

# HABITAT MANAGEMENT PLAN ST. MARKS NATIONAL WILDLIFE REFUGE

*Wakulla, Taylor, and Jefferson Counties, Florida*



**Southeast Region**

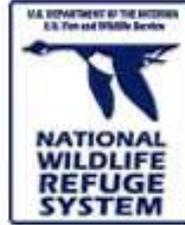




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# St. Marks National Wildlife Refuge

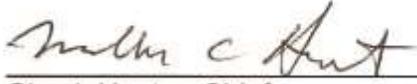
## Habitat Management Plan

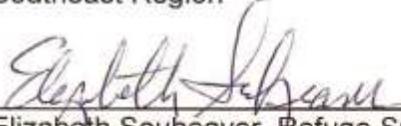


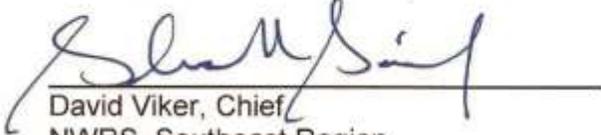
**U.S. Department of the Interior**  
**Fish and Wildlife Service**  
*Southeast Region*

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**St. Marks National Wildlife Refuge  
Habitat Management Plan**

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# I. Introduction

For over 100 years the Fish and Wildlife Service (Service) has practiced land stewardship with the aim of protecting habitat and its associated wildlife for the benefit of the American people. Since the establishment of Pelican Island National Wildlife Refuge in 1903, refuge employees have developed and refined the latest tools for wildlife conservation. Nationally and internationally, refuges have garnered a reputation for being premier ground for the refinement of habitat management techniques.

With the exception of Wilderness and some other specially designated lands, leaving nature to itself is not the approach taken by the Service for the conservation of wildlife. This is because historical ecological processes, such as fires, have been altered, requiring specific habitat prescriptions to maintain or restore those areas for the benefit of the priority resources they are required to support. In addition, new threats, such as an increasing number of invasive species, the impacts of climate change, and development of neighboring lands require active management to prevent degradation of refuge resources. Generally, wildlife and habitats are actively managed for particular objectives. This management has a sound scientific basis. It is, in fact, the practical application of the science of ecology. As the discipline of wildlife management evolved, largely through the efforts of Aldo Leopold with his publication of *Game Management* in 1933, it was recognized that a greater emphasis needed to be placed on making decisions that are based on the best science of the day, while retaining some of the artful intuition that comes from years of field experience. Sound wildlife management will always involve the skillful integration of science and art in disciplines as diverse as biology and sociology.

Habitat is defined as simply "the physical and biological surroundings of an organism" (Bolen and Robinson 1995). It includes all of the natural components of an ecosystem that are essential for survival, including food, cover, and water. Thus, the purpose of this Habitat Management Plan (HMP) is to guide the refuge staff in their efforts to meet the needs of the refuge's biota. In this HMP, the terms "habitat, vegetative communities, and plant communities" are used synonymously.

## **SCOPE AND RATIONALE**

Managed by the Service, St. Marks National Wildlife Refuge (NWR) supports an array of habitats, ranging from saltwater marshes to upland pine forests. The refuge's location in the Florida panhandle (Figure 1) contributes to this diversity. The wetlands and uplands that make up the refuge provide for the needs of a variety of invertebrate, fish, and wildlife species.

There is a need for habitat management on St. Marks NWR, as has been identified in the Comprehensive Conservation Plan (CCP) (USFWS 2006). This HMP is a step-down plan to the St. Marks NWR CCP. The wildlife and habitat management goals and objectives contained in this HMP are a reflection of the information and recommendations derived from the CCP, the 2000 biological review of the refuge (USFWS 2004), a 2011 "pulse check" of the refuge biological and habitat programs, internal scoping within the Service, and information and recommendations gathered from the public and governmental partners during public scoping for the CCP.

Habitat management plans are dynamic working documents that provide refuge managers with a decision-making process; guidance for the management of refuge habitat; and a long-term vision, continuity, and consistency for habitat management on refuge lands. Each habitat

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management plan incorporates the role of refuge habitat in international, national, regional, tribal, state, ecosystem, and refuge goals and objectives; guides analysis and selection of specific habitat management strategies to achieve those habitat goals and objectives; and uses key data, scientific literature, expert opinion, and staff expertise.

The statutory authority for conducting habitat management planning on national wildlife refuges is derived from the National Wildlife Refuge System Administration Act of 1966 (Administration Act), as amended by the National Wildlife Refuge System Improvement Act of 1997 (Improvement Act), 16 U.S.C. 668dd - 668ee. Section 4(a)(3) of the Improvement Act states: "With respect to the System, it is the policy of the United States that each refuge shall be managed to fulfill the mission of the System, as well as the specific purposes for which that refuge was established" and Section 4(a)(4) states: "In administering the System, the Secretary shall monitor the status and trends of fish, wildlife, and plants in each refuge." The Improvement Act provides the Service the authority to establish policies, regulations, and guidelines governing habitat management planning within the National Wildlife Refuge System (Refuge System).

Habitat management plans comply with all applicable laws, regulations, and policies governing the management of the Refuge System. The lifespan of a habitat management plan is 15 years and parallels that of refuge CCPs. Habitat management plans are reviewed every 5 years and updated as necessary.

## **LEGAL MANDATES**

### *Refuge Purposes*

The purposes of a national wildlife refuge, as established by Congress or the Executive Branch, are the barometer by which all actions on that designated public land are measured. Habitat management, public use, and all other programs are required to fulfill the established purposes of the refuge.

Under Executive Order 5740, dated October 31, 1931, which established the refuge, the purpose of the acquisition was "as a refuge and breeding ground for wild animals and birds." For lands acquired under the Migratory Bird Conservation Act of 1929 (16 U.S.C., Section 715d), the purpose of the acquisition was "for use as an inviolate sanctuary, or for any other management purpose, for migratory birds." For lands acquired under the Refuge Recreation Act of 1962 (16 U.S.C., Section 460k-1), the purpose of the acquisition was "for (1) incidental fish and wildlife-oriented recreational development; (2) the protection of natural resources; and (3) the conservation of endangered species or threatened species." Under the Administration Act, refuges were established for "conservation, management, and restoration of the fish, wildlife, and plant resources and their habitats for the benefit of present and future generations of Americans (16 U.S.C. 668dd(a)(2). The Wilderness Act of 1964, Public Law 92-363, dated January 3, 1975, also designated "certain lands in the St. Marks Wildlife Refuge, Florida, which comprise approximately seventeen thousand seven hundred and forty-six acres as the St. Marks Wilderness."

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In addition to the specific purposes that were established for each refuge, the Improvement Act provides clear guidance for the mission of the Refuge System and priority wildlife-dependent public uses. The Improvement Act states that each refuge will:

- Fulfill the mission of the Refuge System;
- Fulfill the individual purposes of each refuge;
- Consider the needs of wildlife first;
- Fulfill requirements of comprehensive conservation plans that are prepared for each unit of the Refuge System;
- Maintain the biological integrity, diversity, and environmental health of the Refuge System; and
- Recognize that wildlife-dependent recreation activities, including hunting, fishing, wildlife observation, wildlife photography, and environmental education and interpretation are legitimate and priority public uses; and allow refuge managers authority to determine compatible public uses.

### *System Mission*

The Administration Act, as amended by the Improvement Act, states: “The mission of the System is to administer a national network of lands and waters for the conservation, management, and where appropriate, restoration of the fish, wildlife, and plant resources and their habitats within the United States for the benefit of present and future generations of Americans.” This HMP will support the Refuge System mission by providing a framework for habitat management and restoration.

### **REFUGE VISION**

The refuge vision was developed for the CCP:

The St. Marks National Wildlife Refuge will be a model for conserving the natural diversity of plants and animals, preserving cultural resources, and providing opportunities for research, environmental education, and quality outdoor recreation. The refuge will link other north Florida wildlands with vital habitat for threatened and endangered species, migratory birds, and resident wildlife and it will protect the rich resources of Apalachee Bay. Conservation of the natural health and beauty of the refuge is the Service’s promise to the community and future generations.

This HMP will be part of a comprehensive effort to achieve the refuge vision.

### **RELATIONSHIP TO OTHER PLANS**

A CCP was finalized for the refuge in 2006, which includes broad goals and objectives for refuge management over a 15-year period. The purpose of this HMP is to provide more specific guidance that will facilitate the selection of prescriptions for implementing the goals and objectives of the CCP. In order to maintain consistent strategies for managing wildlife and habitats on the refuge, several other planning documents and reports were used in the development of this HMP. See Section 6.0 for a complete listing of literature cited.

Refuge threatened and endangered species with approved recovery plans include: Florida manatee, *Trichechus manatus latirostris* (USFWS 2001), piping plover, *Charadrius melodus* (USFWS 2003a), wood stork, *Mycteria americana* (USFWS 1996), red-cockaded woodpecker, *Picoides borealis* (USFWS 2003b), Kemp’s Ridley sea turtle, *Lepidochelys kempii* (USFWS and

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NMFS 1992), green sea turtle, *Chelonia mydas* (NMFS and USFWS 1991), loggerhead sea turtle, *Caretta caretta* (NMFS and USFWS 2008), leatherback sea turtle, *Dermochelys coriacea* (NMFS and USFWS 1992), eastern indigo snake, *Drymarchon corais couperi* (USFWS 1982, Hyslop 2012), Gulf sturgeon, *Acipenser oxyrinchus desotoi* (USFWS and GSMFC 1995), Ochlockonee moccasinshell, *Medionidus simpsonianus*, and purple bankclimber, *Elliptoideus sloatianus* (USFWS 2003c). In 2009, the refuge became a wintering ground for the ultralight lead whooping cranes (*Grus americana*), and management objectives and strategies from the latest recovery plan (Canadian Wildlife Service and USFWS 2007) have been reviewed and incorporated (where appropriate) into this HMP. Whenever possible, priority actions identified in recovery plans were incorporated into the goals, objectives, and strategies of this HMP.

Several regional bird conservation and management plans were used in the development of this HMP, as the refuge is an important stopover site for neotropical migratory birds and has been designated as a Globally Important Bird Area by the American Bird Conservancy. Plans that were consulted for neotropical migratory bird habitat priorities include the Partners in Flight North American Landbird Conservation Plan (Rich et al. 2004), Partners in Flight Bird Conservation Plan for the South Atlantic Coastal Plain – Version 1.0. (Hunter et al. 2001), Bird Conservation Plan for the East Gulf Coastal Plain (Partners in Flight 2008), and A Blueprint for the Future of Migratory Birds: Migratory Bird Program Strategic Plan 2004-2014 (USFWS 2008a). For shorebird habitat objectives, the U.S. Shorebird Conservation Plan (Brown et al. 2001), the Southeastern Coastal Plains-Caribbean Region Report of the U.S. Shorebird Conservation Plan (Hunter 2003), and the Southeastern Coastal Plains–Caribbean Regional Shorebird Plan - Version 1.0 (Hunter et al. 2005) provided essential guidance. Additionally, the North American Waterfowl Management Plan (NAWMP Plan Committee 2004) and the Southeast United States Regional Waterbird Conservation Plan (USFWS 2006) were consulted.

The Florida Fish and Wildlife Conservation Commission (FWC) is a critical partner in the effort to implement conservation strategies on the Florida Gulf Coast. In 2005, FWC published the Florida's Wildlife Legacy Initiative (FWLI), which identified the priority actions for the state's imperiled species (FWC 2005). The FWLI was consulted during the development of this HMP and shares similar habitat and wildlife objectives. In addition, FWC management plans for the following listed species were reviewed: flatwoods salamander, *Ambystoma cingulatum* (FWC 2001), Florida manatee, (FWC 2007), gopher tortoise, *Gopherus polyphemus* (FWC 2012), and red-cockaded woodpecker (FWC 2003).

Florida Exotic Pest Plant Council (FLEPPC) management plans and recommendations were consulted with regard to the eradication and control of the following nonnative plant species: air potato, *Dioscorea bulbifera* (FLEPPC 2008), Chinese tallow, *Sapium sebiferum* (FLEPPC 2005), Japanese climbing fern, *Lygodium japonicum* (Van Loan 2006, Ferriter 2001, Bohn 2011), and cogon grass/*Imperata cylindrica* (Loewenstein and Miller 2007, MacDonald et al. 2009). Hoyer et al. (2005) offers management recommendations for hydrilla (*Hydrilla verticillata*).

This HMP also incorporates the recommendations of other approved refuge plans, including the Fire Management Plan (USFWS 2009a) and the Wildlife and Habitat Management Review (USFWS 2004). Prescribed fire strategies detailed in this HMP will coincide with strategies in the Fire Management Plan. This HMP will replace the following refuge plans:

Marsh and Water Management Plan (1986); and  
Forest Management Plan (1989).

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## II. Environmental Setting and Background

Established in 1931, the refuge is named after the St. Marks River, which flows through the refuge to the Gulf of Mexico. It lies in the Florida panhandle, an area characterized by mesic uplands that transition to vast saltwater marshes fringing the coastal areas of the refuge.

### **LOCATION**

Located in Wakulla, Jefferson, and Taylor Counties, St. Marks NWR lies in the eastern portion of the Florida panhandle, approximately 25 miles south of Tallahassee, the nearest metropolitan area (Figure 1). The refuge covers approximately 70,412 acres.

### **MANAGEMENT UNITS**

St. Marks NWR is broadly divided into three management units: St. Marks, Wakulla, and Panacea (Figures 2, 3, and 4). These are described and mapped in the CCP. Other management subunits include forest compartments, impoundments, wilderness area, and conservation easements in Florida and Georgia. These units and associated management are described in the following sections.

#### *Forest Compartments and Prescribed Burn Units*

The forested and upland habitats of the refuge are divided into workable units (compartments) that can be systematically inventoried and management prescribed (Figure 5). While prescriptions were developed annually prior to 1996 (the FY1995 Forest Prescription was the last), staff shortages have reduced prescriptions to only two since then – 1999 and 2003. Fire management units (Figure 6) have evolved over the years and use roads and natural firebreaks as boundaries to facilitate control and minimize fireline plowing ([USFWS 2009a](#)). A listing of the forest compartments, approximate acreages, and corresponding burn units are exhibited in Appendix A. The proposed forest management compartment treatment schedule is listed in Appendix B.

