building the reference species list.

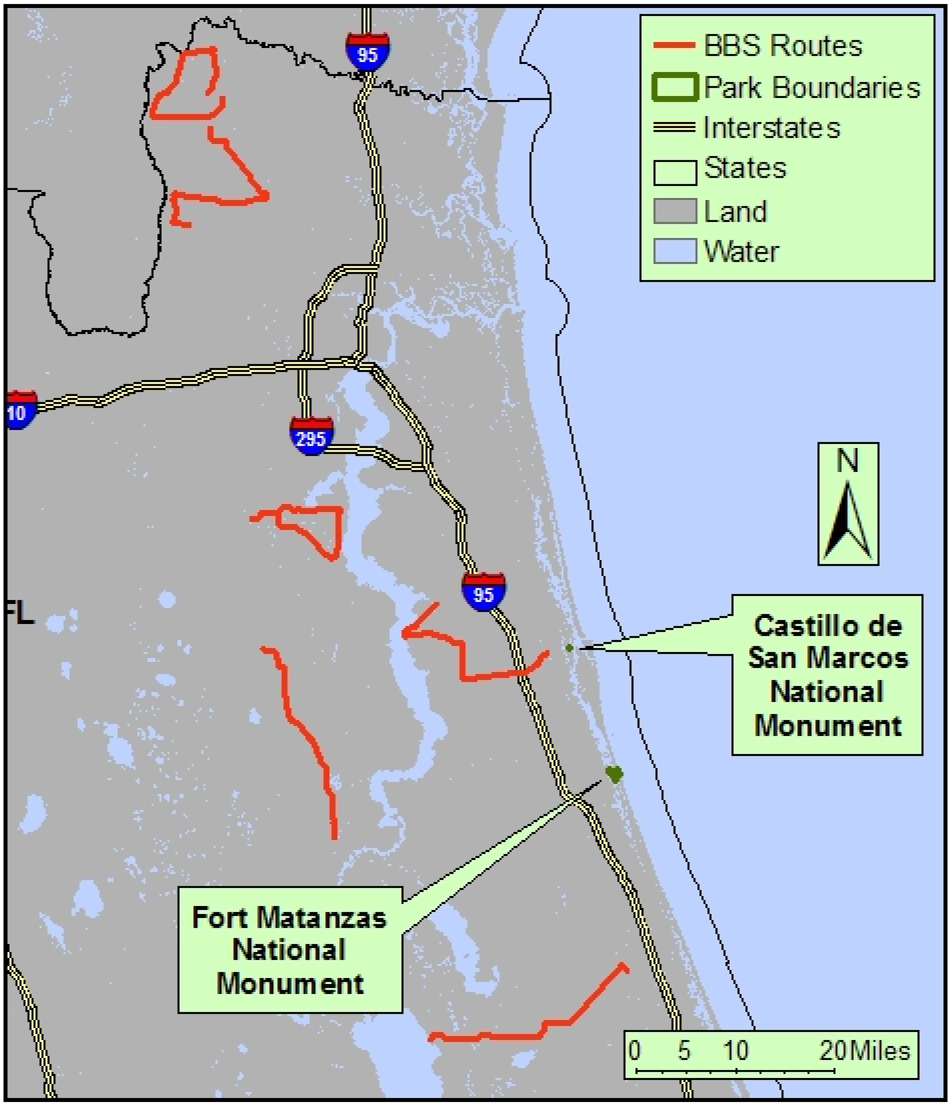

Figure 64. USGS Breeding Bird Survey Routes in the area surrounding Castillo de San Marcos and Fort Matanzas National Monuments that were chosen for the assessment.

We compiled the total number of species seen on each route over the 42-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.

A total of 86 species were identified as breeding in the landscape surrounding Castillo de San Marcos NM. We then cross-referenced this list to the breeding and resident list obtained for Castillo de San Marcos NM (n = 43). A total of 30 species were found on both lists. The Jaccard Index of Similarity between the reference breeding bird list and the breeding bird list from Castillo De San Marcos NM was 0.30.

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):

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

Another means for assessing the biotic condition of the birds at Castillo de San Marcos and Fort Matanzas NM was to examine the population trends for each species. From a management perspective, the monuments would like to see each species either at, or moving towards, population levels desired for management. These levels will differ depending on the status of the species. For example, we assume that rare species populations would be desirable if they are increasing. The opposite would be true of exotic or nuisance species.

Using the BBS data, we were able to establish observation trends for 30 species known to be present at Castillo De San Marcos NM. For each species, we calculated the number of times the species was observed each year over the course of the surveys, then calculated a regional average by dividing the total seen by the total number of routes that were completed in that year. In years that a route was completed but the species was not observed, we recorded a 0 value. We then plotted the mean number of observations against the years and used linear regression to create a trend line for each species. We used the statistical output to determine if the slope of the line was significantly different from 0. If so, it was classified as either “increasing” or “decreasing” for the period.

We calculated this slope value for two periods. The first period was for the entire survey period (1966 – 2007). The second period was for the last 15 years only (1992 – 2007). Comparisons between these periods will allow us to determine if any non-significant long-term trends are changing more recently.

We categorized trends as “acceptable” or “unacceptable” by using a simple management matrix for each class of species in the set (Table 62). These three classes were species of “concern,” “nuisance,” or “breeder.” These values were used to determine the overall management acceptability of population trends for the bird community.

Table 62. Management matrix used to categorize trend combinations.

Period 1	*Period 2*	*Management Evaluation*		
1966 – 2007	*1992 – 2007*	*Concern*	*Nuisance*	*Breeders*
Increasing	increasing	acceptable	unacceptable	acceptable
Decreasing	increasing	acceptable	unacceptable	acceptable
not significant	increasing	acceptable	unacceptable	acceptable
Increasing	decreasing	unacceptable	acceptable	unacceptable
Decreasing	decreasing	unacceptable	acceptable	unacceptable
not significant	decreasing	unacceptable	acceptable	unacceptable
Increasing	not significant	unacceptable	unacceptable	acceptable
Decreasing	not significant	unacceptable	acceptable	unacceptable
not significant	not significant	unacceptable	unacceptable	acceptable

A total of 13 of the 30 (~ 43%) species were deemed "acceptable" based on their observed trends in the landscape surrounding Castillo de San Marcos NM. The remaining species observation trends were deemed "unacceptable" in light of the management levels placed on them.

This result suggests that the majority of the breeding birds in the landscape surrounding and perhaps including Castillo de San Marcos NM are experiencing either long or short term declines that may increase their conservation priority in the future. It is important to note that this does not provide any proof that these species are declining at Castillo de San Marcos National Monument. There is no long term data on breeding bird observations at Castillo de San Marcos National Monument. However, if these species continue to decline over the local landscape, their continued presence as breeding birds at Castillo de San Marcos NM may be jeopardized.

Additionally, we elected to use species-habitat distribution models published by the Florida Gap Analysis Project (2003). 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 at Castillo de San Marcos NM and used that as a reference list.

A total of 157 species were identified from the FL-GAP models as potentially occurring within the land cover classes coincident with Castillo de San Marcos NM (Appendix D). Of these, 55 species were documented at Castillo de San Marcos NM. The Jaccard Similarity Index was calculated as 0.30 between Castillo de San Marcos NM birds and the FL-GAP derived reference set.

These indices reflect a moderately low overlap between the birds present at Castillo de San Marcos NM relative to similar habitats. That is, areas outside of the monument with similar habitat characteristics will have more species. Lack of proper habitat (approximately 90% of the monument is open space or developed) is likely the cause for low overlap between the data sets. However, 19 species are known to breed at Castillo de San Marcos NM, three of which are species of greatest conservation need for the state of Florida.

St. Johns County Audubon (2008) conducted North American Migratory Counts in spring 2006, and spring and fall of 2008. We used the combined species list from the three survey periods (Appendix E) and compared it with the list for Castillo de San Marcos NM. A total of 144 species were documented for the Audubon surveys, of which 61 species occurred on both lists (Jaccard Index of Similarity = 0.36).

Avian communities, Fort Matanzas National Monument:
The bird community at Fort Matanzas NM is reported to contain 155 species, 37 of which are listed as a confirmed "breeder" at the monument. These species are associated with all the habitats at Fort Matanzas NM. Due to the limited data available on breeding birds at Fort Matanzas NM, we elected to compare this suite of species to that of known breeders from the surrounding landscape.

Using the BBS data (Figure 64), 86 species were identified as breeding in the landscape surrounding Fort Matanzas NM and occurring on at least four of the six routes. A total of 55 species were found on both lists (104 species listed as either breeder or resident at Fort Matanzas NM). The Jaccard Index of Similarity between the reference breeding bird list and the breeding bird list from Fort Matanzas NM was 0.40.

A total of 25 of the 56 (~ 45%) species were deemed "acceptable" based on their observed trends in the landscape surrounding Fort Matanzas NM (from BBS data, Figure 64) and our management matrix (Table 62). The remaining species observation trends were deemed "unacceptable" in light of the management levels placed on them.

A total of 181 species were identified from the FL-GAP models as potentially occurring within the land cover classes coincident with Fort Matanzas NM (Appendix D). Of these, 100 species were documented at the monument. The Jaccard Similarity Index was calculated as 0.41 between Fort Matanzas NM birds and the FL-GAP derived reference set.

St. Johns Audubon conducted North American Migratory Counts in spring 2006, and spring and fall of 2008. We used the combined species list from the three survey periods (Appendix E) and compared it with the list for Fort Matanzas NM. A total of 144 species were documented for the Audubon surveys, of which 114 species occurred on both lists (Jaccard Index of Similarity = 0.56).

Amphibian communities, Castillo de San Marcos 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 Castillo de San Marcos NM along with reptiles (Tuberville et al. 2005). Tuberville et al. (2005) 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 four species of amphibians (all anurans) were observed for Castillo de San Marcos NM as part of this survey. This study suggests that three additional amphibian species (all anurans) have ranges coincident with this monument, 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 0.57.

We elected to use species-habitat distribution models published by the Florida Gap Analysis Project (2003). 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. Predicted species distributions were then attributed to specific land cover classes and mapped for the entire state. Castillo de San Marcos NM contains five land cover classes defined by the FL-GAP program (Sandhill Ecological Complex, Gallberry/Saw Palmetto Shrubland Compositional Group, Saltmarsh Cordgrass Marsh, Urban and Recreation).

We extracted the frogs and salamanders species whose distributions placed them within land cover classes and used that as a reference list (Appendix D).

A total of 31 species were identified from the FL-GAP models as occurring within the land cover classes coincident with Castillo de San Marcos NM. Of these, four species were documented at this monument. The Jaccard Similarity Index was calculated as 0.13 between Castillo de San Marcos NM amphibians and the FL-GAP derived reference set.

These indices reflect a relatively low overlap between the amphibians present at Castillo de San Marcos NM relative to similar habitats. That is, areas outside of the monument with similar habitat characteristics will have more species than were observed here.

Because this monument is bordered by the ocean on the east or otherwise completely surrounded by intensely developed areas, the movement of amphibians from and to the monument is difficult. So, although Castillo de San Marcos NM has relatively few frogs and salamanders this may be due to its isolation from potential immigrants rather than a degraded habitat condition.

Amphibian communities, Fort Matanzas National Monument:
A total of six species of amphibians (all anurans) were observed for Fort Matanzas NM as part of the Tuberville (2005) survey. This study suggests that four more amphibian species (three anurans, one salamander) have ranges coincident with this monument. The Jaccard Similarity Index between the observed species and the potential assemblage is 0.5. Two species, the Cuban treefrog and greenhouse frog, are documented as a record for the park, but not listed as a potential species for the Tuberville survey.

As before, we used species-habitat distribution models published by the Florida Gap Analysis Project (2003). Fort Matanzas NM contains 18 land cover classes classified by FL-GAP. We extracted the frogs and salamanders species whose distributions placed them within those land cover classes and used that as a reference list (Appendix D).

A total of 39 species were identified from the FL-GAP models as occurring within the land cover classes coincident with Fort Matanzas NM. Of these, nine species were documented at this monument. The Jaccard Similarity Index was calculated as 0.23 between Fort Matanzas NM amphibians and the FL-GAP derived reference set.

These indices reflect a relatively low overlap between the amphibians present at Fort Matanzas 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 that fewer species of amphibians and reptiles are found on coastal barrier islands than on adjacent mainland, primarily because freshwater is scarce. Since the monument is surrounded by salt water, the movement of amphibians from mainland populations and habitats to the islands is difficult. So, although Fort Matanzas National Monument has relatively few frogs and salamanders this may be due to its isolation from potential mainland immigrants rather than a degraded habitat condition.

Reptile communities, Castillo de San Marcos National Monument:
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.

Two species of reptiles are recorded present at Castillo de San Marcos NM. The survey suggests the potential for 13 additional species with overlapping ranges (although habitat may not be found at the monument). The Jaccard Similarity Index between the observed species and the potential assemblage is 0.13.

As with amphibians, we elected to utilize predicted distributions of reptile species from the FL-GAP. The FL-GAP models predict the occurrence of 62 species in all (Appendix D). Both species observed at Castillo de San Marcos NM are included, so the Jaccard Similarity Index was calculated at 0.03. The list of 60 additional species is likely comprised of several species unlikely to occur within Castillo de San Marcos NM because of a lack of appropriate habitat

Reptile communities, Fort Matanzas National Monument:
A total of 29 species of reptiles are documented present at Fort Matanzas National Monument (King and Krysko 1999). Tuberville et al (2005) suggests the potential for 15 additional species with overlapping ranges (although habitat may not be found at the monument). This yields a Jaccard Similarity Index of 0.55. There are five species listed on the park's I&M report that are not listed as potential species in the Tuberville report (*Hemidactylus garnotii, Hemidactylus turcicus, Chelonia mydas, Lepidochelys kempii, Norops sagrei).*

The FL-GAP models predict the occurrence of 77 species in all for the land cover classes present at Fort Matanzas NM (Appendix D). Of the 77 predicted species, 24 species have been observed at this monument, Jaccard Similarity Index of 0.29. Three species, Eastern box turtle, ground skink, and Eastern ribbon snake were not included in the FL-GAP list, but have been documented at Fort Matanzas NM. Additionally, King and Krysko (1999) documented four species that are not included on the parks' I&M list.

We decided to do a last comparison by synthesizing a list of reptiles that would be expected to utilize the salt marsh habitats only and compare that to the list of reptiles for Fort Matanzas NM. We generated a reference list of reptiles from Gibbons (1978 as cited in Wiegert and Freeman 1990). This list contains six species that are ubiquitous in coastal salt marshes throughout the southeast. Of these six species, one (diamondback terrapin) has been documented at Fort Matanzas NM (Jaccard Similarity Index = 0.17).

Mammal communities, Castillo de San Marcos National Monument:
The mammal community at Castillo de San Marcos NM is very small. There are three species at the monument including the domestic cat (*Felis catus*). We used the FL-GAP species distribution models as a reference list for comparison of mammals. FL-GAP models predicted the presence of 51 species for the land cover classes present at Castillo de San Marcos NM (Appendix D). All three species observed at this monument were predicted by the FL-GAP models with a low Jaccard Similarity Index of 0.06.

Mammal communities, Fort Matanzas National Monument:
There are 22 species of mammals at Fort Matanzas NM including two marine mammals, West Indian manatee (*Trichechus manatus*) and bottlenose dolphin (*Tursiops truncatus*). Non-native species include the domestic cat (*Felis catus*), domestic dog (*Canis familiaris)*, black rat *(Rattus rattus),* and house mouse *(Mus musculus)*.

We used the FL-GAP species distribution models as a reference list for comparison of mammals. FL-GAP models predicted the presence of 57 species for the land cover classes present at Fort Matanzas NM (did not include marine mammals; Appendix D). Nineteen terrestrial species observed at this monument were predicted by the FL-GAP models with a Jaccard Similarity Index of 0.32.

Wiegert and Freeman (1990) also provided a list of salt marsh mammals (derived from Sanders 1978) found in the salt marshes of the southeast. The Fort Matanzas NM list contained 11 of the 14 species on the reference list with a Jaccard Similarity Index of 0.79.

Other communities:
There are several other key biotic communities that should be examined as part of this assessment. For the salt marsh vegetation communities, fish (especially breeding salt marsh species) and invertebrates (crabs and bivalves in particular) should be considered. 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 fish species that utilize Fort Matanzas NM habitats for some period of their annual or seasonal life requisites. Castillo de San Marcos NM does not have any fish on this list because it has no water resources.

Erickson (2009) performed an analysis of the aquatic condition for Fort Matanzas NM. The analysis compared native fish species documented at this monument to native fish that occur in the watersheds based on NatureServe data. Percent similarity of native fish collected in the NPS unit was 0.19 (5/26).

Without recent field-verified studies, it is difficult to draw assessment conclusions about these biotic groups. Factors such as abundance, distribution, and health for each group or species provide the information necessary to begin to assess their condition. Further, we were unable to identify any available reference species lists appropriate for comparison to fish or plants at Fort Matanzas NM.

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 Florida as endangered, threatened, rare, or a species of greatest conservation need (SGCN) under the Florida Comprehensive Wildlife Conservation Strategy (Florida Fish and Wildlife Conservation Commission 2005a). 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 F through Appendix Q contain complete species lists with associated state and global ranks and federal and state status.

There are 17 bird species of greatest conservation need documented at Castillo de San Marcos NM (Table 63**,** Appendix N). This is 16% of the total number of species of greatest conservation need identified for Florida in the Comprehensive Wildlife Conservation Strategy (Florida Fish and Wildlife Conservation Commission 2005b).

Fort Matanzas NM supports a large number of species of greatest conservation need (Table 64**,** Appendix N). There are 29 fish, 45 bird, five mammal, and nine reptile species of greatest conservation need present within park boundaries.

Table 63. Total number of species documented at Castillo de San Marcos National Monument, number of species of greatest conservation need (SGCN) from the Florida Comprehensive Wildlife Conservation Strategy, and % of SGCN within Florida that are found at Castillo de San Marcos NM.

Taxonomic Group	*# species documented at CASA**	*# unconfirmed species*	*# SGCN in FL***	*# SGCN at CASA*	*% SGCN at CASA*
Fish	0	--	--	--	--
Birds	70	14	104	17	16%
Mammals	3	--	56	0	--
Amphibians	4	--	19	0	--
Reptiles	2	--	48	0	--
Plants	152	--	--	--	--

Table 64. Total number of species documented at Fort Matanzas National Monument, number of species of greatest conservation need (SGCN) from the Florida Comprehensive Wildlife Conservation Strategy, and % of SGCN within Florida that are found at Fort Matanzas NM.

Taxonomic Group	*# species documented at FOMA**	*# unconfirmed species*	# SGCN *in FL***	# SGCN *at FOMA*	% SGCN *at FOMA*
Fish	80	--	378	29	8%
Birds	155	17	104	45	43%
Mammals	22	--	56	5	9%
Amphibians	8	--	19	0	--
Reptiles	25	--	48	9	19%
Plants	241	--	--	--	--

*Including non-native species
** FL Comprehensive Wildlife Conservation Strategy list

At-risk marine reptiles and mammals present at Fort Matanzas NM:

- West Indian manatee (*Trichechus manatus),* federally and state-listed threatened
- Loggerhead Sea Turtle (*Caretta caretta),* federally and state-listed threatened
- Green Sea Turtle (*Chelonia mydas),* federally and state-listed endangered

- Leatherback Sea Turtle (*Dermochelys coriacea),* federally threatened and state-listed endangered
- Kemp's Ridley Sea Turtle (*Lepidochelys kempii),* federally and state-listed endangered
- Hawksbill Sea Turtle (*Eretmochelys imbricata*), federally and state-listed endangered
- Gopher Tortoise (*Gopherus polyphemus),* state-listed threatened

Other at-risk species present at Castillo de San Marcos and Fort Matanzas NMs:
- Piping Plover (*Charadrius melodus*), federally and state-listed threatened (FOMA)
- Peregrine Falcon (*Falco peregrinus)*, state-listed endangered (FOMA)
- Wood Stork (*Mycteria Americana),* federally and state-listed endangered (CASA/FOMA)
- Eastern Indigo Snake (*Drymarchon corais*), federally and state-listed threatened (FOMA)
- Anastasia Island beach mouse (*Peromyscus polionotus phasma*), federally and state-listed endangered (FOMA)

3.6.1.b Resource threats and stressors:
The biotic communities and at-risk species at Castillo de San Marcos and Fort Matanzas NMs are under constant stress from agents within and outside the monument. These threats and stressors have the ability to reduce the natural resource condition within the monument. Therefore, it is important that managers and decision makers at Castillo de San Marcos and Fort Matanzas NMs identify those threats, how they may affect the natural resource condition, and how severe and imminent they may be.

Habitat change:
The most immediate impact to nesting shorebirds (least terns and piping plover), sea turtles, and the Anastasia Island beach mouse at Fort Matanzas NM is the use of off-road vehicles on the beaches. Nationwide, beach nesting birds are rapidly declining to beach loss and disturbance to nesting birds, off-road vehicles being a primary factor (Watson 2005). The park is encouraged to limit the use to areas where birds do not nest, rest, or forage (Watson 2005, DeVivo et al. 2008).

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 Castillo de San Marcos (Table 65) and Fort Matanzas NMs (Table 66). Invasive plant species comprise 18% of all plant species at Castillo de San Marcos NM and 25% of all plant species at Fort Matanzas NM. Per discussions with park personnel, the species currently posing the largest threat to habitat at Castillo de San Marcos NM are Chinese tallow, wisteria and Japanese honeysuckle. At Fort Matanzas National Monument, invasive species of greatest concern are Brazilian pepper, sword fern, cogan grass, Lantana, box orange, and the Redbay ambrosia beetle (*Xyleborus glabratus*).

Table 65. Proportion of invasive species by taxa at Castillo de San Marcos National Monument.

Taxonomic Group	*# native species*	*# Non-native Species*	*% Non-native species*
Birds	70	3	4
Mammals	3	1	33
Amphibians	4	2	50
Reptiles	2	1	50
Plants	152	57	38

Table 66. Proportion of invasive species by taxa at Fort Matanzas National Monument.

Taxonomic Group	*# native species*	*# Non-native Species*	*% Non-native species*
Fish	80	0	0
Birds	155	5	3
Mammals	22	4	18
Amphibians	8	2	25
Reptiles	25	3	12
Plants	241	60	25

External threats and stressors:
There are many external threats to the biotic communities of Castillo de San Marcos and Fort Matanzas NMs from factors external to the boundaries, and management authority of the NPS. These factors have been covered extensively in previous sections and include:

1. Population growth resulting in an increase in recreational use at the monuments.
2. Increased point and non-point source pollution.
3. Potential decline of salt marsh habitat in the future due to sea level rise as discussed in the Water Section (3.4 Water).

3.6.1.c Critical knowledge or data gaps:
Vital Signs Program for the Southeast Coastal Network provides some guidance as to which species communities were considered important enough for future monitoring efforts.

- Complete the breeding bird inventory at Castillo de San Marcos and Fort Matanzas National Monuments,
- Additional surveys of bird species utilizing all habitats during all seasons are also needed, and
- Fish community diversity and relative abundance

The species assemblages present at Castillo de San Marcos NM do not appear to reflect the more complete biotic communities observed in the surrounding area. Relatively low similarity scores for all taxa may reflect the relatively low diversity at Castillo de San Marcos NM as a result. This is primarily due to the fact that the majority of the land cover at the monument is developed. Table 67 shows the summary of condition status and data quality.

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.

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 at both monuments (Table 67 and Table 68). An additional rating was added for bird trend acceptability based on the percentage of observed trends that were deemed "acceptable" in the landscape surrounding Castillo de San Marcos and Fort Matanzas NMs. For both monuments, bird trend acceptability received a fair condition status and the overall condition status for biological integrity is in the fair range.

Table 67. Biotic community condition status summary for Castillo de San Marcos National Monument. Data quality was rated based on *thematic* (1 = best source; 0 = not the best source), *spatial* (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		(0.30 to 0.36)	1	0	1
	Fair	0.5	2 out of 3		
Bird trend acceptability		43%	1	0	1
	Fair	0.5	2 out of 3		
Amphibian community		(0.13 to 0.57)	1	0	1
	Poor	0.17	2 out of 3		
Reptile community		(0.03 to 0.13)	1	0	1
	Poor	0.17	2 out of 3		
Mammal community		0.06	1	0	1
	Poor	0.17	2 out of 3		
Biological integrity total			5	0	5
	Poor	0.30	10 out of 15		

Table 68. Biotic community condition status summary for Fort Matanzas National Monument. Data quality was rated based on *thematic* (1 = best source; 0 = not the best source), *spatial* (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		(0.36 to 0.41)	1	0	1
	Fair	0.5		2 out of 3	
Bird trend acceptability		45%	1	0	1
	Fair	0.5		2 out of 3	
Amphibian community		(0.23 to 0.50)	1	0	1
	Fair	0.5		2 out of 3	
Reptile community		(0.29 to 0.55)	1	0	1
	Fair	0.5		2 out of 3	
Mammal community		(0.32 to 0.79)	1	0	1
	Fair	0.5		2 out of 3	
Fish community		0.19	0	1	1
	Poor	0.17		2 out of 3	
Biological integrity total			5	1	6
	Fair	0.45		12 out of 18	

3.6.1.e Recommendations to park managers:
Park managers are aware of the need for long-term monitoring data (Watson 2005, DiMatteo 2007). 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 Castillo de San Marcos NM when opportunities arise:

1. Work with NPS Inventory and Monitoring Program on breeding bird and amphibian surveys.
2. Develop and/or strengthen relationship with FL DNR, Audubon, etc.

The following are recommended projects for Fort Matanzas NM when opportunities arise:

1. Perform native plant species restoration.
2. Conduct invertebrate surveys.
3. Implement management zones to best balance visitor needs and species conservation.
4. Monitor trends in land condition. Evaluate and manage the impact of off-road vehicles on beach nesting birds, limiting this use in the interim to areas where birds do not nest, rest, or forage.

5. Conduct faunal species surveys every 2 to 3 years. If possible, concentrate on birds and herpetofauna. Focal species can be monitored in addition to some special status species (such as threatened and endangered species, game species and sensitive species).
6. Continue to conduct existing monitoring of least terns and expand to all colonial nesting species on the beaches.
7. Develop a more complete breeding fish survey in salt marsh areas.
8. Conduct water quality monitoring within the park.
9. Develop and/or strengthen relationship with FL DNR, Audubon, etc.

4.0 Summary and Conclusion

The overall condition status for Castillo de San Marcos NM is in the fair range (0.53; Table 70); Fort Matanzas NM is also in the fair range (0.65; Table 71). Midpoint scores were averaged for NPS ecological monitoring framework level 2 categories (Fancy et al. 2008) to come up with the overall condition status for the monument.

At Castillo de San Marcos NM, fire dynamics, visitor use, climate, and geology and soils scored in the good range. Fire dynamics and climate are broad-scale assessment categories upon which Castillo de San Marcos NM has limited management influence. Consistent reporting and collaboration are essential for these categories. Visitor 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 and soil attributes are positive as well.

Landscape dynamics, human effects, and water quality are all in the fair range at Castillo de San Marcos NM. Landscape dynamics and human population, in this case, mirror each other. The landscape was rated within the monument and shows open space and small tree lots offer some benefits. Human effects are plentiful in this region and impervious surface coverage for Castillo de San Marcos NM and within the subbasin study area are high. Although dissolved oxygen was good in surrounding waters, other water quality indicators are in need of improvement.

Hydrology and biological integrity for Castillo de San Marcos NM are extremely limiting. This is more than likely due to the fact and this monument is an urban-centered park, focused on cultural resource management. Despite this, some improvements could be made, and are in process, for shoreline stabilization. Additionally, air quality received a poor rating in this assessment. The poor rating was a result of elevated ozone exposure, 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 Castillo de San Marcos NM has limited management influence.

For Fort Matanzas NM, landscape dynamics, fire dynamics, human effects, visitor use, climate, and geology and soils scored in the good range. Landscape, fire, human effects, and climate are broad-scale assessment categories upon which Fort Matanzas NM has limited management influence. Consistent reporting and collaboration are essential for these categories. Visitor 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.

Biological integrity received a fair rating for Fort Matanzas NM. The species assemblages present do not appear to reflect the more complete biotic communities observed in the surrounding area. This is perhaps due to the unique habitats present at the monument and may be due in part to a lack of comprehensive survey efforts. Other categories that scored in the fair range included hydrology and water quality. Hydrology improvements could be made, and are in process, for shoreline stabilization. Water quality will need coordination with other management organizations to improve. Collecting additional water quality data within park boundaries would allow better assessment of in-park resources.

The only category for Fort Matanzas NM to receive a poor rating was air quality. 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, human effects, and climate, air quality is a broad-scale assessment category upon which Fort Matanzas NM has limited management influence.

For both monuments, 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 National Monuments 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 69) 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 69. Condition status scoring system for Castillo de San Marcos and Fort Matanzas National Monument 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 70. Overall condition status summary for Castillo de San Marcos National Monument. Data quality was rated based on *thematic* (1 = best source; 0 = not the best source), *spatial* (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 69).

Category	***Condition Status***	***Score***	***Data Quality***		
			Thematic	*Spatial*	*Temporal*
Landscape dynamics total			0	3	0
	Fair	0.39	3 out of 9		
Fire dynamics total			0	1	1
	Good	0.84	2 out of 3		
Human effects total			1	2	2
	Fair	0.34	5 out of 6		
Visitor use total			0	1	1
	Good	0.84	2 out of 3		
Air quality total			3	1	3
	Poor	0.17	7 out of 9		
Climate total			5	1	5
	Good	0.70	11 out of 15		
Hydrology total			0	6	6
	Poor	0.30	12 out of 18		
Water quality total			3	4	1
	Fair	0.54	8 out of 12		
Soil total			3	3	3
	Good	0.84	9 out of 9		
Biotic total			5	0	5
	Poor	0.30	10 out of 15		
CASA overall			20	22	27
	Fair	0.53	69 out of 99		

Table 71. Overall condition status summary for Fort Matanzas National Monument. Data quality was rated based on *thematic* (1 = best source; 0 = not the best source), *spatial* (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 69).

Category	***Condition Status***	***Score***	***Data Quality***		
			Thematic	*Spatial*	*Temporal*
Landscape dynamics total			0	3	0
	Good	0.84	3 out of 9		
Fire dynamics total			0	1	1
	Good	0.84	2 out of 3		
Human effects total			1	2	2
	Good	0.67	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
	Good	0.70	11 out of 15		
Hydrology total			0	6	6
	Fair	0.64	12 out of 18		
Water quality total			3	4	1
	Fair	0.54	8 out of 12		
Soil total			3	3	3
	Good	0.73	9 out of 9		
Biotic total			5	1	6
	Fair	0.45	12 out of 18		
FOMA overall			20	23	28
	Fair	0.65	71 out of 102		

This project provided a comprehensive amount of organized tabular data and many geospatial data layers and maps that will aid in the management of Castillo de San Marcos and Fort Matanzas NMs. 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

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 feature 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.

Brief Map Unit Description

Fort Matanzas National Monument, Florida

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

Map unit: 24 - Pellicer silty clay loam, frequently flooded

Description category: aSOI Characteristics

Pellicer silty clay loam, frequently flooded. This is a very poorly drained, nearly level soil that is in low tidal marshes along stream estuaries near the Atlantic coast. Soil areas are wide and elongated in shape. Slopes are less than 1 percent. Typically, the surface layer is very dark brown silty clay loam about 10 inches thick. Between depths of 10 and 55 inches, the material is dark

Description category: dCULtivation Limits

This soil has very low potential for vegetable crops. Daily tidal flooding, extreme wetness and a high sulfur content severely limit most crops. The high sulfur makes this soil extremely acid when dry. Reclamation is difficult requiring dikes and pumping.

Description category: hPASture and Hayland

These soils are not recommended for pasture and hayland. Soil conditions and/or current land use severly limit their suitability for the production of forage and hay crops. Limitations include excessive wetness, flooding and ponding water, restrictive soil textures and layers, and salinity.

Description category: mWOD - Woodland Mgt

These soils are not recommended for the production of pine trees. Forest management is severely limited due to equipment limitation, seedling mortality, winthrow hazard, and plant competition. Soil conditions that produce these limitations include excessive wetness, flooding and ponding water, restrictive soil textures and layers, susceptibility to compaction, and salinity.

Description category: oURB - Urban

These soils have severe limitations for building sites and community development. Wetness, flooding, and soil with shrink/swell and low strength characteristics are the primary restrictions. These conditions are not suited for urban uses.

Description category: sWQ - Water Quality

Soileach=Low and Soilrun=Medium or High These soils have a low potential for pesticide leaching to groundwater and a medium or high potential for pesticide runoff to surface water. They have a medium potential for nitrogen leaching to groundwater and a medium or high potential for nitrogen leaching to groundwater and a medium or high potential for phosphorous runoff to surface

Description category: tPES - Pesticide Mgt

The Florida Pest Control Guide from the Cooperative Extension Service contains a list of pesticides suited to each pest. This list also contains Relative Leaching Potential Index (RLPI) and Relative Runoff Potential Index (RRPI) values. While any approved pesticide listed in the guide can be used, the applicator should consider for use pesticides with a larger RLP1 value, RRPI value, Health Advisory Level (HAL or HALEQ) value, and Aquatic Toxicity value. Read and follow pesticide labels.

Description category: uNUT - Nutrient Mgt

A soil test will be used as a guide to determine plant nutrient needs. In addition, a listing of nitrogen and phosphorous requirements by crop type is available from the Cooperative Extension Service. Nutrients should be added at the rate needed by the crop grown or according to the producer's goals, whichever is lower.

Map unit: 28 - Beaches

Description category: aSOI Characteristics

Beaches. Beaches consist of long narrow strips of nearly level sand along the Atlantic Ocean. Seawater covers these areas twice daily during normal high tides. Beaches also include some small areas of low dunes that are adjacent to the narrow strips that are overwashed by tidal waves.

Description category: hPASture and Hayland

These soils are not recommended for pasture and hayland. Soil conditions and/or current land use severly limit their suitability for the production of forage and hay crops. Limitations include excessive wetness, flooding and ponding water, restrictive soil textures and layers, and salinity.

Description category: sWQ - Water Quality

Soileach and Soilrun=Medium or High These soils have a medium or high potential for pesticide leaching to groundwater and a medium to high potential for pesticide runoff to surface water. They have a medium or high potential for nitrogen leaching to the groundwater and a medium of high potential for phosphorous runoff to surface runoff.

Description category: tPES - Pesticide Mgt

The Florida Pest Control Guide from the Cooperative Extension Service contains a list of pesticides suited to each pest. This list also contains Relative Leaching Potential Index (RLPI) and Relative Runoff Potential Index (RRPI) values. While any approved pesticide listed in the guide can be used, the applicator should consider for use pesticides with a larger RLP1 value, RRPI value, Health Advisory Level (HAL or HALEQ) value, and Aquatic Toxicity value. Read and follow pesticide labels.

Description category: uNUT - Nutrient Mgt

A soil test will be used as a guide to determine plant nutrient needs. In addition, a listing of nitrogen and phosphorous requirements by crop type is available from the Cooperative Extension Service. Nutrients should be added at the rate needed by the crop grown or according to the producer's goals, whichever is lower.

Map unit: 29 - Satellite fine sand

Description category: aSOI Characteristics

Satellite fine sand. This is a somewhat poorly drained, nearly level soil in narrow to broad swales between higher relict beach sand dunes, on low knolls adjacent to drainageways, and on slight ridges in the flatwoods. Most of this soil is in the area between the Inland Waterway and Atlantic Ocean. Areas are generally elongated in shape. Slope ranges from 0 to 2 percent.

Description category: dCULtivation Limits

This soil had a medium potential for cultivated crops when intensive management and soil improving measures are utilized. A water control system is needed to provide both irrigation and drainage as needed. Soil improving cover crops should be planted after crops are harvested. Bedding of the rows is needed prior to planting crops. Fertilizer and lime should be added according to the

Description category: hPASture and Hayland

Potential for improved pasture and hayland for these soils are moderate to low. Surface ditches are needed to remove excess water during times of high rainfall. Improved pasture grasses such as Bahiagrass and Bermudagrass grow well. Regular application of fertilizer and lime are required. Grazing should be controlled to maintain plant vigor. The pasture suitability group is 9 CL.

Map unit: 29 - Satellite fine sand

Description category: mWOD - Woodland Mgt

These soils are suited to the production of slash pine. The site index for slash pine ranges from 65 to 71. Based on a site index of 68, the yield from an even-aged, fully stocked stand of 25 year old trees is 35 cords per acre. The major management concerns are for equipment limitations, seedling mortality, and plant competition.

Description category: oURB - Urban

These soils have severe limitations for building sites and community development. Wetness due to a periodic high water table is the primary restriction. Alternative designs, additional construction costs, and possible increased maintenance may help overcome the limitations. Dwellings without basements and small commercial buildings by require water control measures.

Description category: sWQ - Water Quality

Soileach=Medium or High and Soilrun=Low These soils have a medium or high potential for pesticide leaching to the groundwater and a low potential for pesticide runoff from the field(s) to surface water. They have a medium or high potential for nitrogen leaching to the groundwater and a low potential for phosphorous runoff to surface runoff.

Description category: tPES - Pesticide Mgt

The Florida Pest Control Guide from the Cooperative Extension Service contains a list of pesticides suited to each pest. This list also contains Relative Leaching Potential Index (RLPI) and Relative Runoff Potential Index (RRPI) values. While any approved pesticide listed in the guide can be used, the applicator should consider for use pesticides with a larger RLP1 value, RRPI value, Health Advisory Level (HAL or HALEQ) value, and Aquatic Toxicity value. Read and follow pesticide labels.

Description category: uNUT - Nutrient Mgt

A soil test will be used as a guide to determine plant nutrient needs. In addition, a listing of nitrogen and phosphorous requirements by crop type is available from the Cooperative Extension Service. Nutrients should be added at the rate needed by the crop grown or according to the producer's goals, whichever is lower.

Map unit: 31 - Fripp-Satellite complex

Description category: aSOI Characteristics

Fripp-Satellite complex. In this map unit are excessively drained, rolling or hilly Fripp Soil on narrow relict beach dunes and somewhat poorly drained, nearly level Satellite soil in narrow swales between areas of the Fripp soil. These soils formed in thick sandy deposits of marine origin mixed with small amounts of shell and shell fragments.

Description category: dCULtivation Limits

This soil is not suited to cultivated crops. Soil droughtiness, steep slopes, and rapid leaching of fertilizer limits this soil for this

Description category: hPASture and Hayland

This soil complex has a low potential for pasture and hayland production. Lime and fertilizer are required for maximum potential. Soil suitability group is 9 CL and 9 BL.

Brief Map Unit Description

Fort Matanzas National Monument, Florida

Map unit: 31 - Fripp-Satellite complex

Description category: mWOD - Woodland Mgt

These two soils occur in complex repeating pattern on the landscape, and possess different pine production capabilities. Slash pine is the recommended species to plant. The site index for slash pine on Fripp soils ranges from 65 to 71. Based on a site index of 68, the yield from an even-aged, fully stocked stand at 25 year old tress is 35 cords per acre.

Description category: oURB - Urban

These two soils occur in a complex, repeating pattern on the landscape, and possess different limitations for building site and community development. Fripp soils have moderate limitations for dwellings without basements, small commercial buildings, and local roads and streets. Alternative designs and additional construction costs may be required. Soil conditions are favorable for

Description category: sWQ - Water Quality

Soileach=Medium or High and Soilrun=Low. These soils have a medium or high potential for pesticide leaching to the groundwater and a low potential for pesticide runoff from the field(s) to surface water. They have a medium or high potential for nitrogen leaching to the groundwater and a low potential for phosphorous runoff to surface runoff.

Description category: tPES - Pesticide Mgt

The Florida Pest Control Guide from the Cooperative Extension Service contains a list of pesticides suited to each pest. This list also contains Relative Leaching Potential Index (RLPI) and Relative Runoff Potential Index (RRPI) values. While any approved pesticide listed in the guide can be used, the applicator should consider for use pesticides with a larger RLP1 value, RRPI value, Health Advisory Level (HAL or HALEQ) value, and Aquatic Toxicity value. Read and follow pesticide labels.

Description category: uNUT - Nutrient Mgt

A soil test will be used as a guide to determine plant nutrient needs. In addition, a listing of nitrogen and phosphorous requirements by crop type is available from the Cooperative Extension Service. Nutrients should be added at the rate needed by the crop grown or according to the producer's goals, whichever is lower.

Map unit: 45 - St. Augustine fine sand, clayey substratum

Description category: aSOI Characteristics

St. Augustine fine sand, clayey substratum. This is a somewhat poorly drained, nearly level soil on narrow to broad low flat areas, and low knolls adjacent to tidal salt marshes and estuaries along the Atlantic Coast and Intracoastal Waterway. It formed in marine sands mixed with shells and shell fragments and fragments of loamy or clayey material overlying loamy or clayey layers. This soil formed as the result of dredging operations in the Inland Waterway.

Description category: dCULtivation Limits

This soil has a low potential for cultivated crops. The root zone is limited by a water table 20 to 40 inches below the surface most of the time. Soil and water salt content adversely effect some plants.

Description category: hPASture and Hayland

These soils are not recommended for pasture and hayland. Soil conditions and/or current land use severly limit their suitability for the production of forage and hay crops. Limitations include excessive wetness, flooding and ponding water, restrictive soil textures and layers, and salinity.

Brief Map Unit Description
Fort Matanzas National Monument, Florida

Map unit: 45 - St. Augustine fine sand, clayey substratum

Description category: mWOD - Woodland Mgt

These soils are not recommended for the production of pine trees. Forest management is severely limited due to equipment limitation, seedling mortality, winthrow hazard, and plant competition. Soil conditions that produce these limitations include excessive wetness, flooding and ponding water, restrictive soil textures and layers, susceptibility to compaction, and salinity.

Description category: oURB - Urban

These soils have severe limitations for building sites and community development. Wetness and flooding are the primary restrictions. Alternative designs, additional construction costs, and possible increased maintenance may help overcome the limitations.

Description category: sWQ - Water Quality

Soileach and Soilrun=Medium or High These soils have a medium or high potential for pesticide leaching to groundwater and a medium to high potential for pesticide runoff to surface water. They have a medium or high potential for nitrogen leaching to the groundwater and a medium of high potential for phosphorous runoff to surface runoff.

Description category: tPES - Pesticide Mgt

The Florida Pest Control Guide from the Cooperative Extension Service contains a list of pesticides suited to each pest. This list also contains Relative Leaching Potential Index (RLPI) and Relative Runoff Potential Index (RRPI) values. While any approved pesticide listed in the guide can be used, the applicator should consider for use pesticides with a larger RLP1 value, RRPI value, Health Advisory Level (HAL or HALEQ) value, and Aquatic Toxicity value. Read and follow pesticide labels.

Description category: uNUT - Nutrient Mgt

A soil test will be used as a guide to determine plant nutrient needs. In addition, a listing of nitrogen and phosphorous requirements by crop type is available from the Cooperative Extension Service. Nutrients should be added at the rate needed by the crop grown or according to the producer's goals, whichever is lower.

Map unit: 49 - Moultrie fine sand, frequently flooded

Description category: aSOI Characteristics

Moultrie fine sand, frequently flooded. This very poorly drained, nearly level soil is in tidal marsh areas, generally in long narrow areas on the margins of the tidal marsh or on low islands in the tidal marsh. Slopes range from 0 to 1 percent. Typically, the surface layer is dark grayish brown fine sand about 2 inches thick.

Description category: dCULtivation Limits

This soil has a very low potential for vegetable crops. Excessive salt content and periodic tidal flooding restrict this soil for agriculture purposes.

Description category: hPASture and Hayland

These soils are not recommended for pasture and hayland. Soil conditions and/or current land use severly limit their suitability for the production of forage and hay crops. Limitations include excessive wetness, flooding and ponding water, restrictive soil textures and layers, and salinity.

Map unit: 49 - Moultrie fine sand, frequently flooded

Description category: mWOD - Woodland Mgt

These soils are not recommended for the production of pine trees. Forest management is severely limited due to equipment limitation, seedling mortality, winthrow hazard, and plant competition. Soil conditions that produce these limitations include excessive wetness, flooding and ponding water, restrictive soil textures and layers, susceptibility to compaction, and salinity.

Description category: oURB - Urban

These soils have severe limitations for building sites and community development. Wetness and flooding are the primary restrictions. Alternate designs, additional construction costs, and possible increased maintenance may help overcome the limitations. Dwellings with out basements, small commercial buildings, and local roads and streets require water control measures.

Description category: sWQ - Water Quality

Soileach and Soilrun=Medium or High These soils have a medium or high potential for pesticide leaching to groundwater and a medium to high potential for pesticide runoff to surface water. They have a medium or high potential for nitrogen leaching to the groundwater and a medium of high potential for phosphorous runoff to surface runoff.

Description category: tPES - Pesticide Mgt

The Florida Pest Control Guide from the Cooperative Extension Service contains a list of pesticides suited to each pest. This list also contains Relative Leaching Potential Index (RLPI) and Relative Runoff Potential Index (RRPI) values. While any approved pesticide listed in the guide can be used, the applicator should consider for use pesticides with a larger RLP1 value, RRPI value, Health Advisory Level (HAL or HALEQ) value, and Aquatic Toxicity value. Read and follow pesticide labels.

Description category: uNUT - Nutrient Mgt

A soil test will be used as a guide to determine plant nutrient needs. In addition, a listing of nitrogen and phosphorous requirements by crop type is available from the Cooperative Extension Service. Nutrients should be added at the rate needed by the crop grown or according to the producer's goals, whichever is lower.

Map Unit Description (Brief)
St. Johns County, Florida

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

Map unit: 51 - St. Augustine-Urban land complex

Description category: aSOI

St. Augustine-Urban land complex. This map unit consists of nearly level, somewhat poorly drained St. Augustine soils that have been used for urban development. Most areas of this unit are located near developments along the Atlantic Coast and Intracoastal Waterway. Many areas are adjacent to tidal marshes and other low areas or bodies of water from which sandy soil material has been dredged.

Description category: hPAS

These soils are not recommended for pasture and hayland. Soil conditions and/or current land use severly limit their suitability for the production of forage and hay crops. Limitations include excessive wetness, flooding and ponding water, restrictive soil textures and layers, and salinity.

Description category: oURB

These soils have severe limitations for building sites and community development. Wetness and flooding are the primary restrictions. Alternative designs, additional construction costs, and possible increased maintenance may help overcome the limitations.
Dwellings without basements, small commercial buildings, and septic tank absorption fields require water control measures.

Description category: sWQ

Soileach and Soilrun=Medium or High These soils have a medium or high potential for pesticide leaching to groundwater and a medium to high potential for pesticide runoff to surface water. They have a medium or high potential for nitrogen leaching to the groundwater and a medium of high potential for phosphorous runoff to surface runoff.

Description category: tPES

The Florida Pest Control Guide from the Cooperative Extension Service contains a list of pesticides suited to each pest. This list also contains Relative Leaching Potential Index (RLPI) and Relative Runoff Potential Index (RRPI) values. While any approved pesticide listed in the guide can be used, the applicator should consider for use pesticides with a larger RLP1 value, RRPI value, Health Advisory Level (HAL or HALEQ) value, and Aquatic Toxicity value. Read and follow pesticide labels.

Description category: uNUT

A soil test will be used as a guide to determine plant nutrient needs. In addition, a listing of nitrogen and phosphorous requirements by crop type is available from the Cooperative Extension Service. Nutrients should be added at the rate needed by the crop grown or according to the producer's goals, whichever is lower.