Figure 1. St. Marks NWR

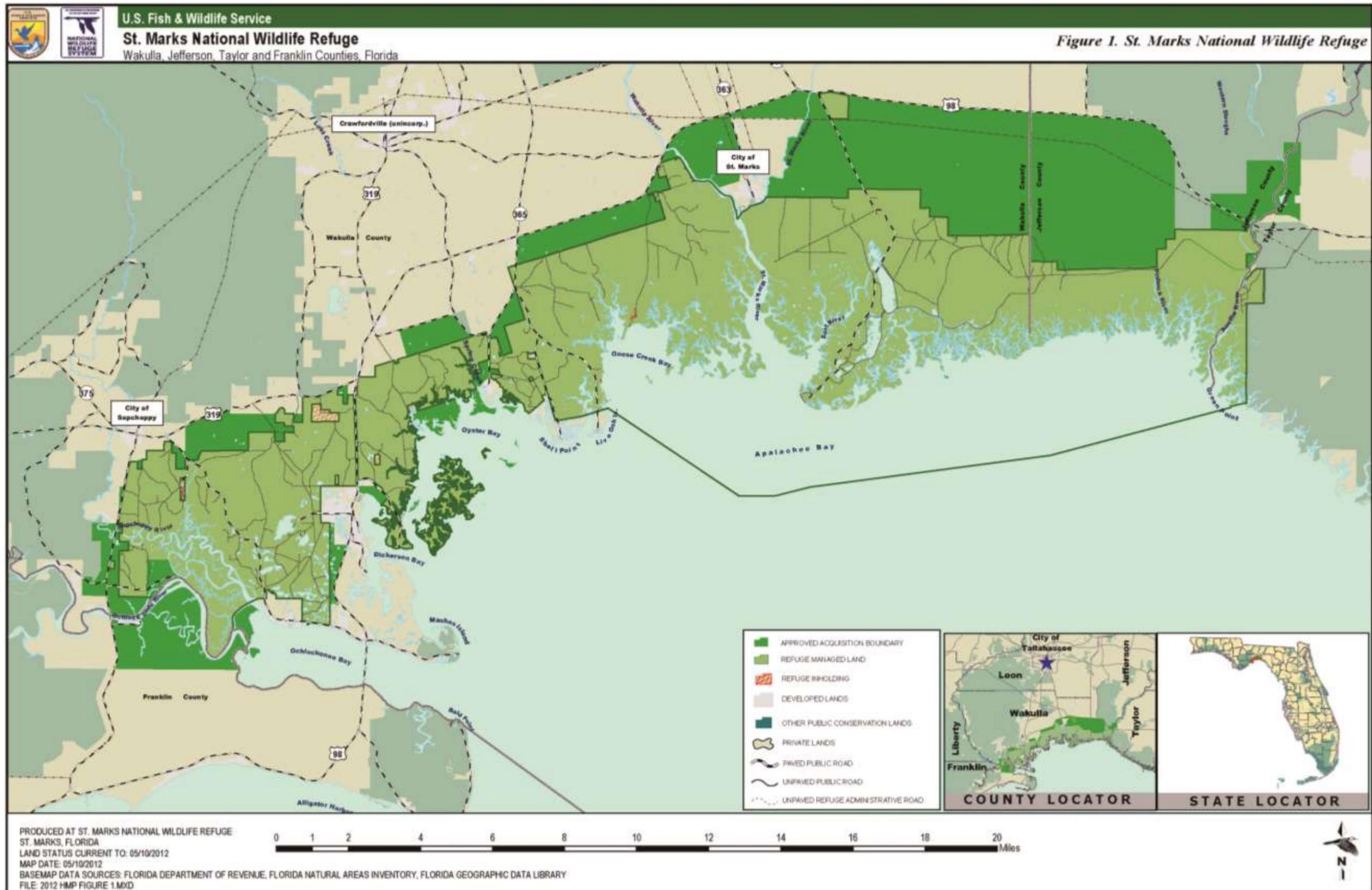


Figure 2. St. Marks Unit natural communities

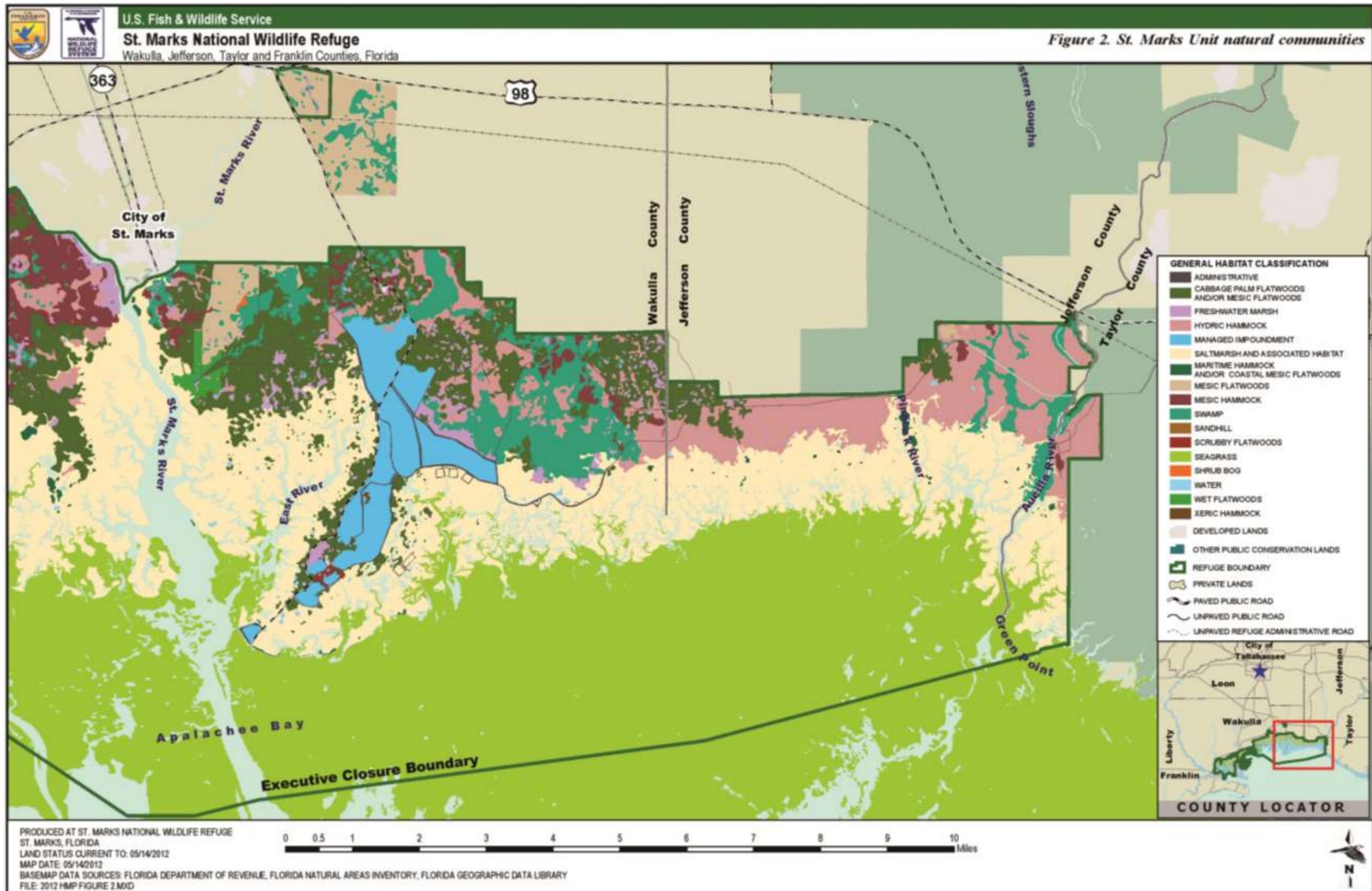


Figure 3. Wakulla Unit natural communities

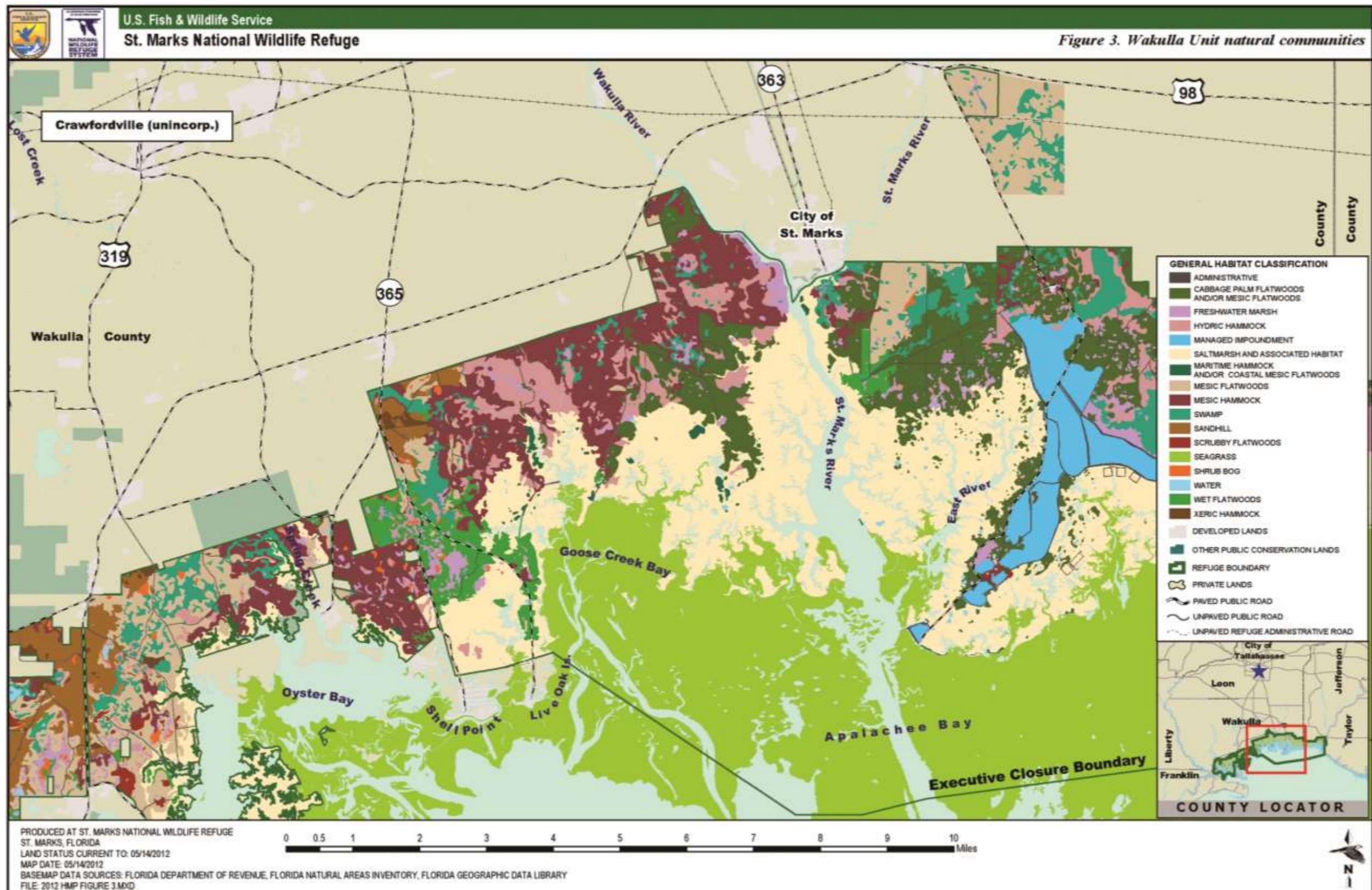


Figure 4. Panacea Unit natural communities

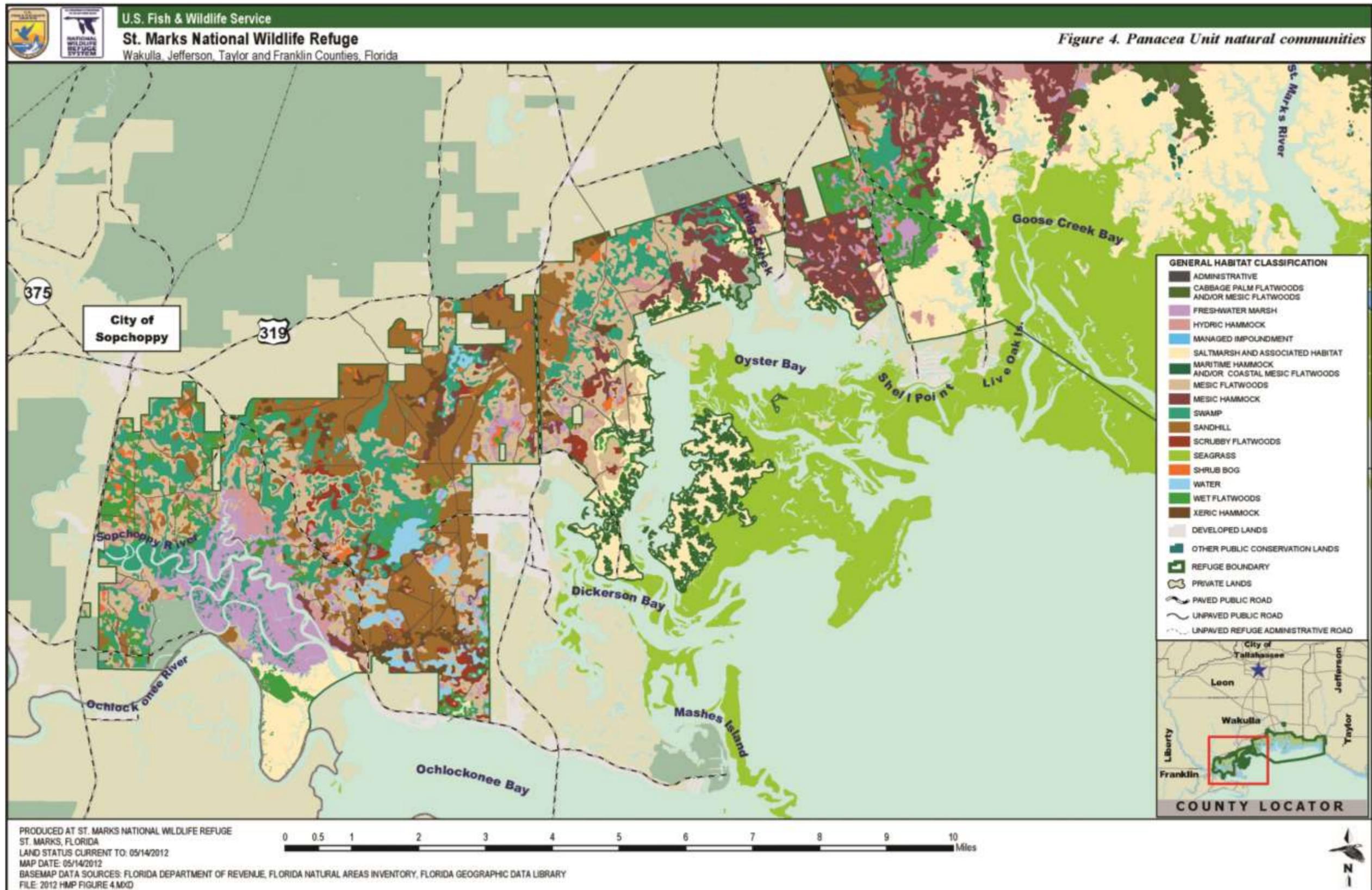


Figure 5. St. Marks NWR forest management compartments

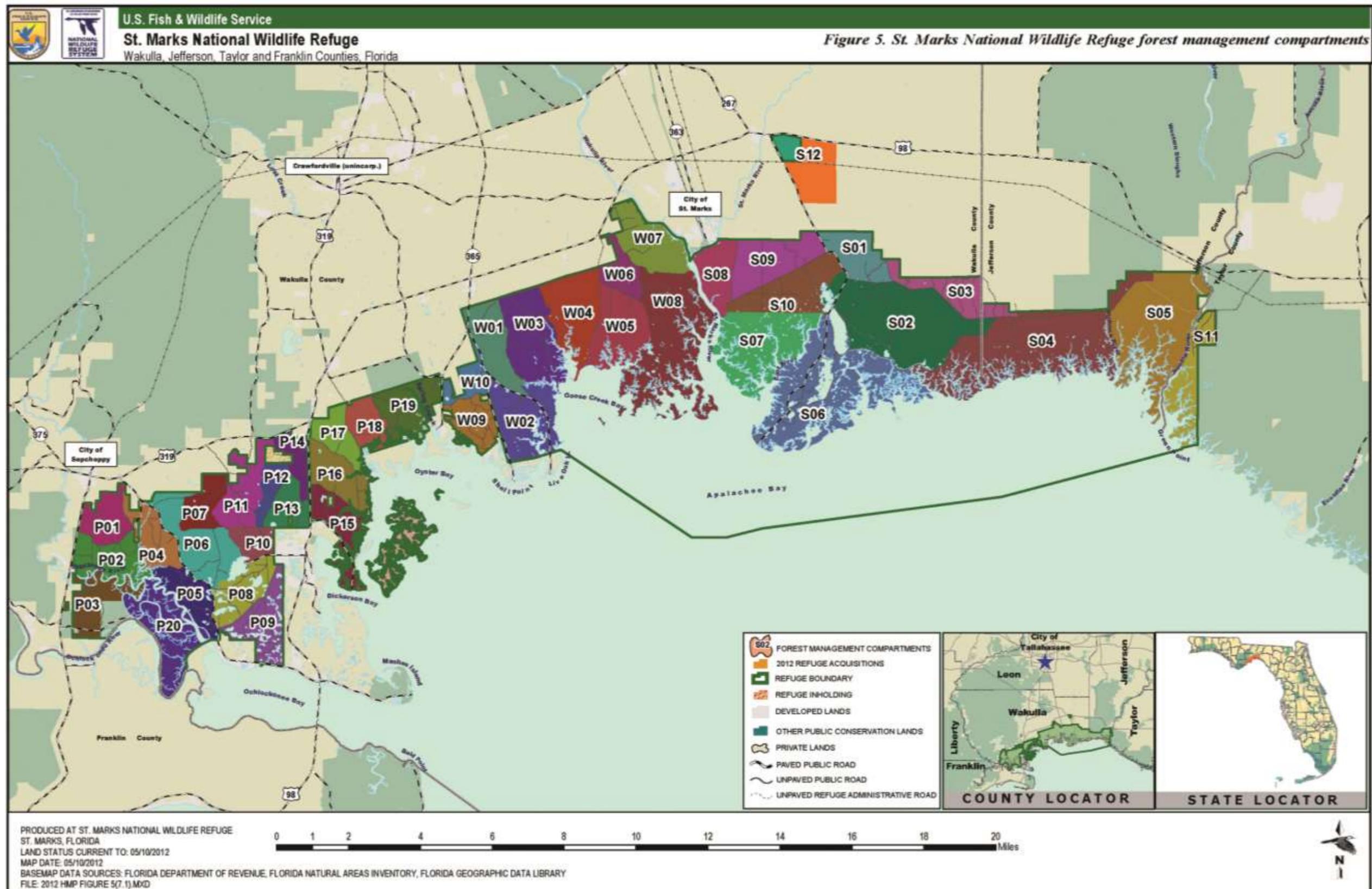
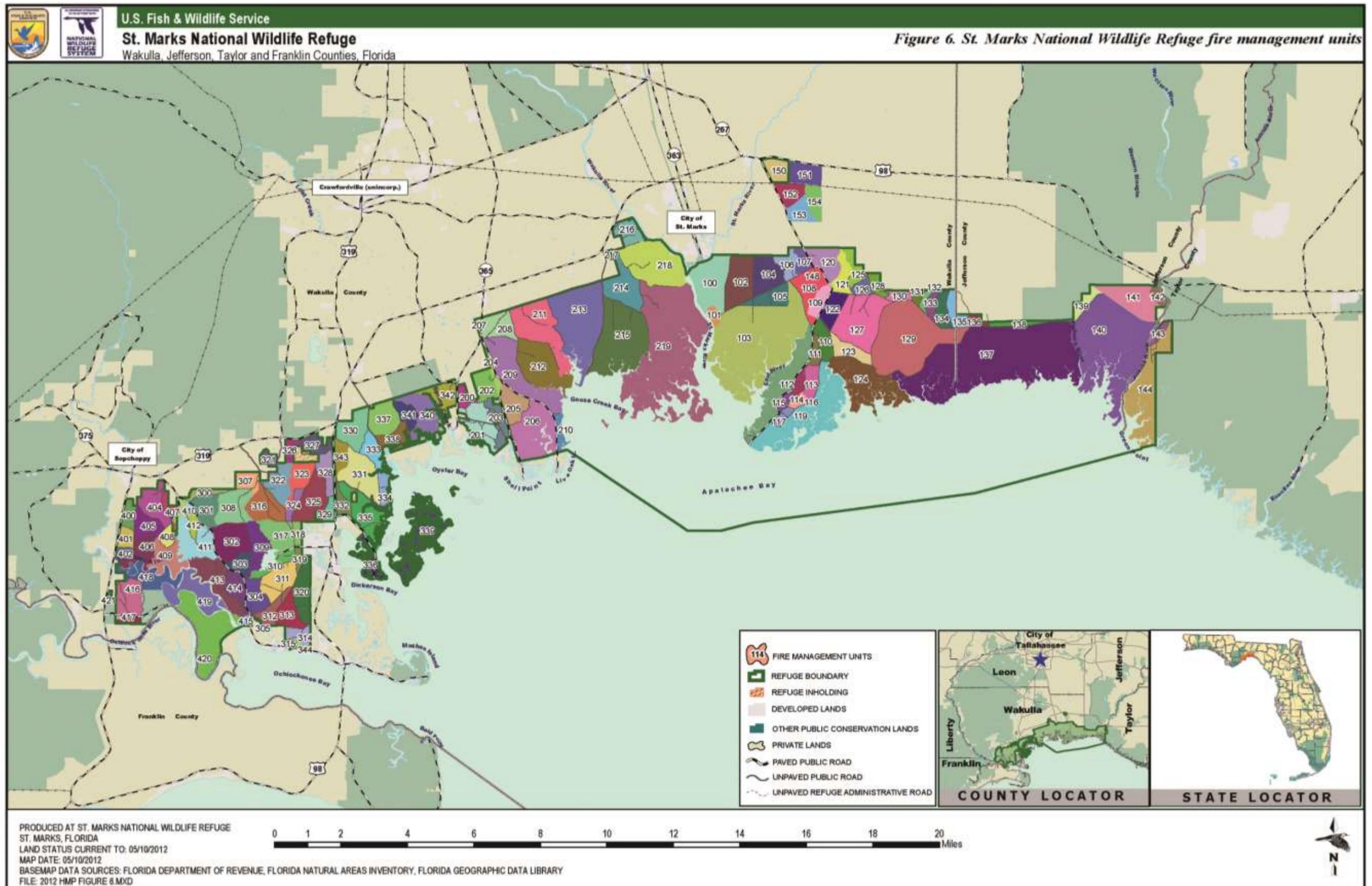


Figure 6. St. Marks NWR fire management units



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### *Wetland Impoundments*

Managed wetlands or impoundments have been used for almost 100 years to improve wintering habitat for migratory birds, particularly waterfowl. The refuge contains approximately 1,600 acres of managed impoundments and nearly 400 acres of other potentially managed wetlands (Tables 1 and 2, Figure 7). In addition to their wildlife value, impoundments are important public use areas, especially for wildlife viewing, photography, and fishing.

**Table 1. Managed impoundment habitats**

<b>Impoundment</b>	<b>Water/Low Marsh (acres)</b>	<b>High Marsh/Wooded(acres)</b>	<b>Total Acreage</b>
<b>East River Pool</b>	189	56	245
<b>Mounds 1</b>	45	88	133
<b>Mounds 2</b>	32	97	129
<b>Mounds 3</b>	232	77	309
<b>Stoney Bayou 1</b>	298	3	301
<b>Stoney Bayou 2</b>	280	6	286
<b>Headquarters Pond</b>	18	0	18
<b>Tower Pond</b>	14	6	20
<b>Picnic Pond</b>	21	36	57
<b>Lighthouse Pool</b>	23	5	28
<b>Stoney Bayou Field</b>	70	--	70

**Table 2. Potentially managed wetland area habitats**

<b>Wetland Area</b>	<b>Habitat</b>	<b>Total Acreage</b>
<b>Stoney Bayou East</b>	mudflats, marsh, timber	302
<b>Plum Orchard Pond</b>	open water, low marsh	4.5
<b>Levy Ditch</b>	oak flats, cypress ponds	50
<b>Johnson Creek</b>	low marsh	30

Figure 7. St. Marks NWR impoundments and water control structures

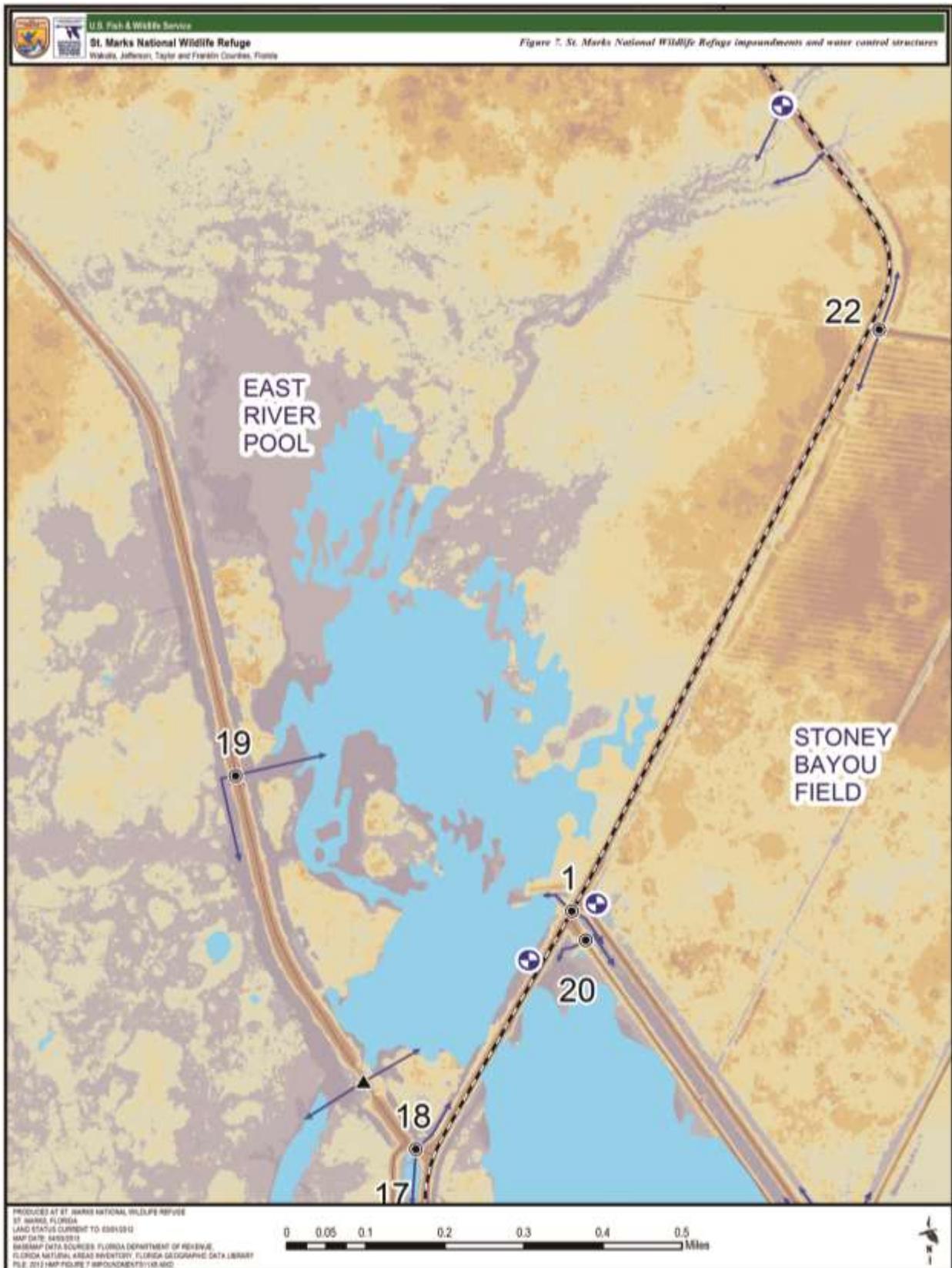


Figure 7a. St. Marks NWR impoundments and water control structures



Figure 7b. St. Marks NWR impoundments and water control structures

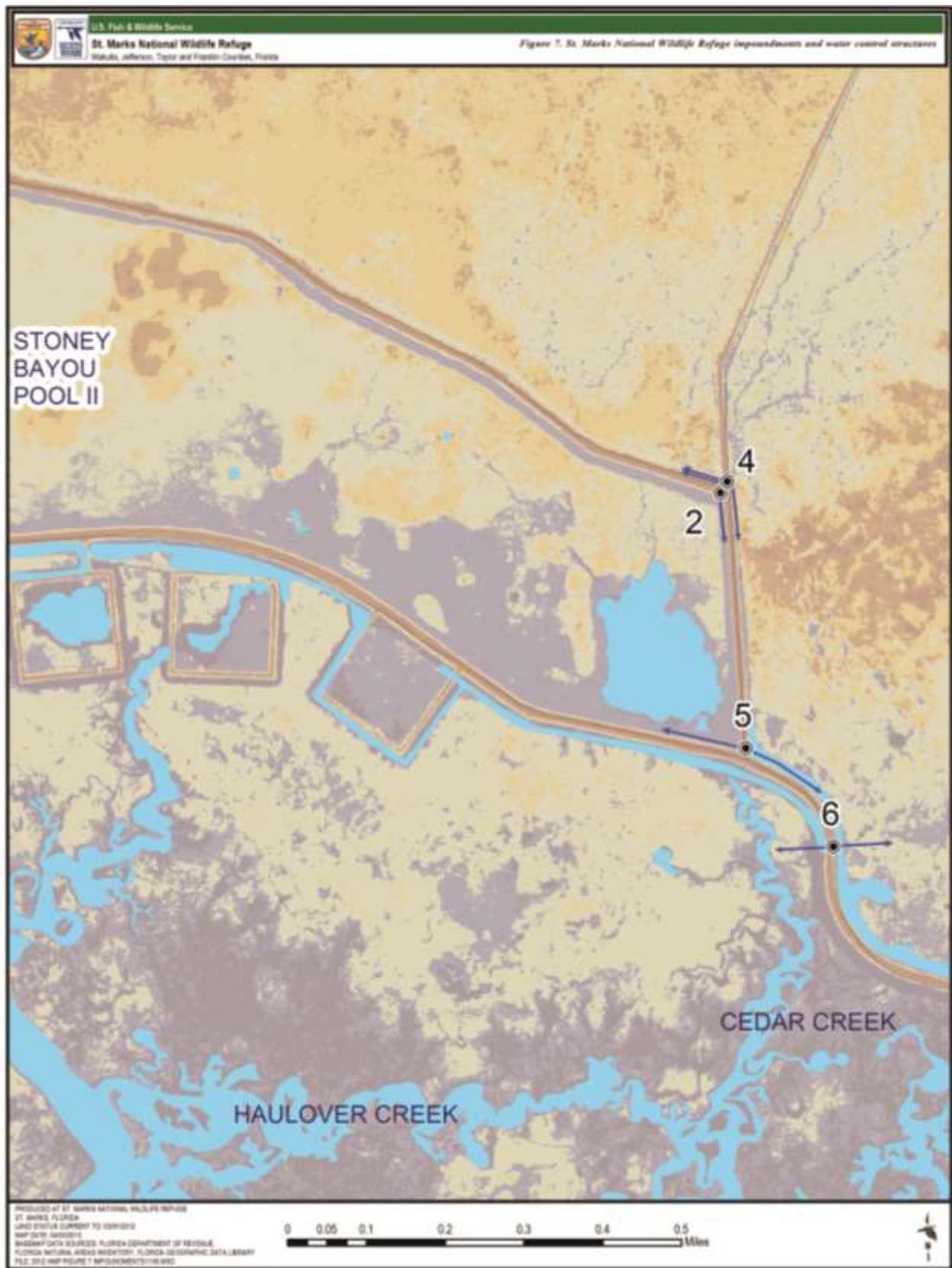


Figure 7c. St. Marks NWR impoundments and water control structures

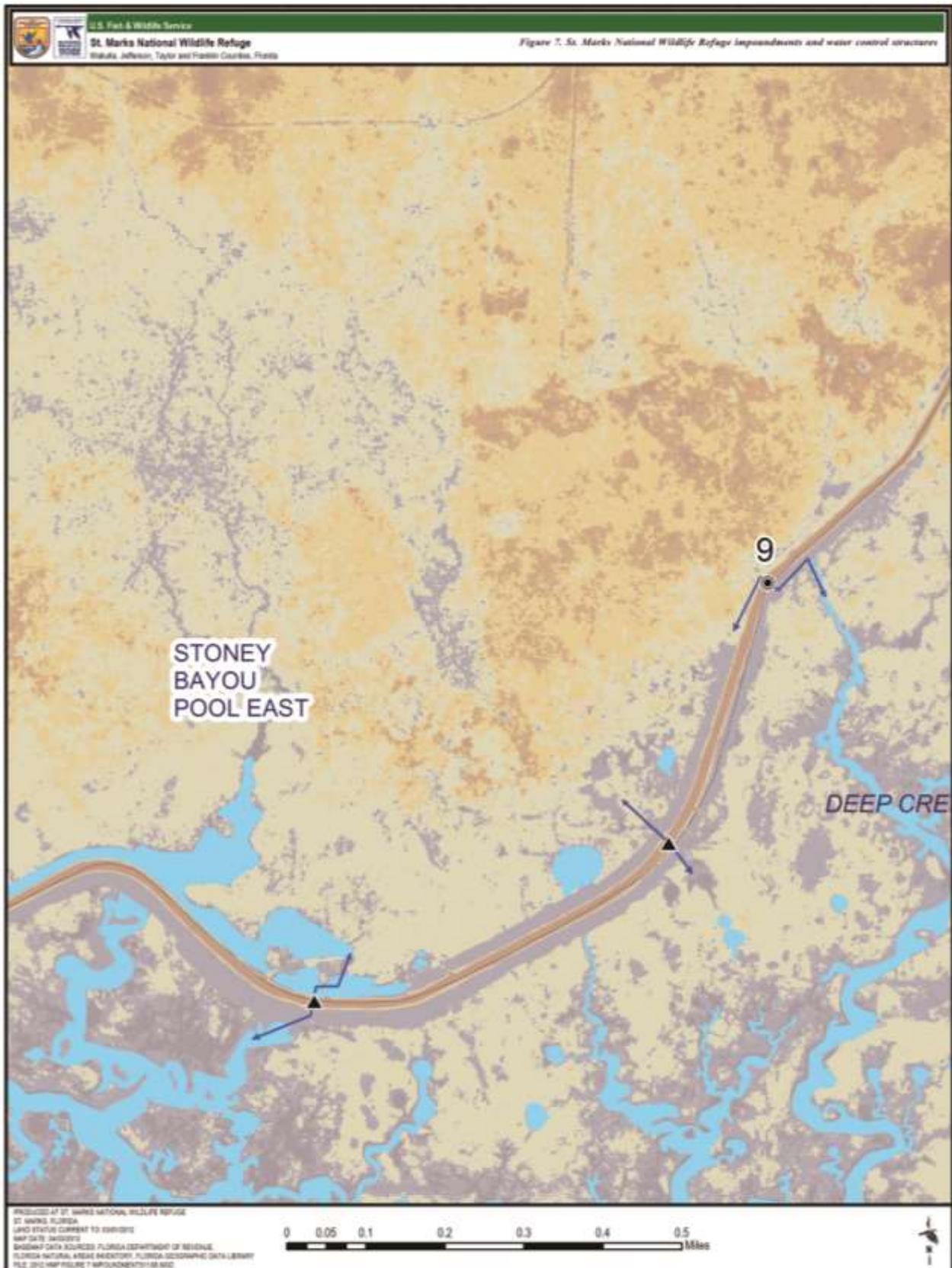


Figure 7d. St. Marks NWR impoundments and water control structures

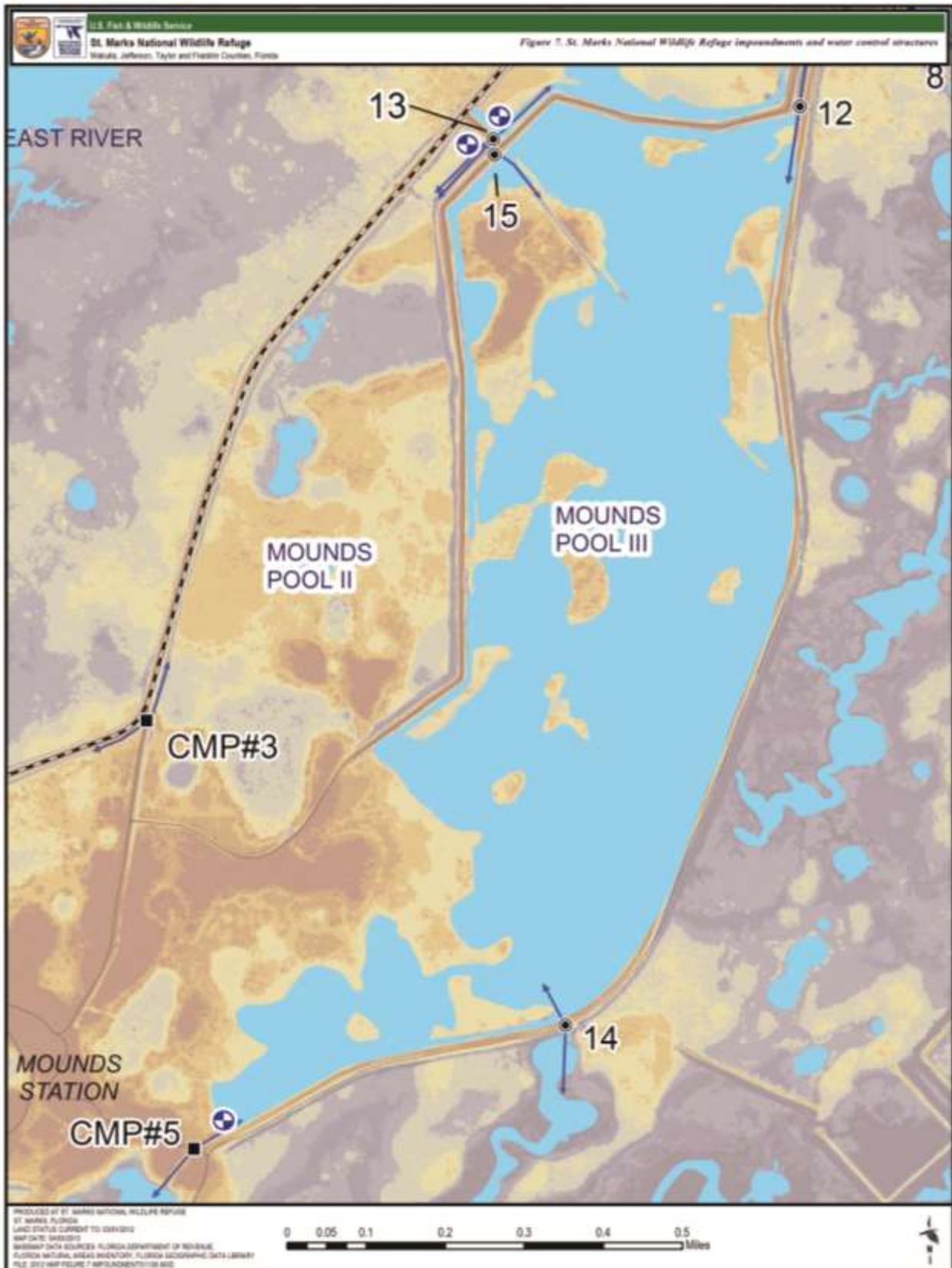


Figure 7e. St. Marks NWR impoundments and water control structures

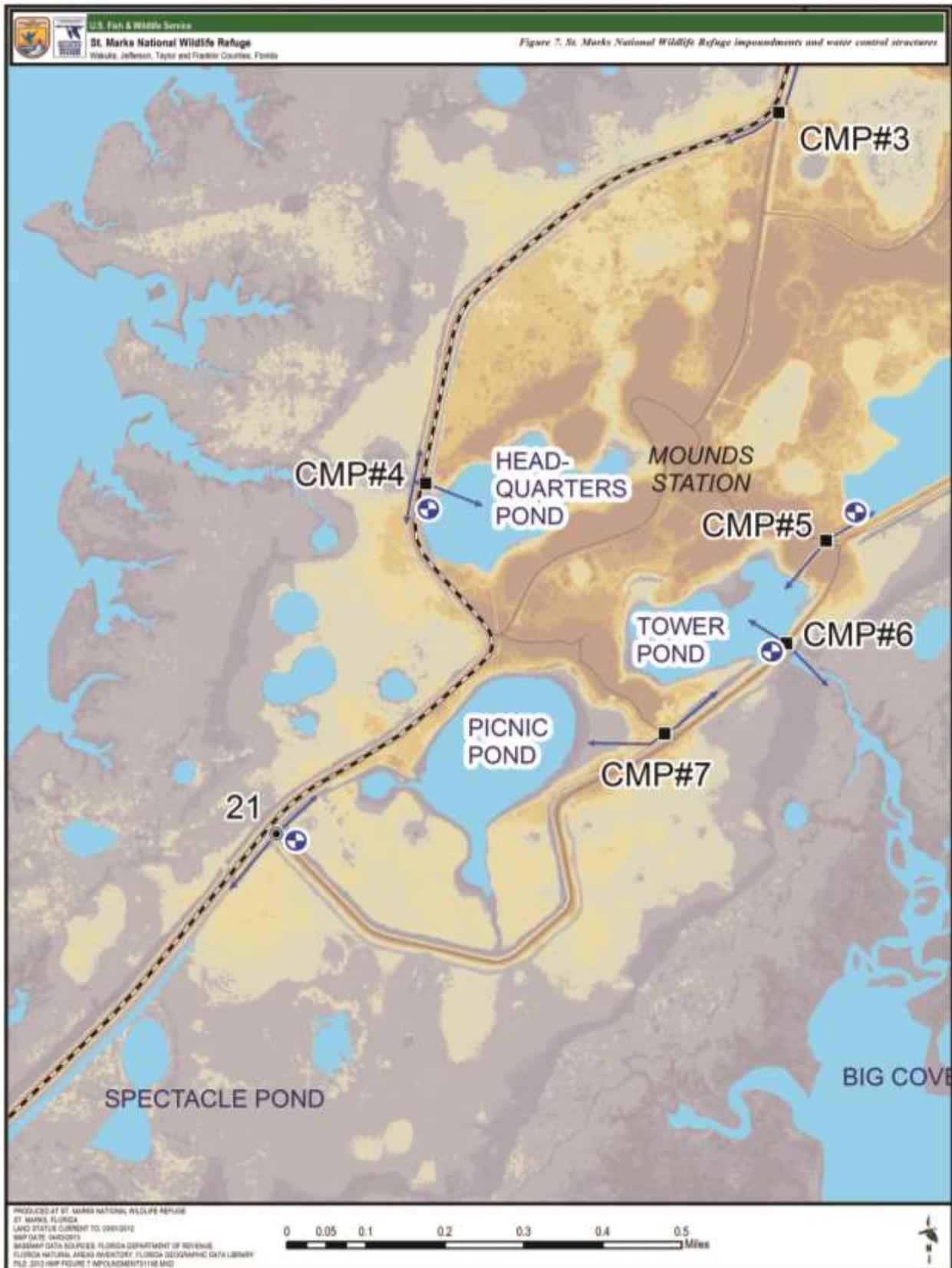
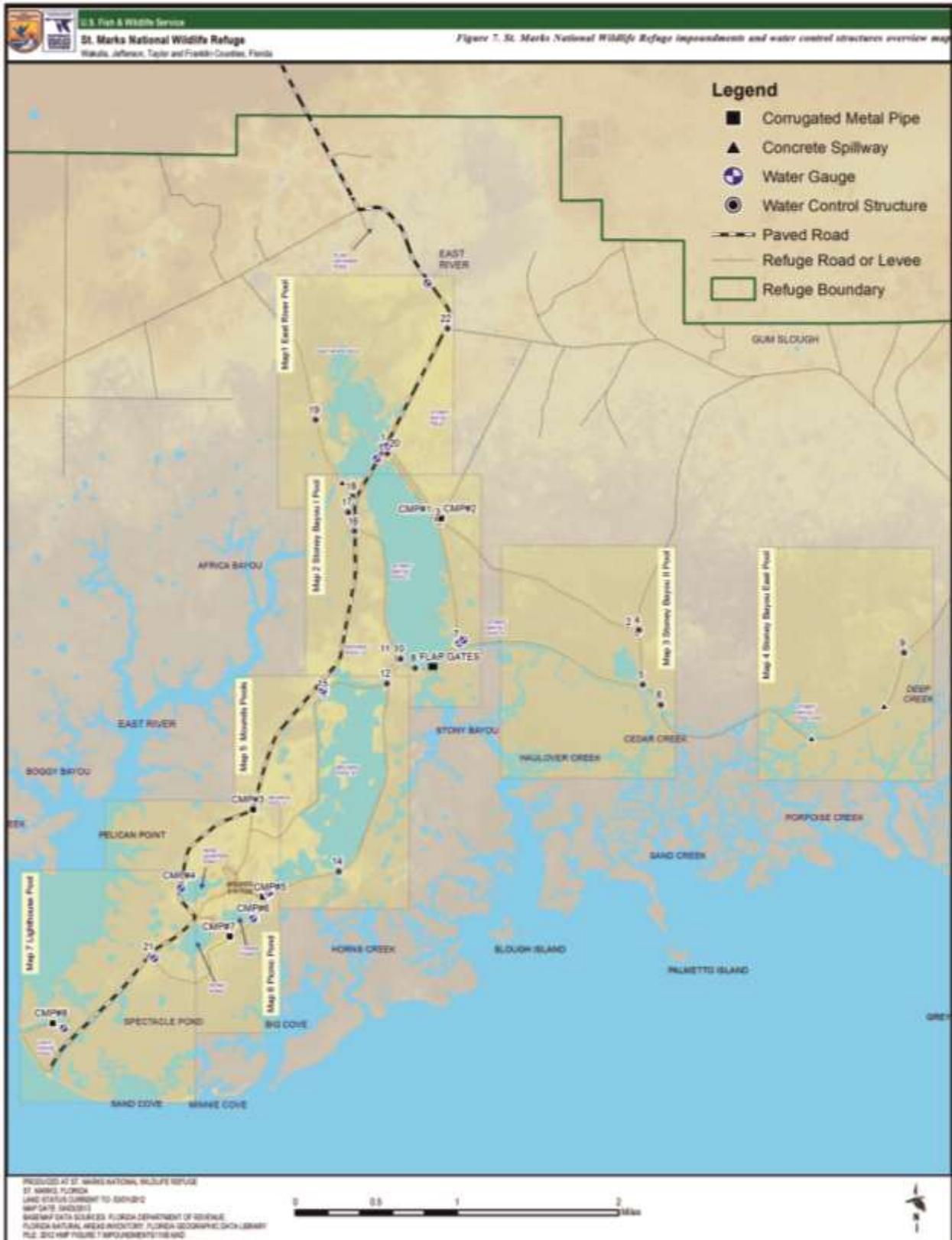


Figure 7f. St. Marks NWR impoundments and water control structures



Figure 7g. St. Marks NWR impoundments and water control structures overview map



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## *Wilderness Areas*

Congress designated 17,746 acres of the refuge as the St. Marks Wilderness Area on January 3, 1975 (Public Law 93-632), to be managed under the Wilderness Act of 1964 (78 Stat. 890.892: 16 U.S.C. 1132). This wilderness area consists of four units. They are described below and portrayed in Figure 8.