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

Aggregation Method: Dominant Condition
Tie-break Rule: Higher

Fort Matanzas National Monument, Florida
Survey Area Version and Date: 4 - 06/29/2006

Map symbol	Map unit name	Rating	Component name and % composition Rating reasons
24	Pellicer silty clay loam, frequently flooded	Slight	Pellicer 80%
28	Beaches	Not rated	Beaches 95%
	Satellite 5%		
29	Satellite fine sand	Slight	Satellite 90%
31	Fripp-Satellite complex	Slight	Fripp 55%
	Satellite 30%		
45	St. Augustine fine sand, clayey substratum	Slight	St. Augustine 90%
49	Moultrie fine sand, frequently flooded	Slight	Moultrie 90%
99	Water	Not rated	Water 100%
100	Waters of the Atlantic Ocean	Not rated	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

Water Features

Fort Matanzas National Monument, Florida

[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*				
24:										
Pellicer	D	Negligible	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
			June	0.0-1.0	>6.0	---	---	None	Long	Frequent
			July	0.0-1.0	>6.0	---	---	None	Long	Frequent
			August	0.0-1.0	>6.0	---	---	None	Long	Frequent
			September	0.0-1.0	>6.0	---	---	None	Long	Frequent
			October	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
Durbin	---	---	Jan-Dec			---	---	None	---	None
St. Augustine	---	---	Jan-Dec			---	---	None	---	None
Tisonia	---	---	Jan-Dec			---	---	None	---	None

Water Features

Fort Matanzas National Monument, Florida

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*				
28:										
Beaches	D	Negligible	January	0.0->6.0	>6.0	---	---	None	Very brief	Frequent
			February	0.0->6.0	>6.0	---	---	None	Very brief	Frequent
			March	0.0->6.0	>6.0	---	---	None	Very brief	Frequent
			April	0.0->6.0	>6.0	---	---	None	Very brief	Frequent
			May	0.0->6.0	>6.0	---	---	None	Very brief	Frequent
			June	0.0->6.0	>6.0	---	---	None	Very brief	Frequent
			July	0.0->6.0	>6.0	---	---	None	Very brief	Frequent
			August	0.0->6.0	>6.0	---	---	None	Very brief	Frequent
			September	0.0->6.0	>6.0	---	---	None	Very brief	Frequent
			October	0.0->6.0	>6.0	---	---	None	Very brief	Frequent
			November	0.0->6.0	>6.0	---	---	None	Very brief	Frequent
			December	0.0->6.0	>6.0	---	---	None	Very brief	Frequent
Satellite	---	---	Jan-Dec			---	---	None	---	None
29:										
Satellite	C	Negligible	June	1.0-3.5	>6.0	---	---	None	---	None
			July	1.0-3.5	>6.0	---	---	None	---	None
			August	1.0-3.5	>6.0	---	---	None	---	None
			September	1.0-3.5	>6.0	---	---	None	---	None
			October	1.0-3.5	>6.0	---	---	None	---	None
			November	1.0-3.5	>6.0	---	---	None	---	None
Fripp	---	---	Jan-Dec			---	---	None	---	None
Pompano	---	---	Jan-Dec			---	---	None	---	None
Moultrie	---	---	Jan-Dec			---	---	None	---	None

Water Features

Fort Matanzas National Monument, Florida

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*				
31:										
Fripp	A	Very low	Jan-Dec			---	---	None	---	None
Satellite	C	Negligible	June	1.0-3.5	>6.0	---	---	None	---	None
			July	1.0-3.5	>6.0	---	---	None	---	None
			August	1.0-3.5	>6.0	---	---	None	---	None
			September	1.0-3.5	>6.0	---	---	None	---	None
			October	1.0-3.5	>6.0	---	---	None	---	None
			November	1.0-3.5	>6.0	---	---	None	---	None
Narcoossee	---	---	Jan-Dec			---	---	None	---	None
Pompano	---	---	Jan-Dec			---	---	None	---	None
45:										
St. Augustine	C	Negligible	July	1.5-3.0	>6.0	---	---	None	Brief	Rare
			August	1.5-3.0	>6.0	---	---	None	Brief	Rare
			September	1.5-3.0	>6.0	---	---	None	Brief	Rare
			October	1.5-3.0	>6.0	---	---	None	Brief	Rare
Pompano	---	---	Jan-Dec			---	---	None	---	None

Water Features

Fort Matanzas National Monument, Florida

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*				
49:										
Moultrie	D	Negligible	January	0.0	>6.0	---	---	None	Long	Frequent
			February	0.0	>6.0	---	---	None	Long	Frequent
			March	0.0	>6.0	---	---	None	Long	Frequent
			April	0.0	>6.0	---	---	None	Long	Frequent
			May	0.0	>6.0	---	---	None	Long	Frequent
			June	0.0	>6.0	---	---	None	Long	Frequent
			July	0.0	>6.0	---	---	None	Long	Frequent
			August	0.0	>6.0	---	---	None	Long	Frequent
			September	0.0	>6.0	---	---	None	Long	Frequent
			October	0.0	>6.0	---	---	None	Long	Frequent
			November	0.0	>6.0	---	---	None	Long	Frequent
			December	0.0	>6.0	---	---	None	Long	Frequent
Pellicier	---	---	Jan-Dec			---	---	None	---	None
Tisonia	---	---	Jan-Dec			---	---	None	---	None
99:										
Water	---	---	Jan-Dec			---	---	None	---	None
100:										
Water	---	---	Jan-Dec			---	---	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 Matanzas National Monument, Florida
Survey Area Version and Date: 4 - 06/29/2006

Map symbol	Map unit name	Rating
24	Pellicer silty clay loam, frequently flooded	Very poorly drained
28	Beaches	Poorly drained
29	Satellite fine sand	Somewhat poorly drained
31	Fripp-Satellite complex	Excessively drained
45	St. Augustine fine sand, clayey substratum	Somewhat poorly drained
49	Moultrie fine sand, frequently flooded	Very poorly drained
99	Water	
100	Waters of the Atlantic Ocean	

USDA Natural Resources Conservation Service

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

Map Unit Hydric Rating

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

Fort Matanzas National Monument, Florida
Survey Area Version and Date: 4 - 06/29/2006

Map symbol	Map unit name	Rating
24	Pellicer silty clay loam, frequently flooded	Partially Hydric
28	Beaches	Unknown Hydric
29	Satellite fine sand	Partially Hydric
31	Fripp-Satellite complex	Not Hydric
45	St. Augustine fine sand, clayey substratum	Not Hydric
49	Moultrie fine sand, frequently flooded	All Hydric
99	Water	Unknown Hydric
100	Waters of the Atlantic Ocean	Unknown Hydric

USDA Natural Resources Conservation Service

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.

Soil Features
St. Johns County, Florida

[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	Hardiness	Initial	Total		Uncoated steel	Concrete
		In	*In*		*In*	*In*			
24:									
Pellicer	---	---	---	---	---	---	None	High	High
Durbin	---	---	---	---	12-14	15-24	None	High	High
St. Augustine	---	---	---	---	---	---	None	High	High
Tisonia	---	---	---	---	16-18	16-25	None	High	High
28:									
Beaches	---	---	---	---	---	---	None	High	High
Fripp	---	---	---	---	---	---	None	Low	Low
Pomona, nonhydric	---	---	---	---	---	---	None	High	High
Satellite	---	---	---	---	---	---	None	Low	Moderate
29:									
Satellite	---	---	---	---	---	---	None	Low	Moderate
Fripp	---	---	---	---	---	---	None	Low	Low
Moultrie	---	---	---	---	---	---	None	High	High
Pompano, nonhydric	---	---	---	---	---	---	None	High	Moderate
31:									
Fripp	---	---	---	---	---	---	None	Low	Low

Soil Features

St. Johns County, Florida

Map symbol and soil name	Restrictive layer				Subsidence		Potential for frost action	Risk of corrosion	
	Kind	Depth to top	Thickness	Hardiness	Initial	Total		Uncoated steel	Concrete
		In	*In*		*In*	*In*			
31:									
Satellite	---	---	---	---	---	---	None	Low	Moderate
Narcoossee	---	---	---	---	---	---	None	Moderate	Low
Pompano, nonhydric	---	---	---	---	---	---	None	High	Moderate
45:									
St. Augustine, clayey substratum	---	---	---	---	---	---	None	High	High
Pompano, nonhydric	---	---	---	---	---	---	None	High	Moderate
49:									
Moultrie	---	---	---	---	---	---	None	High	High
Pellicer	---	---	---	---	---	---	None	High	High
Tisonia	---	---	---	---	16-18	16-25	None	High	High
51:									
St. Augustine	---	---	---	---	---	---	None	High	High
Urban land	---	---	---	---	---	---	---	---	---
Fripp	---	---	---	---	---	---	None	Low	Low
Satellite	---	---	---	---	---	---	None	Low	Moderate
99:									
Water	---	---	---	---	---	---	---	---	---

Soil Features

St. Johns County, Florida

Map symbol and soil name	Restrictive layer				Subsidence		Potential for frost action	Risk of corrosion	
	Kind	Depth to top	Thickness	Hardiness	Initial	Total		Uncoated steel	Concrete
		In	*In*		*In*	*In*			
100:									
Water	---	---	---	---	---	---	---	---	---

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.

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Camp Areas, Picnic Areas, and Playgrounds
St. Johns County, Florida

[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: Rating class and limiting features	Value	Picnic areas: Rating class and limiting features	Value	Playgrounds: Rating class and limiting features	Value
24:							
Pellicer	90	Very limited		Very limited		Very limited	
		Depth to saturated zone	1.00	Depth to saturated zone	1.00	Depth to saturated zone	1.00
		Sodium content	1.00	Sodium content	1.00	Sodium content	1.00
		Salinity	1.00	Salinity	1.00	Salinity	1.00
		Flooding	1.00	Slow water	1.00	Flooding	1.00
		Slow water	1.00	Flooding	0.40	Slow water	1.00
Durbin	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
		Sodium content	1.00	Organic matter content	1.00	Organic matter content	1.00
		Salinity	1.00				
		Flooding	1.00	Sodium content	1.00	Sodium content	1.00
		Organic matter content	1.00	Salinity	1.00	Salinity	1.00
				Flooding	0.40	Flooding	1.00
St. Augustine	3	Very limited		Very limited		Very limited	
		Flooding	1.00	Too sandy	1.00	Too sandy	1.00
		Too sandy	1.00	Depth to saturated zone	0.03	Depth to saturated zone	0.07
		Depth to saturated zone	0.07			Gravel content	0.06
Tisonia	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
		Salinity	1.00	Organic matter content	1.00	Organic matter content	1.00
		Flooding	1.00				
		Organic matter content	1.00	Salinity	1.00	Salinity	1.00
				Slow water	1.00	Flooding	1.00
		Slow water	1.00	Flooding	0.40	Slow water	1.00
28:							
Beaches	95	Not rated		Not rated		Not rated	
Fripp	2	Very limited		Very limited		Very limited	
		Too sandy	1.00	Too sandy	1.00	Slope	1.00
		Slope	0.63	Slope	0.63	Too sandy	1.00
Pomona, nonhydric	2	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	0.99	Too sandy	1.00

Camp Areas, Picnic Areas, and Playgrounds

St. Johns County, Florida

Map symbol and soil name	Pct. of map unit	Camp areas: Rating class and limiting features	Camp areas: Value	Picnic areas: Rating class and limiting features	Picnic areas: Value	Playgrounds: Rating class and limiting features	Playgrounds: Value
28:							
Satellite	1	Very limited		Very limited		Very limited	
		Too sandy	1.00	Too sandy	1.00	Too sandy	1.00
		Depth to saturated zone	0.07	Depth to saturated zone	0.03	Depth to saturated zone	0.07
29:							
Satellite	90	Very limited		Very limited		Very limited	
		Too sandy	1.00	Too sandy	1.00	Too sandy	1.00
		Depth to saturated zone	0.07	Depth to saturated zone	0.03	Depth to saturated zone	0.07
Fripp	4	Very limited		Very limited		Very limited	
		Too sandy	1.00	Too sandy	1.00	Slope	1.00
		Slope	0.63	Slope	0.63	Too sandy	1.00
Moultrie	3	Very limited		Very limited		Very limited	
		Depth to saturated zone	1.00	Too sandy	1.00	Depth to saturated zone	1.00
		Sodium content	1.00	Depth to saturated zone	1.00	Too sandy	1.00
		Salinity	1.00	Sodium content	1.00	Sodium content	1.00
		Flooding	1.00	Salinity	1.00	Salinity	1.00
		Too sandy	1.00	Flooding	0.40	Flooding	1.00
Pompano, nonhydric	3	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	0.99	Too sandy	1.00
31:							
Fripp	55	Very limited		Very limited		Very limited	
		Too sandy	1.00	Too sandy	1.00	Slope	1.00
		Slope	0.63	Slope	0.63	Too sandy	1.00
Satellite	30	Very limited		Very limited		Very limited	
		Too sandy	1.00	Too sandy	1.00	Too sandy	1.00
		Depth to saturated zone	0.07	Depth to saturated zone	0.03	Depth to saturated zone	0.07
Narcoossee	10	Very limited		Very limited		Very limited	
		Too sandy	1.00	Too sandy	1.00	Too sandy	1.00
Pompano, nonhydric	5	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	0.99	Too sandy	1.00

Camp Areas, Picnic Areas, and Playgrounds

St. Johns County, Florida

Map symbol and soil name	Pct. of map unit	Camp areas: Rating class and limiting features	Camp areas: Value	Picnic areas: Rating class and limiting features	Picnic areas: Value	Playgrounds: Rating class and limiting features	Playgrounds: Value
45:							
St. Augustine, clayey substratum	90	Very limited		Very limited		Very limited	
		Flooding	1.00	Too sandy	1.00	Too sandy	1.00
		Too sandy	1.00	Depth to saturated zone	0.03	Depth to saturated zone	0.07
		Depth to saturated zone	0.07			Gravel content	0.06
Pompano, nonhydric	10	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	0.99	Too sandy	1.00
49:							
Moultrie	90	Very limited		Very limited		Very limited	
		Depth to saturated zone	1.00	Too sandy	1.00	Depth to saturated zone	1.00
		Sodium content	1.00	Depth to saturated zone	1.00	Too sandy	1.00
		Salinity	1.00	Sodium content	1.00	Sodium content	1.00
		Flooding	1.00	Salinity	1.00	Salinity	1.00
		Too sandy	1.00	Flooding	0.40	Flooding	1.00
Pellicer	5	Very limited		Very limited		Very limited	
		Depth to saturated zone	1.00	Depth to saturated zone	1.00	Depth to saturated zone	1.00
		Sodium content	1.00	Sodium content	1.00	Sodium content	1.0
		Flooding	1.00	Slow water	1.00	Flooding	1.00
		Slow water	1.00	Flooding	0.40	Slow water	1.00
Tisonia	5	Very limited		Very limited		Very limited	
		Depth to saturated zone	1.00	Depth to saturated zone	1.00	Depth to saturated zone	1.00
		Salinity	1.00	Organic matter content	1.00	Organic matter content	1.00
		Flooding	1.00	Salinity	1.00	Salinity	1.00
		Organic matter content	1.00	Slow water	1.00	Flooding	1.00
		Slow water	1.00	Flooding	0.40	Slow water	1.00
51:							
St. Augustine	55	Very limited		Very limited		Very limited	
		Flooding	1.00	Too sandy	1.00	Too sandy	1.00
		Too sandy	1.00	Depth to saturated zone	0.03	Depth to saturated zone	0.07
		Depth to saturated zone	0.07			Gravel content	0.06
Urban land	35	Not rated		Not rated		Not rated	

Camp Areas, Picnic Areas, and Playgrounds

St. Johns County, Florida

Map symbol and soil name	Pct. of map unit	Camp areas: Rating class and limiting features	Camp areas: Value	Picnic areas: Rating class and limiting features	Picnic areas: Value	Playgrounds: Rating class and limiting features	Playgrounds: Value
51:							
Fripp	5	Very limited		Very limited		Very limited	
		Too sandy	1.00	Too sandy	1.00	Slope	1.00
		Slope	0.63	Slope	0.63	Too sandy	1.00
Satellite	5	Very limited		Very limited		Very limited	
		Too sandy	1.00	Too sandy	1.00	Too sandy	1.00
		Depth to saturated zone	0.07	Depth to saturated zone	0.03	Depth to saturated zone	0.07
99:							
Water	100	Not rated		Not rated		Not rated	
100:							
Water	100	Not rated		Not rated		Not rated	

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

St. Johns County, Florida

[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
24:							
Pellicer	90	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	Salinity	1.00
						Sodium content	1.00
						Depth to saturated zone	1.00
						Sulfur content	1.00
Durbin	4	Very limited		Very limited		Very limited	
		Depth to saturated zone	1.00	Depth to saturated zone	1.00	Flooding	1.00
		Organic matter content	1.00	Organic matter content	1.00	Organic matter content	1.00
		Flooding	0.40	Flooding	0.40	Salinity	1.00
						Sodium content	1.00
						Depth to saturated zone	1.00
St. Augustine	3	Very limited		Very limited		Somewhat limited	
		Too sandy	1.00	Too sandy	1.00	Droughty	0.69
						Depth to saturated zone	0.03
Tisonia	3	Very limited		Very limited		Very limited	
		Depth to saturated zone	1.00	Depth to saturated zone	1.00	Flooding	1.00
		Organic matter content	1.00	Organic matter content	1.00	Salinity	1.00
		Flooding	0.40	Flooding	0.40	Depth to saturated zone	1.00
						Sulfur content	1.00
28:							
Beaches	95	Not rated		Not rated		Not rated	
Fripp	2	Very limited		Very limited		Very limited	
		Too sandy	1.00	Too sandy	1.00	Droughty	1.00
						Slope	0.63
Pomona, nonhydric	2	Very limited		Very limited		Very limited	
		Too sandy	1.00	Too sandy	1.00	Depth to saturated zone	0.99
		Depth to saturated zone	0.99	Depth to saturated zone	0.99	Droughty	0.30

Paths, Trails, and Golf Fairways

St. Johns County, Florida

Map symbol and soil name	Pct. of map unit	Paths and trails: Rating class and limiting features	Value	Off-road motorcycle trails: Rating class and limiting features	Value	Golf fairways: Rating class and limiting features	Value
28:							
Satellite	1	Very limited		Very limited		Very limited	
		Too sandy	1.00	Too sandy	1.00	Droughty	1.00
						Depth to saturated zone	0.03
29:							
Satellite	90	Very limited		Very limited		Very limited	
		Too sandy	1.00	Too sandy	1.00	Droughty	1.00
						Depth to saturated zone	0.03
Fripp	4	Very limited		Very limited		Very limited	
		Too sandy	1.00	Too sandy	1.00	Droughty	1.00
						Slope	0.63
Moultrie	3	Very limited		Very limited		Very limited	
		Depth to saturated zone	1.00	Depth to saturated zone	1.00	Flooding	1.00
						Salinity	1.00
		Too sandy	1.00	Too sandy	1.00	Sodium content	1.00
		Flooding	0.40	Flooding	0.40	Depth to saturated zone	1.00
						Droughty	0.97
Pompano, nonhydric	3	Very limited		Very limited		Very limited	
		Too sandy	1.00	Too sandy	1.00	Droughty	1.00
		Depth to saturated zone	0.99	Depth to saturated zone	0.99	Depth to saturated zone	0.99
31:							
Fripp	55	Very limited		Very limited		Very limited	
		Too sandy	1.00	Too sandy	1.00	Droughty	1.00
						Slope	0.63
Satellite	30	Very limited		Very limited		Very limited	
		Too sandy	1.00	Too sandy	1.00	Droughty	1.00
						Depth to saturated zone	0.03
Narcoossee	10	Very limited		Very limited		Somewhat limited	
		Too sandy	1.00	Too sandy	1.00	Droughty	0.65
Pompano, nonhydric	5	Very limited		Very limited		Very limited	
		Too sandy	1.00	Too sandy	1.00	Droughty	1.00
		Depth to saturated zone	0.99	Depth to saturated zone	0.99	Depth to saturated zone	0.99

Paths, Trails, and Golf Fairways
St. Johns County, Florida

Map symbol and soil name	Pct. of map unit	Paths and trails: Rating class and limiting features	Value	Off-road motorcycle trails: Rating class and limiting features	Value	Golf fairways: Rating class and limiting features	Value
45:							
St. Augustine, clayey substratum	90	Very limited		Very limited		Somewhat limited	
		Too sandy	1.00	Too sandy	1.00	Droughty	0.38
						Depth to saturated zone	0.03
Pompano, nonhydric	10	Very limited		Very limited		Very limited	
		Too sandy	1.00	Too sandy	1.00	Droughty	1.00
		Depth to saturated zone	0.99	Depth to saturated zone	0.99	Depth to saturated zone	0.99
49:							
Moultrie	90	Very limited		Very limited		Very limited	
		Depth to saturated zone	1.00	Depth to saturated zone	1.00	Flooding	1.00
						Salinity	1.00
		Too sandy	1.00	Too sandy	1.00	Sodium content	1.00
		Flooding	0.40	Flooding	0.40	Depth to saturated zone	1.00
						Droughty	0.97
Pellicer	5	Very limited		Very limited		Very limited	
		Depth to saturated zone	1.00	Depth to saturated zone	1.00	Flooding	1.00
						Salinity	1.00
		Flooding	0.40	Flooding	0.40	Sodium content	1.00
						Depth to saturated zone	1.00
						Sulfur content	1.00
Tisonia	5	Very limited		Very limited		Very limited	
		Depth to saturated zone	1.00	Depth to saturated zone	1.00	Flooding	1.00
						Salinity	1.00
		Organic matter content	1.00	Organic matter content	1.00	Depth to saturated zone	1.00
		Flooding	0.40	Flooding	0.40	Sulfur content	1.00
51:							
St. Augustine	55	Very limited		Very limited		Somewhat limited	
		Too sandy	1.00	Too sandy	1.00	Droughty	0.48
						Depth to saturated zone	0.03
Urban land	35	Not rated		Not rated		Not rated	
Fripp	5	Very limited		Very limited		Very limited	
		Too sandy	1.00	Too sandy	1.00	Droughty	1.00
						Slope	0.63

Paths, Trails, and Golf Fairways

St. Johns County, Florida

Map symbol and soil name	Pct. of map unit	Paths and trails: Rating class and limiting features	Value	Off-road motorcycle trails: Rating class and limiting features	Value	Golf fairways: Rating class and limiting features	Value
51:							
Satellite	5	Very limited		Very limited		Very limited	
		Too sandy	1.00	Too sandy	1.00	Droughty	1.00
						Depth to saturated zone	0.03
99:							
Water	100	Not rated		Not rated		Not rated	
100:							
Water	100	Not rated		Not rated		Not rated	

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 from habitat distribution models published by the Florida Gap Analysis Project (2003).