The 1,250-acre Thoms Island (Panacea Unit) is located just west of Ochlockonee Bay and is bounded on all four sides by tidal waterways, including the Ochlockonee, Dead, Sopchoppy, and Shell Rivers. The majority of the unit is marsh dominated by black needlerush, but it also contains a mix of sawgrass and a small portion of mesic longleaf pine-wiregrass flatwoods.

The 1,066-acre St. Marks Natural Area (St. Marks Unit) is a long, narrow tract bordering Lighthouse Road on the west, from the south end of East River Pool to the boat ramp near the lighthouse. This area is comprised of 828 acres of tidal salt marshes, 203 acres of coastal slash pine flatwoods, and 24 acres of cabbage palmetto.

The East River-St. Marks River peninsula (St. Marks Unit) is an area of 3,630 acres. Most is salt marsh, although 700 acres are coastal slash pine flatwoods interspersed with mesic and hydric hammock. A portion of the Florida National Scenic Trail passes through this area along the old railroad bed from St. Marks to Port Leon.

The largest unit is 11,800 acres and extends from just east of the St. Marks Lighthouse to the eastern boundary of the refuge, from a southern boundary that extends from mean high tide to the Mounds and Stoney Bayou dikes, and generally east to the northeast boundary of the refuge (St. Marks Unit). This area is characterized by expansive needlerush-dominated salt marsh and small tree islands vegetated primarily with slash pine, southern red cedar, live oak, and cabbage palmetto. Bottomland hardwoods and hydric hardwood hammock border the Pinhook and Aucilla Rivers.

The legal description of the St. Marks Wilderness as certified by the Service's Southeast Regional Director in 1975 actually encompasses 17,350 acres. This slightly smaller acreage figure is the official acreage of the Wilderness as recognized by the Service's Realty Office. Refuge ownership extends only to mean high tide. The refuge has jurisdiction in the Executive Closure Boundary, which is closed to waterfowl hunting. Below mean high tide are State of Florida sovereign, submerged lands. All areas are open to the public unless posted for seasonal closures to protect wildlife.

## *Farm Service Agency (FSA) Conservation Easements*

The easement properties range in size from 34 to 354 acres and consist primarily of wetlands located in Florida and Georgia (see Figure 9 for a map and Appendix E for a list of FSA easements). These easements were placed under Service management as part of the FSA's, formerly known as the Farmers Home Administration, Inventory Property Disposal Program. The FSA is an agency of the U.S. Department of Agriculture. FSA provides farm ownership, farm operating, and other loans to farmers and ranchers unable to obtain credit from commercial lending institutions. In many instances, FSA obtains real property used to secure loans when those loans are defaulted. FSA obtained these properties through foreclosure actions that it or another lien holder initiates on delinquent real estate loans, or through voluntary conveyances from delinquent borrowers in lieu of foreclosure. FSA holds these properties in inventory until they can be sold to other parties or otherwise be disposed.

Figure 8. St. Marks Wilderness Area

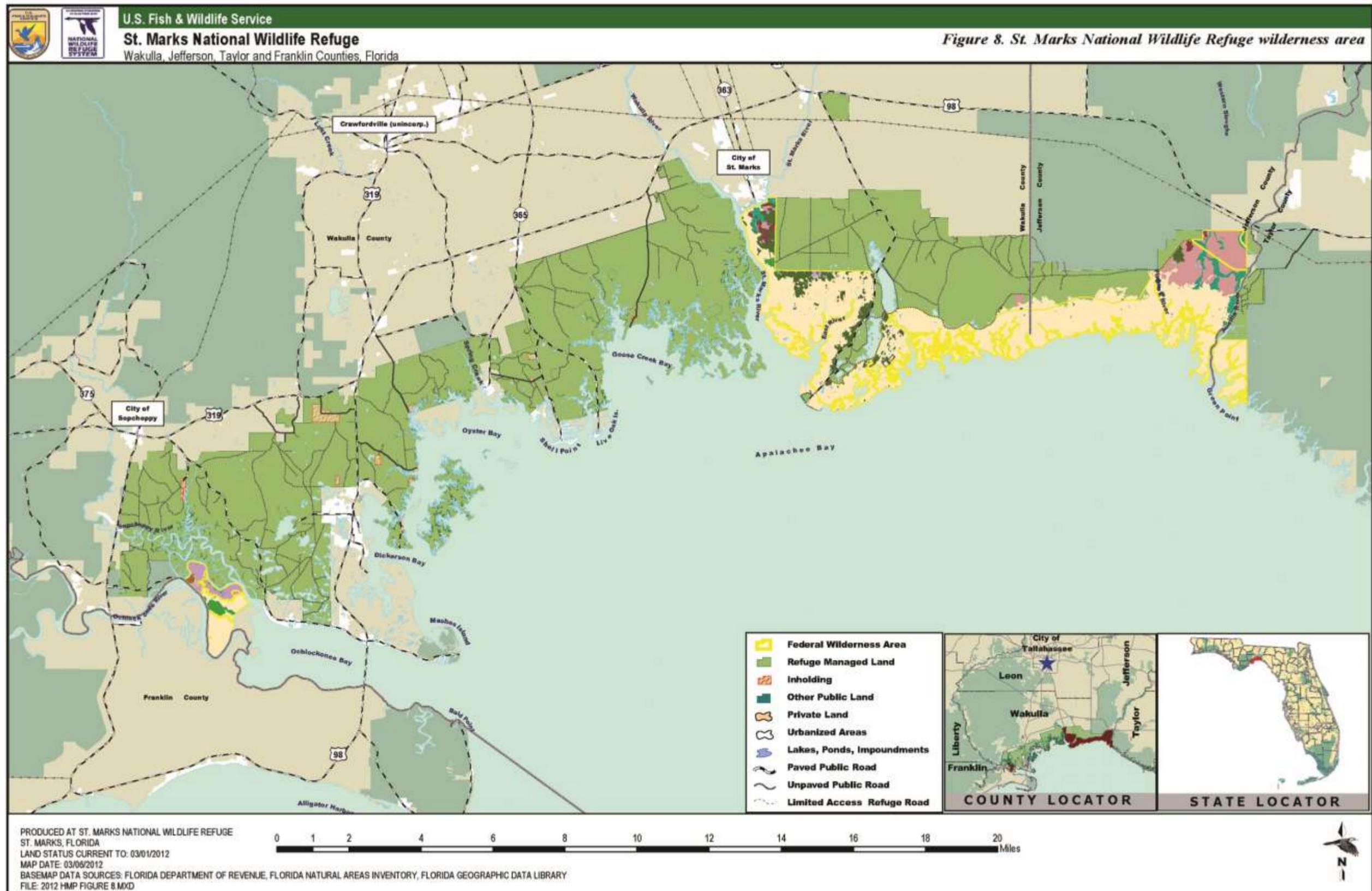
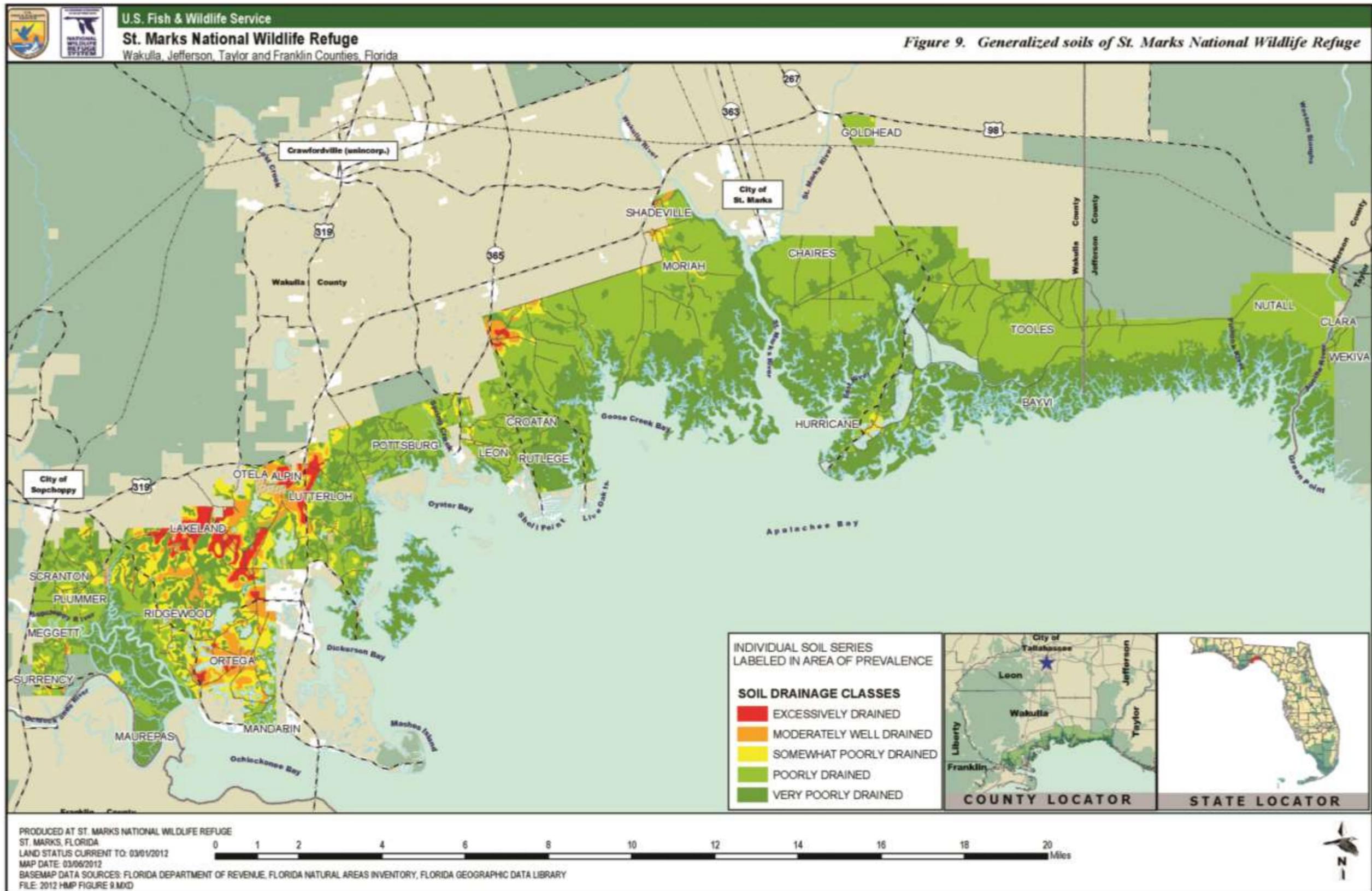


Figure 9. Generalized soils of St. Marks NWR



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FSA has an affirmative responsibility to protect wetlands, floodplains, and other important resources located on inventory properties prior to their disposal. Two primary mechanisms exist to conserve important resources on properties sold or otherwise transferred out of inventory status. Important resources on inventory properties can be protected from future degradation through a conservation easement or through fee-title transfer for conservation purposes.

## **PHYSICAL FEATURES (FOR DETAILED DESCRIPTIONS, REFER TO THE ST. MARKS CCP)**

### *Climate*

Due to its latitude and position near the Gulf of Mexico, St. Marks NWR has a mild, subtropical climate. Winters are generally mild. Summers are hot and humid; summer sea breezes can lower temperatures slightly along the coast. The mean summer temperature of nearby Tallahassee is 81 degrees Fahrenheit, with a mean winter temperature of 54 degrees Fahrenheit.

### *Geology and Soils*

St. Marks NWR lies within the Gulf Coastal Lowlands physiographic province, which extends from the Gulf of Mexico inland to the Northern Highlands or Tallahassee Hills. The separation between the two is the distinctive Cody Scarp, which rises noticeably in the predominantly flat landscape of Florida. The Cody Scarp is the northern extent of a Pliocene Epoch sea level transgression that removed older Miocene and Pliocene sediments and exposed the underlying limestone carbonates.

Refuge soils are representative of those found in much of the Gulf Coast Lowlands Woodville Karst Plain, one of Florida's ten major physiographic subdivisions. Soils in the area are primarily marine and riverine in origin and consist of a variety of sands and mucks (see Figure 9 for a generalized soil map and Appendix C for soil descriptions) ([Allen 1991](#)).

### *Topography and Hydrology*

Historically, the flat topography and low, wet nature of the eastern half of the refuge and adjoining lands to the north provided a slow steady release of water into the refuge and Apalachee Bay. In the 1930s and early 1940s, the Civilian Conservation Corps (CCC) constructed dikes (levees) and developed impoundments for the benefit of wintering waterfowl. The CCC captured some of this runoff, particularly from East River (Figure 10) and Gum Swamp. These regular flows from the private lands north of the refuge changed considerably over time as these low, wet lands were impacted by road building (and their associated roadside ditches) and the bedding of the land for industrial forest production, especially in the late 1970s and early 1980s. Recent flows of water from north of the refuge into the impoundments have been much less consistent than those experienced historically, with heavy flows following major rain events and virtually no flow during dry periods. The altered hydroperiods have greatly decreased the refuge's capability to manage the impoundments for migratory birds (particularly shorebirds), wetland wildlife, and fish, by limiting the ability to reliably re-flood the impoundments throughout the year.

Figure 10. Watershed coincidence of St. Marks NWR

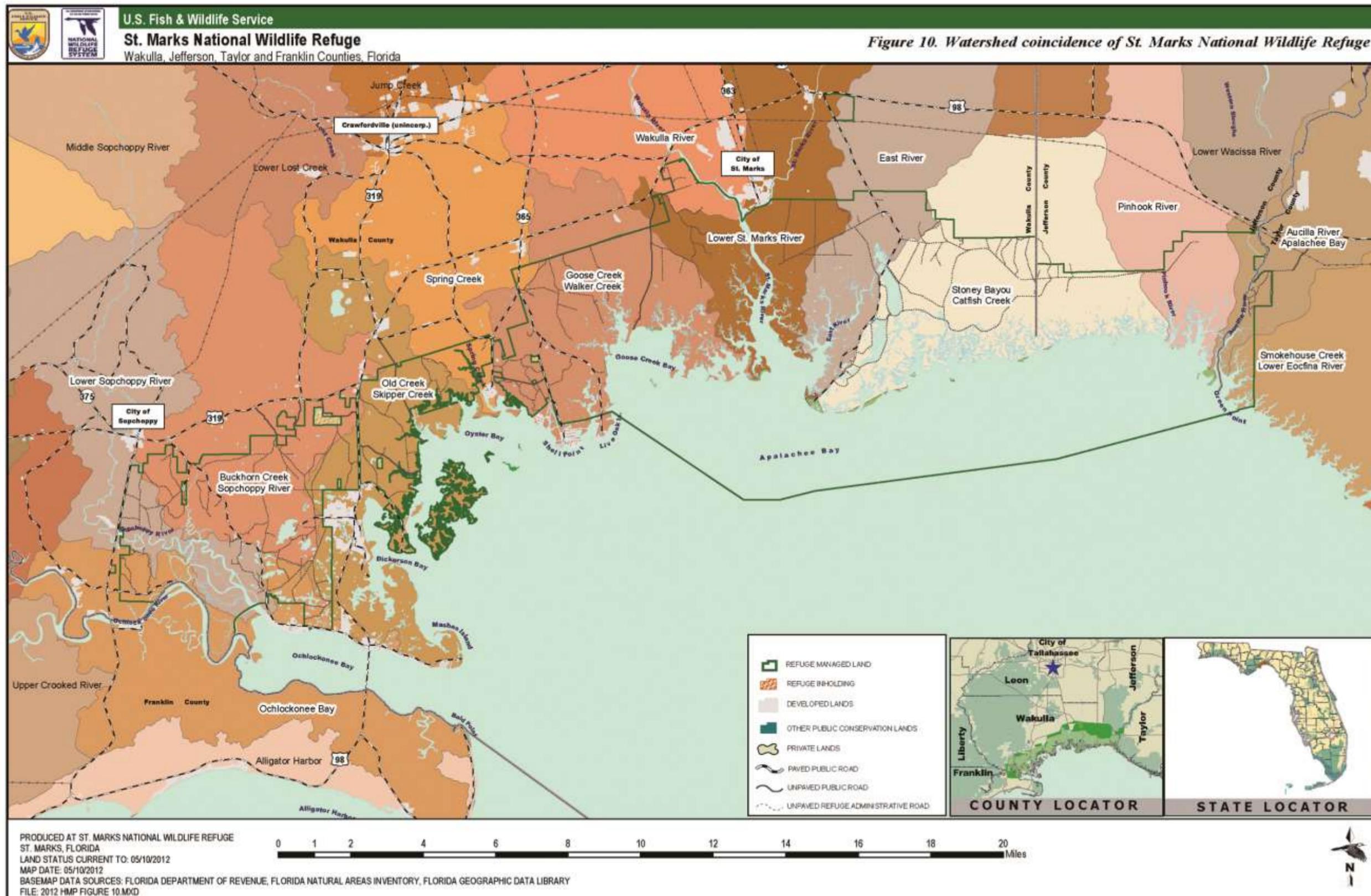
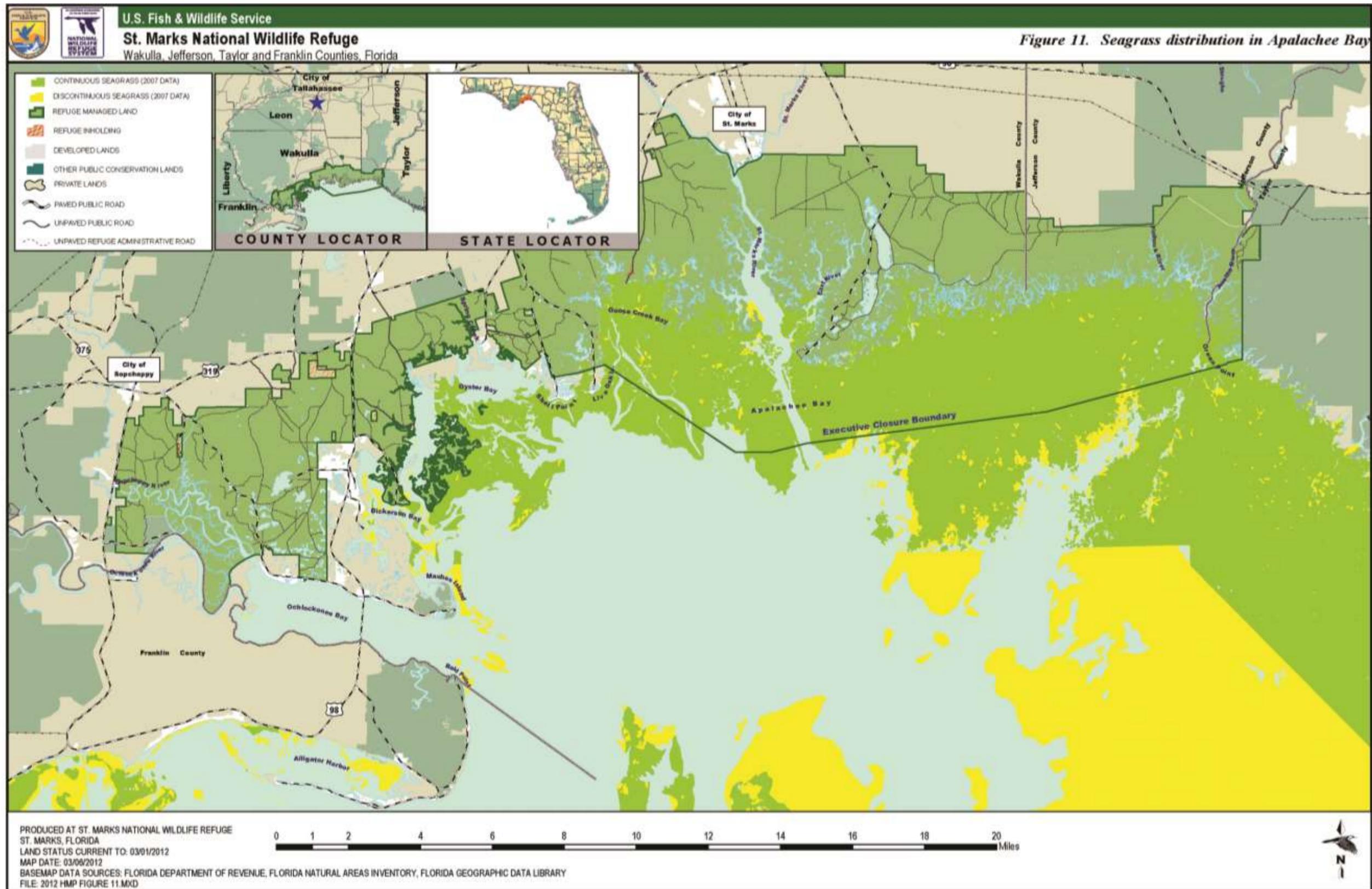


Figure 11. Seagrass distribution in Apalachee Bay



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## Water Quality

There are no permanent stations on refuge land to monitor the quality of surface or ground water. Most of the refuge is contained within the St. Marks and Ochlockonee River Basins (Figure 10). The Ochlockonee River Basin originates in Georgia, extends through 11 counties and drains 2,416 square miles. It flows south 206 miles to Ochlockonee Bay. The St. Marks River Basin also originates in Georgia. It drains about 871 square miles and is 37 miles long. The spring-fed Wakulla River is the largest tributary and flows for 10 miles to its confluence with the St. Marks River. The St. Marks Basin is unique in that it contains six of Florida's 27 first magnitude springs, that is, springs with discharge rates greater than 100 cubic feet per second. The submarine Spring Creek springs, measured at 2,003 cubic feet per second in 1970, had the highest discharge of all Florida spring groups ([NFWMD 2001](#)).

The Florida Department of Environmental Protection (FDEP) classifies both surface and ground waters according to their intended use and sets water quality standards and regulations to maintain these standards. There is only one groundwater classification called Class I, potable water supplies.

Sixty wells were sampled by the FDEP during 2000 to assess water quality in confined and unconfined aquifers for both health and aesthetic contaminants. Basin resource indices signify good ground water overall on a regional scale. The Florida Aquifer supplies the drinking water for most of northwest Florida, with 90 percent of all drinking water coming from ground water. The refuge is classified as an Outstanding Florida Water. The watershed in general has excellent water quality, although water quality problems have been noted in some areas ([Northwest Florida Water Management District/NFWMD 2005](#)). Among these are lakes affected by urban stormwater runoff, such as Lafayette and Munson. Increasing trends in nitrate concentrations have also been observed in Wakulla Springs ([Chelette et al. 2002](#)), where hydrilla infestations, filamentous algae blooms, and decreases in wildlife populations have occurred. A number of watershed segments have been identified as potentially impaired ([Florida Department of Environmental Protection/FDEP 2003](#)), with parameters of concern including nutrients, bacteria, dissolved oxygen, and mercury in fish. The watershed's geology presents distinct challenges for water resource protection, as karst topography dominates much of the landscape. A number of the lakes in the northern portion of the watershed are internally drained, and the Floridan Aquifer is poorly confined in the lower portion of the watershed. As a result, surface and ground waters are closely interconnected, and land use practices readily affect the quality of underlying ground water and associated surface waters ([NFWMD 2005](#)).

Portions of Apalachee and Ochlockonee Bays are Class II (for shellfish propagation or harvesting) due to the presence of oyster beds. Few data exist on the condition of the waters that comprise the coastal watersheds and Apalachee Bay adjacent to the refuge. According to the 2009 Surface Water Management Plan for the St. Marks Watershed ([NFWMD, 2009](#)), "continues to support a diverse ecosystem and important economic, cultural, and recreational characteristics and uses, it has been affected by anthropogenic impacts common to most of Florida's watersheds and coastal systems. Among these are point source and nonpoint source (NPS) pollution, habitat loss and degradation, and other direct and indirect effects of population growth and land use change. Shellfish closings after major rain events suggest otherwise. All other waters in both basins are Class III, meaning that they are intended for recreation, propagation, and maintenance of a healthy, well-balanced population of fish and wildlife."

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The Department's [2001 Basin Status Report](#) indicates that few water quality data have been collected for the South Ochlockonee River. Segments of the river have potentially been impaired by metals (e.g., iron), fish consumption advisories, and low dissolved oxygen. The report also states that the water quality of the Sopchoppy River is generally very good, although it has been listed for fish consumption advisories. The U.S. Geological Survey uses the Sopchoppy River as a national ambient water quality monitoring site to represent pristine water quality.

The Northwest Florida Water Management District has been collecting water quality data for Otter Lake and Otter Creek since 2001. The water quality at both locations has been considered good (C. Mario, pers. comm., January 2013). While the basin status report ranks much of the St. Marks River as good, there are several problems, such as the occurrence of invasive aquatic vegetation, predominantly hydrilla and water hyacinth. At the town of St. Marks, four docking terminals carry, offload, process, and distribute petroleum products and bulk chemicals. Numerous oil spills have occurred throughout the years in this area. A spill of about 10,000 gallons in 1978 contaminated bottom sediments. The refuge has a spill coordination plan, and the emergency response to any significant spills would be directed by NOAA and the Service's Southeast Regional Office, with the refuge coordinating local efforts. Three potentially impaired water bodies for biology include Black and Lloyd Creeks and a segment of the St. Marks River, which is also impaired due to low dissolved oxygen.

The Wakulla River also has problems with invasive aquatic vegetation (e.g., hydrilla and water hyacinth). Nitrate concentrations in Wakulla Springs have tripled in the past 25 years. A major decline in apple snails and the limpkin population since 2000 has been documented. A 2009 Northwest Florida Water Management District ([NWFWM 2009](#)) report states that "based on measurements of stream condition index and other observations, the biota of Wakulla Springs and the upper river have been adversely perturbed by anthropogenic (human-caused) impacts. These appear to result from the introduction of invasive aquatic plants and increased nutrient (nitrate) discharge."

Potentially impaired water bodies include McBride Slough (dissolved oxygen) and Big Boggy Branch (total coliform and biology).

The Northwest Florida Water Management District ([2001](#)) publication, *The Big Picture: St. Marks River Watershed*, states that one of the most effective methods of protecting water quality has been the public purchase of natural lands.

Two contaminant studies have been conducted on the refuge by the Service's Ecological Services Field Office in Panama City, Florida. In 1988, a sediment study was done with 32 samples collected, of which 14 were onsite and 18 were on the St. Marks and Wakulla Rivers ([Hemming et al. 2002](#)). Samples were analyzed for metals, polycyclic aromatic hydrocarbons, organochlorine, and aliphatic hydrocarbons. The only contaminants found on the refuge were oil and grease, located in the impoundment known as Stoney Bayou 2. These contaminants are typically associated with small engine motor use. While metals (e.g., copper and mercury) and both polycyclic aromatic and aliphatic hydrocarbons were found on the industrial portion of the St. Marks River (i.e., near the refinery), none were detected on the refuge ([Hemming et al. 2009](#)). No organochlorine residues were found in the study area. Since these are associated with pesticide use, it is a good indicator for the area.

In 1991, seven species of fish were sampled for mercury contamination ([Bateman et al. 1994](#)). The 11 sampling stations, both on and off the refuge, included a variety of habitats. Four coastal saltwater sites, five freshwater ponds, lakes or impoundments, and two coastal rivers

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were sampled. Fish with muscle tissue that contains greater than 0.5 parts per million wet weight of mercury are limited for consumption. Four of the seven species exceeded the limits, including 12 of 36 largemouth bass sampled. The sites of contaminated bass were Otter Lake, Lake Renfro, and East River Pool. Other species above the limit were spotted sea trout (3 of 26), gafftopsail catfish (4 of 7), and hardhead catfish (4 of 26). The gafftopsail catfish was the only saltwater fish to exceed state consumption advisory levels. These were sampled in Dickerson Bay at channel marker 12. No fish are known to exceed the nonconsumptive standard of 1.4 parts per million wet weight. The study concludes that human-caused inputs of mercury should be stopped, since the difference between naturally occurring emissions (e.g., background levels) and toxic effects is very small.

A more recent mercury (Hg) study was conducted on the refuge and fish tissue levels were compared to those taken from areas of St. Andrews Bay ([Huge et al. 2008](#)). Mercury levels in tissues of largemouth bass (*Micropterus salmoides*), sunfish (*Lepomis sp.*), spotted seatrout (*Cynoscion nebulosus*), and striped mullet (*Mugil cephalus*) were analyzed. Striped mullet and spotted seatrout from St. Andrew Bay had higher Hg concentrations than those from St. Marks NWR. Largemouth bass and sunfish from St. Marks NWR had higher Hg concentrations in musculature than those from St. Andrew Bay. Male spotted seatrout, male striped mullet, male and female sunfish, and female largemouth bass had Hg burdens positively correlated with length. The majority of all four species of fish from both study areas contained mercury levels below 1.5 ppm, the recommended amount set forth by the Florida Department of Health as no consumption.

### *Physiographic Region*

The refuge lies within the Gulf Coastal Lowlands physiographic province, which extends from the Gulf of Mexico inland to the Northern Highlands or Tallahassee Hills. The separation between the two is the distinctive Cody Scarp, which rises noticeably in the predominantly flat landscape of Florida. Within the Gulf Coast Lowlands, the refuge lies mostly within the Woodville Karst Plain. It consists of a thin layer of Plio-Pleistocene sands over limestone. The shallow sand deposits extend down no more than 30 feet and the limestone often outcrops along streams and near the coast. These limestone features are known as karst topography, which is porous land affected over millions of years by the erosion or “solution” of limestone by acidic rain or ground waters. Solution features include sinkholes, lakes, underground rivers, springs, and caverns. Notable karst features in the area include Wakulla Springs, Leon and River Sinks, Natural Bridge, and Spring Creek. The coastal portion of the Woodville Karst Plain is known as the Marsh Strip, where the limestone is within 6 feet of the surface and covered by sand or peat.

## **HISTORY OF REFUGE LANDS.**

### *Forest Management – History*

By the time the refuge was established, most of the forest had been heavily logged. Very little, if any, pristine uplands were ever acquired. In some instances, timber cutting rights were reserved by the former landowner for a period of years after the refuge was acquired. However, even though most of the area was historically subjected to logging, it is not uncommon to encounter longleaf pines within the refuge’s flatwoods and sandhills that exceed 130 years of age.

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Refuge pine management was initiated in 1942, with small sales of worked-out turpentine and round pond pine for railroad ties and pulpwood ([Givens 1942, p. 8](#)). The early timber sales generally focused on removing turpentine-faced and defective trees, thinning young developing stands, and clearing agricultural fields for Canada geese ([Reinman 1989](#)).

In 1953, the first Forest Management Plan was developed, and in 1959 the refuge began to establish even-aged plantations. In many of these early plantations, former longleaf pine habitats were planted to slash pine or loblolly pine. The Forest Management Plan was revised in 1964. Grazing and the cutting of dead and downed oaks and pines for fuel wood were curtailed in 1965. Shelterwood cuts eventually became the preferred method to regenerate pine habitat.

In 1980, there was a major revision of the Forest Management Plan ([USFWS 1980](#)). Natural regeneration techniques, such as shelterwood and seed tree cuts, were established as the preferred methods over clear-cutting. The size of regeneration areas was limited to 25 acres and the rotation of longleaf pine was extended from 80 to 120 years. In addition, non-rotational (e.g., future old growth) corridors were also established.

In 1989, the Forest Management Plan was again revised, this time adopting a multi-aged (uneven-aged) approach to pine management ([Reinman 1989](#)). Rotation management was eliminated. Pine regeneration is now promoted within pine stands in patches, much like what occurred in the longleaf pine forest historically ([Schwarz 1907](#), [Wahlenberg 1946](#), [Noel et al. 1998](#), [Frost 1993](#), [Noss 1989](#), [Gano 1917](#), [Huffman 2006](#)). The plan also initiated the restoration of approximately 382 acres of former longleaf pine sites previously planted to slash and loblolly pines.

### *Marsh and Impoundments – History*

Active wetland management on the refuge was initiated in 1936, with the construction of Pond 1 (Pt. Leon Pond/Lake Philips) by the CCC. Over the next several years, Pond 2 was developed, which is located along the Lighthouse Road (C-59). Since early refuge narratives list Pond 2 as being 6,000 acres, it likely included all of the present-day impoundments on the St. Marks Unit, with the exceptions of Lighthouse Pool and Plum Orchard Pond. In addition to the impoundments on the St. Marks Unit, the CCC began (but never completed) a large impoundment on the Wakulla Unit. The West Goose Creek impoundment is located west of Wakulla Beach Road and extends across West Goose Creek to Live Oak Point Road. World War II halted all construction on the refuge.

The Wakulla Unit low-dike system was developed in the 1950s. In the 1960s, during forest road construction and bridge replacement projects, corrugated metal pipes with flashboard risers were installed in Johnson and Womble Creeks and Levy Ditch on the Panacea Unit. Five, 10-acre experimental pools were constructed on the St. Marks Unit, and Headquarters, Tower, and Picnic Ponds were separated from Mounds Pool. From 1978 to 1981, funding from the Bicentennial Land Heritage Program was used to construct interior dikes to divide Stoney Bayou Pool into two impoundments (Stoney Bayou 1 and 2) and Mounds Pool into three impoundments (Mounds 1, 2, and 3). The construction of roads, canals, and impoundments has substantially altered a portion of the refuge marshes, primarily by changing the natural hydrology of these areas. Figure 7 depicts the current impoundments and water control structures on the St. Marks Unit.

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Over the years, management techniques used in the impoundments to improve and maintain wintering waterfowl feeding habitat have varied significantly. Major management attempts during the 1930s and early 1940s generally consisted of plowing perennial vegetation in higher portions of the new impoundments and planting species such as smartweed (*Polygonum hydropiperoides*), millet (Panicoideae), and saltmarsh bulrush (*Schoenoplectus robustus*); cutting and manual removal of sawgrass (*Cladium* spp.), cattail (*Typha* spp.), pickerelweed (*Pontederia cordata*), needlerush (*Juncus* spp.) and other native plants mistakenly termed “weeds” followed by planting banana waterlily (*Nymphaea mexicana*), muskgrass (*Chara* spp.), widgeon grass (*Ruppia maritima*), and buttonbush (*Cephalanthus occidentalis*); and manipulating water levels. In the 1950s and early 1960s, widespread use of herbicides was added to the list of management techniques. In 1966, saltwater was pumped into Mounds Pool to control undesirable freshwater perennial vegetation and to encourage growth of widgeongrass and muskgrass. The introduction of saltwater was very effective and continues to be used in all pools, except East River Pool.

In addition to management activities within the impoundment systems, several attempts were made over the years to alter, “improve,” natural wetlands for wintering waterfowl. Major documented projects include: herbicidal treatment of approximately 200 acres of needlerush tidal marsh on the St. Marks Unit in an attempt to increase saltgrass (*Distichlis spicata*) for wintering Canada goose browse (1950s); liming acid ponds and planting redroot (*Lachnanthes caroliana*), smartweed, and threesquare bulrush, *Schoenoplectus americanus* (Panacea Unit – 1950s); and disking woody vegetation along pond margins, fertilizing and planting millet (Panacea Unit-1960s).

## **CURRENT CONDITIONS**

### *Forest Management-Current*

The refuge’s forest lands are administratively divided into 42 forest management compartments (Figure 5 and Appendix A). These compartments had been assembled into 10 working groups containing two to five compartments each. Each year, the forest and wildlife habitat were inventoried for one working group and a forest management prescription developed. Due to increased workloads and limited staff, these annual prescriptions have been developed much less frequently. The last three prescriptions were produced in 1996 (for FY 2005), 1999, and 2003. Typically, the forest management prescriptions include a summary of the data collected and the appropriate treatments (e.g., prescribed fire, timber harvest, and tree planting) necessary to maintain or improve the habitat. It has been a working plan used by field personnel to accomplish the proposed habitat treatments over several years.

Under the latest Forest Management Plan ([Reinman 1989](#)), pine habitats are managed in a multi-aged (uneven-aged) approach that promotes pine regeneration within each stand of pines, while retaining a range of tree size classes, particularly the oldest and largest trees. When the density of trees exceeds 80 square feet of basal area per acre, a particular pine stand may be thinned. This is done via commercial harvests and reduces the basal area to 50 to 60 square feet per acre. Thinning produces an irregular spacing of trees, with denser clumps and small openings of up to a quarter-acre, where much of the pine reproduction will occur. Dead snags and old trees with cat-faced scars or flat tops are retained. In general, the trees are divided in thirds between the largest size class (over 17 inches in diameter, if available), the medium diameter size class (11 to 17 inches), and the small-diameter-size class (5 to 11 inches). Where pine plantations are now comprised of pine species, such as slash and loblolly, that were not historically dominant on that site, they are restored to the historic species (usually longleaf pine).

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Controlled fires are prescribed for the pine habitats on an average of every 2 to 3 years, especially within red-cockaded woodpecker foraging habitat, and they are conducted throughout the year. In the Panacea Unit, our most frequently burned unit, the actual fire return intervals range from 2.5 to 6 years. Forest prescriptions identify areas for particularly hot or cool fires and/or growing-season or dormant-season fires to achieve certain objectives, such as to reduce a large hardwood component in stands important to red-cockaded woodpeckers ([Provencher et al. 2002](#)). Currently, hardwood hammock and swamp habitats are passively managed. In these areas, there is no manipulation of tree composition or density, and fires are not prescribed.

### *Marsh Management – Current Activities*

Saltwater marshes currently comprise the largest vegetative community on the refuge. The marshes fringe the refuge along Apalachee Bay, and much of this area has been designated as Wilderness. For Wilderness management, see Section 5.10.

Salt marshes on the refuge are not currently actively managed. Sporadically, upland fires (set as prescription burns) will ignite portions of the marsh, and when this happens, those areas are permitted to burn.

### *Impoundments - Current Activities*

Current management of the impoundments and artificial wetlands consists of manipulating water flows through concrete water control structures and/or corrugated metal pipes with flash board riser structures. By adjusting the height of wooden stoplogs in these structures, water levels are set and gravity-induced water flows can be created from one impoundment to another.

With the constraints of limited and unreliable freshwater inflows from East River Watershed, the refuge usually has only one reliable opportunity each year to reflood the impoundments. That opportunity generally comes in February and early March, before the increases in evaporation and transpiration occur during the growing season. Dry seasons in the spring (April – May) and fall (October – December) further limit freshwater availability.

All pools (with the exception of the isolated Lighthouse Pool) are reflooded to full capacity in late winter. In general, the water levels in these pools are then held as high as possible throughout the summer, although typically the water levels drop up to one foot or more during the period due to evaporation and transpiration. The exception is Tower Pond.

Tower Pond can be managed much more actively than the other impoundments. This is due to its small size (20 acres) and close proximity to Mounds 3 Pool and Picnic Pond (for water inflows). Also a corrugated metal pipe connects the pool to the tidal marsh which allows for dewatering and reflooding with saltwater during high tides. It can provide important foraging habitat for shorebirds during critical migration periods (April and August) when the other pools are normally flooded. The current yearly management regime generally involves flooding the pool from mid-October through February, drawing it down through mid-May, flooding through mid-July, and drawing it down through mid-October. If Stoney Bayou 1 is unavailable for any reason, Tower Pond may also be flooded in early September and drawn down from late October through December.

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In the fall, Mounds 1 and 3, and Stoney Bayou 2 Pools, and occasionally Headquarters and Picnic Ponds, are partially drawn down to create shallow-water habitat used by foraging dabbling ducks, wading birds, and shorebirds. East River Pool is managed to provide deeper water habitats for diving ducks and to provide freshwater as needed for other pools. Water levels are generally maintained in Mounds 2 and Stoney Bayou Field to support emergent marsh habitat for secretive marsh birds. Stoney Bayou 1 is drawn down to target use by wading birds and shorebirds.

Lighthouse Pool is isolated from the rest of the impoundments on the St. Marks Unit and has no freshwater source other than rainfall. There is one corrugated metal pipe connecting the pool to the adjoining boat canal, but the pipe is set too high to manipulate the water level. It serves as an overflow pipe. Active pumping with a portable pump is the only option for dewatering or actively flooding the pool. For the past two decades, no active management (other than prescribed burning) has been required.

The four other wetland areas managed by the refuge are Stoney Bayou East, Plum Orchard Pond (located behind the visitor center), Johnson Creek, and the Levy Ditch Greentree Reservoir. Stoney Bayou East was originally part of a very large Stoney Bayou Pool, but was separated when numerous blowouts under the dike compromised its ability to hold water. Currently, the two concrete water control structures connecting the pool to the tidal marsh are left open to permit tidal flushing and prevent water build-up on either side of the frequently compromised dike. As a result, the impoundment is managed as tidal salt marsh and occasionally prescribed burned. In 2005, Hurricane Dennis compromised three sections of the outer levee of Stoney Bayou East. When the levee was repaired, two spillways were installed to protect the dike from future washouts.

Plum Orchard Pond is a former borrow pit developed during Lighthouse Road construction. Management is generally restricted to occasional cattail spraying to maintain an open wetland for the enjoyment of visitors at the visitor center. There is no structure to control water levels. On rare occasions (1984, 1993, and 2011), the pond has been pumped down and the muck accumulation removed by heavy equipment.

### *Greentree Reservoir Management*

Greentree reservoirs (GTRs) are hardwood forests that are flooded during the winter months to provide feeding habitat for wintering waterfowl. These sites provide waterfowl access to hard mast, particularly acorns, and a variety of invertebrate life.

Until 2007, the refuge managed one GTR, Levy Ditch, which encompassed approximately 50 acres on the Panacea Unit north of Otter Lake. The GTR included oak flats and cypress ponds that could potentially flood when stoplogs were added to a corrugated metal pipe in the road crossing at Levy Ditch. The ditch is reportedly a 1800s-era effort to drain the area for farming. Stoplogs were generally added to the corrugated metal pipe in early fall to flood the acorn-rich area for wintering ducks, then removed by early March to minimize damage to the trees. The water level in the reservoir was dependent on rainfall and was very unreliable in recent years, often remaining dry throughout the winter. This certainly has been an impact of droughts, but could also have been affected by groundwater withdrawals for public water systems. Except for water level manipulation, management had been identical to other refuge hardwood hammock habitats. Due to the inability to flood the area in recent years and apparent reduced waterfowl use, management was suspended in the spring of 2007.

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## *Exotic and Nuisance Plant Management*

The overall approach to exotic and nuisance plant management can be generally described as a four-step process: identification, prioritization, control/eradication, and monitoring. The first step involves identifying and mapping infestations. Prioritization depends upon two independent factors: (1) The degree and kind of biological/ ecological/management threat; and (2) the cost and expectation of control, based on the current population distribution of the exotic species. Each factor must be considered in planning a suitable course of action. For the refuge, Florida Exotic Pest Plant Council's classification (Class I or II plants) are used to help determine the level of threat for each species and is an important component of the prioritization process. Following specific treatment(s) of infested areas, monitoring is required to ensure that small populations are controlled effectively. Once exotic plants colonize large areas, control or eradication, and subsequent restoration becomes much more costly and time-consuming.

## *Habitat Management in Wilderness*

Approximately 25 percent of St. Marks NWR is designated as Wilderness; much of which consists of salt marsh (Figure 8). Most activities, including habitat management, in the Wilderness are subject to Service and other federal policies/guidance. Essentially, all activities are subject to the "minimum tool analysis," which would be used to develop a revised Wilderness Management Plan.

For over three decades the Wilderness area has been managed according to the Wilderness Management Plan (USFWS 1980). The CCP ([USFWS 2006](#)) included Goal 6, Wilderness, Objective 1 (page 104) which states: Revise the Wilderness Plan by 2009. To that end, a review of the Wilderness Program was conducted in 2012 ([McCarter 2012](#)). Entitled "St. Marks Wilderness A Report on Wilderness Character Monitoring," this report will be used as baseline information for the proposed revision to the Wilderness Plan in 2020. Some additional details of Wilderness policy and guidance are included in Appendix D.

Currently, no restoration or active management is undertaken in the St. Marks NWR Wilderness except for prescribed fire and a minimal amount of invasive plant control. Prescribed burning is one of the few human activities that can mimic nature. It is considered an acceptable management tool to preserve the wilderness value of the St. Marks NWR Wilderness. This area has been divided into several prescribed burning units. In general, mainland pine habitats are prescribed burned. Adjoining salt marshes are not actively lit during burning, but any fires that run into the marshes are allowed to burn. Islands within the salt marsh are not actively lit, but may burn when fire crosses the marsh from the mainland. Since gopher tortoises have been documented on the northeastern most portion of Thoms Island nearest the state park, this area is regularly prescribed burned as well. Other portions of Thoms Island are not prescribed burned and wildfires are not suppressed.

Invasive plant-control efforts have focused on single-tree, basal bark herbicide treatments of Chinese tallow by backpack sprayer around the wetland margins within the St. Marks Unit. Access is by foot only. Similar treatments have been used on other invasive exotic plant species, such as lantana, cogon grass, purple sesban, and Japanese climbing fern, which are sometimes found near or within the Wilderness.

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## *Habitat Management on Farm Service Agency (FSA) Conservation Easements*

Currently, the status of the FSA conservation easement properties is not known. CCP Goal 1, Objective 1 (p. 81), includes a strategy to protect and manage these areas. It states that by 2014 the boundaries of each FSA would be mapped and a management plan developed. To accomplish this task, an inventory of each area would be taken to establish its contribution to the conservation of priority species. A list of threats to each FSA property would be compiled, with associated strategies for mitigating those threats. Next, a brief management plan would be developed, incorporating the inventory, threats, and strategies. Finally, all FSA properties would be visited at least once each year to conduct any management and monitor the current status of their conditions. Given the current management constraints of reduced refuge staffing and funding, it is unlikely that this task could be undertaken by 2014, or in the near future. At such time that a plan may be developed, any relevant habitat management provisions would be incorporated by reference to this HMP and/or considered an addendum [and appended] to this HMP.

## *Research Natural Area Management*

Nine Research Natural Areas were established on the refuge by 1980 and are described in the CCP. Since some of the plant communities differ from the original classification and few have received any scientific or educational interest, these sites will not continue to be maintained as a separate designation. The plant communities will be managed as prescribed in this HMP for that specific habitat, and research and education will be promoted on communities throughout the refuge.

## **VEGETATION**

St. Marks NWR encompasses more than 43 miles of coastal salt marshes backed by hardwood swamps, hardwood hammocks, and upland pine communities within Florida's Big Bend Region (Figures 2, 3, and 4). The dominant forces affecting vegetation communities are minor elevation changes; hydrology, soils, saltwater, climate and fire management practices; historical timber harvest; and timber management practices. The following are generalized habitat descriptions of the four most common habitat assemblages on the refuge and collectively account for 91 percent of the refuge land area. The remaining 9 percent of vegetation assemblages are primarily mesic hammock, maritime hammock, and various human-altered habitat types. The natural community descriptions used in this HMP are based on those defined in the Florida Natural Areas Inventory (FNAI) a "Guide to the Natural Communities of Florida" ([FNAI 2010b](#)). In the CCP and for the purposes of this HMP, several natural communities are described below and have been grouped into categories based on similarities of structure, dominant species present, and associated management techniques.

### *Salt Marsh (Tidal Marsh)*

Salt marshes cover 29 percent of lands within St. Marks NWR, forming the immediate landward side of the low energy coastline along Apalachee Bay and extending up tidally influenced rivers. They are plant communities of the intertidal zone, the transition area between terrestrial and marine environments. The dominant plant is black needlerush (*Juncus roemerianus*), found in expansive stands with few other plants, generally slightly elevated above average tidal influence. The lowest fringes of the salt marsh, inundated at least twice daily by tides, are dominated by smooth cordgrass (*Spartina alterniflora*). Saltmeadow cordgrass (*Spartina*

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*patens*) transitions between the tidal reach and the highest portions of the salt marsh community, which are only flooded during the highest tides or storm surges. There a mix of herbaceous and woody salt-tolerant vegetation is found, which includes saltbush (*Baccharis* spp.), marsh elder (*Iva frutescens*), Christmas berry (*Lycium carolinanum*), seaside goldenrod (*Solidago sempervirens*), sea blite (*Suaeda maritime*), saltwort (*Batis* spp.), glasswort (*Salicornia* spp.), sea purslane (*Sesuvium portulacastrum*), coastal dropseed (*Sporobolus virginicus*), and sand cordgrass (*Spartina bakeri*).

### *Longleaf and Slash Pine Flatwoods and Sandhills*

Pine-dominated uplands occupy about 28 percent of the total refuge area, and are represented by four FNAI natural community types: mesic flatwoods, scrubby flatwoods, wet flatwoods, and sandhill. While great variation exists between these communities, all are influenced by frequent fire. They typically have pine-dominated overstory and ground cover with a highly diverse herbaceous component. Vegetation plots representative of the various pine types on St. Marks NWR document approximately 650 vascular plant species. Four of the six native pine species present are common: longleaf (*Pinus palustris*), slash (*P. elliottii*), pond (*P. serotina*), and loblolly (*P. taeda*). Sand pine (*P. clausa*) is rare, occurring as scattered individual trees on the Panacea Unit, while spruce pine (*P. glabra*) is an occasional component of some hardwood hammock forests. Woody midstory species are typically dominated by scrub oaks (e.g., turkey/*Quercus laevis*, bluejack/*Q. incana*, sand-live/*Q. geminata*, and sand-post/*Q. margaretta*; hollies (e.g., large gallberry/*Ilex coriacea*, gallberry/*I. glabra*, and yaupon/*I. vomitoria*); oaks (e.g., live/*Q. virginiana*, laurel/*Q. laurifolia*, and water/*Q. nigra*); blueberry species (e.g., sparkleberry/*Vaccinium arboreum*, highbush/*V. corymbosum*, and deerberry/*V. stamineum*); and a variety of other trees (e.g., sweetgum/*Liquidambar styraciflua*, persimmon/*Diospyros virginiana*, red maple/*Acer rubrum*, swamp bay/*Persea palustris*, pond cypress/*Taxodium ascendens*, and cabbage palm/*Sabal palmetto*). The greatest diversity of these communities resides in the understory. The most common grasses, forbs, and woody plants include wiregrass (*Aristida stricta*), Florida dropseed (*Sporobolus junceus*), blueberries (*Vaccinium* spp.), ground oaks (*Q. pumila* and *minima*), huckleberries (*Gaylussacia* spp.), and saw palmetto (*Serenoa repens*).

### *Hardwood Swamp Forest and Hydric Hammock*

In contrast to the pinelands of St. Marks NWR, hardwood habitat types generally have a relatively closed canopy formed by a diverse array of overstory tree species. Lowland hardwood forests occupy 24 percent, typically situated between saltmarsh communities and pine-dominated uplands, as a wetland mosaic interspersed within pine flatwoods, or associated with river and creek systems. Though represented by a broad array of ten FNAI community types, lowland hardwood forests frequently share several dominant common tree species: pond cypress, cabbage palm, live oak, water oak, red maple, blackgum (*Nyssa sylvatica*), Southern and sweetbay magnolias (*Magnolia* spp.), southern red cedar (*Juniperus silicicola*), and loblolly pine (*Pinus taeda*). These hardwood communities, however, have not been sampled in past forest management inventories and there is little quantitative data describing the composition and structure of these communities.

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## *Freshwater Lakes, Marshes, and Impoundments*

These habitat types collectively amount to 10 percent of St. Marks NWR's surface area, and provide a majority of the seasonal waterfowl and shorebird habitat available on the refuge. Public use activities, such as wildlife viewing, photography, and freshwater fishing, are highly concentrated within the roughly 1,600 acres of managed impoundments. Numerous natural freshwater lakes occur in the Panacea Unit, while extensive freshwater marshes are associated with the upper tidal portions of the Sopchoppy and St. Marks/Wakulla River systems. Dominant vegetation in these communities includes emergent herbaceous plants (e.g., cattails/*Typha* spp., sawgrass/*Cladium jamaicense*, spikerushes/*Elocharis* spp., and sedges/*Cyperus* spp.); grasses (e.g., maidencane/*P. hemitomon*, and cord grasses/*Spartina* spp.); and sparse woody shrubs or small trees (e.g., willows/*Salix* spp., buttonbush/*Cephalanthus occidentalis*, and wax myrtle/*Myrica cerifera*). Submerged aquatic vegetation includes muskgrass (*Chara* spp.), widgeon grass (*Ruppia maritima*), and white water lily (*Nymphae odorata*).

## *Seagrass Beds*

The Big Bend Seagrasses Aquatic Preserve is the largest aquatic preserve in the state. It comprises about 945,000 acres of sovereign submerged lands along 150 miles of coastline from the St. Marks River in Wakulla County to the Withlacoochee River in Levy and Citrus Counties. The boundaries encompass all tidal lands, islands, seagrass beds, shallow banks, and submerged bottoms located 9 miles waterward into the Gulf of Mexico to which the state holds title, generally below the mean high water line. The preserve was designated as such in 1985 for the primary purpose of biological resource protection and to ensure public recreational opportunities while assuring the continued propagation of fish, birds, manatees, and other wildlife resources ([FDEP 1988](#)). Management intent is defined in the Florida Aquatic Preserve Act of 1975 for such preserves possessing "exceptional biological, aesthetic and scientific value...to be set aside forever as aquatic preserves or sanctuaries for the benefits of future generations" (Section 258.36, Florida Statutes). In 1986, the Florida Department of Environmental Regulation (now merged into the Department of Environmental Protection) designated the entire preserve as Outstanding Florida Waters.

The refuge currently plays a passive but important role in the protection of aquatic resources. The Big Bend Region of Florida contains one of the largest continuous areas of seagrass beds in the United States (Figure 11) and its importance to redheads and other wintering waterfowl was a key factor in the establishment of St. Marks NWR. The seagrass beds located offshore from the Aucilla, St. Marks, and Ochlockonee Rivers appear to be in good health although heavy scarring from watercraft is evident near the mouth of the St. Marks River (M. Charbonneau, pers. comm., Jan 2010). For additional information, see Section 4.3.

## *Minor Habitats*

Minor habitats include several natural and anthropogenic land cover types that are relatively small in acreage (see CCP Table 5 for a listing). Most of these habitats are not actively managed. The refuge is currently working on a road plan, and ruderal areas are mowed as needed.