FL GAP Birds (reference for Castillo de San Marcos National Monument):

American Coot
American Crow
American Kestrel
American Oystercatcher
American Redstart
American Robin
American Woodcock
Anhinga
American Swallow-tailed Kite
Bald Eagle
Barred Owl
Bachman's Sparrow
Barn Swallow
Black-crowned Night-Heron
Blue-crowned Parakeet
Belted Kingfisher
Blue-gray Gnatcatcher
Blue-and-yellow Macaw
Brown-headed Cowbird
Brown-headed Nuthatch
Black-hooded Parakeet
Blue Grosbeak
Blue Jay
Black Rail
Black Swan
Black Vulture
Black-necked Stilt
Brown Thrasher
Boat-tailed Grackle
Budgerigar
Burrowing Owl
Black-whiskered Vireo
Carolina Chickadee
Cave Swallow
Carolina Wren
Chesnut-fronted Macaw
Chipping Sparrow
Chimney Swift
Clapper Rail
Barn Owl
Common Ground-Dove
Common Grackle
Cooper's Hawk
Common Moorhen
Common Myna
Common Nighthawk
Common Yellowthroat
Crested Myna
Canary-winged Parakeet
Chuck-will's-widow
Double-crested Cormorant
Dusky-headed Parakeet
Downy Woodpecker
Eastern Bluebird
Eastern Kingbird
Eastern Meadowlark
Eastern Phoebe
Eastern Screech-Owl
Eastern Wood-Pewee
Egyptian Goose
European Starling
Fish Crow
Field Sparrow
Great Blue Heron
Gull-billed Tern
Great Crested Flycatcher
Green-cheeked Parakeet
Great Horned Owl
Glossy Ibis
Gray Catbird
Great Egret
Green-backed Heron
Gray Kingbird
Great White Heron
Hairy Woodpecker
Hill Myna
Hispaniolan Parrot
House Finch
House Sparrow
Indigo Bunting

Kentucky Warbler
Killdeer
King Rail
Little Blue Heron
Least Bittern
Least Tern
Limpkin
Loggerhead Shrike
Mangrove Cuckoo
Mallard
Marsh Wren
Mississippi Kite
Mitred Parakeet
Mourning Dove
Mottled Duck
Monk Parakeet
Mute Swan
Northern Parula
Northern Rough-winged Swallow
Orange-fronted Parakeet
Orchard Oriole
Osprey
Orange-winged Parrot
Painted Bunting
Pied-billed Grebe
Pine Warbler
Pileated Woodpecker
Prairie Warbler
Purple Martin
Red-bellied Woodpecker
Red-crested Cardinal
Red-crowned Parrot
Red-cockaded Woodpecker
Reddish Egret
Red-headed Woodpecker
Ringed Turtle-Dove
Red-lored Parrot
Red-masked Parakeet
Rock Dove
Roseate Spoonbill
Rose-ringed Parakeet
Red-shouldered Hawk
Eastern Towhee
Red-tailed Hawk
Ruby-throated Hummingbird
Red-winged Blackbird
Red-whiskered Bulbul
Smooth-billed Ani
Spot-breasted Oriole
Scrub Jay
Seaside Sparrow
Shiny Cowbird
Snowy Egret
Short-tailed Hawk
Summer Tanager
Swainson's Warbler
Turquoise-fronted Parrot
Tricolored Heron
Tufted Titmouse
Turkey Vulture
White-breasted Nuthatch
White-eyed Parakeet
White-eyed Vireo
White-fronted Parrot
White Ibis
Willet
Wilson's Plover
Wood Stork
Wood Thrush
White-winged Dove
Yellow-breasted Chat
Yellow-billed Cuckoo
Yellow-crowned Night-Heron
Yellow-crowned Parrot
Yellow-headed Parrot
Yellow-throated Vireo
Yellow-throated Warbler

FL GAP Birds (reference for Fort Matanzas National Monument):

Acadian Flycatcher
American Coot
American Crow
American Kestrel
American Oystercatcher
American Redstart
American Robin
American Woodcock
Anhinga
American Swallow-tailed Kite
Bald Eagle
Barred Owl
Bachman's Sparrow
Barn Swallow
Black-bellied Whistling-Duck
Black-crowned Night-Heron
Blue-crowned Parakeet
Belted Kingfisher
Blue-gray Gnatcatcher
Blue-and-yellow Macaw
Brown-headed Cowbird
Brown-headed Nuthatch
Black-hooded Parakeet
Blue Grosbeak
Blue Jay
Black Rail
Black Skimmer
Black Swan
Black Vulture
Black-necked Stilt
Brown Pelican
Bridled Tern
Brown Thrasher
White-tailed Kite
Boat-tailed Grackle
Budgerigar
Burrowing Owl
Broad-winged Hawk
Black-whiskered Vireo
Carolina Chickadee
Cave Swallow
Caspian Tern
Carolina Wren
Chesnut-fronted Macaw
Chipping Sparrow
Chimney Swift
Clapper Rail
Barn Owl
Common Ground-Dove
Common Grackle
Cooper's Hawk
Common Moorhen
Common Myna
Common Nighthawk
Common Yellowthroat
Crested Caracara
Crested Myna
Canary-winged Parakeet
Chuck-will's-widow
Double-crested Cormorant
Dusky-headed Parakeet
Downy Woodpecker
Eastern Bluebird
Eastern Kingbird
Eastern Meadowlark
Eastern Phoebe
Eastern Screech-Owl
Eastern Wood-Pewee
Egyptian Goose
European Starling
Fish Crow
Field Sparrow
Great Blue Heron
Gull-billed Tern
Great Crested Flycatcher
Green-cheeked Parakeet
Great Horned Owl
Glossy Ibis
Gray Catbird
Great Egret
Green-backed Heron
Gray Kingbird
Grasshopper Sparrow
Great White Heron

Hairy Woodpecker
Hill Myna
Hispaniolan Parrot
House Finch
House Sparrow
Indigo Bunting
Kentucky Warbler
Killdeer
King Rail
Laughing Gull
Little Blue Heron
Least Bittern
Least Tern
Limpkin
Loggerhead Shrike
Louisiana Waterthrush
Masked Booby
Mangrove Cuckoo
Mallard
Marsh Wren
Mississippi Kite
Mitred Parakeet
Mourning Dove
Mottled Duck
Monk Parakeet
Mute Swan
Northern Parula
Northern Rough-winged Swallow
Orange-fronted Parakeet
Orchard Oriole
Osprey
Orange-winged Parrot
Painted Bunting
Pied-billed Grebe
Pine Warbler
Pileated Woodpecker
Prothonotary Warbler
Prairie Warbler
Purple Martin
Red-bellied Woodpecker
Red-crested Cardinal
Red-crowned Parrot
Red-cockaded Woodpecker
Reddish Egret
Red-eyed Vireo
Red-headed Woodpecker
Ringed Turtle-Dove
Red-lored Parrot
Red-masked Parakeet
Rock Dove
Roseate Spoonbill
Royal Tern
Rose-ringed Parakeet
Red-shouldered Hawk
Rufous-sided Towhee
Red-tailed Hawk
Ruby-throated Hummingbird
Red-winged Blackbird
Red-whiskered Bulbul
Sandhill Crane
Sandwich Tern
Smooth-billed Ani
Spot-breasted Oriole
Scrub Jay
Seaside Sparrow
Shiny Cowbird
Snowy Egret
Snowy Plover
Short-tailed Hawk
Summer Tanager
Swainson's Warbler
Turquoise-fronted Parrot
Tricolored Heron
Tufted Titmouse
Turkey Vulture
White-breasted Nuthatch
White-crowned Pigeon
White-eyed Parakeet
White-eyed Vireo
Worm-eating Warbler
White-fronted Parrot
White Ibis
Willet
Wilson's Plover
Wild Turkey
Wood Duck

Wood Stork
Wood Thrush
White-winged Dove
Yellow-breasted Chat
Yellow-billed Cuckoo
Yellow-crowned Night-Heron
Yellow-crowned Parrot
Yellow Warbler
Yellow-headed Parrot
Yellow-throated Vireo
Yellow-throated Warbler

FL GAP Reptiles (reference for Castillo de San Marcos National Monument):

Copperhead
Cottonmouth
American alligator
Jungle runner
Green anole
Anole
Crested anole
Large-headed anole
Bark anole
Knight anole
Jamaican giant anole
Brown anole
Brown basilisk
Scarlet snake
Rainbow whiptail
Racerunner
Racer
Eastern diamondback
Timber rattlesnake
Spiny-tailed iguana
Ringneck snake
Indigo snake
Corn snake
Rat snake
Mole skink
Five-lined skink
Southeastern five-lined skink
Broad-headed skink
Tokay gecko
Yellow-headed gecko
Gopher tortoise
Indo-pacific gecko
Common house gecko
Medditeranian gecko
Eastern hognose snake
Southern hognose snake
Common iguana
Prairie kingsnake
Common kingsnake
Milk snake
Curly-tailed lizard
Hispaniolan curly-tailed lizard
Coachwhip
Diamondback terrapin
Eastern coral snake
Gulf salt marsh snake
Banded water snake
Brown water snake
Rough green snake
Slender glass lizard
Island glass lizard
Mimic glass lizard
Eastern glass lizard
Texas horned lizard
Pine-gopher snake
Suwannee cooter
Peninsula cooter
Florida redbelly turtle
Glossy crayfish snake
Queen snake
Pine woods snake
Worm lizard

FL GAP Reptiles (reference for Fort Matanzas National Monument):

Copperhead
Cottonmouth
American alligator
Jungle runner
Green anole
Anole
Crested anole
Large-headed anole
Bark anole
Knight anole
Jamaican giant anole
Brown anole
Florida softshell
Gulf Coast smooth softshell
Gulf Coast spiny softshell
Brown basilisk
Loggerhead
Spectacled caiman
Scarlet snake
Green turtle
Common snapping turtle
Spotted turtle
Rainbow whiptail
Racerunner
Racer
Eastern diamondback
Timber rattlesnake
Spiny-tailed iguana
Chicken turtle
Atlantic leatherback
Ringneck snake
Indigo snake
Corn snake
Rat snake
Coal skink
Mole skink
Five-lined skink
Southeastern five-lined skink
Broad-headed skink
Tokay gecko
Yellow-headed gecko
Gopher tortoise
Indo-pacific gecko
Common house gecko
Medditeranian gecko
Eastern hognose snake
Southern hognose snake
Common iguana
Striped mud turtle
Mud turtle
Prairie kingsnake
Common kingsnake
Milk snake
Curly-tailed lizard
Hispaniolan curly-tailed lizard
Coachwhip
Diamondback terrapin
Eastern coral snake
Sand skink
Gulf salt marsh snake
Banded water snake
Florida green water snake
Brown water snake
Rough green snake
Slender glass lizard
Island glass lizard
Mimic glass lizard
Eastern glass lizard
Texas horned lizard
Pine-gopher snake
Suwannee cooter
Peninsula cooter
Florida redbelly turtle
Glossy crayfish snake
Queen snake
Pine woods snake
Worm lizard

FL GAP Amphibians (reference for Castillo de San Marcos National Monument):

Flatwoods salamander
Tiger salamander
Giant toad
Oak toad
Southern toad
Woodhouse's toad
Peurto Rican coqui
Greenhouse frog
Dwarf salamander
Eastern narrow-mouthed frog
Pine barrons treefrog
Bird-voiced treefrog
Green treefrog
Pine woods treefrog
Barking treefrog
Squirrel treefrog
Cuban treefrog
Southern chorus frog
Ornate chorus frog
Chorus frog
Mud salamander
Red salamander
Gopher frog
Bullfrog
Green frog
Pig frog
River frog
Florida bog frog
Leopard frog
Carpenter frog
Eastern spadefoot

FL GAP Amphibians (reference for Fort Matanzas National Monument):

Northern cricket frog
Southern cricket frog
Flatwoods salamander
Many-lined salamander
Mole salamander
Tiger salamander
Giant toad
Oak toad
Southern toad
Woodhouse's toad
Southern dusky salamander
Peurto Rican coqui
Greenhouse frog
Southern two-lined salamander
Long-tailed salamander
Dwarf salamander
Eastern narrow-mouthed toad
Four-toed salamander
Pine barrons treefrog
Bird-voiced treefrog
Green treefrog
Pine woods treefrog
Barking treefrog
Squirrel treefrog
Striped newt
Eastern newt
Cuban treefrog
Southern chorus frog
Ornate chorus frog
Chorus frog
Dwarf siren
Gopher frog
Green frog
Pig frog
River frog
Florida bog frog
Leopard frog
Carpenter frog
Eastern spadefoot

FL GAP Mammals (reference for Castillo de San Marcos National Monument):

Jamaican fruit bat
Sherman's short tailed shrew
domestic dog (feral)
Coyote
sambar deer
least shrew
nine-band armadillo
virginia oppossum
big brown bat
domestic cat (feral)
Panther
Bobcat
southeast pocket gopher
southern flying squirrel
eastern red bat
Northern yellow bat
seminole bat
northern river otter
striped skunk
pine vole
common house bat
long-tailed weasal
house mouse
Mink
round-tailed muskrat
evening bat
golden mouse
white-tailed deer
silver rice rat
marsh rice rat
cotton mouse
oldfield mouse
eastern pipistrelle
Florida mouse
common raccoon
Norway rat
black rat
eastern harvest mouse
eastern mole
eastern grey squirrel
eastern fox squirrel
hispid cotton rat
southeastern shrew
eastern spotted skunk
wild boar
eastern cottontail
marsh rabbit
Brazilian free-tailed bat
black bear
gray fox
red fox

FL GAP Mammals (reference for Fort Matanzas National Monument):

Jamaican fruit bat
Sherman's short tailed shrew
domestic dog (feral)
Coyote
sambar deer
least shrew
nine-band armadillo
virginia opossum
big brown bat
mastiff bat
domestic cat (feral)
Panther
Bobcat
southeast pocket gopher
southern flying squirrel
eastern red bat
Northern yellow bat
seminole bat
northern river otter
striped skunk
meadow vole
pine vole
common house bat
long-tailed weasal
house mouse
Mink
southeastern myotis
round-tailed muskrat
eastern woodrat
evening bat
golden mouse
white-tailed deer
silver rice rat
marsh rice rat
cotton mouse
oldfield mouse
eastern pipistrelle
Southeastern big-eared bat
Florida mouse
common raccoon
Norway rat
black rat
eastern harvest mouse
eastern mole
eastern grey squirrel
eastern fox squirrel
hispid cotton rat
southeastern shrew
eastern spotted skunk
wild boar
eastern cottontail
marsh rabbit
Brazilian free-tailed bat
eastern chipmunk
black bear
gray fox
red fox

Appendix E: Reference bird species lists from St. Johns County Audubon (2008) North American Migratory Counts in spring 2006, spring 2008, and fall 2008.

Spring 2006 St. Johns Aubodbon reference bird list:

Red-throated Loon
Pacific Loon
Common Loon
loon sp.
Pied-billed Grebe
Horned Grebe
Aechmophorus sp.
Northern Gannet
American White Pelican
Brown Pelican
Great Cormorant
Double-crested Cormorant
Anhinga
Magnificent Frigatebird
American Bittern
Least Bittern
Great Blue Heron
    Wurdemann's form
    Great White Heron
Great Egret
Snowy Egret
Little Blue Heron
Tricolored Heron
Reddish Egret
    White form
Cattle Egret
Green Heron
Black-crowned Night-Heron
Yellow-crowned Night-Heron
night-heron sp.
White Ibis
Glossy Ibis
White-faced Ibis
Plegadis sp.
Roseate Spoonbill
Wood Stork
Greater Flamingo
Fulvous Whistling Duck
Black-bellied Whistling Duck
Canada Goose
Muscovy Duck
Wood Duck
Green-winged Teal
Mottled Duck
Mallard
White-cheeked Pintail
Northern Pintail
Blue-winged Teal
Cinnamon Teal
Northern Shoveler
Gadwall
Eurasian Wigeon
American Wigeon
Canvasback
Redhead
Ring-necked Duck
Greater Scaup
Lesser Scaup
scaup sp.
Common Eider
King Eider
Bufflehead
Hooded Merganser
Common Merganser
Red-breasted Merganser
Ruddy Duck
Black Vulture
Turkey Vulture
Osprey
Swallow-tailed Kite
White-tailed Kite
Snail Kite
Mississippi Kite
Bald Eagle
Northern Harrier
Sharp-shinned Hawk
Cooper's Hawk
accipiter sp.
Red-shouldered Hawk
Broad-winged Hawk

Short-tailed Hawk
Swainson's Hawk
Red-tailed Hawk
    Harlan's form
    Krider's form
buteo sp.
Golden Eagle
Crested Caracara
American Kestrel
Merlin
Peregrine Falcon
Wild Turkey
Northern Bobwhite
Yellow Rail
Black Rail
Clapper Rail
King Rail
large rail sp.
Virginia Rail
Sora
Purple Gallinule
Common Moorhen
American Coot
Limpkin
Sandhill Crane
Whooping Crane
Black-bellied Plover
American Golden-Plover
Snowy Plover
Wilson's Plover
Semipalmated Plover
Piping Plover
Killdeer
American Oystercatcher
Black-necked Stilt
American Avocet
Greater Yellowlegs
Lesser Yellowlegs
Solitary Sandpiper
Willet
Spotted Sandpiper
Upland Sandpiper
Whimbrel
Long-billed Curlew
Hudsonian Godwit
Marbled Godwit
Ruddy Turnstone
Red Knot
Sanderling
Semipalmated Sandpiper
Western Sandpiper
Least Sandpiper
White-rumped Sandpiper
Baird's Sandpiper
peep sp.
Pectoral Sandpiper
Purple Sandpiper
Dunlin
Curlew Sandpiper
Stilt Sandpiper
Buff-breasted Sandpiper
Ruff
Short-billed Dowitcher
Long-billed Dowitcher
dowitcher sp.
Common Snipe
American Woodcock
Wilson's Phalarope
Pomarine Jaeger
Parasitic Jaeger
Long-tailed Jaeger
jaeger sp.
Laughing Gull
Franklin's Gull
Black-headed Gull
Bonaparte's Gull
Ring-billed Gull
Herring Gull
Lesser Black-backed Gull
Great Black-backed Gull
Black-legged Kittiwake
gull sp.
Gull-billed Tern
Caspian Tern

Royal Tern
Sandwich Tern
Roseate Tern
Common Tern
Forster's Tern
Least Tern
Bridled Tern
Sooty Tern
Black Tern
Brown Noddy
Black Noddy
Black Skimmer
Rock Dove
White-crowned Pigeon
Ringed Turtle-Dove
Eurasian Collared Dove
White-winged Dove
Mourning Dove
Common Ground-Dove
Key West Quail-Dove
Red-crowned Parrot
Lilac-crowned Parrot
Yellow-crowned Parrot
White-fronted Parrot
Mealy Parrot
Orange-winged Parrot
Blue-crowned Parakeet
Red-masked Parakeet
Green Parakeet
Mitred Parakeet
Dusky-headed Parakeet
Orange-fronted Parakeet
Black-hooded Parakeet
Yellow-chevroned Parakeet
Canary-winged Parakeet
Budgerigar
Monk Parakeet
Black-billed Cuckoo
Yellow-billed Cuckoo
Mangrove Cuckoo
Smooth-billed Ani
Groove-billed Ani

Barn Owl
Eastern Screech-Owl
Great Horned Owl
Burrowing Owl
Barred Owl
Common Nighthawk
Antillean Nighthawk
Chuck-will's-widow
Whip-poor-will
Chimney Swift
Vaux's Swift
Ruby-throated Hummingbird
Belted Kingfisher
Red-headed Woodpecker
Red-bellied Woodpecker
Yellow-bellied Sapsucker
Downy Woodpecker
Hairy Woodpecker
Red-cockaded Woodpecker
Northern Flicker
    Yellow-shafted Flicker
    Red-shafted Flicker
Pileated Woodpecker
Olive-sided Flycatcher
Eastern Wood-Pewee
Acadian Flycatcher
Eastern Phoebe
Vermilion Flycatcher
Ash-throated Flycatcher
Great Crested Flycatcher
Western Kingbird
Eastern Kingbird
Gray Kingbird
Scissor-tailed Flycatcher
Fork-tailed Flycatcher
Purple Martin
Tree Swallow
Northern Rough-winged Swallow
Bank Swallow
Cliff Swallow
Cave Swallow
Barn Swallow

Blue Jay
Florida Scrub Jay
American Crow
Fish Crow
crow sp.
Carolina Chickadee
Tufted Titmouse
Red-breasted Nuthatch
White-breasted Nuthatch
Brown-headed Nuthatch
Brown Creeper
Red-whiskered Bulbul
Carolina Wren
Bewick's Wren
House Wren
Winter Wren
Sedge Wren
Marsh Wren
Golden-crowned Kinglet
Ruby-crowned Kinglet
Blue-gray Gnatcatcher
Eastern Bluebird
Veery
Gray-cheeked Thrush
Bicknell's Thrush
Swainson's Thrush
Hermit Thrush
Wood Thrush
American Robin
Gray Catbird
Northern Mockingbird
Bahama Mockingbird
Brown Thrasher
Cedar Waxwing
Loggerhead Shrike
European Starling
Common Myna
Crested Myna
Hill Myna
White-eyed Vireo
Bell's Vireo
Blue-headed Vireo
Yellow-throated Vireo
Warbling Vireo
Philadelphia Vireo
Red-eyed Vireo
Black-whiskered Vireo
Blue-winged Warbler
  Brewster's Hybrid
  Lawrence's Hybrid
Golden-winged Warbler
Tennessee Warbler
Orange-crowned Warbler
Nashville Warbler
Northern Parula
Yellow Warbler
Chestnut-sided Warbler
Magnolia Warbler
Cape May Warbler
Black-throated Blue Warbler
Yellow-rumped Warbler
Black-throated Green Warbler
Blackburnian Warbler
Yellow-throated Warbler
  yellow-lored form
  white-lored form
Pine Warbler
Kirtland's Warbler
Prairie Warbler
Palm Warbler
  Yellow Palm Warbler
  Western Palm Warbler
Bay-breasted Warbler
Blackpoll Warbler
Cerulean Warbler
Black-and-white Warbler
American Redstart
Prothonotary Warbler
Worm-eating Warbler
Swainson's Warbler
Ovenbird
Northern Waterthrush
Louisiana Waterthrush
Kentucky Warbler

Connecticut Warbler
Mourning Warbler
Common Yellowthroat
Hooded Warbler
Wilson's Warbler
Canada Warbler
Yellow-breasted Chat
Stripe-headed Tanager
Bananaquit
Summer Tanager
Scarlet Tanager
Western Tanager
Northern Cardinal
Rose-breasted Grosbeak
Blue Grosbeak
Indigo Bunting
Painted Bunting
Dickcissel
Eastern Towhee
    Red-eyed Towhee
    White-eyed Towhee
Spotted Towhee
Black-faced Grassquit
Bachman's Sparrow
Chipping Sparrow
Clay-colored Sparrow
Field Sparrow
Vesper Sparrow
Lark Sparrow
Savannah Sparrow
    Belding's Sparrow
    Ipswich Sparrow
Grasshopper Sparrow
Henslow's Sparrow
Le Conte's Sparrow
Nelson's Sharp-tailed Sparrow
    Acadian
    James Bay
    Nelson's
Saltmarsh Sharp-tailed Sparrow
    Southern
Seaside Sparrow
Song Sparrow
Lincoln's Sparrow
Swamp Sparrow
White-throated Sparrow
White-crowned Sparrow
Bobolink
Red-winged Blackbird
Eastern Meadowlark
Boat-tailed Grackle
Common Grackle
Bronzed Cowbird
Brown-headed Cowbird
Shiny Cowbird
blackbird sp.
Orchard Oriole
Spot-breasted Oriole
Baltimore Oriole
House Finch
Pine Siskin
American Goldfinch
House Sparrow

Spring 2008 St. Johns Aubodbon reference bird list:

Red-throated Loon
Pacific Loon
Common Loon
loon sp.
Pied-billed Grebe
Horned Grebe
Aechmophorus sp.
Northern Gannet
American White Pelican
Brown Pelican
Great Cormorant
Double-crested Cormorant
Anhinga
Magnificent Frigatebird
American Bittern
Least Bittern
Great Blue Heron
    Wurdemann's form
    Great White Heron
Great Egret
Snowy Egret
Little Blue Heron
Tricolored Heron
Reddish Egret
    White form
Cattle Egret
Green Heron
Black-crowned Night-Heron
Yellow-crowned Night-Heron
night-heron sp.
White Ibis
Glossy Ibis
White-faced Ibis
Plegadis sp.
Roseate Spoonbill
Wood Stork
Greater Flamingo
Fulvous Whistling-Duck
Black-bellied Whistling-Duck
Canada Goose
Muscovy Duck
Wood Duck
Green-winged Teal
Mottled Duck
Mallard
White-cheeked Pintail
Northern Pintail
Blue-winged Teal
Cinnamon Teal
Northern Shoveler
Gadwall
Eurasian Wigeon
American Wigeon
Canvasback
Redhead
Ring-necked Duck
Greater Scaup
Lesser Scaup
scaup sp.
Common Eider
King Eider
Bufflehead
Hooded Merganser
Common Merganser
Red-breasted Merganser
Ruddy Duck
Black Vulture
Turkey Vulture
Osprey
Swallow-tailed Kite
White-tailed Kite
Snail Kite
Mississippi Kite
Bald Eagle
Northern Harrier
Sharp-shinned Hawk
Cooper's Hawk
accipiter sp.
Red-shouldered Hawk
Broad-winged Hawk
Short-tailed Hawk
Swainson's Hawk

Red-tailed Hawk
    Harlan's form
    Krider's form
buteo sp.
Golden Eagle
Crested Caracara
American Kestrel
Merlin
Peregrine Falcon
Wild Turkey
Northern Bobwhite
Yellow Rail
Black Rail
Clapper Rail
King Rail
large rail sp.
Virginia Rail
Sora
Purple Gallinule
Common Moorhen
American Coot
Limpkin
Sandhill Crane
Whooping Crane
Black-bellied Plover
American Golden-Plover
Snowy Plover
Wilson's Plover
Semipalmated Plover
Piping Plover
Killdeer
American Oystercatcher
Black-necked Stilt
American Avocet
Greater Yellowlegs
Lesser Yellowlegs
Solitary Sandpiper
Willet
Spotted Sandpiper
Upland Sandpiper
Whimbrel
Long-billed Curlew
Hudsonian Godwit
Marbled Godwit
Ruddy Turnstone
Red Knot
Sanderling
Semipalmated Sandpiper
Western Sandpiper
Least Sandpiper
White-rumped Sandpiper
Baird's Sandpiper
peep sp.
Pectoral Sandpiper
Purple Sandpiper
Dunlin
Curlew Sandpiper
Stilt Sandpiper
Buff-breasted Sandpiper
Ruff
Short-billed Dowitcher
Long-billed Dowitcher
dowitcher sp.
Common Snipe
American Woodcock
Wilson's Phalarope
Pomarine Jaeger
Parasitic Jaeger
Long-tailed Jaeger
jaeger sp.
Laughing Gull
Franklin's Gull
Black-headed Gull
Bonaparte's Gull
Ring-billed Gull
Herring Gull
Lesser Black-backed Gull
Great Black-backed Gull
Black-legged Kittiwake
gull sp.
Gull-billed Tern
Caspian Tern
Royal Tern
Sandwich Tern