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## *Watershed Restoration*

The availability and quality of water in St. Marks NWR's low-lying areas are strongly influenced by the hydrological conditions of its upland areas and those off the refuge. For years, the Service has recognized the importance of the proper functioning watersheds and has included watershed restoration, with emphasis on improving water quality and water quantity, in its landscape-level conservation priorities. The East River Watershed is particularly important to the management of the refuge's impoundment system. Efforts to protect the lower portion of the watershed have focused on land acquisition (USFWS 2011). This HMP outlines hydrological/water quality restoration efforts that would benefit priority resources (Section 4.8).

## *Threats to Habitats*

In this section, several threats to habitats on St. Marks NWR are discussed, including insects, diseases, severe weather and disturbances, water quality/availability, climate change, exotic plants, and exotic animals. Many of these factors can have beneficial effects on the refuge (for instance, periodic ground fires are essential in maintaining some forest communities), while others have the potential to substantially alter important refuge resources.

## *Insects*

Insects are a natural part of the forest ecosystem. They have a part in culling out weak and inferior trees, breaking down and recycling litter on the forest floor, and act as a food source for birds and other animals. The majority of these insects have only a minor impact and are generally controlled by natural predators, parasites, and unfavorable weather conditions. One of the most important insects in terms of causing tree mortality is the Southern pine beetle (*Dendroctonus frontalis*). This species attacks all species of pines, but prefers loblolly (*Pinus taeda*), shortleaf (*P. echinata*), Virginia (*P. virginiana*), pond (*P. serotina*), and pitch pines (*P. rigida*), and has killed millions of trees across the south since the 1970s ([Thatcher and Barry 1997](#)). Although the refuge does not actively manage to minimize pine beetles, it is believed that the overall management to maintain open pine stands, particularly through the use of commercial harvest and prescribed fire, will reduce the risk and/or extent of infestations ([Knebel and Wentworth 2007](#)). Ips engraver beetle (*Ips* spp.) and black turpentine beetle (*Dendroctonus terebrans*) attacks on standing pines are considered to be much less serious than the Southern pine beetle. Generally, the infestations are of short duration and limited to stressed trees ([Barnard and Dixon 1983](#)).

Considering the low potential loss of significant numbers of trees and the wildlife value of snags, the policy of the refuge is to allow the population of pine bark beetles and other native insect pests to fluctuate without any attempts to control outbreaks by timber harvest or pesticide application, unless there is substantial evidence that the insects will significantly impact large tracts of forest. The salvage harvest of dead and dying trees as a result of fire, insects, disease, flooding, or wind will generally not be permitted except where the trees pose a safety risk to staff and visitors. When the loss of trees occur over an extensive area (5 acres or more), a salvage harvest may be conducted. Any salvage harvest will leave a minimum of 15 of the largest standing dead and dying trees per acre, scattered across the site.

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## Diseases

Various tree diseases are likely found in refuge forests, but none appear to significantly impact the health of the forest ecosystems. Annosus root rot (*Heterobasidion annosum*), pitch canker (*Fusarium moniliforme* var. *subglutinans*), cone rust (*Cronartium strobilinum*), and other pathogens may infect longleaf pine (Boyer 1990). Epidemics of brown-spot disease (*Mycosphaerella dearnessii*) occasionally occur in young longleaf pines, and this pathogen is usually fatal unless a surface fire consumes the infected needles and cleanses the stand of inoculum (Wright and Bailey 1982, Boyer 1990). Certain diseases such as red heart disease in pines or hardwood heart rots are actually highly beneficial to wildlife. For example, the endangered red-cockaded woodpecker has shown a strong preference for trees infected with red heart fungus (*Phellinus pini*) for construction of roosting and nesting cavities (Jackson 1977, Hooper et al. 1991, Conner et al. 1994), and numerous species of wildlife use the dens created by heart rots in hardwoods. (Conner et al. 1976) found that all downy woodpecker (*P. pubescens*), hairy woodpecker (*P. villosus*), pileated woodpecker (*Dryocopus pileatus*), and common flicker (*Colaptes auratus*) nest cavities that they studied in softwood were associated with fungal heart rots.

Considering the importance of these fungal heart rots in both pines and hardwoods and their prevalence in mature trees (Barnard and Dixon 1983, McComb et al. 1986), these older trees, especially those showing signs of heart rot, will be favored during any commercial harvest or noncommercial thinning operation. Certain cull trees that will likely be invaded by heart rot and provide dens in the future will also be favored.

## Severe Weather and the Role of Disturbance on Natural Communities

Severe weather in the form of high winds, hurricanes, tornadoes, lightning, and floods can damage individual trees or large swaths of refuge habitat. The most recent storm to significantly affect the refuge was Hurricane Dennis in 2005, where an estimated 8- to 10-foot-high storm surge severely damaged roads, levees, and killed a stand of pines north of Headquarters Pond. Historically, naturally occurring sources of disturbance (which can also include biotic sources, such as tree death due to insects and disease) are unlikely to have a major impact, as long as they are relatively small in scope and infrequent. In fact, moderate levels of disturbance are considered to play a key function in maintaining spatial heterogeneity and biodiversity (Sousa 1984). The vegetation gaps caused by various disturbance events release less-dominant species from competition and promote the growth of early successional species. According to Sousa (1984), each ecosystem has an optimal level of disturbance, both in terms of frequency and intensity. If disturbance events are too infrequent, climax communities develop and biodiversity declines because the strongest competitors tend to dominate. A disturbance regime that limits the dominance of a few species will foster the greatest diversity. Over time and during stable climates, the biota of a particular area will adapt to this optimal disturbance rate. At the other extreme, when disturbance events are too frequent and catastrophic, many species are eliminated causing the system to be perpetually maintained at an early successional stage, and the biological diversity of the area does not attain its peak levels. Because formerly vast and contiguous natural communities have been largely replaced by smaller, isolated patches, natural disturbances now have the ability to seriously affect these resources. For instance, hurricanes could cause blow-downs of mature pines on the refuge, resulting in loss of red-cockaded woodpecker cavities. Furthermore, the disturbance regime affecting the refuge could be altered by climate change, as discussed in Section 2.8.5.

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## *Water Quality and Availability*

St. Marks NWR lies within the St. Marks River watershed, which encompasses several counties in Florida and Georgia, as well as much of Tallahassee, a large metropolitan area. Large tracts of commercial forest, rural communities, and agricultural lands fall within its borders. It is bisected by I-10, a major interstate corridor, as well as several state and rural roads. Population growth has been increasing rapidly around Tallahassee and along I-10. With this growth comes increased pressure on the natural environment, as every person living in or passing through a watershed creates water quality and quantity impacts.

In natural environments, water quality is a function of climate, geology, hydrology, and biological factors. Anthropogenic threats to water quality are related to the manner in which this resource is used and altered through public, agricultural, silvicultural, mining, and industrial uses. These uses can cause water quality impairments, including sedimentation, nutrients, toxic substances, oxygen-depleting wastes, and fecal coliform bacteria. Sources of pollution can be divided into two main categories--point source and non-point source. Point source has a single identifiable localized origin, such as a sewage outfall. Non-point source water pollution affects a water body from diffuse sources, such as contaminated runoff from agricultural areas draining into a river.

Water availability is a function of many factors, including climate, geology, hydrology, and human use. Water withdrawals for household, agricultural, hydropower, mining, and industrial use are increasing in the watershed. Although the current water supply in Florida is more than the amount used, this comparison obscures the fact that availability and demand vary spatially and temporally. Only a fraction of all rainfall replenishes groundwater systems; the remainder is lost to evaporation or becomes surface water, an unreliable source for most human needs. In addition, Florida shares water sources with other states, which reduces the quantity available to the state. Furthermore, water availability is lowest during summer, and is further reduced during periods of drought. Finally, access to groundwater is costly or underground sources may not be suitable due to saltwater intrusion. As the region's population grows, issues related to water availability are likely to increase.

## *Climate Change*

Warming of the Earth's climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures. Global mean surface air temperatures have ranged from 1.0 to 1.7 degrees Fahrenheit (°F) for and average rise of 1.3 °F over the last 100 years (1906–2005). The rise is accelerating ([Trenberth et al. 2007](#)). In the past three decades, surface temperature record shows an upward trend of about 0.36 °F per decade. In total, average global temperatures have increased by about 1.5 degrees °F since 1880, and January 2000 to December 2009 was the warmest decade on record ([NASA 2010](#)). The oceans are warming in response, and over the period 1961 to 2003, global ocean temperature has risen by 0.33°F from the surface to a depth of 2,296 feet (ft.)([Bindoff et al. 2007](#)). As a consequence of the thermal expansion of sea water and melting glaciers, global mean sea level has been rising. During the 20th Century, the average rate was 0.066 plus or minus (±) 0.02 inches per year. Sea level rise appears to be accelerating, with the average rate during the period from 1961 to 2003 being 0.070 ± 0.02 inches annually. More recently (1993 to 2003), sea level rise estimated from observations with satellite altimetry measured 0.122 ± 0.027 inches annually, significantly higher than the

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average rate, although it is too early to determine if this a long-term trend ([Bindoff et al. 2007](#)). The refuge's marshes are at risk from continued sea level rise, both from direct inundation and saltwater intrusion. The latter is already being manifested as cabbage palms have been dying along parts of the Florida Gulf Coast ([Williams et al. 1999](#)).

Worldwide, sea level rise will increase erosion rates and cause inundation of low-sloping shores. Among coastal systems, saltmarshes such as those found along the southern edge of St. Marks NWR, are expected to have the most severe landward retreat, due to their low tidal range and relatively low accretion rates ([Nicholls et al. 2007](#)).

In an effort to address the potential effects of sea level rise on United States national wildlife refuges, Sea-Level Affecting Marshes Models (SLAMM) for most Region 4 refuges, including St. Marks NWR ([Clough 2008](#)), were developed. High resolution, Light Detection and Ranging (LIDAR), topographic data were not available at the time of the study, so there was considerable uncertainty in the results ([Clough 2008](#)). The model used various International Panel on Climate Change (IPCC) ([Bindoff et al. 2007](#)) sea level rise scenarios for 2100, ranging from 1.28 to 4.9 feet. SLAMM results suggest that the refuge would be fairly resilient to continuations in the current global sea level rise or even increases to 1.28 feet by 2100. Under the scenario of 2.26 feet by 2100, much of the brackish marsh is predicted to be converted to salt marsh due to saline intrusion. Under the 3.28 feet sea level rise scenario, the converted salt marsh begins to be lost as well (changing to tidal flats and open water). Under the sea level rise scenario of 4.9 feet by 2100, much of the southern portion of this site is predicted to have converted to open water ([Clough 2008](#)). It must be noted that the sea level rise range provided by the IPCC in its 2007 is considered conservative, as its models only included the effect of thermal expansion and melting glaciers on sea level rise, but did not incorporate the contribution of mass ice flow.

Another consequence of global warming will be an increase in the intensity of tropical cyclones ([Bindoff et al. 2007](#)). Tropical cyclones derive their energy from latent heat stored in the surface waters of the ocean, and warmer water is correlated with more powerful cyclones. Sea surface temperatures have been increasing, and data from the past 30 years suggests that it is already resulting in stronger hurricanes ([Emanuel 1987](#), [Emanuel 2005](#), [Webster et al. 2005](#), [Mann and Emanuel 2006](#), [Holland and Webster 2007](#), [Trenberth et al. 2007](#)). St. Marks NWR's location adjacent to the shallow south-facing Apalachee Bay basin makes it particularly vulnerable to catastrophic storm surge heights (in excess of 15'), which may increase the rate of marsh losses predicted by Clough ([2008](#)).

Although the precise effects of climate change on refuge habitats and wildlife are unknown, it is highly likely that the increase in temperatures, associated heat waves, and expected decrease in water availability will cause the distributional shift of some species or whole communities as summarized in the Fourth Assessment Report of the Intergovernmental Panel on Climate Change ([Fischlin et al. 2007](#)). Species from lower latitudes, including nonnative animals and plants, will become more prevalent, while temperate species decline ([McCarty 2001](#), [Parmesan and Yohe 2003](#), [Root et al. 2003](#), [Hannah et al. 2005](#), [Parmesan 2006](#)). Stream-dwelling species, especially freshwater mussels, have been shown to be adversely affected by heat waves ([Mouthon and Daufresne 2006](#)). As migratory species often move annually in response to seasonal climate changes, their behavior, including migratory routes, is sensitive to climate. Changes in the timing of biological events are of particular concern because of a potential disconnect between migrants and their food resources if the phenology of each advances at different rates ([Inouye et al. 2000](#), [Root et al. 2003](#)). For instance, climate change

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may trigger earlier peaks of insect larvae abundance prior to the peak nesting of returning neotropical migratory birds. As a result, there are fewer food resources available to nestlings and productivity is therefore reduced ([Visser et al., 2004](#)).

While precipitation is expected to increase in a warmer world (the capacity of air to retain water increases with temperature), the additional rain will fall during shorter, more intense storms with alternating periods of drought. This variability in precipitation events has been documented for the southeast ([Wang et al. 2008](#)). Soil moisture is likely to decline, on average, even though rainfall events are predicted to become more intense. Prolonged dry spells and increased evaporation rates resulting from warmer temperatures will reduce soil moisture. Drought-tolerant species will become more common, and outbreaks of pine bark beetles and other forest pests will be more frequent. The frequency of wildfires is expected to increase. In the scenarios with the largest changes, models suggest the possibility of significant drought-induced forest dieback in the southeast, with conversion of forested land cover to savanna and grassland ([Bachelet et al. 2001](#)).

Because of the uncertainty of the intensity and distribution of impacts caused by a warming world, it is important for the refuge to increase data collection at regular intervals and across the resource spectrum. The goals, objectives, and strategies proposed in this HMP and other step-down plans are an important first step in understanding and monitoring the potential threats related to climate change. The information obtained will help the Service determine how it can best manage for increased resiliency in important species and their habitats.

### *Exotic Plant Species*

The St. Marks NWR staff has identified and initiated treatment of 18 species of terrestrial nonnative plants (classified by the Florida Exotic Pest Plant Council as Category I and II exotic invasive pest plants) on no less than 27 discrete locations throughout the refuge. Appendix F lists all current exotic invasive species tracked in the state by the Florida Exotic Pest Plant Council that are known to occur on the refuge.

Category I plants are altering native plant communities by displacing native species, changing community structure or ecological functions, or hybridizing with native species. This definition does not rely on the economic severity or geographic range of the problem, but on the documented ecological damage caused.

Category II plants have increased in abundance or frequency, but have not yet altered Florida plant communities to the extent shown by Category I species. These species may become ranked Category I, if ecological damage is demonstrated.

All known populations of Category I and II species on the refuge have undergone initial chemical and/or mechanical treatment, but it is suspected that numerous infestations remain to be discovered. The majority of sites and species has been identified since 1999, although the largest two exotic pest plant infestations, cogon grass on the levees and Chinese tallow at an old field (Mounds) east of Picnic Pond, were identified and partially treated prior to this date. While these 18 exotic invasive plant species have disrupted natural communities and displaced native species on the refuge, less than 0.7 percent of the refuge's non-aquatic habitats have been affected to date. With continuous treatment, these infestations will be eradicated or brought under maintenance control, and new sites discovered before treatment options become limited.

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In addition to the 18 upland species, 4 aquatic Category I and II species are known to be present in state sovereign waters on or adjacent to the refuge. Of these, hydrilla has by far been the most disruptive to natural communities, and it remains a potential threat to inland freshwater sites. Boats and trailers have often been implicated in aiding the spread of invasive aquatic weeds, and due to this threat, the refuge impoundments were closed to boat trailers and limited to electric motors in 2009.

### *Exotic Animal Species*

Considered the most destructive exotic animal on St. Marks NWR, the feral hog (*Sus scrofa*) competes with native wildlife for mast and preys upon small vertebrates and invertebrates. Furthermore, its rooting destroys wetland vegetation including many rare species. Hog rooting also damages grassy refuge roads and dikes and provides favorable conditions for the spread of invasive exotic plants. Refuge hunts provide some minimal control of the hog population on the Wakulla and Panacea Units, but the hunting pressure is too light to be very effective. Therefore, trapping and shooting efforts administered by the refuge provide additional means of population control.

Domestic and feral cats (*Felis catus*) and dogs (*Canis familiaris*) are occasionally found on the refuge, particularly near houses adjoining the refuge boundary. The impacts of these animals on overall refuge wildlife are considered relatively small, although free-ranging cats can have a devastating impact on small bird, reptile, and mammal populations (Hatley 2003).

Other exotic animals, including the rock pigeon (*Columba livia*), Eurasian collared dove (*Streptopelia decaocto*), starling (*Sturnus vulgaris*), Norway rat (*Rattus norvegicus*), black rat (*R. rattus*), house mouse (*Mus musculus*), and possibly the house sparrow (*Passer domesticus*), occur in small numbers, mostly in developed areas. Greenhouse frogs (*Eleutherodactylus planirostris*) have been recently discovered on the refuge and are more widespread. They are thought to have little impact on native refuge wildlife. Nutria (*Myocaster poyppus*), a large aquatic rodent, has the potential to seriously degrade saltwater marshes as is the case in Louisiana and several mid-Atlantic states. It is currently infrequently reported in Florida, with recent records from Duval, Hillsborough and northern Jefferson Counties. Once established, they are almost impossible to eradicate and can cause significant damage to marshes, in some cases causing these to be replaced by open water ([USGS 2001](#)). A few species, such as the cattle egret (*Bubulcus ibis*), coyote (*Canis latrans*), and armadillo (*Dasypus novemcinctus*), occur (or would have occurred) on the refuge due to range expansion, and are not currently considered to be exotic species.

The red imported fire ant (*Solenopsis invicta*) is another exotic animal that has had significant impacts to native wildlife, including reptiles, amphibians, and ground nesting birds (Allen et al. 1994). Most occurrences on the refuge are associated with man-altered landscape, such as levees, road shoulders, and lawns. In problem areas, fire ant mounds may be treated to reduce the infestation.

The redbay ambrosia beetle (*Xyleborus glabratus*) has been expanding its range rapidly ([Fraedrich et al. 2008](#), [Johnson et al. 2008](#), J. Reinman, pers. comm. Nov 2009). This beetle carries a fatal fungal wilt disease (*Raffaelea lauricola*), which primarily affects redbay (*Persea borbonia*) and several other related species in the laurel family. If it were to become established on the refuge, it would likely lead to the local extirpation of redbays and related species. Experimental management treatments would be considered in response.

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The cactus moth (*Cactoblastis cactorum*) is an invasive species from South America, which was first detected on the refuge in 2002 ([Hight et al. 2002](#)). The larvae of this species feed on native *Opuntia* cactus species. Currently, no satisfactory method of chemical control of this moth is known. The use of pesticides is not recommended because of the potential occurrence of rare butterflies. Likewise, releases of egg parasites such as *Trichogramma* could have an adverse effect on other desirable Lepidoptera. Preliminary investigations indicate an appreciable level of predation of the pupae and the occurrence of a pupal parasite, *Brachymeria* spp., but these are unlikely to control cactus moth. Mechanical removal of host plants has been shown to work at some locations ([Rose 2009](#)), although this method would not be easily implemented on the refuge. Efforts to use sterilized insects are being improved for commercial applications, and research into classical biological controls is ongoing ([Rose 2009](#)).

## WILDLIFE

### *Birds*

The documented natural communities of the refuge provide habitat for 278 species of birds throughout the year. A total of 116 are considered to be common or abundant during some seasons. Avian species that are listed under the provisions of the Endangered Species Act and documented on the refuge include the red-cockaded woodpecker (*Picoides borealis*) ([Reinman 1995](#)), wood stork (*Mycteria americana*), and piping plover (*Charadrius melodus*). State-listed species include the least tern (*Sternula antillarum*) and peregrine falcon (*Falco peregrinus*). Even though it is situated between the Atlantic and Mississippi Flyways, St. Marks NWR provides important breeding, wintering, and stopover habitat for neotropical migratory birds (e.g., songbirds, raptors, and shorebirds). Through the Partners in Flight initiative, federal, state, and private agencies are developing and implementing a comprehensive approach for managing selected species of migratory nongame birds. In an attempt to prevent the listing of most of these birds as threatened or endangered species, these trust species are given high priority in management decisions. However, few systematic surveys for migratory nongame birds are currently underway on the refuge. Red-cockaded woodpeckers are monitored and banded yearly, in accordance with the Red-cockaded Woodpecker Recovery Plan ([USFWS 2003b](#)). Some nesting bald eagles, wading birds, and least terns are also surveyed annually.

*Waterfowl.* The refuge's coastal marshes, seagrass beds, and riverine estuaries are important wintering and migration areas for diving ducks of national importance, for example, redheads (*Aythya americana*) and scaup (*A. marila* and *A. affinis*). Additionally, the managed impoundments provide a mix of habitats and water depth capabilities not readily available in adjacent marshes or associated habitats of Apalachee Bay. Teal (*Anas discors* and *A. crecca*), pintail (*A. acuta*), widgeon (*A. americana*), mallard (*A. platyrhynchos*), and many other ducks are common in the impoundments and wintering use numbers in the thousands.

Of the refuge's 99,919 acres (including the Executive Closure Areas) less than two percent have the capability for water management. When managed, the 1,600 acres of impoundments provide flexibility for creating habitats scarce throughout the refuge and Apalachee Bay ecosystem. Impoundment management adds a multitude of plant/water communities required by a large variety of migratory bird groups (e.g., freshwater, shallow depths, and multi-vegetation types).

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Shorebirds, Waterbirds, and Marshbirds. The refuge is host to 28 species of breeding shorebirds, waterbirds, and marshbirds. Another 57 species of this group use refuge habitats for non-breeding portions of their life cycles. Examples of high-priority species found on the refuge include the black (*Laterallus jamaicensis*), king (*Rallus elegans*), and yellow rails (*Coturnicops noveboracensis*); piping plover; little blue heron (*Egretta caerulea*); Wilson's plover (*Charadrius wilsonia*); short-billed dowitcher (*Limnodromus griseus*); western sandpiper (*Calidris mauri*); semipalmated snadpiper (*Calidris pusilla*); stilt sandpiper (*Calidris himantopus*); American oystercatcher (*Haematopus palliates*), and whimbrel (*Numenius phaeopus*).

Tower Pond and Stoney Bayou 1 have been specifically managed for shorebirds over the past few years. Thousands of shorebirds use the other impoundments during drought and low water conditions also, which attests to the importance of the pools in providing quality northbound and likely southbound shorebird stopover habitat when it is made available. Similarly, these conditions can benefit wading birds, terns, and other species.

The refuge also contains inland waterbird rookeries within depressional marsh, scrub/shrub, and swamp forest habitat types. These sites have produced high proportions of failed nest attempts due to unreliable water levels during moderate to severe drought years.

Certain small islands in Apalachee Bay (especially Palmetto and Smith) are critically important as waterbird and shorebird nesting habitat, but only Palmetto Island is owned by the refuge. These two islands support one of the few brown pelican (*Pelecanus occidentalis*) rookeries in the northeast Gulf of Mexico. The number of nesting wading birds shifts between Smith and Palmetto Islands over the years, demonstrating their collective importance.

Marsh bird surveys were conducted by U.S. Geological Survey researchers in 2008-2009.

Landbirds. In the pinelands and hardwood forests several high-priority birds are residents or utilize the refuge during some part of their annual cycle. Healthy pine habitats are critical to Bachman's sparrows (*Aimophila aestivalis*), Henslow's sparrows (*Ammodramus henslowii*), brown-headed nuthatches (*Sitta pusilla*), northern bobwhites (*Colinus virginianus*), and red-cockaded woodpeckers (*Picoides borealis*). Swamps and hardwood hammocks are important habitats for swallowed-tailed kites (*Elanoides forficatus*), Swainson's warblers (*Limnothlypis swainsonii*), prothonotary warblers (*Protonotaria citrea*), American woodcock (*Scolopax minor*), rusty blackbirds (*Euphagus carolinus*), Kentucky warblers (*Oporornis formosus*), and wood thrushes (*Hylocichla mustelina*).

Neotropical Migratory Birds. One of the refuge's primary purposes is conservation of migratory birds. This includes neotropical migratory birds, which are defined as shorebirds, waterbirds, and landbirds that are listed in the most recent American Ornithologists Union checklist ([A.O.U., 2013](#)). They are distinguished by having separate breeding and wintering ranges, with at least part of the wintering range being south of the Tropic of Cancer. Where separate populations of a species exhibit differing breeding and wintering behavior, an effort has been made to include only those local species that spend the winter in the tropics. These species are of keen public and conservation interest, because they migrate incredible distances, often at night, or in rain, wind, and snow. Breeding males are often visibly stunning and have distinctive songs or calls.

These same species are experiencing population-wide declines due to destruction and fragmentation of breeding and wintering habitat, poisoning by pesticides, and climate change. Collisions with skyscrapers and communication towers kill an estimated four to five million birds per year and are a major source of population decline. Predation is another source of decline,

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with feral domestic cats killing an estimated 39 million birds per year. Of the 278 regularly occurring avian species listed for the refuge, 142 are categorized as neotropical migratory birds. All but three of the refuge's 48 listed warblers, tanagers, vireos, and new world finches are neotropical migratory birds.

Raptors (Vultures, Hawks and Allies). Nineteen species of raptors are recorded on the refuge: three species of incidental occurrence; seven species which are abundant or common during some portion of the year; and nine species that are uncommon, occasional, or rare throughout the year. Nine species are known to nest on the refuge.

### *Mammals*

Fifty species of mammals are known or suspected to occur on the refuge, including the least shrew (*Cryptotis parva*), Seminole bat (*Lasiurus seminolus*), golden mouse (*Ochrotomys nuttalli*), marsh rice rat (*Oryzomys palustris*), fox squirrel (*Sciurus niger*), gray fox (*Urocyon cinereoargenteus*), river otter (*Lontra canadensis*), bobcat (*Lynx rufus*), Florida black bear (*Ursus americanus floridanus*), coyote (*Canis latrans*), and Florida manatee (*Trichechus manatus latirostris*). Presently, no surveys are being conducted to monitor the population levels of these species except for a few fox squirrel surveys conducted in the Panacea Unit.

White-tailed deer are currently monitored through data collected at check stations during refuge hunts and occasionally through herd health checks by the Southeastern Cooperative Wildlife Disease Study, which is based in Athens, Georgia. The last health check was conducted in July 2002. No future checks are planned unless a problem is detected. In addition, night spotlight surveys were conducted annually from 1974 through 2000 and 2006-2008.

### *Amphibians*

Forty species of amphibians (21 frogs and 19 salamanders) are known or suspected to occur on the refuge. These include the barking tree frog (*Hyla gratiosa*), river frog (*Rana hecksheri*), gopher frog (*R. capito*), striped newt (*Notophthalmus perstriatus*), frosted flatwoods salamander (*Ambystoma cingulatum*), and one-toed amphiuma (*Amphiuma pholeter*). The U.S. Geological Survey's Florida Integrated Science Center examined the amphibians on the refuge as part of its Southeastern Amphibian Research and Monitoring Initiative ([Dodd et al, 2007](#), [Gunzburger 2010](#)). A three-year inventory phase was completed in 2005 and monitoring of selected populations has continued. The Florida Fish and Wildlife Conservation Commission surveyed refuge ponds for the federally listed flatwoods salamander 2001 through 2007. Flatwoods salamanders are found in the St. Marks Unit ([Printiss 2001](#)). No striped newt or gopher frogs were found.

### *Reptiles*

Sixty-eight species of reptiles are known or suspected to occur on the refuge. These include the American alligator (*Alligator mississippiensis*), 13 species of lizards, 36 species of snakes, and 18 species of turtles. The mole skink (*Eumeces egregious*), island glass lizard (*Ophisaurus compressus*), Florida pine snake (*Pituophis melanoleucus*), eastern hognose snake (*Heterodon platirhinos*), blue-striped garter snake (*Thamnophis sirtalis similis*), common snapping turtle (*Chelydra serpentina*), gopher tortoise (*Gopherus polyphemus*), Kemp's ridley sea turtle (*Lepidochelys kempii*), and diamondback terrapin (*Malaclemys terrapin*) are noteworthy species. The eastern indigo snake (*Drymarchon corais couperi*), southern hognose snake (*H. simus*),

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and the spotted turtle (*Clemmys gutaatta*) are within the range of the refuge, but have not been seen in recent years. With the exception of gopher tortoise surveys ([Logan 1979](#), [McCoy and Mushinsky 1995](#), [Nomani et al. 2008](#), [Legleu 2012](#)), no specific monitoring of refuge reptiles is currently underway, although the amphibian surveys may generate some information on reptiles.

### *Fish*

Due to the high diversity of the refuge's aquatic habitats--from open bays to tidal creeks, estuaries, blackwater rivers, spring runs, fresh and brackish impoundments, freshwater ponds, and wooded wetlands--the refuge hosts over 145 species of fish ([Subranmanyam 1975](#)). Fish surveys, including a simple inventory of fishes occurring on the refuge, are needed for resource management. To support sport fishing, the refuge occasionally stocks its impoundments with gamefish such as largemouth bass (*Micropterus salmoides*) and bluegill (*Lepomis macrochirus*).