Roseate Tern
Common Tern
Forster's Tern
Least Tern
Bridled Tern
Sooty Tern
Black Tern
Brown Noddy
Black Noddy
Black Skimmer
Rock Pigeon
White-crowned Pigeon
Ringed Turtle-Dove
Eurasian Collared-Dove
White-winged Dove
Mourning Dove
Common Ground-Dove
Key West Quail-Dove
Red-crowned Parrot
Lilac-crowned Parrot
Yellow-crowned Parrot
White-fronted Parrot
Mealy Parrot
Orange-winged Parrot
Blue-crowned Parakeet
Red-masked Parakeet
Green Parakeet
Mitred Parakeet
Dusky-headed Parakeet
Orange-fronted Parakeet
Black-hooded Parakeet
Yellow-chevroned Parakeet
    brotogeris sp
Budgerigar
Monk Parakeet
Black-billed Cuckoo
Yellow-billed Cuckoo
Mangrove Cuckoo
Smooth-billed Ani
Groove-billed Ani
Barn Owl
Eastern Screech-Owl
Great Horned Owl
Burrowing Owl
Barred Owl
Common Nighthawk
Antillean Nighthawk
Chuck-will's-widow
Whip-poor-will
Chimney Swift
Vaux's Swift
Ruby-throated Hummingbird
Belted Kingfisher
Red-headed Woodpecker
Red-bellied Woodpecker
Yellow-bellied Sapsucker
Downy Woodpecker
Hairy Woodpecker
Red-cockaded Woodpecker
Northern Flicker
    Yellow-shafted Flicker
    Red-shafted Flicker
Pileated Woodpecker
Olive-sided Flycatcher
Eastern Wood-Pewee
Acadian Flycatcher
Eastern Phoebe
Vermilion Flycatcher
Ash-throated Flycatcher
Great Crested Flycatcher
Western Kingbird
Eastern Kingbird
Gray Kingbird
Scissor-tailed Flycatcher
Fork-tailed Flycatcher
Purple Martin
Tree Swallow
Northern Rough-winged Swallow
Bank Swallow
Cliff Swallow
Cave Swallow
Barn Swallow
Blue Jay
Florida Scrub-Jay

American Crow
Fish Crow
crow sp.
Carolina Chickadee
Tufted Titmouse
Red-breasted Nuthatch
White-breasted Nuthatch
Brown-headed Nuthatch
Brown Creeper
Red-whiskered Bulbul
Carolina Wren
Bewick's Wren
House Wren
Winter Wren
Sedge Wren
Marsh Wren
Golden-crowned Kinglet
Ruby-crowned Kinglet
Blue-gray Gnatcatcher
Eastern Bluebird
Veery
Gray-cheeked Thrush
Bicknell's Thrush
Swainson's Thrush
Hermit Thrush
Wood Thrush
American Robin
Gray Catbird
Northern Mockingbird
Bahama Mockingbird
Brown Thrasher
Cedar Waxwing
Loggerhead Shrike
European Starling
Common Myna
Crested Myna
Hill Myna
White-eyed Vireo
Bell's Vireo
Blue-headed Vireo
Yellow-throated Vireo
Warbling Vireo
Philadelphia Vireo
Red-eyed Vireo
Black-whiskered Vireo
Blue-winged Warbler
    Brewster's Hybrid
    Lawrence's Hybrid
Golden-winged Warbler
Tennessee Warbler
Orange-crowned Warbler
Nashville Warbler
Northern Parula
Yellow Warbler
Chestnut-sided Warbler
Magnolia Warbler
Cape May Warbler
Black-throated Blue Warbler
Yellow-rumped Warbler
Black-throated Green Warbler
Blackburnian Warbler
Yellow-throated Warbler
    yellow-lored form
    white-lored form
Pine Warbler
Kirtland's Warbler
Prairie Warbler
Palm Warbler
    Yellow Palm Warbler
    Western Palm Warbler
Bay-breasted Warbler
Blackpoll Warbler
Cerulean Warbler
Black-and-white Warbler
American Redstart
Prothonotary Warbler
Worm-eating Warbler
Swainson's Warbler
Ovenbird
Northern Waterthrush
Louisiana Waterthrush
Kentucky Warbler
Connecticut Warbler
Mourning Warbler

Common Yellowthroat
Hooded Warbler
Wilson's Warbler
Canada Warbler
Yellow-breasted Chat
Western spindalis
Bananaquit
Summer Tanager
Scarlet Tanager
Western Tanager
Northern Cardinal
Rose-breasted Grosbeak
Blue Grosbeak
Indigo Bunting
Painted Bunting
Dickcissel
Eastern Towhee
    Red-eyed Towhee
    White-eyed Towhee
Spotted Towhee
Black-faced Grassquit
Bachman's Sparrow
Chipping Sparrow
Clay-colored Sparrow
Field Sparrow
Vesper Sparrow
Lark Sparrow
Savannah Sparrow
    Belding's Sparrow
    Ipswich Sparrow
Grasshopper Sparrow
Henslow's Sparrow
Le Conte's Sparrow
Nelson's Sharp-tailed Sparrow
    Acadian
    James Bay
    Nelson's
Saltmarsh Sharp-tailed Sparrow
    Southern
Seaside Sparrow
Song Sparrow
Lincoln's Sparrow
Swamp Sparrow
White-throated Sparrow
White-crowned Sparrow
Bobolink
Red-winged Blackbird
Eastern Meadowlark
Boat-tailed Grackle
Common Grackle
Bronzed Cowbird
Brown-headed Cowbird
Shiny Cowbird
blackbird sp.
Orchard Oriole
Spot-breasted Oriole
Baltimore Oriole
House Finch
Pine Siskin
American Goldfinch
House Sparrow

Fall 2008 St. Johns Aubodbon reference bird list:

Red-throated Loon
Pacific Loon
Common Loon
loon sp.
Pied-billed Grebe
Horned Grebe
Aechmophorus sp.
Northern Gannet
American White Pelican
Brown Pelican
Great Cormorant
Double-crested Cormorant
Anhinga
Magnificent Frigatebird
American Bittern
Least Bittern
Great Blue Heron
    Wurdemann's form
    Great White Heron
Great Egret
Snowy Egret
Little Blue Heron
Tricolored Heron
Reddish Egret
    White form
Cattle Egret
Green Heron
Black-crowned Night-Heron
Yellow-crowned Night-Heron
night-heron sp.
White Ibis
Glossy Ibis
White-faced Ibis
Plegadis sp.
Roseate Spoonbill
Wood Stork
Greater Flamingo
Fulvous Whistling-Duck
Black-bellied Whistling-Duck
Canada Goose
Muscovy Duck
Wood Duck
Green-winged Teal
Mottled Duck
Mallard
White-cheeked Pintail
Northern Pintail
Blue-winged Teal
Cinnamon Teal
Northern Shoveler
Gadwall
Eurasian Wigeon
American Wigeon
Canvasback
Redhead
Ring-necked Duck
Greater Scaup
Lesser Scaup
scaup sp.
Common Eider
King Eider
Bufflehead
Hooded Merganser
Common Merganser
Red-breasted Merganser
Ruddy Duck
Black Vulture
Turkey Vulture
Osprey
Swallow-tailed Kite
White-tailed Kite
Snail Kite
Mississippi Kite
Bald Eagle
Northern Harrier
Sharp-shinned Hawk
Cooper's Hawk
accipiter sp.
Red-shouldered Hawk
Broad-winged Hawk
Short-tailed Hawk
Swainson's Hawk

Red-tailed Hawk
    Harlan's form
    Krider's form
buteo sp.
Golden Eagle
Crested Caracara
American Kestrel
Merlin
Peregrine Falcon
Wild Turkey
Northern Bobwhite
Yellow Rail
Black Rail
Clapper Rail
King Rail
large rail sp.
Virginia Rail
Sora
Purple Gallinule
Common Moorhen
American Coot
Limpkin
Sandhill Crane
Whooping Crane
Black-bellied Plover
American Golden-Plover
Snowy Plover
Wilson's Plover
Semipalmated Plover
Piping Plover
Killdeer
American Oystercatcher
Black-necked Stilt
American Avocet
Greater Yellowlegs
Lesser Yellowlegs
Solitary Sandpiper
Willet
Spotted Sandpiper
Upland Sandpiper
Whimbrel
Long-billed Curlew
Hudsonian Godwit
Marbled Godwit
Ruddy Turnstone
Red Knot
Sanderling
Semipalmated Sandpiper
Western Sandpiper
Least Sandpiper
Baird's Sandpiper
White-rumped Sandpiper
peep sp.
Pectoral Sandpiper
Purple Sandpiper
Dunlin
Curlew Sandpiper
Stilt Sandpiper
Buff-breasted Sandpiper
Ruff
Short-billed Dowitcher
Long-billed Dowitcher
dowitcher sp.
Common Snipe
American Woodcock
Wilson's Phalarope
Pomarine Jaeger
Parasitic Jaeger
Long-tailed Jaeger
jaeger sp.
Laughing Gull
Franklin's Gull
Black-headed Gull
Bonaparte's Gull
Ring-billed Gull
Herring Gull
Lesser Black-backed Gull
Great Black-backed Gull
Black-legged Kittiwake
gull sp.
Gull-billed Tern
Caspian Tern
Royal Tern
Sandwich Tern

Roseate Tern
Common Tern
Forster's Tern
Least Tern
Bridled Tern
Sooty Tern
Black Tern
Brown Noddy
Black Noddy
Black Skimmer
Rock Pigeon
White-crowned Pigeon
Ringed Turtle-Dove
Eurasian Collared-Dove
White-winged Dove
Mourning Dove
Common Ground-Dove
Key West Quail-Dove
Red-crowned Parrot
Lilac-crowned Parrot
Yellow-crowned Parrot
White-fronted Parrot
Mealy Parrot
Orange-winged Parrot
Blue-crowned Parakeet
Red-masked Parakeet
Green Parakeet
Mitred Parakeet
Dusky-headed Parakeet
Orange-fronted Parakeet
Black-hooded Parakeet
Yellow-chevroned Parakeet
    brotogeris sp
Budgerigar
Monk Parakeet
Black-billed Cuckoo
Yellow-billed Cuckoo
Mangrove Cuckoo
Smooth-billed Ani
Groove-billed Ani
Barn Owl
Eastern Screech-Owl
Great Horned Owl
Burrowing Owl
Barred Owl
Common Nighthawk
Antillean Nighthawk
Chuck-will's-widow
Whip-poor-will
Chimney Swift
Vaux's Swift
Ruby-throated Hummingbird
Belted Kingfisher
Red-headed Woodpecker
Red-bellied Woodpecker
Yellow-bellied Sapsucker
Downy Woodpecker
Hairy Woodpecker
Red-cockaded Woodpecker
Northern Flicker
    Yellow-shafted Flicker
    Red-shafted Flicker
Pileated Woodpecker
Olive-sided Flycatcher
Eastern Wood-Pewee
Acadian Flycatcher
Eastern Phoebe
Vermilion Flycatcher
Ash-throated Flycatcher
Great Crested Flycatcher
Western Kingbird
Eastern Kingbird
Gray Kingbird
Scissor-tailed Flycatcher
Fork-tailed Flycatcher
Purple Martin
Tree Swallow
Northern Rough-winged Swallow
Bank Swallow
Cliff Swallow
Cave Swallow
Barn Swallow
Blue Jay
Florida Scrub-Jay

American Crow
Fish Crow
crow sp.
Carolina Chickadee
Tufted Titmouse
Red-breasted Nuthatch
White-breasted Nuthatch
Brown-headed Nuthatch
Brown Creeper
Red-whiskered Bulbul
Carolina Wren
Bewick's Wren
House Wren
Winter Wren
Sedge Wren
Marsh Wren
Golden-crowned Kinglet
Ruby-crowned Kinglet
Blue-gray Gnatcatcher
Eastern Bluebird
Veery
Gray-cheeked Thrush
Bicknell's Thrush
Swainson's Thrush
Hermit Thrush
Wood Thrush
American Robin
Gray Catbird
Northern Mockingbird
Bahama Mockingbird
Brown Thrasher
Cedar Waxwing
Loggerhead Shrike
European Starling
Common Myna
Crested Myna
Hill Myna
White-eyed Vireo
Bell's Vireo
Blue-headed Vireo
Yellow-throated Vireo
Warbling Vireo
Philadelphia Vireo
Red-eyed Vireo
Black-whiskered Vireo
Blue-winged Warbler
    Brewster's Hybrid
    Lawrence's Hybrid
Golden-winged Warbler
Tennessee Warbler
Orange-crowned Warbler
Nashville Warbler
Northern Parula
Yellow Warbler
Chestnut-sided Warbler
Magnolia Warbler
Cape May Warbler
Black-throated Blue Warbler
Yellow-rumped Warbler
Black-throated Green Warbler
Blackburnian Warbler
Yellow-throated Warbler
    yellow-lored form
    white-lored form
Pine Warbler
Kirtland's Warbler
Prairie Warbler
Palm Warbler
    Yellow Palm Warbler
    Western Palm Warbler
Bay-breasted Warbler
Blackpoll Warbler
Cerulean Warbler
Black-and-white Warbler
American Redstart
Prothonotary Warbler
Worm-eating Warbler
Swainson's Warbler
Ovenbird
Northern Waterthrush
Louisiana Waterthrush
Kentucky Warbler
Connecticut Warbler
Mourning Warbler

Common Yellowthroat
Hooded Warbler
Wilson's Warbler
Canada Warbler
Yellow-breasted Chat
Western spindalis
Bananaquit
Summer Tanager
Scarlet Tanager
Western Tanager
Northern Cardinal
Rose-breasted Grosbeak
Blue Grosbeak
Indigo Bunting
Painted Bunting
Dickcissel
Eastern Towhee
    Red-eyed Towhee
    White-eyed Towhee
Spotted Towhee
Black-faced Grassquit
Bachman's Sparrow
Chipping Sparrow
Clay-colored Sparrow
Field Sparrow
Vesper Sparrow
Lark Sparrow
Savannah Sparrow
    Belding's Sparrow
    Ipswich Sparrow
Grasshopper Sparrow
Henslow's Sparrow
Le Conte's Sparrow
Nelson's Sharp-tailed Sparrow
    Acadian
    James Bay
    Nelson's
Saltmarsh Sharp-tailed Sparrow
    Southern
Seaside Sparrow
Song Sparrow
Lincoln's Sparrow
Swamp Sparrow
White-throated Sparrow
White-crowned Sparrow
Bobolink
Red-winged Blackbird
Eastern Meadowlark
Boat-tailed Grackle
Common Grackle
Bronzed Cowbird
Brown-headed Cowbird
Shiny Cowbird
blackbird sp.
Orchard Oriole
Spot-breasted Oriole
Baltimore Oriole
House Finch
Pine Siskin
American Goldfinch
House Sparrow

Appendix F: The following species lists (Appendix G through Appendix Q) have been cross-referenced to NatureServe's global and state rankings (NatureServe 2008); and the FWC listings for endangered, threatened, or rare species (Florida Fish and Wildlife Conservation Commission 2005a). 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.

Florida Fish and Wildlife Conservation Commission (FWC) listings for endangered, threatened, or rare species

Federal Status:
E = Endangered

T = Threatened

State Status:
E = Endangered

T = Threatened

SSC = Species of Special Concern
(1) has a significant vulnerability to habitat modification, environmental alteration, human disturbance, or human exploitation which, in the foreseeable future, may result in its becoming a threatened species unless appropriate protective or management techniques are initiated or maintained;
(2) may already meet certain criteria for designation as a threatened species but for which conclusive data are limited or lacking;
(4) has not sufficiently recovered from past population depletion

S1: NatureServe Subnational Conservation Status Rank - 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: NatureServe Subnational Conservation Status Rank - 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: NatureServe subnational Conservation Status Rank - 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: NatureServe Subnational Conservation Status Rank - Apparently Secure-Uncommon but not rare; some cause for long-term concern due to declines or other factors.

S5: NatureServe Subnational Conservation Status Rank - Secure-Common, widespread, and abundant in the state or province.

SNR: NatureServe Subnational Conservation Status Rank — Unranked— - State or Province conservation status not yet assessed
SNRB - Breeding
SNRN - Non-breeding

SNA: NatureServe Subnational Conservation Status Rank — Not Applicable — A conservation status rank is not applicable because the species is not a suitable target for conservation activities.

Appendix G: Plant species documented for Castillo de San Marcos National Monument.
These species have been cross referenced to NatureServe's global and state rankings (NatureServe 2008). See reference or Appendix F for explanation of abbreviations.

Scientific Name	***Common Name(s)***	***Abundance***	***Nativity***	***Global Rank***	***State Rank***
Hydrocotyle bonariensis	largeleaf pennywort	Common	Native		
Hydrocotyle verticillata	whorled marsh pennywort	Uncommon	Native		
Ptilimnium capillaceum	herbwilliam, threadleaf mockbishopweed	Common	Native		
Hedera helix	English ivy	Rare	Non-Native		
Sabal palmetto	cabbage palm, cabbage palmetto	Unknown	Native		
Ambrosia artemisiifolia	annual ragweed, common ragweed, low ragweed	Common	Native		
Baccharis halimifolia	eastern baccharis	Rare	Native		
Bidens alba var. radiata	bidens, romerillo	Rare	Native		
Conyza canadensis var. canadensis	Canadian horseweed	Common	Native		
Conyza canadensis var. pusilla	Canadian horseweed	Common	Native		
Eclipta prostrate	eclipta, false daisy, yerba de tago, yerba de tajo	Uncommon	Native		
Emilia sonchifolia	lilac tasselflower	Uncommon	Non-Native		
Erechtites hieracifolius		Rare	Native		
Erigeron quercifolius	oakleaf fleabane	Common	Native		
Eupatorium capillifolium	dogfennel	Rare	Native		
Gamochaeta antillana		Uncommon	Native		
Gamochaeta purpurea	spoon-leaf purple everlasting	Uncommon	Native		
Pluchea odorata	marsh fleabane, sweetscent	Common	Native		
Pyrrhopappus carolinianus	Carolina desert chicory, Carolina false-dandelion	Uncommon	Native		
Sonchus oleraceus	annual sowthistle, common sow-thistle	Common	Non-Native		
Sphagneticola trilobata	Bay Biscayne creeping-oxeye	Unknown	Non-Native		
Symphyotrichum subulatum	eastern annual saltmarsh aster	Common	Native		
Taraxacum officinale	blowball, common dandelion, faceclock	Uncommon	Non-Native		
Youngia japonica	oriental false hawksbeard	Common	Non-Native		
Neoregelia spectabilis		Unknown	Non-Native		
Tillandsia recurvata	ballmoss, small ballmoss	Common	Native		
Tillandsia usneoides	Spanish moss	Common	Native		
Capsella bursa-pastoris	shepardspurse	Uncommon	Non-Native		
Coronopus didymus	lesser swinecress	Rare	Non-Native		
Lepidium virginicum	peppergrass, poorman pepperweed, Virginia pepperweed	Common	Native		
Sesuvium portulacastrum	shoreline seapurslane	Common	Native		
Amaranthus hybridus	green pigweed, slim amaranth, smooth amaranth	Uncommon	Non-Native		

Scientific Name	Common Name(s)	Abundance	Nativity	Global Rank	State Rank
Amaranthus viridis	slender amaranth	Common	Non-Native		
Drymaria cordata	chickweed, whitesnow	Common	Native		
Spergularia marina		Uncommon	Non-Native		
Stellaria media	chickweed, common chickweed, nodding chickweed	Common	Non-Native		
Chenopodium ambrosioides	Mexican tea, Mexican-tea	Uncommon	Non-Native		
Boerhavia diffusa	red spiderling	Common	Native		
Portulaca amilis	Paraguayan purslane	Uncommon	Non-Native		
Portulaca oleracea	common purslane, duckweed, garden purslane	Uncommon	Native		
Portulaca pilosa	chisme, kiss me quick, kiss-me-quick	Uncommon	Native		
Ilex vomitoria	Yaupon	Unknown	Native		
Commelina erecta	erect dayflower, whitemouth dayflower	Common	Native		
Tradescantia ohiensis	bluejacket, Ohio spiderwort	Uncommon	Native		
Cycas revolute	sago palm	Unknown	Non-Native		
Zamia pumila	Coontie	Unknown	Native		
Cyperus compressus	poorland flatsedge	Rare	Native		
Cyperus polystachyos	manyspike flatsedge	Rare	Native		
Cyperus retrorsus	pine barren flatsedge	Common	Native		
Cyperus rotundus	cocograss, purple nutsedge	Uncommon	Non-Native		
Cyperus strigosus	strawcolor flatsedge, strawcolor nutgrass	Uncommon	Native		
Cyperus surinamensis	tropical flatsedge	Uncommon	Native		
Eleocharis flavescens	yellow spikerush	Common	Native		
Kyllinga brevifolia	shortleaf spikesedge	Uncommon	Non-Native		
Andropogon glomeratus	bushy bluestem	Uncommon	Native		
Andropogon virginicus	broomsedge, broomsedge bluestem, yellow bluestem	Rare	Native		
Cynodon dactylon	Bermudagrass, chiendent pied-de-poule, common bermudagrass, devilgrass, grama-seda, manienie, motie molulu	Unknown	Non-Native		
Dactyloctenium aegyptium	crowfoot grass, Durban crowsfoot grass, Egyptian grass	Common	Non-Native		
Digitaria bicornis	Asian crabgrass	Common	Native		
Eleusine indica	crowsfoot grass, goose grass, silver crabgrass, wiregrass	Common	Non-Native		
Eragrostis elliottii	field lovegrass	Common	Native		
Eustachys petraea	pinewoods fingergrass	Uncommon	Native		
Oplismenus hirtellus	bristle basketgrass	Common	Native		

Scientific Name	Common Name(s)	Abundance	Nativity	Global Rank	State Rank
Panicum repens	couch panicum, creeping panic, panic rampant	Uncommon	Non-Native		
Paspalum notatum var. saurae	bahiagrass	Common	Non-Native		
Paspalum urvillei	Vasey grass, Vasey's grass, vaseygrass	Common	Non-Native		
Poa annua	annual blue grass, annual bluegrass, walkgrass	Common	Non-Native		
Sphenopholis obtusata	prairie wedgegrass, prairie wedgescale	Common	Native		
Sporobolus indicus var. indicus	smut grass	Uncommon	Non-Native		
Stenotaphrum secundatum	St. Augustine grass, St. Augustinegrass	Common	Native		
Zea mays ssp. Mays	Corn	Rare	Non-Native		
Sideroxylon tenax	tough bully	Rare	Native		
Acalypha gracilens	slender copperleaf, slender threeseed mercury	Uncommon	Native		
Chamaesyce hirta	pill-pod sandmat, pillpod sandmat	Uncommon	Native		
Chamaesyce hypericifolia	graceful sandmat, graceful spurge	Uncommon	Native		
Chamaesyce maculate	large spurge, spotted sandmat, spotted spurge	Common	Native		
Chamaesyce prostrate	prostrate sandmat, prostrate spurge	Uncommon	Native		
Phyllanthus tenellus	Mascarene Island leaf-flower	Uncommon	Non-Native		
Phyllanthus urinaria	chamber bitter	Rare	Non-Native		
Sapium sebiferum	Chinese tallow tree, Florida aspen, popcorn tree	Rare	Non-Native		
Chamaecrista nictitans var. aspera	partridge pea	Common	Native		
Desmodium incanum	tickclover, zarzabacoa comun	Common	Non-Native		
Galactia volubilis	downy milkpea	Uncommon	Native		
Indigofera spicata	trailing indigo	Uncommon	Non-Native		
Medicago lupulina	black medic, black medic clover, black medick	Uncommon	Non-Native		
Medicago polymorpha	bur clover, burclover, California burclover	Uncommon	Non-Native		
Melilotus albus		Uncommon	Non-Native		
Melilotus indicus	annual yellow sweetclover, Indian sweet-clover	Uncommon	Non-Native		
Trifolium repens	Dutch clover, ladino clover, white clover	Common	Non-Native		
Vigna luteola	deer pea, hairypod cowpea	Common	Native		
Quercus virginiana	live oak	Uncommon	Native		
Catharanthus roseus	Madagascar periwinkle	Unknown	Non-Native		
Impatiens balsamina	spotted snapweed	Unknown	Non-Native		
Geranium carolinianum	Carolina crane's-bill, Carolina geranium	Common	Native		
Oxalis corniculata	creeping oxalis, creeping woods, oxalis, yellow wood sorrel	Common	Native		
Oxalis rubra	Oxalis rubra, windowbox woodsorrel	Uncommon	Non-Native		
Liquidambar styraciflua	sweetgum	Rare	Native		
Carya illinoinensis	Pecan	Unknown	Non-Native		
Juncus megacephalus	bighead rush	Common	Native		