### *Invertebrates*

No attempt has been made to catalogue the plethora of invertebrates on the refuge, although some outside researchers have studied certain species or groups. The Shepherd Spring basin and underwater cave system has been partially explored under a refuge special use permit by cave divers with the Woodville Karst Plain Project. Their explorations have yielded documentation of three imperiled but not federally listed invertebrates: the Big Blue Springs cave crayfish (*Procambarus horsti*), Hobb's cave amphipod (*Crangonyx hobbsi*), and Florida cave amphipod (*Crangonyx grandimanus*). Scallops (*Argopecten irradians*) are at times plentiful in Apalachee Bay, and scalloping is a popular recreational activity.

The monarch butterfly (*Danaus plexippus*) fall migration roosting aggregation at the lighthouse area has been studied since 1981. The monarchs have been regularly banded at the lighthouse since 1989 through present. A checklist of butterflies is available.

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## III. Resources of Concern

### IDENTIFYING RESOURCES OF CONCERN

Resources of concern include species, species groups, and/or communities that support refuge purposes, as well as Service trust resource responsibilities (including threatened and endangered species and migratory birds). Resources of concern are also native species and natural, functional communities such as those found under historic conditions that are to be maintained and, where appropriate, restored on a refuge (601 FW 3.10B[1]).

The Habitat Management Plan policy (620 FW) defines “resources of concern” as:

“All plant and/or animal species, species groups, or communities specifically identified in Refuge purpose(s), System mission, or international, national, regional, state, or ecosystem conservation plans or acts. For example, waterfowl and shorebirds are a resource of concern on a refuge whose purpose is to protect ‘migrating waterfowl and shorebirds.’ Federal or State threatened and endangered species on that same refuge are also a resource of concern under terms of the respective endangered species acts.”

Resources of concern on the refuge include the plant communities and wildlife described in Chapter 2.

### PRIORITY RESOURCES OF CONCERN

Priorities associated with wildlife and habitat management for the Refuge System are determined through directives, policies, and legal mandates. Priority resources of concern for St. Marks NWR were selected after taking into account the conservation needs identified within international, national, regional, or ecosystem goals/plans; state fish and wildlife conservation plans; recovery plans for threatened and endangered species; and previously approved refuge resource management plans as identified in the Comprehensive Conservation Planning Process policy [602 FW 3.4C[1][e]]. The species/communities selected as priority resources of concern from these plans support the following Refuge System mandates:

- Support refuge purposes and the Refuge System mission;
- Conserve biological integrity, diversity, and environmental health; and
- Fulfill Service trust resource responsibilities.

The resources of concern contain a large number of species (with a broad array of habitat needs) and several plant communities. These resources were prioritized in order to determine what the refuge is best suited to focus on in its management strategies. To guide the process of setting priority, the following concepts were taken into account:

- Achieving refuge purposes and managing for trust resources, as well as biological diversity, integrity, and environmental health, can be addressed through the habitat requirements of "focal species" or species that may represent guilds that are highly associated with important attributes or conditions within habitat types. The use of focal species is particularly valuable when addressing Service trust resources such as migratory birds.

- The Bird Conservation Region (BCR) plans are increasing their effectiveness at ranking and prioritizing those migratory birds most in need of management or conservation focus. Although all species that make it to a ranked BCR priority list are in need of conservation attention, we selected focal species that were ranked High or Moderate in Continental concern with a High to Moderate BCR Responsibility. If there were too many or too few birds with these rankings for a given habitat type, then the highest ranked birds were chosen. (See [www.abcbirds.org/nabci](http://www.abcbirds.org/nabci) for BCR rules used to rank birds.)
- Habitat conditions on or surrounding the refuge may limit the capability to support or manage for a potential species of concern. The following site-specific factors were evaluated:
  - Patch size requirements;
  - Habitat connectivity;
  - Compatibility of surrounding land use;
  - Environmental conditions: soils, hydrology, disturbance patterns, contaminants, predation, invasive species;
  - Specific life history needs;
  - The likelihood that a potential species of concern would have a positive reaction to management strategies; and
  - Rare habitats and those that support large numbers and/or a high diversity of trust species.

The priority resources of concern have been identified by habitat and are shown in Table 3. Additional details regarding these resources and the desired future conditions of these habitats can be found in Appendix G.

**Table 3. Resources of concern (ROC) and desired future condition for St. Marks NWR**

Habitat Types	Desired Future Conditions	Priority ROCs	Monitoring Species
<b>Sandhill</b>	Basal area of pine (square feet per acre) higher if pines are larger than 20 inches(”) diameter at breast height (DBH) = 30-60 Pines exhibiting flat topped crowns = 25-50 percent (%) Basal area of hardwood (square feet per acre) = 5-20 Herbaceous groundcover = 25-75% Snags greater than (>) 10” DBH = 2-5 per acre	Red-cockaded woodpecker, Bachman’s sparrow, brown-headed nuthatch, red-headed woodpecker, gopher tortoise, fox squirrel, gopher frog, indigo snake, Godfrey’s blazing star, zigzag silkgrass	Bachman’s sparrow, fox squirrel, red-cockaded woodpecker, gopher tortoise, brown-headed nuthatch

Habitat Types	Desired Future Conditions	Priority ROCs	Monitoring Species
<b>Mesic Flatwoods</b>	Basal area of pine (square feet per acre); (higher if pines are larger than 20") = 40-70 Pines exhibiting flat topped crowns = 25-50% Basal area of hardwoods (square feet per acre) = 0-10 Herbaceous groundcover = 25-75% Snags >10" DBH = 2-5 per acre	Red-cockaded woodpecker, Bachman's sparrow, brown-headed nuthatch, northern bobwhite, red-headed woodpecker, frosted flatwoods salamander, scareweed.	Bachman's sparrow, red-cockaded woodpecker, brown-headed nuthatch
<b>Wet Flatwoods</b>	Basal area of pine (square feet per acre) = 5-40 Pines exhibiting flat topped crowns = 40-60% Basal area of hardwood (square feet per acre) = 0-10	Henslow's sparrow, Bachman's sparrow, red-cockaded woodpecker, brown-headed nuthatch, wiregrass gentian.	Henslow's sparrow, Bachman's sparrow, red-cockaded woodpecker, brown-headed nuthatch
<b>Scrubby Flatwoods</b>	Basal area of pine (square feet per acre) = 20-70 Pines exhibiting flat topped crowns = 12-50% Basal area of hardwood (square feet per acre) = 10-20	Gopher tortoise, brown-headed nuthatch, Chuck-will's-widow, scareweed, Godfrey's blazing star, zigzag silkgrass	Gopher tortoise, brown-headed nuthatch
<b>Cabbage Palm Flatwoods</b>	Basal area of pine (square feet per acre) = 40-70 Basal area of hardwood (square feet per acre) = <10	Henslow's sparrow, brown headed nuthatch, nightflowering petunia, and Chapman's sedge	Brown-headed nuthatch
<b>Mesic &amp; Hydric Hammocks</b>	Basal area of pine (square feet per acre) 0-20 Basal area of hardwood (square feet per acre) 40-100	Swallow-tailed kite, Kentucky warbler, Swainson's warbler, wood thrush, woodcock, rusty blackbird,	Swainson's warbler, Kentucky warbler, wood thrush

Habitat Types	Desired Future Conditions	Priority ROCs	Monitoring Species
<b>Shrub Bog</b>		Swainson's warbler, Kentucky warbler, woodcock, rusty blackbird	Swainson's warbler, Kentucky warbler
<b>Impoundments</b>	Shallow submerged aquatic vegetation Fish concentrated in shallow open water Shallow to exposed mudflats, 0-10% herbaceous cover	Wood stork, short-billed dowitcher, pintail, king rail, waterfowl, wading birds, shorebirds	Waterfowl, wading birds, shorebirds
<b>Salt Marsh</b>	Shrub cover 0-40% Herb cover 85-100%	Saltmarsh topminnow, seaside sparrow, black rail, salt marsh sparrow, Nelson's sparrow, Wilson's plover, diamond-backed terrapin, Godfrey's spider lily	Seaside sparrow, black rail, Wilson's plover
<b>Seagrass</b>	Set by the Florida DEP as detailed in the Big Bend Seagrasses Aquatic Preserve Management Plan (June 2012)	Seagrasses, manatee, sea turtles, redhead duck, waterfowl, loons	Seagrasses, redheads

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## IV. Habitat Management Goals and Objectives

The following goals were developed for the CCP and are applicable to this HMP:

**Goal 1.** Wildlife Habitat and Population Management: Conserve, restore, and enhance a natural diversity and abundance of habitats for native plants and animals.

**Goal 2.** Threatened, Endangered, Rare, and Imperiled Species: Conserve and enhance populations of threatened, endangered, rare, and imperiled plants and animals and their native habitats.

**Goal 3.** Migratory Birds: Provide high-quality habitat for migratory birds.

**Goal 4.** Wilderness: Protect and preserve the wilderness character of those refuge lands designated by Congress as part of the National Wilderness Preservation System.

In order to meet the listed goals, specific objectives have been developed for major habitats, wilderness, and selected resources of concern whose needs are not met under the habitat objectives. Objectives are derived from goals, and as such, they are more quantitative and provide some measurable statement that can be used to determine whether the action was successfully accomplished. Most objectives will be accompanied by strategies or tools needed to carry out the objectives and an associated rationale for their use. While this document provides specific guidance for habitat management, it is essential that it is also dynamic and adaptable to changes as they occur on the St. Marks NWR.

### FOREST MANAGEMENT

This section describes the forest management objectives for the major forest habitats on the refuge. As such, it will replace the previous Forest Management Plan (Reinman 1989).

In an effort to maintain management consistency and continuity, the goals and objectives defined in the CCP will be guiding principles of the forest management activities on the refuge. Three of the goals focus on three essential resource components of the refuge, biodiversity (Goal 1), listed species (Goal 2), and migratory birds (Goal 3). Following each goal is a set of objectives and associated strategies that are specific to the major forest types that have been identified on the refuge: pine flatwoods and sandhills, hardwood swamps, and hydric hammocks.

### PINE FOREST MANAGEMENT OBJECTIVES

These pine-dominated sandhill and flatwoods are highly fire dependent communities that consist of sandhills, scrubby flatwoods, mesic flatwoods, wet flatwoods, and cabbage palm flatwoods. Frequent fires help maintain a low and diverse understory, wiregrass groundcover, and open canopy; allow for the development of large pines; and limit hardwood encroachment. By restoring and maintaining these forest types, a number of objectives will be met as they relate to red-cockaded woodpeckers, flatwoods salamanders, gopher tortoises, indigo snakes, migratory birds, fox squirrels, rare plants, and the refuge's overall biodiversity. The following objectives were developed in the CCP for these pine forests:

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**Pine Forest Objective 1:** Continue to restore and maintain open multi-aged, historic pine communities with low, diverse understories in support of multiple wildlife populations including 59 active clusters of red-cockaded woodpeckers, 50 pairs/1,000 acres for the Bachman's sparrow, and 45 pairs/1,000 acres for the brown-headed nuthatch. Annually conduct habitat inventories on seven percent of the forested compartments. Prescribe treatments to maintain average pine basal areas of 20 to 70 square feet per acre (see Appendix G for specific ranges for each pine sub-type). Retain greater than or equal to 65 pines of greater than (>) 5 inches diameter at breast height (DBH) per acre, except in wet flatwoods. Evaluate revising the target pine basal areas upward for stands with larger diameter pines. Manage pine understories to average less than four feet in height. Under current funding and staffing levels, the refuge can expect to inventory and prescribe management to less than 20 percent of the pine habitat over the next 15 years.

**Rationale:** Many imperiled wildlife and species of concern are a result of the regional decline of the natural pine ecosystems of the southeast, especially the longleaf pine ecosystem. By restoring these ecosystems and their processes to the extent possible, the wildlife associated with these ecosystems will benefit. Monitoring will not only evaluate the changes in habitat, but select species that are linked to healthy components of the ecosystem (e.g., red-cockaded woodpecker, gopher tortoise, Bachman's sparrow, Henslow's sparrow, brown-headed nuthatch, red-headed woodpecker, and fox squirrel). Through adequate monitoring of both the habitat and wildlife, management then can be refined under the adaptive management model to provide the most appropriate habitat conditions for the targeted wildlife.

Breeding population targets were derived from the Partners in Flight Bird Conservation Plan for the South Atlantic Coastal Plain (Physiographic Area 03) – Version 1.0 ([Hunter et al. 2001](#)).

Bachman's sparrows (*Aimophila aestivalis*) and red-cockaded woodpeckers use mature pine woodlands characterized by well-spaced pines, an open midstory, and a dense understory of grasses and forbs. Although many of their habitat requirements are similar, habitat comparisons at Eglin's Air Force Base between active red-cockaded woodpecker clusters occupied and unoccupied by Bachman's sparrows showed that Bachman's sparrows selected areas with a dense understory of grasses and sparse midstory vegetation ([Plentovich et al. 1998](#)). Prescribed burning is key for development and maintenance of the dense herbaceous understory preferred by both Bachman's sparrows and red-cockaded woodpeckers ([Tucker 2004](#), [James et al 2001](#)). In areas managed for red-cockaded woodpeckers, frequent (3-5 year) burning early in the growing season appears the best way to increase habitat suitability for Bachman's sparrows ([Cox 2008](#)) ([Plentovich et al. 1998](#)).

Henslow's sparrows (*Ammodramus henslowii*) use open pine woods with grassy ground cover. Henslow's sparrows prefer lush habitats containing high, dense herbaceous vegetation and a thick layer of ground litter. In breeding habitat in Illinois, they prefer an average maximum plant height of 35-39 inches, an average plant height of 16-22 inches and average duff height between 2-3 inches (Nanavati 2007). The Henslow's sparrow is also particular about the ground cover in its habitat. It prefers ground cover ranging from 45 to 60 percent, forbs cover from 15 to 25 percent, duff cover that ranges around 25 percent, and minimal bare ground ([Nanavati 2007](#)). Such habitats are dominated by grasses, sedges, forbs, or clover and contain little or no woody vegetation and few scattered shrubs. Unmowed agricultural fields or ungrazed pastures are preferred for their thick cover. Henslow's sparrows are tolerant of a variety of moisture regimes and thus will occupy both wet and dry habitats. Large open areas are preferred; fields of 10 to 100 hectares (25 to 250 acres) may be needed to support breeding populations ([Samson 1980](#)). The refuge currently is known to support only wintering birds.

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The red-headed woodpecker (*Melanerpes erythrocephalus*) is typically found in open woodland, especially with beech or oak ([Brown et al. 1999](#)). It generally avoids unbroken forest, favoring open country or at least clearings in the woods. Also found in pine-savannah, pine-oak barrens, forested wetlands or flooded timber, and timber stands treated with herbicides or burns. It prefers open areas with snags and lush herbaceous ground and open, upland meadow or short-grass areas ([Smith et al. 2000](#)). It often uses dead trees of deciduous forests adjoining fields ([Veit and Petersen 1993](#)). Habitat management includes: maintaining open areas with little understory; providing small and large snags and dead limbs on large living trees to provide nesting, roosting, and foraging opportunities; and using prescribed burning to maintain a savannah-like condition with good aerial and ground foraging opportunities. Habitat should be managed to provide forest fragments greater than 5 acres with large snags for nesting and open areas for catching flying insects.

Brown-headed nuthatches (*Sitta pusilla*) are pine-obligate species that generally prefer open forest stands. Pine species composition is not as critical as the DBH of the trees. Studies in east Texas indicated an average DBH of 10.1 inches was optimal ([O'Halloran and Conner 1987](#), [Dornak et al. 2004](#)). Brown-headed nuthatches prefer open pine stands with few hardwoods ( $\leq 2.8$  stems/acre and basal area  $\leq 21.7$  square-feet-per-acre (ft<sup>2</sup>/acre) and an open midstory ([Wilson and Watts 1999](#)). Undergrowth is typically sparse (approximately 35 percent; [Dornak et al. 2004](#)). In Texas, preferred sites had a mean pine basal area of 24.2 ft<sup>2</sup>/acre ([O'Halloran and Conner 1987](#)). At Tall Timbers (northwest Florida), where shortleaf-loblolly pine stands are considered to be high-quality nuthatch habitat, basal areas range between 30 and 70 square-feet-per-acre (ft<sup>2</sup>/acre) (J. Cox, pers. comm., June 2009). A shrub height  $< 5$  feet ensures that cavity entrances are not obscured ([Wilson and Watts 1999](#)). Stands with closed canopies are not preferred, but optimal canopy closure is highly variable (15 to 85 percent) ([O'Halloran and Conner 1987](#), [Wilson and Watts 1999](#)); when deciduous hardwoods begin to reach the canopy of stands, this bird is rarely present ([McNair 1984](#), [McComb et al. 1986](#), [Miller and Marion 1995](#)). As the mid-story reaches 20 to 30 feet under mature pines, the brown-headed nuthatch begins to decline.

Restoration approaches that emphasize the functional nature of communities help build resiliency by reestablishing biota that are compatible with the dynamic changes in present and future ecosystems. Key attributes to be restored include: (1) Species composition; (2) vertical structure; (3) horizontal pattern; (4) spatial heterogeneity; (5) properly functioning ecological processes; and (6) ecosystem resiliency sufficient to permit recovery from disturbances at multiple scales ([Hobbs and Norton 1996](#)). Restoration can be seen as a long-term, step-wise process with the aim of moving forest sites from current toward desired conditions, using ecological theory of scientific research and appropriate silvicultural techniques applied through adaptive management. Ecological restoration at the field level requires a cadre of physical, chemical and biological methods, implemented as single or multiple treatments. For longleaf pine, essential processes such as periodic fire and regeneration, are key to bringing forested areas on the refuge closer to the desired condition.

Longleaf pine restoration has become an important component of conservation and land management efforts across the southeast ([Brockway et al. 2005](#), [Kirkman 2002](#)). Longleaf forests tend to support a greater biodiversity than other pine forests ([Martin et al. 1993](#), [Peet and Allard 1993](#), [Drew et al. 1998](#), [Kirkman et al. 2000](#), [Goebel et al. 2001](#), [Provencher et al. 2003](#), [Kirkman et al. 2004](#)), are less susceptible to insect outbreaks ([Thatcher and Barry 1997](#)), and are relatively resistant to fire ([Wright and Bailey 1982](#), [Noss 1989](#), [Brockway and Lewis 1997](#), [Outcalt 2000](#)). They are also believed to be resilient to climate change, compared to other pine species now commonly found in the southeast ([Diop et al. 2009](#)). However, longleaf restoration science is relatively new, and the success of restorative actions vary regionally due to differences in climate,

topography, soils, and biological factors. Although the importance of the role of fire in restoring and maintaining longleaf communities has generally been accepted ([Barnett 2002](#)), vegetative responses to the timing ([Platt et al. 1988a](#), [Streng et al. 1993](#), [Glitzenstein et al. 1995](#), [Glitzenstein et al. 2003](#), [Glitzenstein and Streng 2005](#), [Glitzenstein et al 2012](#)), intensity ([Sullivan et al. 2003](#)), and other aspects of prescription burning are often site-specific and also dependent on the fire-history of a site ([Provencher et al. 2001](#), [Ruth et al. 2007](#), [Varner et al. 2007](#)).

Furthermore, the use of mechanical ([Connor 2006](#), [Haywood 2006](#), [Brockway et al. 2009](#), [Menges and Gordon 2010](#)) and chemical ([Wilkins 1993](#), [Brockway et al. 1998](#), [Brockway and Outcalt 2000](#), [Ramsey et al. 2003](#), [Ramsey and Jose 2004](#), [Haywood 2006](#), [Jose et al. 2008](#), [Freeman and Jose 2009](#), [Osieca 2010](#), [Addington 2012](#)) treatments that can be used in conjunction with fire to maintain the desired structure of longleaf pine communities continues to be researched. Longleaf regeneration is known to be problematic due to such factors as erratic seed production, high seedling mortality, and slow seedling growth ([Brockway et al. 2005](#)), but various natural ([Boyer 1979](#), [1993](#), [1997](#), [1999](#); [Brockway and Outcalt 1998](#)) and artificial ([Barnett et al. 1990](#), [Barnett 2000](#), [McGuire et al. 2001](#), [Barnett et al. 2002](#), [Gagnon 2003](#)) techniques have been developed and continue to be improved to overcome these difficulties.

**Resources of Concern:** Red-cockaded woodpecker, frosted flatwoods salamander, gopher tortoise, Eastern indigo snake, striped newt, gopher frog, Bachman’s sparrow, Henslow’s sparrow, brown-headed nuthatch, fox squirrel, eastern diamondback rattlesnake, southern hognose snake, Florida pine snake, red-headed woodpecker, northern bobwhite, Chuck-will’s-widow, longleaf pine communities, wiregrass gentian, Godfrey’s blazing star, zigzag silkgrass, St. Marks yellow-eyed grass, scare-weed, night-flowering wild petunia, Chapman’s sedge, wiregrass, slash pine flatwoods, and scrubby flatwoods.

*Adaptive Management Monitoring Elements*

Primary Habitat Response Variables	Probable Methods
<ul style="list-style-type: none"> <li>▪ Forest overstory structure and composition</li> <li>▪ Forest mid- and understory structure and height</li> <li>▪ Herbaceous component of understory</li> </ul>	<ul style="list-style-type: none"> <li>▪ Conduct a forest inventory. Through sampling, use proven techniques to obtain measurements of vegetation along the forest stratum that include the Habitat Response Variables.</li> <li>▪ Rare plant surveys</li> </ul>
Primary Wildlife Response Variables	Probable Methods
<ul style="list-style-type: none"> <li>▪ Population trends of Bachman’s and Henslow’s sparrows, brown-headed nuthatches, red-headed woodpeckers, and bobwhites</li> <li>▪ Population trends of red-cockaded woodpeckers</li> <li>▪ Population trends of gopher tortoises</li> <li>▪ Population trends of fox squirrels</li> </ul>	<ul style="list-style-type: none"> <li>▪ Conduct annual breeding and wintering bird surveys.</li> <li>▪ Conduct annual population monitoring.</li> <li>▪ Survey established gopher tortoise transects according to established protocol once every 5 years.</li> <li>▪ Conduct annual camera surveys.</li> </ul>

**Pine Forest Objective 2:** Over the next 15 years, manage groundcover to promote or maintain 25-75 percent grassy/herbaceous vegetation in pine habitats (except scrubby flatwoods) to benefit fire dependent pine-associated species including the following targets: 59 active clusters of red-cockaded woodpeckers; 50 pairs/1,000 acres for the Bachman’s sparrow; and 45 pairs/1,000 acres for the brown-headed nuthatch. Under current funding and staffing levels, the refuge can expect to maintain suitable groundcover in 30-50 percent of the pine habitat over the course of this HMP.

**Rationale:** Many imperiled wildlife species of pine habitats are linked to healthy, primarily herbaceous, groundcovers. These species include the frosted flatwoods salamander, gopher tortoise, Bachman’s sparrow, Henslow’s sparrow, red-headed woodpecker, and northern bobwhite. Breeding population targets were derived from the Partners in Flight Bird Conservation Plan for the South Atlantic Coastal Plain (Physiographic Area 03) – Version 1.0 ([Hunter et al. 2001](#)).

**Resources of Concern:** Red-cockaded woodpecker, frosted flatwoods salamander, gopher tortoise, eastern indigo snake, striped newt, gopher frog, Bachman’s sparrow, Henslow’s sparrow, brown-headed nuthatch, fox squirrel, eastern diamondback rattlesnake, southern hognose snake, Florida pine snake, red-headed woodpecker, northern bobwhite, Chuck-will’s-widow, longleaf pine communities, wiregrass gentian, Godfrey’s blazing star, zigzag silkgrass, St. Marks yellow-eyed grass, scare-weed, night-flowering wild petunia, Chapman’s sedge, wiregrass, and slash pine flatwoods.

*Adaptive Management Monitoring Elements*

Primary Habitat Response Variables	Probable Methods
<ul style="list-style-type: none"> <li>▪ Herbaceous groundcover composition</li> <li>▪ Rare plant population trends</li> </ul>	<ul style="list-style-type: none"> <li>▪ Ocular % cover class estimation with aid of 10% cover circle</li> <li>▪ Rare plant surveys</li> </ul>
Primary Wildlife Response Variables	Probable Methods
<ul style="list-style-type: none"> <li>▪ Population trends of Bachman’s and Henslow’s sparrows, red-headed woodpeckers, and bobwhites</li> <li>▪ Density of gopher tortoise burrows</li> </ul>	<ul style="list-style-type: none"> <li>▪ Conduct annual breeding and wintering bird surveys.</li> <li>▪ Survey established gopher tortoise transects according to established protocol once every 5 years.</li> </ul>

**Pine Forest Objective 3:** Assess habitat management needs for and monitor fox squirrels, migratory birds, and bats in sandhills to evaluate the impacts of management on biodiversity. Adapt management as necessary to maintain the natural biodiversity. Under current funding and staffing levels, the refuge can expect to only slowly begin to assess and monitor these species and biodiversity in the sandhills over the next 15 years.

**Rationale:** Turkey, sand post, bluejack, southern red, and sand-live oaks are natural components of the sandhill community and provide important habitat features for several species of wildlife, including the fox squirrel and red-headed woodpecker ([Abrahamson et al.](#)

1990), [Rebertus 1989](#), [Frost 1993](#), [Guerin 1993](#), [Greenberg and Simons 1999](#), [Hiers et al. 2007](#)). Optimal habitat for fox squirrels often contains both pines and oaks, such as along longleaf pine savannas and live oak forests ecotones ([Kantola and Humphrey 1990](#), [Conner and Godbois 2003](#), [Perkins and Conner 2004](#), [Perkins et al. 2008](#)), particularly where there are large, mature trees and fires occur at intermediate frequency. Fox squirrels contribute to the dispersal of spores of hypogeous mycorrhizal fungi which aid longleaf pine in nutrient absorption. Forest prescriptions since 1980 have indicated that the increase in prescribed fires, coupled with an increase in fires during the growing season, has dramatically reduced overstory and midstory sandhill oaks by up to 50 percent or more in 12 years. Further sandhill oak reductions are identified in this HMP to reach targeted desired future conditions. A proper balance of longleaf pine and sandhill oaks will likely provide the best diversity of wildlife associated with the habitat.

**Resources of Concern:** Fox squirrels, migratory birds, bats

*Adaptive Management Monitoring Elements*

Primary Habitat Response Variables	Probable Methods
<ul style="list-style-type: none"> <li>▪ Oak and pine composition</li> <li>▪ Forest structure</li> </ul>	<ul style="list-style-type: none"> <li>▪ Conduct a forest inventory. Through sampling, use proven techniques to obtain measurements of vegetation along the forest stratum that include the Habitat Response Variables.</li> </ul>
Primary Wildlife Response Variables	Probable Methods
<ul style="list-style-type: none"> <li>▪ Population trends of fox squirrel</li> <li>▪ Population trends of migratory song birds</li> <li>▪ Bat species composition</li> </ul>	<ul style="list-style-type: none"> <li>▪ Fox squirrel survey</li> <li>▪ Modified point counts</li> <li>▪ Cavity nest surveys</li> <li>▪ Anabat survey</li> </ul>

**Pine Forest Objective 4:** Continue to survey for striped newt (*Notophthalmus perstriatus*) and gopher frog (*Rana capito*) distributions and work with U.S. Geological Survey (USGS) to evaluate the reintroduction of these two species. Maintain required appropriate habitat to support the reintroduction. Under current funding and staffing levels, the refuge can expect to maintain 30-50 percent of the appropriate habitat for the reintroduction of these species over the next 15 years. Surveys will likely only be conducted by partners such as USGS.

**Rationale:** Recent surveys by USGS have failed to discover any populations of striped newts or gopher frogs on the refuge even though they were documented on the refuge in the 1970s ([Dodd et al. 2007](#)). The habitat appears suitable and prescribed fires have improved habitat ([Roznik and Johnson 2009](#)) by reducing midstory and canopy hardwoods and enhancing herbaceous groundcover in the sandhills since that time. If further investigations fail to discover the striped newt or gopher frog on the refuge (and the habitat remains suitable), then the reintroduction of these imperiled species will be evaluated and conducted, if it is determined to be in the best interest of the species. The removal of fish may be required from potential breeding ponds.

Gopher frogs and striped newts are predominantly found in longleaf pine–turkey oak sandhill habitat in association with ephemeral breeding ponds that do not support predatory fish species ([Palis 1995](#), [FNAI 2010a](#), [Johnson 2002](#), [Johnson 2004](#), [Roznik and Johnson 2009](#), [Humphries and Sission 2012](#)), but are also known to utilize other xeric habitats and pine flatwoods ([Godley 1992](#)). Gopher frogs often use gopher tortoise burrows for shelter ([Jackson and Milstrey 1989](#), [Blihovde 2000](#)). In addition to the habitat needs of juveniles and adults, breeding ponds free of fish are required as bluegill (*Lepomis macrochirus*) and mosquitofish (*Gambusia affinis*) have been implicated in the lack of continued breeding ([Jensen 1995](#), [USFWS 2011](#)).