Scientific Name	Common Name(s)	Abundance	Nativity	Global Rank	State Rank
Salvia lyrata	lyreleaf sage	Common	Native		
Stachys floridana	Florida betony, Florida hedgenettle	Common	Native		
Lantana montevidensis	trailing shrubverbena	Unknown	Non-Native		
Phyla nodiflora	frog fruit, sawtooth fogfruit, turkey tangle	Common	Native		
Cinnamomum camphora	camphor laurel, camphor tree, camphortree	Unknown	Non-Native		
Yucca aloifolia	aloe yucca	Unknown	Native		
Asparagus aethiopicus		Uncommon	Non-Native		
Hemerocallis lilioasphodelus	yellow daylily	Unknown	Non-Native		
Liriope spicata		Unknown	Non-Native		
Zephyranthes rosea	Cuban zephyrlily	Rare	Non-Native		
Smilax auriculata	earleaf greenbrier	Rare	Native		
Smilax bona-nox	saw greenbrier	Rare	Native		
Magnolia grandiflora	southern magnolia	Unknown	Native		
Hibiscus syriacus	althea, rose of Sharon, shrub-althea	Unknown	Non-Native		
Malvastrum corchorifolium	false mallow	Uncommon	Native		
Malvastrum coromandelianum	threelobe false mallow	Rare	Native		
Gaura angustifolia	southern beeblossom	Common	Native		
Ludwigia octovalvis	Mexican primrose-willow	Common	Native		
Juniperus virginiana	eastern red-cedar, eastern redcedar	Rare	Native		
Lygodium japonicum	Japanese climbing fern	Rare	Non-Native		
Pleopeltis polypodioides var. michauxiana		Common	Native		
*Adiantum capillus-veneris**	common maidenhair, venus hairfern	Common	Native	G5	S3S4
*Pteris vittata**	Chinese brake, ladder brake	Common	Non-Native	GNR	SNA
Samolus valerandi ssp. parviflorus	seaside brookweed, smallflower water pimpernel, water brookweed	Common	Native		
Cissus trifoliate	sorrelvine	Uncommon	Native		
Parthenocissus quinquefolia	American ivy, fiveleaved ivy, Virginia creeper, woodbine	Rare	Native		
Vitis aestivalis	summer grape	Rare	Native		
Pittosporum tobira	Japanese cheesewood	Unknown	Non-Native		
Rhaphiolepis indica		Unknown	Non-Native		
Cephalanthus occidentalis	buttonbush, common buttonbush	Unknown	Native		
Diodia virginiana	Virginia buttonweed	Uncommon	Native		
Galium uniflorum	oneflower bedstraw	Uncommon	Native		
Houstonia procumbens	roundleaf bluet	Uncommon	Native		
Oldenlandia corymbosa	flat-top mille graines, flattop mille graines	Uncommon	Non-Native		
Richardia brasiliensis	tropical Mexican clover	Common	Non-Native		

Scientific Name	*Common Name(s)*	*Abundance*	*Nativity*	*Global Rank*	*State Rank*
Spermacoce assurgens	woodland false buttonweed	Uncommon	Native		
Phoradendron leucarpum	oak mistletoe	Rare	Native		
Melia azedarach	chinaberry, Indian lilac, white cedar	Rare	Non-Native		
Forestiera segregate	florida privet, Florida swampprivet	Rare	Native		
Osmanthus serrulatus		Unknown	Non-Native		
Bacopa monnieri	coastal waterhyssop, herb of grace	Common	Native		
Linaria Canadensis	Canada toadflax	Common	Native		
Dichondra carolinensis	Carolina ponysfoot, grass ponyfoot	Uncommon	Native		
Ipomoea cordatotriloba	cotton morningglory, tievine	Common	Native		
Physalis walteri	Walter's groundcherry	Common	Native		
Solanum americanum	American black nightshade, purple nightshade	Common	Native		
Morus alba	mulberry, white mulberry	Unknown	Non-Native		
Morus rubra	red mulberry	Rare	Native		
Celtis laevigata	sugar berry, sugar hackberry, sugarberry	Rare	Native		
Ulmus alata	winged elm	Rare	Native		
Parietaria floridana	Florida pellitory, pellitory	Common	Native		
Parietaria praetermissa	clustered pellitory	Rare	Native		
Pilea microphylla	rockweed	Rare	Native		

Appendix H: Plant species documented for Fort Matanzas National Monument.
These species have been cross referenced to NatureServe's global and state rankings (NatureServe 2008). See reference or Appendix F for explanation of abbreviations. ***FOMA management priority species**

Scientific Name	***Common Name(s)***	***Abundance***	***Nativity***	***Global Rank***	***State Rank***
Hydrocotyle bonariensis	largeleaf pennywort	Common	Native		
Ptilimnium capillaceum	herbwilliam, threadleaf mockbishopweed	Uncommon	Native		
Sabal palmetto	cabbage palm, cabbage palmetto	Common	Native		
Serenoa repens	saw palmetto	Common	Native		
Ageratina jucunda	hammock snakeroot	Uncommon	Native		
Ambrosia artemisiifolia	annual ragweed, common ragweed, low ragweed	Common	Native		
Baccharis angustifolia	saltwater false willow	Rare	Native		
Baccharis halimifolia	eastern baccharis	Common	Native		
Bidens alba var. radiate	bidens, romerillo	Common	Native		
Borrichia frutescens	bushy seaoxeye, bushy seaside tansy	Common	Native		
Calyptocarpus vialis	straggler daisy	Rare	Non-Native		
Cirsium horridulum	yellow thistle	Common	Native		
Conyza canadensis var. canadensis	Canadian horseweed	Common	Native		
Erechtites hieracifolius		Common	Native		
Erigeron quercifolius	oakleaf fleabane	Common	Native		
Eupatorium capillifolium	Dogfennel	Rare	Native		
Gaillardia pulchella	firewheel, Indian blanket, Indianblanket, rosering gaillardia	Common	Native		
Gamochaeta antillana		Common	Native		
Helianthus debilis ssp. debilis	cucumberleaf sunflower	Common	Native		
Heterotheca subaxillaris	camphorweed, golden aster	Common	Native		
Iva frutescens	bigleaf sumpweed, Jesuit's bark	Common	Native		
Iva imbricate	seacoast marshelder	Common	Native		
Krigia virginica	Virginia dwarfdandelion	Rare	Native		
Lactuca graminifolia	grass-leaf lettuce, grassleaf lettuce	Rare	Native		
Mikania cordifolia	Florida Keys hempvine	Common	Native		
Pluchea odorata	marsh fleabane, sweetscent	Uncommon	Native		
Solidago odora var. chapmanii	Chapman's goldenrod	Rare	Native		
Solidago stricta	wand goldenrod	Uncommon	Native		
Sonchus asper	perennial sowthistle, prickly sowthistle, spiny sowthistle	Uncommon	Non-Native		
Sonchus oleraceus	annual sowthistle, common sow-thistle, common sowthistle	Uncommon	Non-Native		

Scientific Name	***Common Name(s)***	***Abundance***	***Nativity***	***Global Rank***	***State Rank***
Taraxacum officinale	blowball, common dandelion, dandelion, faceclock	Rare	Non-Native		
Youngia japonica	oriental false hawksbeard	Uncommon	Non-Native		
Batis maritime	saltwort, turtleweed	Common	Native		
Neoregelia spectabilis		Unknown	Non-Native		
Tillandsia recurvata	ballmoss, small ballmoss	Common	Native		
Tillandsia usneoides	Spanish moss	Common	Native		
Triodanis perfoliata	clasping bellwort, clasping Venus' looking-glass	Rare	Native		
Cakile edentula ssp. harperi	Harper's searocket	Common	Native		
Cakile lanceolata	coastal searocket	Uncommon	Native		
Coronopus didymus	lesser swinecress	Rare	Non-Native		
Descurainia pinnata	green tansymustard, pinnate tansy mustard	Rare	Native		
Lepidium virginicum	peppergrass, poorman pepperweed, poorman's pepper	Uncommon	Native		
Sesuvium portulacastrum	shoreline seapurslane	Common	Native		
Blutaparon vermiculare	Silverhead	Uncommon	Native		
Gomphrena serrata	arrasa con todo	Rare	Non-Native		
Iresine rhizomatosa	Juda's bush, rootstock bloodleaf	Common	Native		
Opuntia pusilla	cockspur pricklypear	Common	Native		
Opuntia stricta	erect pricklypear	Common	Native		
Paronychia baldwinii	Baldwin's nailwort	Rare	Native		
Paronychia herniarioides	coastalplain nailwort	Uncommon	Native		
Stellaria media	chickweed, common chickweed, nodding chickweed	Common	Non-Native		
Atriplex cristata	crested saltbush	Common	Non-Native		
Chenopodium album	common lambsquarters, lambsquarters, lambsquarters goosefoot, white goosefoot	Uncommon	Non-Native		
Chenopodium ambrosioides	Mexican tea, Mexican-tea	Common	Non-Native		
Salsola kali ssp. Pontica	Russian thistle, tumbleweed	Common	Non-Native		
Sarcocornia perennis	Chickenclaws	Common	Native		
Suaeda linearis	annual seepweed	Common	Native		
Boerhavia diffusa	red spiderling	Common	Native		
Phytolacca americana var. rigida	American pokeweed	Uncommon	Native		
Rivina humilis	bloodberry rougeplant, rougeplant	Uncommon	Native		
Portulaca oleracea	akulikuli-kula, common purslane, duckweed, garden purslane	Rare	Native		

Scientific Name	*Common Name(s)*	*Abundance*	*Nativity*	*Global Rank*	*State Rank*
Portulaca pilosa	chisme, kiss me quick, kiss-me-quick	Uncommon	Native		
Ilex vomitoria	Yaupon	Common	Native		
Commelina diffusa var. diffusa	climbing dayflower	Rare	Non-Native		
Commelina erecta	erect dayflower, whitemouth dayflower	Uncommon	Native		
Tradescantia ohiensis	bluejacket, Ohio spiderwort	Common	Native		
Zamia pumila	Coontie	Common	Native		
Cyperus esculentus	chufa, chufa flatsedge, yellow nutgrass, yellow nutsedge	Common	Non-Native		
Cyperus polystachyos	manyspike flatsedge	Common	Native		
Cyperus retrorsus	pine barren flatsedge	Common	Native		
Cyperus tetragonus	fourangle flatsedge	Uncommon	Native		
Fimbristylis spadicea		Common	Native		
Scleria triglomerata	whip nutrush	Rare	Native		
Andropogon glomeratus var. hirsutior	bushy bluestem	Common	Native		
Andropogon glomeratus var. pumilus	bushy bluestem	Common	Native		
Andropogon virginicus var. virginicus	broomsedge, broomsedge bluestem	Uncommon	Native		
Cenchrus echinatus	burgrass, common sandbur, field sandbur	Uncommon	Native		
Cenchrus gracillimus	slender sandbur	Common	Native		
Cenchrus spinifex	coastal sandbur	Common	Native		
Cenchrus tribuloides	sanddune sandbur	Uncommon	Native		
Cynodon dactylon	Bermudagrass, chiendent pied-de-poule, common bermudagrass, devilgrass, grama-seda, manienie, motie molulu	Common	Non-Native		
Dactyloctenium aegyptium	crowfoot grass, Durban crowsfoot grass, Egyptian grass	Common	Non-Native		
Dichanthelium scabriusculum	woolly rosette grass	Common	Native		
Digitaria bicornis	Asian crabgrass	Uncommon	Non-Native		
Digitaria filiformis var. filiformis		Common	Native		
Distichlis spicata	desert saltgrass, inland saltgrass, marsh spikegrass	Common	Native		
Eleusine indica	crowsfoot grass, goose grass, Indian goose grass	Common	Non-Native		
Eragrostis elliottii	field lovegrass	Common	Native		
Eragrostis secundiflora ssp. oxylepis	red lovegrass	Common	Native		
Eustachys petraea	pinewoods fingergrass	Common	Native		
Imperata cylindrical*	**cogon grass, cogongrass**	**Rare**	**Non-Native**	**GNR**	**SNA**

Scientific Name	Common Name(s)	Abundance	Nativity	Global Rank	State Rank
Lolium perenne	italian ryegrass, perennial rye grass, perennial ryegrass	Uncommon	Non-Native		
Muhlenbergia capillaris var. filipes	Gulf muhly, gulfhairawn muhly	Common	Native		
Muhlenbergia capillaris var. trichopodes	cutover muhly	Common	Native		
Oplismenus hirtellus	bristle basketgrass	Common	Native		
Panicum amarum	bitter panicgrass, bitter panicum	Common	Native		
Paspalum notatum var. saurae	bahiagrass	Common	Non-Native		
Paspalum setaceum	fringeleaf paspalum, sand paspalum, slender crown grass	Common	Native		
Poa annua	annual blue grass, annual bluegrass, walkgrass	Common	Non-Native		
Setaria parviflora	knotroot bristlegrass, marsh bristle grass, marsh bristlegrass	Common	Native		
Spartina alterniflora	Atlantic cordgrass, saltmarsh cordgrass, smooth cordgrass	Common	Native		
Spartina patens	marshhay cordgrass, salt meadow cordgrass	Common	Native		
Sphenopholis obtusata	prairie wedgegrass, prairie wedgescale	Common	Native		
Sporobolus indicus var. pyramidalis	West Indian dropseed	Uncommon	Non-Native		
Sporobolus virginicus	seashore dropseed	Common	Native		
Stenotaphrum secundatum	St. Augustine grass, St. Augustinegrass	Rare	Native		
Triplasis purpurea	purple sand grass, purple sandgrass	Uncommon	Native		
Uniola paniculata	seaoats	Common	Native		
Sambucus nigra ssp. canadensis	blue elder, common elderberry, elder, elderberry	Common	Native		
Viburnum odoratissimum	sweet arrowwood	Unknown	Non-Native		
Diospyros virginiana	common persimmon, eastern persimmon, Persimmon	Rare	Native		
Sideroxylon tenax	tough bully	Common	Native		
Rhododendron simsii		Unknown	Non-Native		
Acalypha gracilens	slender copperleaf, slender threeseed mercury	Uncommon	Native		
Chamaesyce bombensis	dixie sandmat	Common	Native		
Chamaesyce hirta	pill-pod sandmat, pillpod sandmat	Uncommon	Native		
Chamaesyce hyssopifolia	hyssop spurge, hyssopleaf sandmat, leafy spurge	Common	Native		
Chamaesyce maculate	large spurge, spotted sandmat, spotted spurge	Common	Native		
Cnidoscolus stimulosus	finger rot	Common	Native		
Croton glandulosus var. glandulosus	vente conmigo	Common	Native		
Croton punctatus	gulf croton	Common	Native		

Scientific Name	***Common Name(s)***	***Abundance***	***Nativity***	***Global Rank***	***State Rank***
Phyllanthus abnormis	abnormis leaflower, Drummond's leaf-flower	Common	Native		
Phyllanthus tenellus	Mascarene Island leaf-flower, Mascarene Island leafflower	Uncommon	Non-Native		
Poinsettia cyathophora	wild poinsettia	Uncommon	Native		
Centrosema virginianum	butterflypea, spurred butterfly pea	Common	Native		
Chamaecrista fasciculata	partridge pea, Showy partridgepea, sleepingplant	Common	Native		
Desmodium tortuosum	Dixie tick trefoil, dixie ticktrefoil	Rare	Non-Native		
Erythrina herbacea	eastern coralbean, redcardinal	Rare	Native		
Galactia volubilis	downy milkpea	Common	Native		
Indigofera hirsute	roughhairy indigo	Rare	Non-Native		
Indigofera spicata	trailing indigo	Uncommon	Non-Native		
Medicago lupulina	black medic, black medic clover, hop clover, hop medic	Common	Non-Native		
Medicago polymorpha	bur clover, burclover, California burclover, toothed medick	Common	Non-Native		
Melilotus albus		Common	Non-Native		
Melilotus indicus	annual yellow sweetclover, Indian sweet-clover	Uncommon	Non-Native		
Senna obtusifolia	Java-bean, sicklepod	Rare	Non-Native		
Strophostyles helvola		Common	Native		
Vigna luteola	deer pea, hairypod cowpea	Common	Native		
Quercus chapmanii	Chapman oak	Uncommon	Native		
Quercus geminate	sand live oak	Common	Native		
Quercus myrtifolia	myrtle oak	Common	Native		
Quercus virginiana	live oak	Common	Native		
Nerium oleander	oleander	Unknown	Non-Native		
Cynanchum angustifolium	gulf coast swallow-wort, Gulf coast swallowwort	Uncommon	Native		
Geranium carolinianum	Carolina crane's-bill, Carolina geranium	Uncommon	Native		
Oxalis corniculata	creeping oxalis, creeping woods, creeping woodsorrel, oxalis	Common	Native		
Oxalis rubra	Oxalis rubra, windowbox woodsorrel	Uncommon	Non-Native		
Carya illinoinensis	pecan	Unknown	Non-Native		
Juncus dichotomus	forked rush	Common	Native		
Juncus roemerianus	needlegrass rush	Common	Native		
Heliotropium curassavicum	quail plant, salt heliotrope, seaside heliotrope	Rare	Native		
Hyptis mutabilis	tropical bushmint	Uncommon	Non-Native		

Scientific Name	***Common Name(s)***	***Abundance***	***Nativity***	***Global Rank***	***State Rank***
Monarda punctata	spotted beebalm	Common	Native		
Salvia lyrata	lyreleaf sage	Common	Native		
Stachys floridana	Florida betony, Florida hedgenettle	Uncommon	Native		
Teucrium canadense	American germander, Canada germander, hairy germander	Common	Native		
Trichostema dichotomum	blue curls, forked bluecurls	Uncommon	Native		
Avicennia germinans	black mangrove	Common	Native		
Callicarpa Americana	American beautyberry	Common	Native		
Lantana camara*	**lantana, largeleaf lantana**	**Common**	**Non-Native**	**G5**	**SNA**
Phyla nodiflora	frog fruit, sawtooth fogfruit, turkey tangle, turkey tangle fogfruit	Common	Native		
Verbena bonariensis	pretty verbena, purpletop vervain	Uncommon	Non-Native		
Verbena officinalis ssp. halei		Common	Native		
Cinnamomum camphora	camphor laurel, camphor tree, camphortree	Unknown	Non-Native		
Persea borbonia	redbay	Common	Native		
Yucca aloifolia	aloe yucca	Rare	Non-Native		
Asparagus aethiopicus		Unknown	Non-Native		
Crinum asiaticum	poisonbulb	Unknown	Non-Native		
Smilax auriculata	earleaf greenbrier	Common	Native		
Smilax bona-nox	saw greenbrier	Common	Native		
Asimina parviflora	smallflower pawpaw	Common	Native		
Magnolia grandiflora	southern magnolia	Rare	Native		
Malvastrum corchorifolium	false mallow	Uncommon	Native		
Malvastrum coromandelianum	threelobe false mallow	Uncommon	Non-Native		
Malvaviscus penduliflorus	mazapan	Unknown	Non-Native		
Sida rhombifolia	arrowleaf sida, cuban jute, Cuban-jute	Common	Native		
Myrica cerifera	southern bayberry, wax myrtle	Common	Native		
Gaura angustifolia	southern beeblossom	Common	Native		
Oenothera humifusa	seabeach evening-primrose	Common	Native		
Oenothera laciniata	cut-leaf evening-primrose	Rare	Native		
Oenothera speciosa	pinkladies, Showy evening primrose, showy eveningprimrose	Uncommon	Non-Native		
Juniperus virginiana	eastern red-cedar, eastern redcedar, red cedar juniper	Common	Native		
Pinus elliottii	slash pine	Common	Native		
Plantago virginica	paleseed Indianwheat, Virginia plantain	Uncommon	Native		

Scientific Name	*Common Name(s)*	*Abundance*	*Nativity*	*Global Rank*	*State Rank*
Limonium carolinianum	Carolina sea-lavender, Carolina sealavender	Common	Native		
Polygala incarnate	procession flower	Uncommon	Native		
Rumex hastatulus	heartwing dock, heartwing sorrel	Uncommon	Native		
Pteridium aquilinum var. pseudocaudatum	bracken, bracken fern, western brackenfern	Common	Native		
Nephrolepis cordifolia*	**Boston fern, narrow swordfern, sword fern, tuber ladder fern**	**Common**	**Non-Native**	**G4G5**	**SNA**
Phlebodium aureum	golden polypody	Rare	Native		
Pleopeltis polypodioides var. michauxiana		Common	Native		
Pteris vittata*	**Chinese brake, ladder brake**	**Common**	**Non-Native**	**GNR**	**SNA**
Ampelopsis arborea	peppervine	Common	Native		
Cissus trifoliate	sorrelvine	Uncommon	Native		
Parthenocissus quinquefolia	American ivy, fiveleaved ivy, Virginia creeper, woodbine	Common	Native		
Vitis aestivalis	summer grape	Common	Native		
Vitis rotundifolia	muscadine, muscadine grape	Common	Native		
Rhizophora mangle	American mangrove, mangrove, red mangrove	Rare	Native		
Eriobotrya japonica	loquat	Rare	Non-Native		
Prunus caroliniana	Carolina laurelcherry	Uncommon	Native		
Prunus serotina var. serotina	black cherry	Common	Native		
Rhaphiolepis indica		Unknown	Non-Native		
Rubus trivialis	southern dewberry	Uncommon	Native		
Chiococca alba	West Indian milkberry	Rare	Native		
Diodia teres	poor joe, poorjoe, rough buttonweed	Rare	Native		
Galium hispidulum	coastal bedstraw	Common	Native		
Houstonia procumbens	roundleaf bluet	Uncommon	Native		
Oldenlandia corymbosa	flat-top mille graines, flattop mille graines	Uncommon	Non-Native		
Richardia brasiliensis	tropical Mexican clover	Uncommon	Non-Native		
Spermacoce assurgens	woodland false buttonweed	Rare	Native		
Stenaria nigricans var. nigricans		Common	Native		
Phoradendron leucarpum	oak mistletoe	Uncommon	Native		
Rhus copallinum	flameleaf sumac	Common	Native		
Severinia buxifolia		Unknown	Non-Native		
Zanthoxylum clava-herculis	Hercules' club, hercules-club, hercules-club pricklyash	Common	Native		
Justicia brandegeeana	shrimpplant	Unknown	Non-Native		
Ruellia caroliniensis	Carolina wild petunia	Uncommon	Native		

Scientific Name	Common Name(s)	Abundance	Nativity	Global Rank	State Rank
Polypremum procumbens	juniper leaf	Common	Native		
Forestiera segregate	florida privet, Florida swampprivet	Uncommon	Native		
Jasminum mesnyi	Japanese jasmine	Unknown	Non-Native		
Bacopa monnieri	coastal waterhyssop, herb of grace	Common	Native		
Linaria Canadensis	Canada toadflax	Uncommon	Native		
Scoparia dulcis	licorice weed	Uncommon	Native		
Dichondra carolinensis	Carolina ponysfoot, grass ponyfoot	Uncommon	Native		
Ipomoea batatas	'uala, sweet potato, sweetpotato	Rare	Non-Native		
Ipomoea cordatotriloba	cotton morningglory, tievine	Uncommon	Native		
Ipomoea imperati	beach morning-glory, beach morningglory	Common	Native		
Ipomoea pandurata	bigroot morningglory, man-of-the-earth	Rare	Native		
Ipomoea pes-caprae	bayhops	Common	Native		
Merremia dissecta	noyau vine	Rare	Non-Native		
Ipomopsis rubra	standing-cypress, Texas plume	Rare	Native		
Lycium carolinianum	Carolina desert-thorn, Carolina wolfberry	Rare	Native		
Physalis walteri	Walter's groundcherry	Common	Native		
Solanum chenopodioides	goosefoot nightshade	Uncommon	Native		
Hypericum gentianoides	orangegrass, pinweed st. johnswort	Rare	Native		
Hypericum hypericoides	St. Andrew's cross, St. Andrews cross	Uncommon	Native		
Morus rubra	red mulberry	Rare	Native		
Celtis laevigata	sugar berry, sugar hackberry, sugarberry	Common	Native		
Parietaria praetermissa	clustered pellitory	Rare	Native		
Pilea microphylla	rockweed	Uncommon	Native		
Alpinia zerumbet	shellplant	Unknown	Non-Native		

Appendix I: Fish species documented for Fort Matanzas National Monument.
These species have been cross referenced to the FL Comprehensive Wildlife Conservation Strategy species of greatest conservation need (SGCN) (Florida Fish and Wildlife Conservation Commission 2005b); NatureServe's global and state rankings (NatureServe 2008); and the FWC listings for endangered, threatened, or rare species (Florida Fish and Wildlife Conservation Commission 2005a). See reference or Appendix F for explanation of abbreviations.

Scientific Name	***Common Name(s)***	***Abundance***	***Residency***	***FL SGCN***	***Global Rank***	***State Rank***	***Federal Status***	***State Status***
Membras vagrans		Unknown	Unknown					
Menidia beryllina	inland silverside, tidewater silverside	Unknown	Breeder					
Menidia menidia	Atlantic silverside	Common	Breeder					
Synodus foetens	inshore lizardfish	Unknown	Unknown					
Strongylura marina	Atlantic needlefish, silver gar	Abundant	Breeder					
Carcharhinus isodon	finetooth shark	Unknown	Unknown	Yes				
Rhizoprionodon terraenovae	Atlantic sharpnose shark	Rare	Breeder	Yes				
Sphyrna lewini	scalloped hammerhead	Rare	Breeder	Yes				
Sphyrna tiburo	bonnethead, shovelhead	Uncommon	Breeder	Yes				
Brevoortia smithi	yellowfin menhaden	Common	Breeder					
Brevoortia tyrannus	Atlantic menhaden, bugfish, bunker, fatback, menhaden	Common	Breeder					
Dorosoma cepedianum	American gizzard shad, eastern gizzard shad, hickory shad	Unknown	Unknown					
Dorosoma petenense	threadfin shad	Unknown	Unknown					
Harengula jaguana	scaled herring, scaled sardine	Unknown	Unknown					
Opisthonema oglinum	Atlantic thread herring	Unknown	Unknown					
Anchoa hepsetus	broad-striped anchovy, striped anchovy	Unknown	Unknown					
Anchoa mitchilli	bay anchovy	Unknown	Unknown					
Cyprinodon variegates	sheepshead minnow, sheepshead pupfish	Unknown	Breeder					
Fundulus heteroclitus	mummichog	Unknown	Unknown					
Fundulus majalis	striped killifish	Unknown	Unknown					
Fundulus similis	longnose killifish	Unknown	Unknown					
Elops saurus	ladyfish	Uncommon	Breeder					
Megalops atlanticus	tarpon	Uncommon	Breeder	Yes				
Hippocampus erectus	lined seahorse, spotted seahorse	Rare	Breeder	Yes				
Syngnathus louisianae	chain pipefish	Unknown	Unknown	Yes				
Mugil cephalus	black mullet, gray mullet, striped mullet	Abundant	Breeder	Yes				
Mugil curema	silver mullet, white mullet	Abundant	Breeder	Yes				
Dasyatis Americana	southern stingray	Common	Breeder					

Scientific Name	*Common Name(s)*	*Abundance*	*Residency*	*FL SGCN*	*Global Rank*	*State Rank*	*Federal Status*	*State Status*
Aetobatus narinari	bonnetray, spotted eagle ray	Rare	Breeder	Yes				
Hypleurochilus pseudoaequipinnis	oyster blenny	Unknown	Unknown					
Lupinoblennius nicholsi	highfin blenny	Unknown	Unknown					
Scartella cristata	molly miller	Unknown	Unknown					
Caranx hippos	crevalle jack	Common	Breeder					
Caranx latus	horse-eye jack	Common	Breeder	Yes				
Chloroscombrus chrysurus	Atlantic bumper	Unknown	Unknown					
Oligoplites saurus	leatherjack, leatherjacket	Unknown	Unknown					
Selene vomer	lookdown	Common	Breeder					
Trachinotus carolinus	Florida pompano	Common	Breeder	Yes				
Trachinotus falcatus	permit	Common	Breeder	Yes				
Trachinotus goodie	palometa	Unknown	Breeder	Yes				
Centropomus undecimalis	common snook, snook	Uncommon	Breeder	Yes				
Chaetodipterus faber	Atlantic spadefish	Common	Breeder	Yes				
Eucinostomus argenteus	spotfin mojarra	Unknown	Unknown					
Eucinostomus gula	silver jenny	Unknown	Unknown					
Ctenogobius boleosoma	darter goby	Unknown	Unknown					
Ctenogobius stigmaticus	marked goby	Unknown	Unknown					
Gobionellus oceanicus	highfin goby, sharptail goby, slim goby	Unknown	Unknown					
Orthopristis chrysoptera	pigfish	Abundant	Breeder					
Labrisomus nuchipinnis	hairy blenny	Unknown	Unknown	Yes				
Lutjanus griseus	gray snapper, grey snapper	Common	Breeder	Yes				
Abudefduf saxatilis	sergeant major	Common	Breeder	Yes				
Pomatomus saltatrix	bluefish	Common	Breeder	Yes				
Bairdiella chrysoura	silver perch	Unknown	Unknown					
Cynoscion nebulosus	spotted seatrout	Common	Breeder	Yes				
Leiostomus xanthurus	spot	Abundant	Breeder					
Menticirrhus americanus	jewsharp drummer, southern kingfish	Common	Breeder					
Menticirrhus littoralis	Gulf kingfish	Common	Breeder					
Micropogonias undulates	Atlantic croaker	Common	Breeder					
Pogonias cromis	black drum	Uncommon	Breeder	Yes				
Sciaenops ocellatus	red drum	Common	Breeder	Yes				
Centropristis striata	black sea bass	Uncommon	Breeder	Yes				
Mycteroperca microlepis	charcoal belly, gag	Uncommon	Breeder	Yes				
Rypticus maculates	whitespotted soapfish	Unknown	Unknown					

Scientific Name	*Common Name(s)*	*Abundance*	*Residency*	*FL SGCN*	*Global Rank*	*State Rank*	*Federal Status*	*State Status*
Archosargus probatocephalus	sheepshead	Abundant	Breeder	Yes				
Diplodus argenteus	silver porgy	Common	Breeder					
Lagodon rhomboids	pinfish	Abundant	Breeder					
Trichiurus lepturus	Atlantic cutlassfish, Australian hairtail, largehead hairtail	Unknown	Unknown					
Astroscopus y-graecum	southern stargazer	Unknown	Unknown					
Achirus lineatus	lined sole	Unknown	Unknown					
Trinectes maculates	hogchoker	Unknown	Unknown					
Symphurus plagiusa	blackcheek tonguefish	Unknown	Unknown					
Citharichthys spilopterus	bay whiff	Unknown	Unknown					
Paralichthys albigutta	Gulf flounder	Common	Breeder	Yes				
Prionotus evolans	striped searobin	Unknown	Unknown					
Prionotus scitulus	leopard searobin	Unknown	Unknown					
Ariopsis felis	hardhead catfish	Abundant	Breeder					
Bagre marinus	gafftopsail catfish	Common	Breeder					
Chilomycterus schoepfii	burrfish, porcupinefish, striped burrfish	Unknown	Unknown	Yes				
Cantherhines pullus	orangespotted filefish	Unknown	Unknown	Yes				
Sphoeroides nephelus	southern puffer	Uncommon	Breeder					

Appendix J: Amphibian species documented for Castillo de San Marcos National Monument.
These species have been cross referenced to the FL Comprehensive Wildlife Conservation Strategy species of greatest conservation need (SGCN) (Florida Fish and Wildlife Conservation Commission 2005b); NatureServe's global and state rankings (NatureServe 2008); and the FWC listings for endangered, threatened, or rare species (Florida Fish and Wildlife Conservation Commission 2005a). See reference or Appendix F for explanation of abbreviations.

Scientific Name	***Common Name(s)***	***Park Status***	***Abundance***	***Residency***	***Nativity***	***FL SGCN***	***Global Rank***	***State Rank***	***Federal Status***	***State Status***
Bufo terrestris	Southern Toad	Present in Park	Unknown	Unknown	Native		G5	SNR		
Hyla squirella	Squirrel Treefrog	Present in Park	Unknown	Unknown	Native		G5	SNR		
Osteopilus septentrionalis	Cuban Treefrog	Present in Park	Unknown	Unknown	Non-Native		G5	SNA		
Eleutherodactylus planirostris	Greenhouse Frog	Present in Park	Unknown	Unknown	Non-Native		G5	SNA		
Acris gryllus	Southern cricket frog	Found near vicinity					G5	SNR		
Gastrophryne carolinensis	Eastern narrowmouth toad	Found near vicinity					G5	SNR		
Hyla cinerea	Green treefrog	Found near vicinity					G5	SNR		

Appendix K: Amphibian species documented for Fort Matanzas National Monument.
These species have been cross referenced to the FL Comprehensive Wildlife Conservation Strategy species of greatest conservation need (SGCN) (Florida Fish and Wildlife Conservation Commission 2005b); NatureServe's global and state rankings (NatureServe 2008); and the FWC listings for endangered, threatened, or rare species (Florida Fish and Wildlife Conservation Commission 2005a). See reference or Appendix F for explanation of abbreviations.

Scientific Name	***Common Name(s)***	***Abundance***	***Residency***	***Nativity***	***FL SGCN***	***Global Rank***	***State Rank***
Bufo terrestris	Southern Toad	Common	Breeder	Native		G5	SNR
Hyla cinerea	Green Treefrog	Unknown	Unknown	Native		G5	SNR
Hyla squirella	Squirrel Treefrog	Common	Breeder	Native		G5	SNR
Osteopilus septentrionalis	Cuban Treefrog	Unknown	Unknown	Non-Native		G5	SNA
Eleutherodactylus planirostris	Greenhouse Frog	Unknown	Unknown	Non-Native		G5	SNA
Gastrophryne carolinensis	Eastern Narrow-mouthed Toad	Unknown	Unknown	Native		G5	
Rana sphenocephala	Florida leopard frog, Southern Leopard Frog	Unknown	Unknown	Native		G5	SNR
Scaphiopus holbrookii	eastern spadefoot toad	Common	Breeder	Native		G5	SNR
Hyla gratiosa	barking treefrog	Unknown	Unknown	Native		G5	SNR

Appendix L: Reptile species documented for Castillo de San Marcos National Monument.
These species have been cross referenced to the FL Comprehensive Wildlife Conservation Strategy species of greatest conservation need (SGCN) (Florida Fish and Wildlife Conservation Commission 2005b); NatureServe's global and state rankings (NatureServe 2008); and the FWC listings for endangered, threatened, or rare species (Florida Fish and Wildlife Conservation Commission 2005a). See reference or Appendix F for explanation of abbreviations.

Scientific Name	***Common Name(s)***	***Park Status***	***Abundance***	***Nativity***	***FL SGCN***	***Global Rank***	***State Rank***	***Federal Status***	***State Status***
Norops sagrei	Brown Anole	Present in Park	Abundant	Non-Native		G5	SNA		
Rhadinaea flavilata	Pine Woods Snake	Present in Park	Occasional	Native		G4	SNR		
Anolis carolinensis	Green anole	Found near vicinity				G5	SNR		
Cnemidophorus sexlineatus	Six-lined racerunner	Found near vicinity				G5	SNR		
Eumeces fasciatus	Five-lined skink	Found near vicinity				G5	SNR		
Eumeces inexpectatus	Southeastern five-lined skink	Found near vicinity				G5	SNR		
Scincella lateralis	Ground skink	Found near vicinity				G5	SNR		
Coluber constrictor	Black racer	Found near vicinity				G5T5	SNR		
Elaphe guttata	Corn snake	Found near vicinity				G5	S5		
Elaphe obsolete	Rat snake	Found near vicinity				G5	SNR		
Lampropeltis getula	Eastern kingsnake	Found near vicinity			YES	G5T5	SNR		
Opheodrys aestivus	Rough green snake	Found near vicinity				G5	SNR		
Storeria dekayi	Brownsnake	Found near vicinity				G5	S5		
Thamnophis sauritus	Ribbon snake	Found near vicinity			YES	G5	SNR		
Thamnophis sirtalis	Common Gartersnake	Found near vicinity				G5	SNR		

Appendix M: Reptile species documented for Fort Matanzas National Monument.
These species have been cross referenced to the FL Comprehensive Wildlife Conservation Strategy species of greatest conservation need (SGCN) (Florida Fish and Wildlife Conservation Commission 2005b); NatureServe's global and state rankings (NatureServe 2008); and the FWC listings for endangered, threatened, or rare species (Florida Fish and Wildlife Conservation Commission 2005a). See reference or Appendix F for explanation of abbreviations.

Scientific Name	***Common Name(s)***	***Abundance***	***Residency***	***Nativity***	***FL SGCN***	***Global Rank***	***State Rank***	***Federal Status***	***State Status***
Ophisaurus ventralis	Eastern Glass Lizard	Unknown	Unknown	Native		G5	SNR		
Coluber constrictor	Eastern Racer	Uncommon	Breeder	Native		G5	SNR		
Drymarchon corais	Eastern Indigo Snake	Uncommon	Breeder	Native	Yes	G3	S3	T	T
Elaphe guttata	Red Cornsnake	Uncommon	Breeder	Native		G5	S5		
Elaphe obsolete	Eastern Ratsnake	Unknown	Unknown	Native		G5	SNR		
Heterodon platirhinos	Eastern Hognose Snake	Unknown	Unknown	Native	Yes	G5	SNR		
Masticophis flagellum	Coachwhip	Uncommon	Breeder	Native		G5	SNR		
Opheodrys aestivus	Rough Greensnake	Uncommon	Breeder	Native		G5	SNR		
Rhadinaea flavilata	Pine Woods Snake	Unknown	Unknown	Native		G4	SNR		
Thamnophis sauritus	Eastern Ribbonsnake	Unknown	Unknown	Native	Yes	G5	S5		
Micrurus fulvius	Eastern Coral Snake, Harlequin	Unknown	Unknown	Native		G5	SNR		
Hemidactylus garnotii	Fox Gecko, Indo-Pacific Gecko, Indopacific Gecko	Unknown	Unknown	Non-Native		G5	SNA		
Hemidactylus turcicus	Mediterranean House Gecko	Unknown	Unknown	Non-Native		G5	SNA		
Anolis carolinensis	Green Anole	Abundant	Breeder	Native		G5	SNR		
Norops sagrei	Brown Anole	Abundant	Breeder	Non-Native		G5	SNA		
Eumeces inexpectatus	Southeastern Five-lined Skink	Abundant	Breeder	Native		G5	SNR		
Scincella lateralis	Ground Skink, Little Brown Skink	Uncommon	Breeder	Native		G5	SNR		
Cnemidophorus sexlineatus	Six-lined Racerunner	Abundant	Breeder	Native		G5	SNR		
Crotalus adamanteus	Eastern Diamond-backed Rattlesnake	Uncommon	Breeder	Native	Yes	G4	S3		
Caretta caretta	Loggerhead Sea Turtle	Rare	Breeder	Native	Yes	G3	S3	T	T
Chelonia mydas	Green Sea Turtle	Occasional	Breeder	Native	Yes	G3	S2	E	E

Scientific Name	***Common Name(s)***	***Abundance***	***Residency***	***Nativity***	***FL SGCN***	***Global Rank***	***State Rank***	***Federal Status***	***State Status***
Dermochelys coriacea	Leatherback Sea Turtle	Occasional	Breeder	Native	Yes	G2	S2	T	E
Malaclemys terrapin	Diamondback Terrapin	Unknown	Unknown	Native	Yes	G4	S4		
Terrapene Carolina	Eastern Box Turtle	Rare	Breeder	Native		G5	S5		
Gopherus polyphemus	Gopher Tortoise	Abundant	Breeder	Native	Yes	G3	S3		T
Lepidochelys kempii	Kemp's Ridley	Occasional	Unknown	Native		G1	S1	E	E
Thamnophis sirtalis	Eastern Garter Snake	Unknown	Unknown	Native		G5	SNR		
Diadophis punctatus	Southern Ringneck Snake	Unknown	Unknown	Native		G5	S5		
Cemophora coccinea	Scarlet Snake	Unknown	Unknown	Native	Yes	G5	SNR		

Appendix N: Bird species documented for Castillo de San Marcos National Monument.
These species have been cross referenced to the FL Comprehensive Wildlife Conservation Strategy species of greatest conservation need (SGCN) (Florida Fish and Wildlife Conservation Commission 2005b); NatureServe's global and state rankings (NatureServe 2008); and the FWC listings for endangered, threatened, or rare species (Florida Fish and Wildlife Conservation Commission 2005a). See reference or Appendix F 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***	***FL SGCN***	***PIF priority species***	***Audubon watchlist***	***Global Rank***	***State Rank***	***Federal Status***	***State Status***
Corvus brachyrhynchos	American Crow	Present in Park	Common	Breeder	Native				G5	SNR		
Falco sparverius	American Kestrel (southeastern sub-species)	Present in Park	Uncommon	Breeder	Native	YES	YES		G5	SNR, SNRN		T
Setophaga ruticilla	American Redstart	Probably Present	n/a	n/a	Native				G5	S2		
Turdus migratorius	American Robin	Present in Park	Common	Migratory	Native				G5	SNR, SNRN		
Anhinga anhinga	Anhinga	Present in Park	Common	Resident	Native				G5	SNR		
Icterus galbula	Baltimore Oriole	Present in Park	Unknown	Unknown	Native				G5	SNRN		
Hirundo rustica	Barn Swallow	Probably Present	n/a	n/a	Native				G5	SNRB		
Megaceryle alcyon	Belted Kingfisher	Present in Park	Unknown	Breeder	Native				G5	SNR, SNRN		
Rynchops niger	Black Skimmer	Probably Present	n/a	n/a	Native	YES		YES	G5	S3		SSC (1)
Coragyps atratus	Black Vulture	Present in Park	Abundant	Resident	Native				G5	SNR		
Nandayus nenday	Black-hooded Parakeet	Present in Park	Occasional	Resident	Non-Native							
Cyanocitta cristata	Blue Jay	Present in Park	Abundant	Breeder	Native				G5	SNR		
Quiscalus major	Boat-tailed Grackle	Present in Park	Abundant	Breeder	Native				G5	SNR		
Pelecanus occidentalis	Brown Pelican	Present in Park	Abundant	Resident	Native	YES			G4	S3		SSC (1)

Scientific Name	Common Name(s)	Park Status	Abundance	Residency	Nativity	FL SGCN	PIF priority species	Audubon watchlist	Global Rank	State Rank	Federal Status	State Status
Toxostoma rufum	Brown Thrasher	Present in Park	Abundant	Breeder	Native				G5	SNR		
Molothrus ater	Brown-headed Cowbird	Present in Park	Unknown	Unknown	Native				G5	SNR		
Sitta pusilla	Brown-headed Nuthatch	Present in Park	Uncommon	Unknown	Native		YES		G5	SNR		
Poecile carolinensis	Carolina Chickadee	Present in Park	Common	Unknown	Native				G5	SNR		
Thryothorus ludovicianus	Carolina Wren	Present in Park	Abundant	Breeder	Native				G5	SNR		
Bubulcus ibis	Cattle Egret	Present in Park	Abundant	Resident	Native				G5	SNR		
Chaetura pelagica	Chimney Swift	Present in Park	Uncommon	Breeder	Native				G5	SNRB		
Caprimulgus carolinensis	Chuck-will's-widow	Probably Present	n/a	n/a	Native					SNRB		
Quiscalus quiscula	Common Grackle	Present in Park	Abundant	Breeder	Native				G5	SNR		
Gavia immer	Common Loon	Present in Park	Unknown	Migratory	Native	YES			G5	SNRN		
Junco hyemalis	Dark-eyed Junco	Present in Park	Unknown	Unknown	Native				G5	SNRN		
Phalacrocorax auritus	Double-crested Cormorant	Present in Park	Abundant	Resident	Native				G5	SNR		
Picoides pubescens	Downy Woodpecker	Present in Park	Abundant	Breeder	Native				G5	SNR		
Sialia sialis	Eastern Bluebird	Present in Park	Rare	Migratory	Native				G5	SNR		
Tyrannus tyrannus	Eastern Kingbird	Present in Park	Common	Unknown	Native				G5	SNRB		
Sayornis phoebe	Eastern Phoebe	Present in Park	Common	Unknown	Native				G5	SNRN		

Scientific Name	Common Name(s)	Park Status	Abundance	Residency	Nativity	FL SGCN	PIF priority species	Audubon watchlist	Global Rank	State Rank	Federal Status	State Status
Pipilo erythrophthalmus	Eastern Towhee	Present in Park	Unknown	Unknown	Native				G5	SNR		
Sturnus vulgaris	European Starling	Present in Park	Abundant	Migratory	Non-Native				G5	SNA		
Corvus ossifragus	Fish Crow	Probably Present	n/a	n/a	Native				G5	SNR		
Dumetella carolinensis	Gray Catbird	Present in Park	Abundant	Unknown	Native				G5	SNR, SNRN		
Tyrannus dominicensis	Gray Kingbird	Present in Park	Common	Unknown	Native	YES			G5	SNRB		
Catharus minimus	Gray-cheeked Thrush	Probably Present	n/a	n/a	Native				G5	SNA		
Larus marinus	Great Black-backed Gull	Probably Present	n/a	n/a	Native				G5	SNRN		
Ardea herodias	Great Blue Heron	Present in Park	Abundant	Resident	Native				G5	SNR		
Myiarchus crinitus	Great Crested Flycatcher	Present in Park	Common	Unknown	Native				G5	SNRB		
Ardea alba	Great Egret	Present in Park	Abundant	Resident	Native				G5	S4		
Butorides virescens	Green Heron	Present in Park	Uncommon	Resident	Native				G5	SNR		
Catharus guttatus	Hermit Thrush	Probably Present	n/a	n/a	Native				G5	SNRN		
Larus argentatus	Herring Gull	Present in Park	Abundant	Resident	Native				G5	SNRN		
Lophodytes cucullatus	Hooded Merganser	Present in Park	Occasional	Migratory	Native				G5	SNRN		
Troglodytes aedon	House Wren	Probably Present	n/a	n/a	Native				G5	SNRN		
Charadrius vociferus	Killdeer	Present in Park	Unknown	Breeder	Native				G5	SNR		
Larus atricilla	Laughing Gull	Present in Park	Abundant	Resident	Native				G5	SNR		
Egretta caerulea	Little Blue Heron	Present in Park	Common	Resident	Native	YES			G5	S4		SSC (1,4)

Scientific Name	Common Name(s)	Park Status	Abundance	Residency	Nativity	FL SGCN	PIF priority species	Audubon watchlist	Global Rank	State Rank	Federal Status	State Status
Lanius ludovicianus	Loggerhead Shrike	Present in Park	Common	Breeder	Native	YES			G4	SNR		
Zenaida macroura	Mourning Dove	Present in Park	Unknown	Breeder	Native				G5	SNR		
Cardinalis cardinalis	Northern Cardinal	Present in Park	Unknown	Breeder	Native				G5	SNR		
Morus bassanus	Northern Gannet	Present in Park	Occasional	Resident	Native				G5	SNRN		
Circus cyaneus	Northern Harrier	Probably Present	n/a	n/a	Native				G5	SNRN		
Mimus polyglottos	Northern Mockingbird	Present in Park	Abundant	Breeder	Native				G5	SNR		
Parula americana	Northern Parula	Present in Park	Unknown	Vagrant	Native				G5	SNRB		
Stelgidopteryx serripennis	Northern Rough-winged Swallow	Present in Park	Uncommon	Unknown	Native				G5	SNRB		
Icterus spurius	Orchard Oriole	Present in Park	Unknown	Unknown	Native				G5	SNRB		
Pandion haliaetus	Osprey	Present in Park	Abundant	Resident	Native				G5	S3S4		
Protonotaria citrea	Prothonotary Warbler	Present in Park	Uncommon	Breeder	Native	YES		YES	G5	SNRB		
Melanerpes carolinus	Red-bellied Woodpecker	Present in Park	Common	Breeder	Native				G5	SNR		
Egretta rufescens	Reddish Egret	Present in Park	Rare	Resident	Native	YES		YES	G4	S2		SSC (1,4)
Buteo lineatus	Red-shouldered Hawk	Probably Present	n/a	n/a	Native				G5	SNR		
Buteo jamaicensis	Red-tailed Hawk	Probably Present	n/a	n/a	Native				G5	SNR		
Agelaius phoeniceus	Red-winged Blackbird	Present in Park	Common	Breeder	Native				G5	SNR		
Larus delawarensis	Ring-billed Gull	Present in Park	Abundant	Resident	Native				G5	SNRN		

Scientific Name	Common Name(s)	Park Status	Abundance	Residency	Nativity	FL SGCN	PIF priority species	Audubon watchlist	Global Rank	State Rank	Federal Status	State Status
Columba livia	Rock Pigeon	Present in Park	Common	Breeder	Non-Native				G5	SNA		
Pheucticus ludovicianus	Rose-breasted Grosbeak	Present in Park	Unknown	Unknown	Native				G5	SNA		
Calidris alba	Sanderling	Present in Park	Common	Resident	Native	YES		YES	G5	SNRN		
Egretta thula	Snowy Egret	Present in Park	Abundant	Resident	Native	YES			G5	S3		SSC (1)
Melospiza melodia	Song Sparrow	Present in Park	Unknown	Unknown	Native				G5	SNRN		
Catharus ustulatus	Swainson's Thrush	Probably Present	n/a	n/a	Native				G5	SNA		
Melospiza georgiana	Swamp Sparrow	Present in Park	Unknown	Unknown	Native				G5	SNRN		
Tachycineta bicolor	Tree Swallow	Present in Park	Uncommon	Unknown	Native				G5	SNRN		
Egretta tricolor	Tricolored Heron	Present in Park	Occasional	Resident	Native	YES			G5	S4		SSC (1,4)
Baeolophus bicolor	Tufted Titmouse	Present in Park	Uncommon	Unknown	Native				G5	SNR		
Cathartes aura	Turkey Vulture	Present in Park	Abundant	Resident	Native				G5	SNR		
Catharus fuscescens	Veery	Present in Park	Unknown	Unknown	Native				G5	SNA		
Caprimulgus vociferus	Whip-poor-will	Probably Present	n/a	n/a	Native				G5	SNRN		
Eudocimus albus	White Ibis	Present in Park	Common	Resident	Native	YES			G5	S4		SSC (2)
Charadrius wilsonia	Wilson's Plover	Present in Park	Unknown	Resident	Native	YES		YES	G5	S2		
Mycteria americana	Wood Stork	Present in Park	Uncommon	Resident	Native	YES			G4	S2	E	E
Hylocichla mustelina	Wood Thrush	Present in Park	Rare	Unknown	Native	YES		YES	G5	SNRB		