**Resources of Concern:** Gopher frog and striped newt

*Adaptive Management Monitoring Elements*

Primary Habitat Response Variables	Probable Methods
<ul style="list-style-type: none"> <li>▪ Forest overstory structure and composition</li> <li>▪ Forest mid- and understory structure and height</li> <li>▪ Herbaceous component of understory</li> </ul>	<ul style="list-style-type: none"> <li>▪ Conduct a forest inventory. Through sampling, use proven techniques to obtain measurements of vegetation along the forest stratum that include the Habitat Response Variables.</li> </ul>
Primary Wildlife Response Variables	Probable Methods
<ul style="list-style-type: none"> <li>▪ Presence or absence of gopher frog and striped newt</li> <li>▪ Absence of fish in potential breeding ponds</li> </ul>	<ul style="list-style-type: none"> <li>▪ Continue searches for presence of the species.</li> <li>▪ Pond sampling</li> </ul>

**Pine Forest Objective 5:** By 2015, determine habitat restoration needs for flatwoods salamanders.

**Rationale:** The desired future habitat conditions for flatwoods salamanders can generally be described as open slash or longleaf pine with a herbaceous understory interspersed with seasonal, graminoid-dominated wetlands. For breeding sites, data suggests that managing ephemeral wetlands in pine flatwoods for herbaceous cover and an open canopy may improve conditions for breeding flatwoods salamanders ([Means et al. 1996](#), [Printiss 2001](#), [FWC 2001](#), [Gorman et al. 2009](#)). Although specific habitat parameters for breeding ponds have not been established, the following characteristics typified wetlands occupied by flatwoods salamander larvae at Eglin Air Force Base, Florida: canopy cover (43 percent), basal area (25 square-feet-per-acre (ft<sup>2</sup>/ac), herbaceous cover (68 percent), and woody debris (21 percent) ([Gorman et al. 2009](#)). Specific terrestrial habitat parameters have not been adequately quantified. The following vegetation characteristics describe upland pine savannah groundcover conditions where adult flatwoods salamanders were found ([Palis and Aresco 2007](#)): graminoid cover (84 percent), fern/forbs cover (15 percent), woody plant cover (18 percent), and organic debris cover (21 percent).

Special management attention will need to be given to ephemeral ponds, potential breeding sites for flatwoods salamanders. Regular prescription burns in these habitats will encourage the growth of preferred graminoid vegetation ([Palis 1997](#), [Sekerak et al. 1996](#), [Bishop and](#)

[Haas 2005](#)). Although the indirect effects of fire on flatwoods salamanders are generally considered beneficial, direct effects are not well known. Fire mortality is possible, as it is for many amphibians ([Pilliod et al. 2003](#), [Humphries and Sission 2012](#)). However, flatwoods salamanders likely would not be harmed by fires, since they spend most of their time in below-ground retreats away from the high temperatures of fire. They are typically above-ground for very short periods of time, generally when it is dark and raining, during the fall months. Additionally, flatwoods salamanders typically move to and from ponds when conditions are wet and flatwoods typically would not burn ([Ripley and Printiss 2005](#)).

**Resources of Concern:** Frosted flatwood salamander

*Adaptive Management Monitoring Elements*

Primary Habitat Response Variables	Probable Methods
<ul style="list-style-type: none"> <li>▪ Forest overstory structure and composition</li> <li>▪ Mid- and understory structure and height</li> <li>▪ Herbaceous component of understory</li> </ul>	<ul style="list-style-type: none"> <li>▪ Conduct a habitat inventory of potential breeding ponds and adjoining habitat. Through sampling, use proven techniques to obtain measurements of vegetation along the forest stratum that include the Habitat Response Variables.</li> </ul>
Primary Wildlife Response Variables	Probable Methods
<ul style="list-style-type: none"> <li>▪ Presence or absence of frosted flatwood salamanders</li> </ul>	<ul style="list-style-type: none"> <li>▪ Spring surveys for presence of larvae in suspected breeding ponds</li> </ul>

**Pine Forest Objective 6:** By 2020, review the literature, survey associated wildlife, and evaluate cabbage palm flatwoods (hydric pine-cabbage palm) management techniques to improve the management of this habitat. Under current funding and staffing levels, the refuge does not expect to achieve this objective in the next 15 years.

**Rationale:** Much of the pine flatwoods in the eastern portion of the refuge occurs on wet, shallow soils over limestone bedrock. Cabbage palmetto is a major component of this unique community. The wildlife associated with this flatwoods community and the best management techniques to maintain the ecosystem is not fully understood. This objective will begin the process of examining the plant and animal assemblage of this community and develop appropriate management strategies.

**Resources of Concern:** Frosted flatwoods salamander, eastern indigo snake, Bachman’s sparrow, Henslow’s sparrow, brown-headed nuthatch, eastern diamondback rattlesnake, northern bobwhite, Chuck-will’s-widow, migratory birds, amphibians, reptiles, small mammals, wiregrass gentian, St. Marks yellow-eyed grass, night-flowering wild petunia, Chapman’s sedge, wiregrass, and slash pine flatwoods.

*Adaptive Management Monitoring Elements*

Primary Habitat Response Variables	Probable Methods
<ul style="list-style-type: none"> <li>▪ Forest overstory structure and composition</li> <li>▪ Forest mid- and understory structure and height</li> <li>▪ Herbaceous component of understory</li> <li>▪ Rare plant population trends</li> </ul>	<ul style="list-style-type: none"> <li>▪ Conduct a forest inventory. Through sampling, use proven techniques to obtain measurements of vegetation along the forest stratum that include the Habitat Response Variables.</li> <li>▪ Rare plant surveys</li> </ul>
Primary Wildlife Response Variables	Probable Methods
<ul style="list-style-type: none"> <li>▪ Determine wildlife use of habitat and response to management.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Point counts, small mammal trapping, and herp arrays</li> </ul>

*Mesic and Hydric Hammock Management Objectives*

In contrast to the pinelands of St. Marks NWR, the various hardwood habitat types generally have a closed canopy formed by a diverse array of overstory tree species that do not respond well to fire. Compared with pine forests, considerably less inventory work and research have been performed in these communities. Baseline studies of species composition, structure, and wildlife use of these habitats on the refuge are limited. [Thompson \(1980\)](#) sampled the vegetation and soil at six calcareous hydric hammock sites in the eastern St. Marks Unit in the 1970s, while [Vince et al. 1989](#) and [Simons et al. 1989](#) summarized information on hydric hammocks in Florida.

**Hardwood Forest Objective 1:** Determine high-priority migratory bird use and needs in hydric hardwood hammocks and other refuge habitats. Evaluate Swainson’s warbler, Kentucky warbler, woodcock, and wood thrush habitat use and, if necessary, develop and initiate experimental management treatments to promote or maintain their preferred habitat conditions. Under current funding and staffing levels, the refuge does not expect to achieve this objective in the next 15 years. Pine forest management and monitoring are higher priorities.

**Rationale:** Swainson’s warbler (*Limnothlypis swainsonii*) inhabits swamps and river floodplain forests during the breeding season in the Coastal Plain of southeastern United States. It generally inhabits rich, damp, deciduous floodplain and swamp forests, and requires areas with deep shade from both canopy and understory cover. [Graves \(2002\)](#) studied breeding habitat associations across four states, including Florida. He found that warblers attained their greatest abundance in floodplain forest characterized by small (<9.8 inch DBH) trees at densities of 251-332 stems/acre and understory thickets of saplings, vines, and shrubs (14,170-19,433 small woody stems/acre). Territories in mature forest typically were associated with disturbance gaps. Canopy height, basal area, and floristics appeared to be relatively unimportant factors in habitat selection, provided that understory requirements were met, which explained the warbler’s occurrence in regenerating clear-cuts, as well as in relic tracts of old growth forest. Selective thinning and clear-cutting were considered viable habitat management techniques for the Swainson’s warbler ([Graves 2002](#)). In the area near

the refuge, Swainson’s warblers have been found in association with evergreen shrub bogs on Aucilla Wildlife Management Area (M. Wilbur, pers. comm. April 2012) and Ochlockonee River State Park (J. Reinman, pers. comm. April 2012).

Kentucky warblers (*Oporornis formosus*) are typically found in humid deciduous forest ([Hamel 1992](#)), dense second growth, and swamps. They occur in stands of various ages, but are most common in medium-aged forests ([Shugart et al. 1978](#)). This species prefers forests with a slightly open canopy, dense understory, and well-developed ground cover ([Bushman and Therres 1988](#)), and is seldom found in conifers.

Unlike most other shorebirds and marsh birds, woodcock (*Scolopax minor*) are a forest-dwelling species. Woodcock are often associated with forested wetlands. Alluvial floodplains with a brushy forest understory are apparently a preferred habitat type. Swamp privet (*Forestiera acuminata*), holly (*Ilex* spp.), switch cane (*Arundinaria gigantea*), peppervine (*Ampelopsis arborea*), trumpet creeper (*Campsis radicans*), greenbriar (*Smilax* spp.), and grapes (*Vitis* spp.) have been identified as important understory species ([Owen et al. 1977](#), [Roberts 1989](#)). The composition of the tree overstory appears unimportant ([Owen et al. 1977](#)). Old fields, croplands, pasturelands, wet seeps, and damp thickets also provide important habitat for woodcock on wintering grounds. Old fields and other early-successional habitat types are often used as nocturnal habitat, and should be located within 251 yards of diurnal habitats ([Berdeen and Krementz 1998](#)). While a high density of plant stems is preferred by woodcock, open ground underneath the canopy is a necessity to provide easy access to worms and other invertebrates in the ground litter ([Roberts 1989](#), [Krementz and Jackson 1999](#)).

Wood thrushes (*Hylocichla mustelina*) are typically found in deciduous or mixed forests with a dense tree canopy and a fairly well-developed deciduous understory, especially where moist ([Bertin 1977](#), [Roth 1987](#), [Roth et al. 1996](#)). Bottomlands and other rich hardwood forests are prime habitats. This species also uses pine forests with a deciduous understory and well-wooded residential areas ([Hamel et al. 1982](#)). Thickets and early successional woodland generally do not provide suitable habitat ([Bertin 1977](#)).

**Resources of Concern:** Swainson’s warbler, Kentucky warbler, woodcock, and wood thrush.

*Adaptive Management Monitoring Elements*

Primary Habitat Response Variables	Probable Methods
<ul style="list-style-type: none"> <li>▪ Forest overstory structure and composition</li> <li>▪ Forest mid- and understory structure and height</li> <li>▪ Herbaceous component of understory</li> <li>▪ Rare plant population trends</li> </ul>	<ul style="list-style-type: none"> <li>▪ Conduct a forest inventory. Through sampling, use proven techniques to obtain measurements of vegetation along the forest stratum that include the Habitat Response Variables.</li> <li>▪ Rare plant surveys</li> </ul>
Primary Wildlife Response Variables	Probable Methods
<ul style="list-style-type: none"> <li>▪ Habitat use and response to management by migratory song birds</li> </ul>	<ul style="list-style-type: none"> <li>▪ Point counts, woodcock surveys</li> </ul>

**Hardwood Forest Objective 2:** By 2020, evaluate modifying the structure of mesic and hydric hardwood and pine-hardwood hammocks to provide better habitat for breeding birds. Under current funding and staffing levels, the refuge does not expect to achieve this objective in the next 15 years. Pine forest management and monitoring are higher priorities.

**Rationale:** Hydric hardwood and pine-hardwood hammocks occur in the lowland poorly drained areas of the refuge and are also found near streams, creeks, and rivers where they can provide watershed protection (SCS 1989). Fires are typically not an important force in maintaining this community type (Simons et al. 1989). Instead, increased diversity in these habitats is generally the result of forest gaps caused by windfall or other tree mortality. Damage from invasive exotic plants and animals is a common problem in hardwood forests (FWC 2005). Plant species that often invade these forests include Chinese tallow (*Sapium sebiferum*), coral ardisia (*Ardisia crenata*), Chinese privet (*Ligustrum sinense*), camphor tree (*Cinnamomum camphora*), Japanese climbing fern (*Lygodium japonicum*), and heavenly bamboo (*Nandina domestica*). Feral hog (*Sus scrofa*) foraging (rutting) damages soil and vegetation, may interfere with forest regeneration, and can lead to erosion problems, especially on slopes. **Resources of Concern:** Swainson’s warbler, Kentucky warbler, woodcock, wood thrush, wood stork, eastern indigo snake, swallow-tailed kite, one-toed amphiuma, Rafinesque big-eared bat, southeastern myotis, bald eagle, Florida black bear, white ibis, eastern diamondback rattlesnake, Chapman’s sedge, corkwood, cypress swamp, and hydric hammock.

*Adaptive Management Monitoring Elements*

Primary Habitat Response Variables	Probable Methods
<ul style="list-style-type: none"> <li>▪ Forest overstory structure and composition</li> <li>▪ Forest mid- and understory structure and height</li> <li>▪ Herbaceous component of understory</li> <li>▪ Rare plant population trends</li> </ul>	<ul style="list-style-type: none"> <li>▪ Conduct a forest inventory. Through sampling, use proven techniques to obtain measurements of vegetation along the forest stratum that include the Habitat Response Variables.</li> <li>▪ Rare plant surveys</li> </ul>
Primary Wildlife Response Variables	Probable Methods
<ul style="list-style-type: none"> <li>▪ Forest breeding bird species composition and abundance</li> </ul>	<ul style="list-style-type: none"> <li>▪ Point count surveys</li> </ul>

**MARSH MANAGEMENT**

**Marsh Objective 1:** Determine the effects of marsh fires on priority birds using these areas (seaside sparrow, Nelson’s sparrow, saltmarsh sparrow, black rail, and clapper rail). Under current funding and staffing levels, the refuge does not expect to achieve this objective in the next 15 years.

**Rationale:** The most extensive habitat on the refuge is salt marsh, host to a unique suite of wildlife. In many parts of the country, salt marshes are burned regularly for wildlife. In this area of Florida, the marshes are dominated by black needlerush (*Juncus roemerianus*),

which is more difficult to burn. Fires will be pushed by the wind and spread as head fires, but will frequently die out when the wind ceases and on the flanks or back of the fire. This characteristic suggests that historic fires may have been less frequent in these needlerush marshes than pine habitats. This is also supported by an early account by Harper (1914), which notes a “considerable” amount of cedar was cut along the coast between Shell Point and the Suwannee River. The eastern red-cedar (*Juniperus virginiana*) has a thin bark and is very susceptible to fire.

In an effort to mimic the presumed natural fire intervals in the needlerush salt marshes of the refuge, the previous forest management plan ([Reinman 1989](#)) established the management regime that allowed the salt marshes to burn when prescribed fires enter the marsh from adjacent pinelands, but not specifically attempt to burn extensive areas. This assumes a relatively infrequent fire return interval and that the wildlife associated with the marshes are adapted to those infrequent disturbances.

**Resources of Concern:** Seaside sparrow, Nelson’s sparrow, saltmarsh sparrow, black rail, clapper rail, whooping crane, salt marsh mink, Godfrey’s spiderlily, diamondback terrapin, Wilson’s plover, salt marsh snake, saltmarsh topminnow, and salt marsh habitat.

*Adaptive Management Monitoring Elements*

Primary Habitat Response Variables	Probable Methods
<ul style="list-style-type: none"> <li>▪ Number of years since wildland fire</li> <li>▪ Amount of marsh that burns during wildland fires</li> </ul>	<ul style="list-style-type: none"> <li>▪ GPS burn edges of the marsh over several years</li> </ul>
Primary Wildlife Response Variables	Probable Methods
<ul style="list-style-type: none"> <li>▪ Determine bird use in marshes at different intervals following prescribed burns.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Point counts, area searches</li> </ul>

**SEAGRASS MANAGEMENT**

**Seagrass Objective 1:** In partnership with Florida Department of Environmental Protection (FDEP), monitor and assess impacts from watercraft vessels in the Executive Closure Area (ECA) to determine if limitations are needed regarding access to prevent noise, disturbance to wildlife, and seagrass bed scarring by 2015. Under current funding and staffing levels, progress on this objective will depend on the resources of our partners.

**Rationale:** Open water habitats on the refuge that support seagrass beds are within the ECA. The ECA protects migratory birds from hunting. It does not allow for restrictions of state waters due to boating impacts on wildlife and on seagrasses.

Boating (including airboats) can negatively affect a variety of wildlife. It has been shown to alter distribution, reduce use of particular habitats by birds, alter feeding behavior, and cause premature departure from areas. Impacts of boating can occur even at low densities, given the ability of powerboats to cover extensive areas in a short amount of time, the noise they produce, and their speed. Wildlife responds differently to boats based on their size, speed, the amount of noise they make, and how close the crafts get to wildlife ([DeLong 2002](#)). In addition, boats can alter the behavior of dolphins (Mattson et al. 2005).

The shallow coastal zone within the ECA supports extensive seagrass beds. A vital part of the marine ecosystem due to their productivity level, seagrasses provide food, habitat, and nursery areas for numerous vertebrate and invertebrate species. Seagrasses perform other important functions such as stabilizing the sea bottom and maintaining water quality. Marine-habitat degradation in Florida has many sources (e.g., pollution, dredge, and fill), but an increasingly common cause of habitat degradation is the scarring of seagrasses. Seagrass beds can be scarred by many activities, but scars are most commonly made when a boat’s propeller tears and cuts up roots, stems, and leaves of seagrasses, producing a long, narrow furrow devoid of seagrasses. Boats operating in shallow waters are severely scarring, and sometimes completely denuding, seagrass beds throughout the state. Seagrass scarring has been monitored via aerial imagery across the state since the 1990s ([Sargent et al. 1995](#)). The most recent information from FDEP shows that although scarring is not a major concern in the Big Bend area, there is heavy propeller damage around the St. Marks River mouth (M. Charbonneau, pers. comm., January 2010).

A “four-point approach” has been implemented to help reduce scarring in Monroe County, Florida, consisting of education, channel marking, limited motoring zones, and enforcement ([Barker and Garrett 1992](#)). In preparation for a rule-change regarding propeller scarring in the Big Bend Seagrasses Aquatic Preserve, signs were posted at boat ramps and an educational program initiated in 2010. Since 2011, fines can now be imposed for scarring seagrass beds in the Preserve (T. Jones, pers. comm., May 2012).

**Resource of Concern:** Seagrasses, manatees, sea turtles, redhead ducks, waterfowl, loons

*Adaptive Management Monitoring Elements*

Primary Habitat Response Variables	Probable Methods
<ul style="list-style-type: none"> <li>▪ Distribution and species composition of seagrass beds</li> </ul>	<ul style="list-style-type: none"> <li>▪ Assist FDEP with seagrass inventorying and monitoring.</li> </ul>
Primary Wildlife Response Variables	Probable Methods
<ul style="list-style-type: none"> <li>▪ Wintering redhead population in bay</li> </ul>	<ul style="list-style-type: none"> <li>▪ Aerial survey</li> </ul>

**IMPOUNDMENT MANAGEMENT**

Although refuge impoundments were originally built for the purposes of improving conditions for migratory waterfowl, management of these areas has evolved to also include threatened and endangered species, shorebirds, wading birds, other wildlife, and public use activities where

compatible (for refuge compatibility determinations see the St. Marks NWR CCP). The following objectives were developed from those outlined in the CCP and would be applied to individual impoundment units based on their size, vegetation types, and water level control capability. For a summary of targeted impoundment water levels, water control structures, and management details, see Appendix H.

**Impoundment Objective 1:** Continue to employ active water and plant community management activities on most impoundments to create a range of freshwater to brackish environs on approximately 1,600 acres within the St. Marks Unit. Production of a mix of wetland communities, mudflats, and water depths for a variety of Apalachee Bay avian groups will be emphasized, with priority on providing habitat for shorebirds, marshbirds, waterfowl, and waders.

**Rationale:** Multi-species impoundment management allows the refuge to gain the most benefit from an area. Shorebirds, waterfowl, and wading birds have different water level requirements, and by managing different pools to provide different habitat conditions, the needs of most species can be met at various times in some impoundment(s) throughout the year. Providing a range of water levels (e.g., open water, flats, submerged aquatic vegetation, and hemi-marsh) will benefit shorebirds, wading birds, and waterfowl. Detailed records need to be kept of water levels and corresponding bird use in order to determine the efficacy of multi-species management efforts.

**Resource of Concern:** Waterfowl, shorebirds, water birds, and marsh birds.

*Adaptive Management Monitoring Elements*

Primary Habitat Response Variables	Probable Methods
<ul style="list-style-type: none"> <li>▪ Water level manipulation</li> <li>▪ Salinities</li> <li>▪ Determine vegetation composition of marsh.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Read water gauges.</li> <li>▪ Monitor salinities.</li> <li>▪ Conduct transects of marsh vegetation.</li> </ul>
Primary Wildlife Response Variables	Probable Methods
<ul style="list-style-type: none"> <li>▪ Waterfowl, shorebird, wading bird and marsh bird use of impoundments</li> </ul>	<ul style="list-style-type: none"> <li>▪ Surveys and call back point counts.</li> </ul>

**Impoundment Objective 2:** Provide sufficient habitat and sanctuary on the refuge to support migrating, wintering, and breeding waterfowl of the Atlantic and Mississippi Flyways.

**Rationale:** The refuge was established to protect habitat for wintering waterfowl. The impoundments were constructed by the Civilian Conservation Corps for the same reason. Managing a minimum of five impoundments (including Mounds 3 and Stoney Bayou 2) primarily for waterfowl, currently provides sufficient habitat for wintering waterfowl while allowing other impoundments to be managed primarily for shorebirds, wading birds, marsh birds, and other priority resources.

The maintenance of wood duck boxes in appropriate habitat promotes the nesting of this trust species.

**Resource of Concern:** Pintail and other migratory waterfowl.

*Adaptive Management Monitoring Elements*

Primary Habitat Response Variables	Probable Methods
<ul style="list-style-type: none"> <li>▪ Water level manipulations</li> </ul>	<ul style="list-style-type: none"> <li>▪ Reading water gauges</li> </ul>
Primary Wildlife Response Variables	Probable Methods
<ul style="list-style-type: none"> <li>▪ Migratory waterfowl use of impoundments</li> <li>▪ Wood duck use of boxes</li> </ul>	<ul style="list-style-type: none"> <li>▪ Surveying wintering waterfowl</li> <li>▪ Wood duck box and use surveys</li> </ul>

**Impoundment Objective 3:** Continue to provide 20 to 300 acres of the 4,625 acres of managed habitat targeted each spring and fall for nesting, foraging, and important migratory stopover habitat for shorebirds in the north Florida portion of the Southeastern Coastal Plain ([Hunter et al. 2005](#)), as well as habitat for other waterbirds and marshbirds in accordance with the Partners in Flight Bird Conservation Plan for the South Atlantic Coastal Plain ([Hunter et al. 2001](#)) and the Southeast United States Regional Waterbird Conservation Plan ([USFWS 2006](#)). Limit human disturbance.

**Rationale:** The refuge is an important migratory stopover and wintering site for shorebirds as well as an important nesting site for the Wilson’s plover. The plover has been documented nesting in salt barrens in the tidal marsh and in the impoundments (on mudflats) during droughts. Nesting season in Florida is between mid-March and the end of June ([Stevenson and Anderson 1994](#)). An impoundment regularly managed for nesting plovers however is not currently feasible due to the current hydrology of the pools. Flooding of the pool would not be realistic most years until February, and the extended drawdown would encourage the establishment of vegetation that would eventually make the impoundment unsuitable to nesting Wilson’s plovers. When droughts do occur, habitat in the impoundments will be available (particularly Mounds 3) and any nesting plovers will be considered when opportunities to flood the pool(s) are evaluated.

Migrating and wintering shorebird and wading bird habitat (low pool levels and mudflats) have been recently provided in Stoney Bayou 1 and Tower Pond impoundments. These pools will be the focus of the impoundment management for shorebirds in most years. Marsh birds (rails) require emergent vegetation that limits shorebird and waterfowl use. Mounds 2 and the south end of Stoney Bayou field have been maintained in emergent vegetation for marsh birds. Additional monitoring of the marsh birds is needed to evaluate their response to management.

**Resources of Concern:** Shorebirds, water birds, and marsh birds.

*Adaptive Management Monitoring Elements*

Primary Habitat Response Variables	Probable Methods
<ul style="list-style-type: none"> <li>▪ Water level manipulation</li> <li>▪ Determine vegetation composition of pools.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Read water gauges.</li> <li>▪ Conduct transects of marsh vegetation.</li> </ul>
Primary Wildlife Response Variables	Probable Methods
<ul style="list-style-type: none"> <li>▪ Shorebird, wading bird and marsh bird use of impoundments</li> </ul>	<ul style="list-style-type: none"> <li>▪ Surveys and call back point counts.</li> </ul>

**Impoundment Objective 4:** Install at least one additional nesting platform in Stoney Bayou 1 Pool when current platform reaches capacity use, and monitor its use by least terns.

**Rationale:** Nesting habitat for the least terns on the refuge is limited. The terns will nest on exposed pool substrate during droughts, but usually fail due to predation. They have nested on a platform in Stoney Bayou 1 most years since 1989.

**Resource of Concern:** Least tern.

*Adaptive Management Monitoring Elements*

Primary Habitat Response Variables	Probable Methods
<ul style="list-style-type: none"> <li>▪ None</li> </ul>	<ul style="list-style-type: none"> <li>▪ None</li> </ul>
Primary Wildlife Response Variables	Probable Methods
<ul style="list-style-type: none"> <li>▪ Nesting attempts/breeding success</li> </ul>	<ul style="list-style-type: none"> <li>▪ Counts</li> </ul>

**Impoundment Objective 5:** Continue to work with the Service’s Panama City Fisheries Office to maintain fisheries in the refuge impoundments and major lakes. Stock only endemic strains of fish into refuge waters.

**Rationale:** The fisheries in the refuge impoundments are important resources for wood storks, other wading birds, gulls, terns, waterfowl, waterbirds, alligators, a host of other wetland wildlife, and the visiting public. Maintaining this vital resource sometimes requires stocking of fish following storm surges associated with tropical storms and hurricanes, droughts, drawdowns, and saltwater treatments.

**Resource of Concern:** Wood storks, other wading birds, least terns, other terns, gulls, waterfowl, waterbirds, alligators, fish, and other wetland wildlife.

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*Adaptive Management Monitoring Elements*

<b>Primary Habitat Response Variables</b>	<b>Probable Methods</b>
<ul style="list-style-type: none"><li>▪ None</li></ul>	<ul style="list-style-type: none"><li>▪ None</li></ul>
<b>Primary Wildlife Response Variables</b>	<b>Probable Methods</b>
<ul style="list-style-type: none"><li>▪ Wading bird foraging use</li></ul>	<ul style="list-style-type: none"><li>▪ Conduct surveys.</li></ul>

**OTHER WETLAND MANAGEMENT**

Johnson Creek, a small tidal wetland, was actively managed for waterfowl from 1971 through 1983. There was little noted waterfowl use and management was abandoned when the riser rusted. Storm surges from the series of tropical storms and hurricanes in 2004 removed the remaining pipe and section of road at the end of the tidal creek. In February 2005, the road was repaired and a larger aluminum pipe and riser were installed. This restored the management capability of the 30-area and provides an opportunity to manage habitat for shorebirds and wading birds.

**Other Wetland Management Objective 1:** Evaluate the impounding of the Johnson Creek area to benefit shorebirds.

**Rationale:** The refuge provides important stopover and wintering habitat for shorebirds. The restored management capability of the Johnson Creek wetland may provide an opportunity to create additional habitat for these priority birds. The GIS mapping of the basin is needed to determine the water level that can be impounded and the impacts of impounding saltwater on adjacent habitats. Surveys are also needed to determine current wildlife use of the basin.

**Resource of Concern:** Migratory shorebirds

*Adaptive Management Monitoring Elements*

<b>Primary Habitat Response Variables</b>	<b>Probable Methods</b>
<ul style="list-style-type: none"><li>▪ Water level</li></ul>	<ul style="list-style-type: none"><li>▪ Install gauge and record gauge readings.</li></ul>
<b>Primary Wildlife Response Variables</b>	<b>Probable Methods</b>
<ul style="list-style-type: none"><li>▪ Shorebird use</li></ul>	<ul style="list-style-type: none"><li>▪ Conduct surveys</li></ul>

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## INVASIVE PLANT CONTROL

***Invasive Plant Objective 1:*** Eradicate or control terrestrial non-indigenous and invasive plants. Eradicate all known populations of Florida Exotic Pest Plant Council-listed plants and find new infestations before they cover more than 0.1-acre per species. Cogon grass, Chinese tallow, and Japanese climbing fern may not be possible to eradicate given current treatment options. Reduce these three species at or below 10 percent of present extent and density levels by 2023.

***Rationale:*** Cooperative weed management is likely to be the most cost effective way in which to control or eradicate invasive plants. State, federal, and private land managers have worked together to combat invasive plants for years, but often the scale of the cooperative effort is confined by political or land ownership boundaries. Invasive plants know no boundaries, and even the diligent, intensive control efforts of land managers will not be successful in the long run if invasive plants can find refuge on a neighboring property. Despite major inputs of time and resources in controlling invasive plants, these species continue to spread.