Scientific Name	Common Name(s)	Park Status	Abundance	Residency	Nativity	FL SGCN	PIF priority species	Audubon watchlist	Global Rank	State Rank	Federal Status	State Status
Nyctanassa violacea	Yellow-crowned Night-Heron	Present in Park	Common	Resident	Native	YES			G5	S3		
Dendroica coronata	Yellow-rumped Warbler	Present in Park	Common	Migratory	Native				G5	SNRN		

Appendix O: Bird species documented for Fort Matanzas National Monument.
These species have been cross referenced to the FL Comprehensive Wildlife Conservation Strategy species of greatest conservation need (SGCN) (Florida Fish and Wildlife Conservation Commission 2005b); NatureServe's global and state rankings (NatureServe 2008); and the FWC listings for endangered, threatened, or rare species (Florida Fish and Wildlife Conservation Commission 2005a). See reference or Appendix F 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***	***FL SGCN***	***PIF priority species***	***Audubon watchlist***	***Global Rank***	***State Rank***	***Federal Status***	***State Status***
Corvus brachyrhynchos	American Crow	Present in Park	Common	Resident	Native							
Carduelis tristis	American Goldfinch	Present in Park	Occasional	Migratory	Native							
Falco sparverius	American Kestrel	Present in Park	Common	Breeder	Native	Yes	Yes		G5	SNR B, SNR N		
Haematopus palliates	American Oystercatcher	Present in Park	Occasional	Migratory	Native	Yes			G5	S2		SSC (1,2)
Setophaga ruticilla	American Redstart	Probably Present	n/a	n/a	Native							
Turdus migratorius	American Robin	Present in Park	Common	Resident	Native							
Pelecanus erythrorhynchos	American White Pelican	Present in Park	Occasional	Migratory	Native							
Anhinga anhinga	Anhinga	Present in Park	Common	Resident	Native							
Aimophila aestivalis	Bachman's Sparrow	Present in Park	Rare	Unknown	Native	Yes			G3	S3		
Haliaeetus leucocephalus	Bald Eagle	Present in Park	Uncommon	Resident	Native	Yes			G5	S3		
Icterus galbula	Baltimore Oriole	Present in Park	Occasional	Migratory	Native							
Tyto alba	Barn Owl	Present in Park	Occasional	Unknown	Native							
Hirundo rustica	Barn Swallow	Present in Park	Uncommon	Migratory	Native							
Strix varia	Barred Owl	Present	Rare	Unknown	Native							

Scientific Name	Common Name(s)	Park Status	Abundance	Residency	Nativity	FL SGCN	PIF priority species	Audubon watchlist	Global Rank	State Rank	Federal Status	State Status
		in Park										
Megaceryle alcyon	Belted Kingfisher	Present in Park	Common	Breeder	Native							
Nandayus nenday	Black-hooded Parakeet	Present in Park	Occasional	Resident	Non-Native							
Rynchops niger	Black Skimmer	Present in Park	Common	Resident	Native	Yes		Yes	G5	S3		SSC (1)
Chlidonias niger	Black Tern	Present in Park	Occasional	Migratory	Native							
Coragyps atratus	Black Vulture	Present in Park	Abundant	Resident	Native							
Mniotilta varia	Black-and-white Warbler	Probably Present	n/a	n/a	Native							
Pluvialis squatarola	Black-bellied Plover	Present in Park	Rare	Resident	Native							
Dendroica fusca	Blackburnian Warbler	Probably Present	n/a	n/a	Native							
Nycticorax nycticorax	Black-crowned Night-Heron	Present in Park	Common	Resident	Native	Yes			G5	S3		
Himantopus mexicanus	Black-necked Stilt	Present in Park	Occasional	Migratory	Native							
Dendroica caerulescens	Black-throated Blue Warbler	Present in Park	Common	Resident	Native							
Dendroica virens	Black-throated Green Warbler	Probably Present	n/a	n/a	Native							
Cyanocitta cristata	Blue Jay	Present in Park	Abundant	Breeder	Native							
Polioptila caerulea	Blue-gray Gnatcatcher	Present in Park	Common	Breeder	Native							
Quiscalus major	Boat-tailed Grackle	Present in Park	Abundant	Breeder	Native							

Scientific Name	*Common Name(s)*	*Park Status*	*Abundance*	*Residency*	*Nativity*	*FL SGCN*	*PIF priority species*	*Audubon watchlist*	*Global Rank*	*State Rank*	*Federal Status*	*State Status*
Larus Philadelphia	Bonaparte's Gull	Present in Park	Rare	Resident	Native							
Pelecanus occidentalis	Brown Pelican	Present in Park	Abundant	Resident	Native	Yes			G4	S3		SSC (1)
Toxostoma rufum	Brown Thrasher	Present in Park	Common	Resident	Native							
Sitta pusilla	Brown-headed Nuthatch	Present in Park	Occasional	Migratory	Native		Yes		G5	SNR		
Poecile carolinensis	Carolina Chickadee	Present in Park	Common	Breeder	Native							
Thryothorus ludovicianus	Carolina Wren	Present in Park	Abundant	Breeder	Native							
Sterna caspia	Caspian Tern	Present in Park	Uncommon	Resident	Native	Yes			G5	S2		
Bubulcus ibis	Cattle Egret	Present in Park	Abundant	Resident	Native							
Bombycilla cedrorum	Cedar Waxwing	Present in Park	Rare	Migratory	Native							
Dendroica pensylvanica	Chestnut-sided Warbler	Probably Present	n/a	n/a	Native							
Chaetura pelagic	Chimney Swift	Present in Park	Common	Breeder	Native							
Spizella passerine	Chipping Sparrow	Probably Present	n/a	n/a	Native							
Caprimulgus carolinensis	Chuck-will's-widow	Present in Park	Uncommon	Breeder	Native							
Rallus longirostris	Clapper Rail	Present in Park	Common	Breeder	Native							
Quiscalus quiscula	Common Grackle	Present in Park	Common	Breeder	Native							
Columbina passerine	Common Ground-Dove	Present in Park	Common	Breeder	Native	Yes			G5	SNR		
Gavia immer	Common Loon	Present in Park	Occasional	Migratory	Native	Yes			G5	SNR N		
Mergus merganser	Common Merganser	Present in Park	Uncommon	Migratory	Native							

Scientific Name	*Common Name(s)*	*Park Status*	*Abundance*	*Residency*	*Nativity*	*FL SGCN*	*PIF priority species*	*Audubon watchlist*	*Global Rank*	*State Rank*	*Federal Status*	*State Status*
Gallinula chloropus	Common Moorhen	Present in Park	Common	Breeder	Native							
Chordeiles minor	Common Nighthawk	Present in Park	Uncommon	Breeder	Native							
Sterna hirundo	Common Tern	Present in Park	Uncommon	Resident	Native							
Geothlypis trichas	Common Yellowthroat	Present in Park	Common	Breeder	Native							
Accipiter cooperii	Cooper's Hawk	Present in Park	Rare	Resident	Native							
Junco hyemalis	Dark-eyed Junco	Present in Park	Common	Breeder	Native							
Phalacrocorax auritus	Double-crested Cormorant	Present in Park	Abundant	Resident	Native							
Picoides pubescens	Downy Woodpecker	Present in Park	Abundant	Breeder	Native							
Calidris alpine	Dunlin	Present in Park	Common	Resident	Native							
Sialia sialis	Eastern Bluebird	Present in Park	Rare	Resident	Native							
Tyrannus tyrannus	Eastern Kingbird	Present in Park	Common	Breeder	Native							
Sturnella magna	Eastern Meadowlark	Present in Park	Uncommon	Resident	Native	Yes			G5	SNR		
Sayornis phoebe	Eastern Phoebe	Present in Park	Common	Breeder	Native							
Megascops asio	Eastern Screech-Owl	Present in Park	Uncommon	Breeder	Native							
Pipilo erythrophthalmus	Eastern Towhee	Present in Park	Common	Unknown	Native							
Contopus virens	Eastern Wood-Pewee	Present in Park	Uncommon	Resident	Native							
Sturnus vulgaris	European Starling	Present in Park	Common	Breeder	Non-Native							
Spizella pusilla	Field	Probably	n/a	n/a	Native							

Scientific Name	Common Name(s)	Park Status	Abundance	Residency	Nativity	FL SGCN	PIF priority species	Audubon watchlist	Global Rank	State Rank	Federal Status	State Status
	Sparrow	Present										
Corvus ossifragus	Fish Crow	Present in Park	Common	Resident	Native							
Sterna forsteri	Forster's Tern	Present in Park	Uncommon	Resident	Native							
Dumetella carolinensis	Gray Catbird	Present in Park	Uncommon	Resident	Native							
Tyrannus dominicensis	Gray Kingbird	Present in Park	Common	Breeder	Native	Yes			G5	SNR B		
Larus marinus	Great Black-backed Gull	Present in Park	Occasional	Resident	Native							
Ardea Herodias	Great Blue Heron	Present in Park	Abundant	Resident	Native							
Myiarchus crinitus	Great Crested Flycatcher	Present in Park	Common	Breeder	Native							
Ardea alba	Great Egret	Present in Park	Common	Resident	Native							
Bubo virginianus	Great Horned Owl	Present in Park	Common	Breeder	Native							
Tringa melanoleuca	Greater Yellowlegs	Present in Park	Occasional	Unknown	Native							
Butorides virescens	Green Heron	Present in Park	Uncommon	Resident	Native							
Sterna nilotica	Gull-billed Tern	Present in Park	Occasional	Resident	Native	Yes			G5	S2		
Larus argentatus	Herring Gull	Present in Park	Common	Resident	Native							
Lophodytes cucullatus	Hooded Merganser	Present in Park	Uncommon	Migratory	Native							
Wilsonia citrine	Hooded Warbler	Probably Present	n/a	n/a	Native	Yes			G5	SNR B		
Podiceps auritus	Horned Grebe	Present in Park	Occasional	Migratory	Native	Yes			G5	SNR N		
Passer domesticus	House Sparrow	Present in Park	Common	Unknown	Non-Native							
Troglodytes aedon	House Wren	Present in Park	Common	Breeder	Native							

Scientific Name	Common Name(s)	Park Status	Abundance	Residency	Nativity	FL SGCN	PIF priority species	Audubon watchlist	Global Rank	State Rank	Federal Status	State Status
Charadrius vociferous	Killdeer	Present in Park	Uncommon	Resident	Native							
Larus atricilla	Laughing Gull	Present in Park	Abundant	Resident	Native							
Calidris minutilla	Least Sandpiper	Probably Present	n/a	n/a	Native							
Sterna antillarum	Least Tern	Present in Park	Common	Breeder	Native	Yes			G4	S2		
Tringa flavipes	Lesser Yellowlegs	Present in Park	Rare	Unknown	Native							
Aramus guarauna	Limpkin	Present in Park	Rare	Resident	Native	Yes			G5	S3		SSC (1)
Egretta caerulea	Little Blue Heron	Present in Park	Common	Resident	Native	Yes			G5	S4		SSC (1,4)
Lanius ludovicianus	Loggerhead Shrike	Present in Park	Rare	Resident	Native	Yes			G4	SNR		
Limnodromus scolopaceus	Long-billed Dowitcher	Present in Park	Occasional	Unknown	Native							
Fregata magnificens	Magnificent Frigatebird	Present in Park	Occasional	Unknown	Native	Yes			G5	S1		
Dendroica magnolia	Magnolia Warbler	Present in Park	Uncommon	Resident	Native							
Anas platyrhynchos	Mallard	Present in Park	Rare	Migratory	Native							
Scolopax minor	Marbled Godwit	Probably Present	n/a	n/a	Native	Yes			G5	SNR N		
Cistothorus palustris	Marsh Wren	Present in Park	Occasional	Unknown	Native							
Falco columbarius	Merlin	Present in Park	Occasional	Unknown	Native	Yes			G5	S2		
Zenaida macroura	Mourning Dove	Present in Park	Common	Breeder	Native							
Colinus virginianus	Northern Bobwhite	Present in Park	Common	Breeder	Native	Yes			G5	SNR		
Cardinalis cardinalis	Northern Cardinal	Present in Park	Abundant	Breeder	Native							

Scientific Name	Common Name(s)	Park Status	Abundance	Residency	Nativity	FL SGCN	PIF priority species	Audubon watchlist	Global Rank	State Rank	Federal Status	State Status
Colaptes auratus	Northern Flicker	Present in Park	Common	Breeder	Native	Yes			G5	SNR		
Morus bassanus	Northern Gannet	Present in Park	Common	Resident	Native							
Circus cyaneus	Northern Harrier	Present in Park	Common	Resident	Native							
Mimus polyglottos	Northern Mockingbird	Present in Park	Abundant	Breeder	Native							
Parula Americana	Northern Parula	Present in Park	Uncommon	Resident	Native							
Stelgidopteryx serripennis	Northern Rough-winged Swallow	Probably Present	n/a	n/a	Native							
Vermivora celata	Orange-crowned Warbler	Probably Present	n/a	n/a	Native							
Icterus spurious	Orchard Oriole	Present in Park	Rare	Migratory	Native							
Pandion haliaetus	Osprey	Present in Park	Abundant	Resident	Native							SSC[2] (1,2)
Seiurus aurocapillus	Ovenbird	Probably Present	n/a	n/a	Native							
Passerina ciris	Painted Bunting	Probably Present	n/a	n/a	Native	Yes			G5	S3		
Dendroica palmarum	Palm Warbler	Probably Present	n/a	n/a	Native							
Falco peregrines	Peregrine Falcon	Present in Park	Occasional	Unknown	Native	Yes			G4	S2		E
Podilymbus podiceps	Pied-billed Grebe	Present in Park	Rare	Migratory	Native							
Dryocopus pileatus	Pileated Woodpecker	Present in Park	Occasional	Resident	Native							
Charadrius melodus	Piping Plover	Present in Park	Rare	Resident	Native	Yes			G3	S3	T	T
Dendroica discolor	Prairie Warbler	Present in Park	Uncommon	Resident	Native							

Scientific Name	*Common Name(s)*	*Park Status*	*Abundance*	*Residency*	*Nativity*	*FL SGCN*	*PIF priority species*	*Audubon watchlist*	*Global Rank*	*State Rank*	*Federal Status*	*State Status*
Calidris canutus	Red Knot	Present in Park	Unknown	Unknown	Native	Yes			G4	SNR N		
Melanerpes carolinus	Red-bellied Woodpecker	Present in Park	Common	Breeder	Native							
Mergus serrator	Red-breasted Merganser	Present in Park	Unknown	Unknown	Native							
Egretta rufescens	Reddish Egret	Present in Park	Occasional	Unknown	Native	Yes		Yes	G4	S2		SSC (1,4)
Vireo olivaceus	Red-eyed Vireo	Present in Park	Uncommon	Migratory	Native							
Melanerpes erythrocephalus	Red-headed Woodpecker	Present in Park	Rare	Resident	Native	Yes			G5	SNR		
Buteo lineatus	Red-shouldered Hawk	Present in Park	Uncommon	Unknown	Native							
Buteo jamaicensis	Red-tailed Hawk	Present in Park	Unknown	Unknown	Native							
Agelaius phoeniceus	Red-winged Blackbird	Present in Park	Common	Resident	Native							
Larus delawarensis	Ring-billed Gull	Present in Park	Abundant	Resident	Native							
Streptopelia risoria	Ringed Turtle-Dove	Present in Park	Occasional	Resident	Non-Native							
Columba livia	Rock Dove	Present in Park	Uncommon	Resident	Non-Native							
Ajaia ajaja	Roseate Spoonbill	Present in Park	Common	Resident	Native	Yes			G5	S2		SSC (1,4)
Pheucticus ludovicianus	Rose-breasted Grosbeak	Present in Park	Occasional	Unknown	Native							
Sterna maxima	Royal Tern	Present in Park	Common	Resident	Native	Yes			G5	S3		
Regulus calendula	Ruby-crowned Kinglet	Present in Park	Uncommon	Unknown	Native							
Archilochus colubris	Ruby-throated	Present in Park	Common	Breeder	Native							

Scientific Name	Common Name(s)	Park Status	Abundance	Residency	Nativity	FL SGCN	PIF priority species	Audubon watchlist	Global Rank	State Rank	Federal Status	State Status
	Hummingbird											
Arenaria interpres	Ruddy Turnstone	Present in Park	Common	Resident	Native							
Ammodramus savannarum	Saltmarsh Sharp-tailed Sparrow	Present in Park	Occasional	Resident	Native							
Calidris alba	Sanderling	Present in Park	Abundant	Resident	Native	Yes		Yes	G5	SNRN		
Sterna sandvicensis	Sandwich Tern	Present in Park	Occasional	Migratory	Native	Yes			G5	S2		
Piranga olivacea	Scarlet Tanager	Present in Park	Occasional	Unknown	Native							
Cistothorus platensis	Sedge Wren	Probably Present	n/a	n/a	Native							
Charadrius semipalmatus	Semipalmated Plover	Present in Park	Common	Breeder	Native							
Calidris pusilla	Semipalmated Sandpiper	Present in Park	Uncommon	Unknown	Native	Yes			G5	SNRM		
Limnodromus griseus	Short-billed Dowitcher	Present in Park	Rare	Unknown	Native							
Egretta thula	Snowy Egret	Present in Park	Abundant	Resident	Native	Yes			G5	S3		SSC (1)
Tringa solitaria	Solitary Sandpiper	Present in Park	Occasional	Unknown	Native							
Vireo solitaries	Solitary Vireo	Present in Park	Rare	Migratory	Native							
Melospiza melodia	Song Sparrow	Present in Park	Common	Migratory	Native							
Actitis macularia	Spotted Sandpiper	Present in Park	Common	Resident	Native							
Calidris himantopus	Stilt Sandpiper	Present in Park	Occasional	Unknown	Native							
Piranga rubra	Summer Tanager	Present in Park	Rare	Unknown	Native							
Elanoides forficatus	Swallow-tailed Kite	Present in Park	Occasional	Resident	Native	Yes			G5	S2		

Scientific Name	*Common Name(s)*	*Park Status*	*Abundance*	*Residency*	*Nativity*	*FL SGCN*	*PIF priority species*	*Audubon watchlist*	*Global Rank*	*State Rank*	*Federal Status*	*State Status*
Melospiza Georgiana	Swamp Sparrow	Present in Park	Uncommon	Migratory	Native							
Tachycineta bicolor	Tree Swallow	Present in Park	Common	Migratory	Native							
Egretta tricolor	Tricolored Heron	Present in Park	Occasional	Unknown	Native	Yes			G5	S4		SSC (1,4)
Parus bicolor	Tufted Titmouse	Present in Park	Uncommon	Resident	Native							
Cathartes aura	Turkey Vulture	Present in Park	Abundant	Resident	Native							
Rallus limicola	Virginia Rail	Present in Park	Rare	Resident	Native							
Calidris mauri	Western Sandpiper	Present in Park	Common	Resident	Native	Yes			G5	SNR N		
Caprimulgus vociferous	Whip-poor-will	Present in Park	Rare	Breeder	Native							
Eudocimus albus	White Ibis	Present in Park	Common	Resident	Native	Yes			G5	S4		SSC (2)
Vireo griseus	White-eyed Vireo	Present in Park	Uncommon	Migratory	Native							
Zonotrichia albicollis	White-throated Sparrow	Probably Present	n/a	n/a	Native							
Catoptrophorus semipalmatus	Willet	Present in Park	Common	Breeder	Native							
Charadrius wilsonia	Wilson's Plover	Present in Park	Common	Breeder	Native	Yes		Yes	G5	S2		
Mycteria Americana	Wood Stork	Present in Park	Common	Resident	Native	Yes			G4	S2	E	E
Hylocichla mustelina	Wood Thrush	Present in Park	Rare	Resident	Native	Yes		Yes	G5	SNR B		
Sphyrapicus varius	Yellow-bellied Sapsucker	Present in Park	Rare	Resident	Native							
Coccyzus americanus	Yellow-billed Cuckoo	Present in Park	Common	Resident	Native							

Scientific Name	Common Name(s)	Park Status	Abundance	Residency	Nativity	FL SGCN	PIF priority species	Audubon watchlist	Global Rank	State Rank	Federal Status	State Status
Nyctanassa violacea	Yellow-crowned Night-Heron	Present in Park	Uncommon	Resident	Native	Yes			G5	S3		
Dendroica coronate	Yellow-rumped Warbler	Present in Park	Abundant	Migratory	Native							
Vireo flavifrons	Yellow-throated Vireo	Present in Park	Rare	Migratory	Native							

Appendix P: Mammal species documented for Castillo de San Marcos National Monument.
These species have been cross referenced to the FL Comprehensive Wildlife Conservation Strategy species of greatest conservation need (SGCN) (Florida Fish and Wildlife Conservation Commission 2005b); NatureServe's global and state rankings (NatureServe 2008); and the FWC listings for endangered, threatened, or rare species (Florida Fish and Wildlife Conservation Commission 2005a). See reference or Appendix F for explanation of abbreviations.

Scientific Name	***Common Name(s)***	***Park Status***	***Abundance***	***Residency***	***Nativity***	***FL SGCN***	***Global Rank***	***State Rank***	***Federal Status***	***State Status***
Felis catus	domestic cat	Present	Rare	Breeder	Non-Native					
Sciurus carolinensis	eastern gray squirrel	Present	Uncommon	Breeder	Native		G5	SNR		
Procyon lotor	raccoon	Present	Occasional	Breeder	Native		G5	S5		

Appendix Q: Mammal species documented for Fort Matanzas National Monument.
These species have been cross referenced to the FL Comprehensive Wildlife Conservation Strategy species of greatest conservation need (SGCN) (Florida Fish and Wildlife Conservation Commission 2005b); NatureServe's global and state rankings (NatureServe 2008); and the FWC listings for endangered, threatened, or rare species (Florida Fish and Wildlife Conservation Commission 2005a). See reference or Appendix F for explanation of abbreviations.

Scientific Name	***Common Name(s)***	***Abundance***	***Nativity***	***FL SGCN***	***Global Rank***	***State Rank***	***Federal Status***	***State Status***
Odocoileus virginianus	white-tailed deer	Uncommon	Native					
Canis familiaris	domestic dog (feral)	Occasional	Non-Native					
Canis latrans	Coyote	Uncommon	Native					
Urocyon cinereoargenteus	gray fox	Rare	Native					
Felis catus	domestic cat	Uncommon	Non-Native					
Lynx rufus	Bobcat	Rare	Native					
Lontra Canadensis	river otter	Occasional	Native	Yes	G5	SNR		
Mustela vison	American mink, mink	Common	Native	Yes	G5	S5		
Procyon lotor	Raccoon	Common	Native					
Tursiops truncates	bottlenose dolphin	Common	Native	Yes	G5	SNR		
Didelphis virginiana	Virginia opossum	Common	Native					
Scalopus aquaticus	eastern mole	Common	Native					
Sylvilagus palustris	marsh rabbit	Common	Native					
Mus musculus	house mouse	Unknown	Non-Native					
Oryzomys palustris	marsh rice rat	Uncommon	Native					
Peromyscus gossypinus	cotton mouse	Unknown	Native					
Peromyscus polionotus phasma	Anastasia Island beach mouse	Common	Native	Yes	G5T1	S1	E	E
Rattus rattus	black rat	Unknown	Non-Native					
Sigmodon hispidus	hispid cotton rat	Unknown	Native					
Sciurus carolinensis	eastern gray squirrel	Uncommon	Native					
Trichechus manatus	Antillean manatee, Caribbean manatee, Florida manatee	Uncommon	Native	Yes	G2	S2	E	E
Dasypus novemcinctus	long-nosed armadillo, nine-banded armadillo	Uncommon	Native					

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