Prevention is key, and the risk of new infestations needs to be minimized. Once a population of exotic plants becomes established, it requires considerably more resources to control or eliminate. Therefore, frequent inspections are important to discover individual plants or small colonies before they establish themselves over larger areas. Maintaining a current list of problematic species will help in this effort.

Without comprehensive knowledge of the current distribution of exotic plants on the refuge and an estimate of the area affected, it will be difficult to determine the efficacy of any control programs. A GIS-based exotic plant management assessment will assist managers to prioritize areas that need to be managed, based on their importance in terms of listed species, relative importance of the habitat affected, and other parameters. It will aid in control coordination efforts by identifying nearby roads, waterways, and vulnerable habitats/species prior to control operations. Obtaining exotic plant distribution data available for areas adjacent to the refuge will also be informative. Knowledge of these potential sources will help focus survey efforts in areas that may be likely to be colonized in the future. A GIS database would need to be updated on an annual basis or whenever new populations are discovered or established ones are eliminated.

It is important to educate the public and neighboring landowners regarding exotic plants (and nonnative species in general) as it can help change behaviors that can inadvertently spread these species. For instance, many problematic exotic plants are landscape varieties that spread to areas beyond private lands. Informing the public about the threats posed by some landscape plants to natural areas could help reduce the use of the more invasive species for ornamental purposes.

Public awareness is the key to both the early detection of exotic invaders and the success of programs aimed at controlling their spread. Invasive species will likely always be an unwanted part of the landscape for years to come, but increased awareness and understanding by the public may constitute the best chance of managing this complex problem.

***Resource of Concern:*** Native ecosystems

*Adaptive Management Monitoring Elements*

<b>Primary Habitat Response Variables</b>	<b>Probable Methods</b>
<ul style="list-style-type: none"> <li>▪ Extent of infestations</li> </ul>	<ul style="list-style-type: none"> <li>▪ Annual invasive plant survey</li> </ul>
<b>Primary Wildlife Response Variables</b>	<b>Probable Methods</b>
<ul style="list-style-type: none"> <li>▪ None</li> </ul>	<ul style="list-style-type: none"> <li>▪ None</li> </ul>

***Invasive Plant Objective 2:*** Eradicate or control aquatic non-indigenous and invasive plants. Active annual integrated pest management of cattails with water level manipulations, salinity manipulations, prescribed burning, and ground and aerial application of aquatic approved herbicides will be continued after ensuring the habitat needs of important secretive marshbirds and other species using emergent vegetation are being met.

***Rationale:*** Except for the St. Marks and Wakulla Rivers, aquatic invasive exotic plants have not been a major problem in refuge waters. Some torpedo grass, alligator weed, and parrot feather occur in refuge wetlands. Monitoring is needed to respond quickly to infestations before their populations build and control is difficult.

While cattails are native plants found in a variety of natural communities, they can behave like aggressive introduced weeds. Cattails have wide ecological amplitude compared to species with greater niche specificity and are able to grow under a variety of conditions. With disruptions, shallow wetlands, ponds, and slow-moving streams may become vulnerable to cattail growths that can eliminate open water, habitat diversity, and other plant species. When cattails develop into monotypic stands, they can significantly decrease the abundance of submerged aquatic vegetation, invertebrates, and fishes, which subsequently reduces the value of the habitat to many wetland wildlife species. Waterfowl and other bird species prefer wetlands with an interspersed cover and open water approximating a 50:50 ratio ([Weller 1975](#), [Kantrud 1986](#), [Linz et al. 1997](#)).

***Resources of Concern:*** Native ecosystems

*Adaptive Management Monitoring Elements*

<b>Primary Habitat Response Variables</b>	<b>Probable Methods</b>
<ul style="list-style-type: none"> <li>▪ Presence and distribution of non-indigenous and invasive aquatic plants</li> </ul>	<ul style="list-style-type: none"> <li>▪ Survey impoundments for presence and extent of non-indigenous and invasive aquatic plants.</li> </ul>
<b>Primary Wildlife Response Variables</b>	<b>Probable Methods</b>
<ul style="list-style-type: none"> <li>▪ Waterfowl, wading bird, shorebird, and marsh bird use</li> </ul>	<ul style="list-style-type: none"> <li>▪ Surveys and call back point counts.</li> </ul>

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## INVASIVE ANIMAL CONTROL

**Invasive Animal Objective 1:** Eradicate or control terrestrial exotic and invasive animals. Feral hogs are known to be having major negative effects on refuge resources, including at least one federally threatened species, the frosted flatwoods salamander. Limit habitat disturbance by hogs to only isolated and incidental rooting in known or likely frosted flatwoods salamander habitat on the St. Marks Unit.

**Rationale:** Feral hogs can have major impacts to reptile and amphibian populations by altering habitat through their rooting and actual consumption of the animals or their eggs. They also negatively impact habitat for migratory birds and can destroy rare and imperiled plants, while creating conditions for the spread of invasive exotic plants.

**Resources of Concern:** Native ecosystems, frosted flatwoods salamanders and other reptiles and amphibians, migratory birds, and rare plants.

### *Adaptive Management Monitoring Elements*

Primary Habitat Response Variables	Probable Methods
<ul style="list-style-type: none"><li>Area of hog rooting</li></ul>	<ul style="list-style-type: none"><li>Conduct transects of groundcover.</li></ul>
Primary Wildlife Response Variables	Probable Methods
<ul style="list-style-type: none"><li>Hog population</li></ul>	<ul style="list-style-type: none"><li>Camera surveys</li></ul>

## HYDROLOGY AND WATER QUALITY MANAGEMENT

In the 2006 CCP, hydrological changes and their impacts on refuge resources were listed among the overarching issues that needed to be addressed. The following objectives and strategies for protecting and improving the refuge's water resources were developed in the CCP.

**Hydrology and Water Quality Management Objective 1:** Over the next 15 years, protect natural wetlands and aquatic habitats and restore natural hydroperiods for the benefit of native wildlife and fish, with an emphasis on trust species.

**Rationale:** Historically, the flat topography and low, wet nature of the eastern half of the refuge and adjoining lands to the north provided a slow steady release of water into the refuge and the Apalachee Bay. In the 1930s and early 1940s, the Civilian Conservation Corps constructed dikes (levees) and developed impoundments for the benefit of wintering waterfowl. In addition, regular flows from the private lands north of the refuge have changed considerably, due to the construction of roads and ditches. Recent flows of water from north of the refuge into the impoundments have been much less consistent than those experienced historically, with heavy flows following major rain events and virtually no flow during dry periods. The altered hydroperiods have greatly decreased the refuge's capability to manage the impoundments for migratory birds (particularly waterfowl and shorebirds), wetland wildlife, and fish, by limiting the ability to reliably re-flood the impoundments

throughout the year. A hydrological study of the refuge should reveal where restoration efforts can best be implemented. Frosted flatwoods salamander habitat needs will be considered before implementing the recommendations.

Flatwoods salamanders generally breed in ephemeral wetlands ([Anderson and Williamson 1976](#), [Palis 1997](#), [FWC 2001](#), [USFWS 2009b](#)) which typically dry in summer and refill in fall and winter ([Palis 1997](#), [Bevelhimer et al. 2008](#)). One of the factors contributing to the decline of this species is altered hydrological regimes. Care during management activities and selected restoration projects could provide long-term benefits. Habitat management techniques related to these efforts are further detailed in Section 5.9.4.

**Resources of Concern:** Refuge water resources and isolated wetlands, wetland function, frosted flatwoods salamanders, waterfowl, shorebirds, wading birds, marsh birds, wetland wildlife, and fish.

*Adaptive Management Monitoring Elements*

Primary Habitat Response Variables	Probable Methods
<ul style="list-style-type: none"> <li>▪ Water flow on the refuge</li> <li>▪ Hydroperiod</li> </ul>	<ul style="list-style-type: none"> <li>▪ Contract hydrological study on St. Marks NWR.</li> <li>▪ Water gauge readings</li> </ul>
Primary Wildlife Response Variables	Probable Methods
<ul style="list-style-type: none"> <li>▪ Presence of larval flatwood salamanders</li> </ul>	<ul style="list-style-type: none"> <li>▪ Dip net surveys during larval season</li> </ul>

**HABITAT MANAGEMENT IN WILDERNESS**

**Wilderness Objective 1:** Continue to conduct habitat management (e.g., prescribed fire and invasive species control) in Wilderness in accordance with applicable laws, policy, and guidance for these specially designated areas.

**Rationale:** The St. Marks Wilderness protects salt marsh, hydric hardwood hammocks, swamps, pine flatwoods, and other habitats found on the refuge. Management is required to maintain these natural communities. Pine forests need prescribed fires and all habitats need to be surveyed and treated to keep invasive plants from gaining a significant foothold in the wilderness and eventually altering the natural habitat. Feral hogs can be quite destructive to natural plant and animal communities and will continue to be controlled to the extent feasible.

**Resources of Concern:** Frosted flatwoods salamander, eastern indigo snake, Bachman’s sparrow, Henslow’s sparrow, brown-headed nuthatch, eastern diamondback rattlesnake, northern bobwhite, Chuck-will’s-widow, migratory birds, amphibians, reptiles, small mammals, Godfrey’s spiderlily, night-flowering wild petunia, Chapman’s sedge, wiregrass, slash pine flatwoods, hydric hammocks, swamps, and longleaf pine flatwoods.

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*Adaptive Management Monitoring Elements*

<b>Primary Habitat Response Variables</b>	<b>Probable Methods</b>
<ul style="list-style-type: none"><li>▪ Forest overstory structure and composition</li><li>▪ Forest mid- and understory structure and height</li><li>▪ Herbaceous component of understory</li><li>▪ Rare plant population trends</li><li>▪ Extent of infestations</li></ul>	<ul style="list-style-type: none"><li>▪ Conduct a forest inventory. Through sampling, use proven techniques to obtain measurements of vegetation along the forest stratum that include the habitat response variables.</li><li>▪ Rare plant surveys</li><li>▪ Annual invasive plant survey</li></ul>
<b>Primary Wildlife Response Variables</b>	<b>Probable Methods</b>
<ul style="list-style-type: none"><li>▪ Hog population</li></ul>	<ul style="list-style-type: none"><li>▪ Camera surveys</li></ul>

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## V. Habitat Management Strategies

Service policy related to habitat management strategies include management activities on national wildlife refuges throughout the United States and are conducted “in a manner that best meets the overall objectives of (that) particular refuge (6 RM 3.2),” with a stated primary goal of developing, managing, and perpetuating the diversity of indigenous wildlife populations needed to meet individual refuge objectives.

The refuge manual further provides specific objectives for marsh and forest management activities on refuges, which are as follows:

- Provide habitat and protection for those species of plants and animals indigenous to the refuge which are officially listed by the Service or states as being threatened or endangered;
- Provide habitat for waterfowl and other wildlife species; and
- Provide compatible opportunities for wildlife-dependent recreation and environmental education and interpretation activities.

Additionally, it is our intention to address or eliminate the threats to the identified resources of concern as outlined in sections 2.86 and 2.87. Each strategy is designed to achieve one or more of the habitat management objectives described in this HMP.

The proposed management techniques will restore long-term wildlife habitat conditions similar to historic conditions that benefit native plant and animal communities. Attempting to recreate native communities is not necessarily the primary goal or objective of the refuge; it is to maintain and enhance habitat conditions in order to meet desired wildlife values. Commercial harvesting is an important tool available to the Service for accomplishing forest habitat management, because it reduces the funds and manpower needed to attain wildlife management objectives. Whenever commercial harvesting is an effective means of achieving refuge objectives, and timber volumes are sufficient to make a commercial operation feasible, it will be the method used. When commercial operations are not feasible, forest habitat improvement activities may be conducted by refuge personnel, contractors, approved volunteers, or educational institutions under cooperative agreements.

Potential strategies for habitat management on St. Marks NWR must be assessed within the parameters of the CCP goals and objectives as described in the previous section. Potential management efforts to achieve habitat goals include prescribed burning, mowing, herbicide application, mulching treatments, timber harvesting, water level management, and salinity management. In selecting the most appropriate management regimes, the potential treatment options will be evaluated based on the geophysical and ecological characteristics of individual sites and specific habitat objectives.

The “desired future conditions” for most of the major forested habitats are described in Appendix G. These descriptions provide quantitative and qualitative guidelines for management. Data will be collected during forest inventories and compared to the guidelines to help prescribe treatments. The treatments will be based on the evaluation of the habitat, observed wildlife use, management constraints, and diversity of the entire compartment and may not strictly adhere to the guidelines, although most stands are expected to be managed within the ranges targeted.

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The management strategies outlined below are designed to be applied to accomplish the habitat management objectives described in this HMP. This HMP identifies objectives for the 15-year planning cycle. The strategies listed will be proportionately accomplished as refuge staffing levels increase, decrease, or remain constant.

To facilitate management, logically defined subdivisions of a managed property must be set forth and prioritized (Davis 1966). St. Marks NWR has been divided into three sub-units, which are further divided into compartments for forest management, burn blocks for prescribed fire, and impoundments and greentree reservoirs for water management (Figures 5, 6, and 7).

All strategies prescribed in this HMP will be applied to forest compartments through forest prescriptions. A proposed forest management compartment treatment schedule is located in Appendix B. Due to the limited forest management activities since the mid-1990s, this schedule is tentative and stands or entire compartments may be moved forward and incorporated into an earlier forest prescription to address needed management. Similarly compartments with less pressing needs may be moved later in the schedule. Regardless, all habitat management activities other than prescribed burning will be prescribed in annual forest prescriptions or annual habitat management plans and carried out as staffing and funding allows.

Under current funding and staffing levels the management of most refuge habitats will continue to be limited and less than required to achieve the objectives of this HMP and the CCP. Priorities of management will continue to be the impoundments, pine habitats (particularly prescribed fire), and invasive species control, respectively. Any additional resources will be focused first on restoring the full management of our pine habitats. Once that is accomplished, the management of cabbage palm flatwoods and hardwood hammocks can be pursued.

## **FOREST MANAGEMENT STRATEGIES**

### *Strategies supporting Pine Forest Management Objectives*

*Strategy 5.1.1.1:* Continue to use commercial harvest to conduct thinning as identified in forest or habitat management prescriptions, while maintaining strict oversight to minimize rutting or other habitat damage from logging, roadwork, fire line plowing, and other uses of heavy equipment. Thinning operations will also be managed to limit possible disturbance to important wildlife habitat. Regulations to avoid take of flatwoods salamanders will be followed ([in accordance with 6700 Federal Register/Vol.74, No.26](#)) during timber harvests within the 1,476-foot radius buffer zone surrounding salamander breeding ponds.

*Strategy 5.1.1.2:* Continue the development of a Land Management Research and Demonstration Area on the refuge, focusing on restoration and management of longleaf pine ecosystems and expanding related research and educational programs.

In its 1999 “Fulfilling the Promise, Visions for Wildlife, Habitat, People, and Leadership,” the Service proposed the development of Land Management Research and Demonstration (LMRD) areas to facilitate development, testing, teaching, publishing, and demonstration of state-of-the-art management techniques that support the critical habitat management information needs for fish, wildlife, and plant conservation within the Refuge System and other lands ([USFWS 1999](#)). Nationwide, fourteen sites have been designated, including areas that would represent longleaf pine habitat management (St. Marks and Carolina Sandhills NWRs). In October 2009, the refuge began implementation of this program, by dedicating a portion of a position to this effort. The refuge will work to acquire funding to continue to implement this strategy.

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The full development of LMRD areas would benefit the refuge in meeting its restoration objectives and promote the application of adaptive management. Longleaf pine management techniques would be refined, contribute to the body of knowledge regarding longleaf forest ecology, and used to promote the restoration and management of longleaf pine communities on other public and private lands.

*Strategy 5.1.1.3:* Continue to restore slash or loblolly pine plantations to longleaf (or other historic) pine. Initiate restorations using the most environmentally sound method necessary to effectively accomplish the restoration. Techniques will favor the least invasive and minimal disturbance alternatives and may include burning, using herbicides ([Osiecka and Minogue 2010](#), [Tatum 2004](#)), disking, or employing other methods ([Menges and Gordon 2010](#)).

*Strategy 5.1.1.4:* Conduct prescribed fires in the growing season in prescribed fire blocks within the 1,476-acre radius buffer zone around known and likely flatwoods salamander breeding ponds. Maintain frequent fire regimes (2- to 3-year intervals) in these sites, whether in growing or dormant season (or both). If growing season fires cannot be conducted in the required frequency due to drought or other factors, then dormant season fires will be used.

*Strategy 5.1.1.5:* Continue to use prescribed fire to maintain understories less than 4 feet in height and use growing season fires to increase diversity by reducing woody plant cover and increasing herbaceous plant cover and richness in pine habitats (except scrubby flatwoods).

*Strategy 5.1.1.6:* Since research indicates that red-cockaded woodpecker populations are more productive where growing season prescribed fires are conducted in their foraging habitat, shift prescribed fires in foraging habitat to the growing season as much as feasible. Also, increase fire frequency to 2-year intervals in sandhill red-cockaded woodpecker-occupied recruitment clusters and surrounding foraging habitat to reduce midstory oaks to targeted levels (per [Red-cockaded Woodpecker Recovery Plan](#)).

*Strategy 5.1.1.7:* Protect gopher tortoise burrows during refuge operations including logging, non-emergency fire line plowing, or other heavy equipment use in sandhills.

*Strategy 5.1.1.8:* Continue to manage the old agricultural fields (e.g., Panacea, Abe Trull, Wakulla, Mounds, and Stoney Bayou). Continue the understory restoration in Panacea Field and reforest to longleaf pine. Defer restoration of the other fields and continue to burn all fields.

*Strategy 5.1.1.9:* Continue the restoration of Panacea Field, using the most scientifically sound method necessary to effectively accomplish the restoration. Techniques will favor the least invasive and minimal disturbance alternatives and may include burning, using herbicides, disking, mowing, or employing other methods.

*Strategy 5.1.1.10:* Review literature and consult with experts on the ecology of the hydric pine-cabbage palmetto community and options for its management. Evaluate wildlife use of hydric pine-cabbage palmetto through literature review and surveys.

*Strategy 5.1.1.11:* Based on literature reviews, consultations, and surveys, initiate a series of studies of potential management techniques for the pine-cabbage palm community (e.g., prescribed fire or tree removal) as deemed necessary to evaluate potential management techniques. Monitor wildlife impacts of these techniques on key species.

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## PINE FOREST MANAGEMENT GUIDELINES

### *Commercial Harvest*

Commercial harvest, as well as non-commercial thinning activities, may be used in pine habitats to open the crown canopy for understory enhancement and to create multi-age forests with emphasis on old-growth characteristics. These habitats include: sandhill; scrubby, mesic, wet and cabbage palmetto flatwoods; and those mesic pine-hardwood hammocks that are identified in the forest management prescriptions to be managed as mesic flatwoods. Descriptions of old-growth longleaf pine forests by Schwarz ([1907](#)), Wahlenberg ([1946](#)), Engstrom ([1980](#)), Clewell ([1986](#)), Greenberg and Simons ([1999](#)), Kush and Meldahl ([2000](#)), and Frost ([2005](#)) provide information on tree density, size and age distributions, canopy cover, and basal areas. In general, the forests were highly variable, ranging from 30 to 167 trees per acre of varying sizes and ages, mostly in the older age classes. Crown cover ranged from 30 to 80 percent, although the majority of samples fell between 50 and 60 percent. Basal areas calculated from Schwarz ([1907](#)) ranged from 67 to 147 square-feet-per-acre and were negatively correlated with the number of trees per acre and canopy closure. This indicates that those stands with a greater proportion of larger trees had a higher basal area yet lower density of trees and canopy cover than stands with a greater proportion of smaller trees. Schwarz ([1907](#)) and Platt et al. ([1988b](#)) reveal that there is a high positive correlation between size and age of longleaf pines within old-growth stands.

Considering these factors, it may be necessary to alter the parameters for commercial harvest in subsequent revisions of this plan, to allow for increased basal areas as the pine forest ages and becomes more open. Due to the current age and structure of the pine habitats on the refuge, the maintenance of basal areas between 20 and 80 square-feet-per-acre (depending on the habitat type) should provide an acceptable mix of pine densities and canopy openings.

As a general rule, commercial harvest may be prescribed when the average basal area of a particular pine stand exceeds 10 square-feet-per-acre above the upper target of the desired future condition of that pine community. These stands will generally be thinned to an average basal area about the midpoint of the target range for that community. In most cases, the stand will not be reduced to less than an average of 65 pines per acre except in wet flatwoods and shrubby flatwoods communities.

The thinnings will be conducted in such a manner as to maintain or promote patchiness within the stand rather than creating uniform spacing of the stems or crowns. The selection method of thinning will be used. The term, selection method, is used to describe a silvicultural system aimed at the development and maintenance of multi-age stands. Under this method, removal of trees either as single scattered individuals (singletree selection) or in small groups of less than one-quarter acre (group selection) will be employed to develop a heterogeneous mixture of lightly stocked to more heavily stocked pockets within a relatively open stand, to create openings, to encourage continuous reproduction, and to maintain several age classes. Pine management will generally be similar to the Stoddard-Neel approach to “ecological forestry” ([McIntyre et al. 2008](#)).

While thinning is a well-established forestry tool for competitive release ([Zeide 2006](#)), it can result in hardwood intrusion. A study by Jack et al. ([2006](#)) showed that hardwoods invaded gaps of different sizes in longleaf-wiregrass stands. The results of this study have some important implications for gap-based silvicultural approaches. First, the presence (or absence) of advance pine regeneration is an important consideration in choosing gaps to be created with

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harvests, as is the control of competing hardwoods in potential gaps. Second, gaps should be kept small and situated such that continuous fine fuels (especially pine needles) are available to carry prescribed fire. Once hardwoods are well-established in gaps, the burning conditions required to provide control are generally outside of the prescription parameters for the surrounding pine matrix. In cases where there are insufficient fuel sources, other operational treatments may be required to keep the hardwood competition under control ([Jack et al. 2006](#) [Outcalt 2008](#)). It is also important to keep in mind that gap-size will affect stand dynamics, and no more than 5-10 percent of an area should be opened up at once ([Noel et al.1998](#)).

*The following guidelines will be observed when thinning a pine stand:*

The older, larger trees will generally be favored for retention, although a mixture of size classes should be maintained or eventually developed in each stand. Management activities will strive to establish and maintain these older, larger pines so that they comprise roughly one-third of all pines over 5 inches DBH and are distributed throughout each stand. A 17-inch pine will be considered the minimum size for this old-growth component, which is estimated to reflect the size of a 125- to 150-year old longleaf pine ([Wahlenberg 1946](#)). Since data on age-size relationships are not available for refuge habitats, this minimum size will be used for all pines in all habitats. As the forest ages and these data are acquired, the size classes of the old growth component can be determined for each pine species and habitat type.

Roughly one-third of pines in the stand should eventually be maintained in the 12- to 16-inch DBH size classes (11 to 17 inches) and the remaining one-third on the 6- to 10-inch DBH size classes (5 to 11 inches); the remaining one-third will be 17" and above.

Since most pine stands on the refuge do not currently contain many trees in the larger size classes, flat-topped pines (indicating old age) and the largest pines in the stand will generally be set-a-side as the old-growth component until the large size classes develop.

All residual cat-faced pines that have survived since the days of turpentine prior to refuge acquisition and flat-topped pines will be left due to their age, mast production, and likelihood of heart rot. Other trees to receive consideration due to their wildlife value include suppressed pines under the canopy, pines with visible red heart disease "conchs," culls, and unhealthy trees of poor vigor. The approach is not to "high grade" the pine stand, but to be aware of the wildlife value of the trees that are normally considered "defective" and removed. Most pines retained are expected to be healthy and relatively vigorous.

Snags and trees with severely reduced crowns that will likely become snags within the next few years will not be cut and will not be included in the basal area or tree density calculations. To maintain between-stand diversity, small stands or pockets of stands less than 5 acres in size that occur adjacent to other pine stands will generally not be thinned unless the surrounding stand is also thinned.

The creation of gaps in the pine canopy will generally be limited to ¼-acre in size to maintain the continuity of the light fuels to promote frequent prescribed fire. Where advanced pine regeneration is present, slightly larger gaps (less than ½-acre) may be created when a few residual pines are left in the gap to provide needlecast. Advanced pine regeneration may also be released by removing a few pines on the south edge of a small natural gap to increase light to the young trees. Except for small stands (less than 5 acres) and when restoring slash and loblolly pine plantations to longleaf pine, created gaps will be limited to less than 5 percent of the stand.

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Pine plantations and shelterwoods will be thinned as soon as commercially feasible to reduce or prevent the closure of the canopy.

In general, stocking rates to be left in these regenerated sites will be 200 trees per acre in mesic flatwoods, 150 trees per acre in longleaf pine-turkey oak sandhills, and 100 trees per acre in wet flatwoods. These stocking rates may be higher if the crowns are small and additional trees are necessary to maintain fuels for prescribed fires.

In plantations, shelterwoods, and stands which are generally even-aged in character, there should be no attempt to have the remaining trees evenly distributed within the stand. In these stands where the majority of trees are in the same size class, trees to be favored will generally include the most vigorous trees with well-developed, healthy crowns and trees which contain suitable or potential cavities for nesting and denning.

Single-tree selection and group selection will be used to create openings, promote regeneration, and develop a mosaic of habitat conditions within these even-aged stands instead of producing an evenly spaced residual stand. These stands may be heavily thinned at least initially to reduce canopy closure and prepare for restoration. Row thinnings may be used to accomplish the work efficiently and create linear gaps to restore groundcover and/or overstory species.

When commercial harvest is planned in potentially occupied gopher tortoise habitat, a complete area survey of gopher tortoise burrows will be conducted no more than 90 days prior to the logging operation. Active and inactive-appearing burrows will be clearly marked and no heavy machinery will be permitted within a 25-foot buffer of each burrow.

Due to the wildlife value of snags, the salvage harvest of dead and dying trees as a result of fire, insects, disease, flooding, or wind will generally not be permitted except where the trees pose a safety risk to staff and visitors. When the loss of trees occurs over an extensive area (5 acres or more) a salvage harvest may be conducted. Any salvage harvest will leave a minimum of 15 of the largest standing dead and dying trees per acre, scattered across the site.

### *Fire*

Prescribed fire is the most important and effective management action to restore and maintain pine communities. Frequent fires are critical to the restoration and maintenance of the longleaf pine ecosystem. Many imperiled species that are a focus of this HMP rely on habitat maintained by these frequent fires, particularly those fires in the growing season. The discussions on fire seasonality and benefits can be found in the Fire Management Plan ([2009a](#)).

Prescribed burning is conducted throughout the year when prescription parameters are met. Unfortunately, weather conditions, fire funding, wildfires, and available staffing all limit the amount of prescribed burning completed in a given year and burning targets are not met in most years.

### *Regeneration*

Forest management activities in pinelands under the multi-age management program will provide for the regeneration of overstory trees throughout each stand over the long term. Thinnings will provide canopy openings and sunlight penetration to the understory, while frequent prescribed burning will generally promote low, herbaceous understories that enhance pine seedling establishment.

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Due to the fire tolerance of longleaf pine seedlings, this species should regenerate well under the normal prescribed burning regimes. Modification of fire regime may be considered on units with abundant first year seedlings. Slash pine seedlings are not as fire tolerant and, if sufficient regeneration does not occur under the normal prescribed burning regimes, then a modification of the long-term fire regime may be required to create periodic fire-free intervals for the establishment and development of slash pine reproduction.

The amount of reproduction desired is that amount of recruitment needed to perpetuate the pine stand over time. Seedling densities that will result in a “fully-stocked stand” as in a pine shelterwood system or that are designed to provide a continual timber harvest are not an objective of this HMP. However, seedling stocking will often exceed the minimum required due to the variability in pine masting and regeneration establishment and survival from year to year. In the same light, it is not necessary to ensure a certain amount of regeneration each year. Certain pine species (e.g., slash, loblolly, and pond pines) may actually be perpetuated more readily by “pulses” of large amounts of regeneration separated by a few to many years of little to none.

The emphasis of the forest management program will be the general restoration of these pineland understories through fire to a greater proportion of herbaceous species. Once these herbaceous understories are developed, the emphasis will then shift to understory maintenance and pine regeneration.

In some cases the planting of pine seedlings will be necessary to complete the conversion of certain pine plantations to their original pine species or restock formerly cutover areas. All plantings will be of that species suspected to have occupied the site historically (usually longleaf pine). When planting by hand, the seedlings should be placed in the best location for survival (groundcover gap or herbaceous groundcover instead of a shrub thicket) in the general vicinity of the appropriate spacing rather than in strict uniform spacing. Seedling stocking rates will generally be as follows: wet flatwoods (with healthy herbaceous groundcover) 100 per acre, mesic and cabbage palm flatwoods 360 per acre, and longleaf pine-turkey oak sandhills 360 per acre (10 x 12 spacing). Seedlings may also be planted in higher densities in small gaps (up to twice the stocking) as long as the total planted in the stand does not exceed the stocking rate for the habitat.

In former agricultural fields and recently acquired sites of industrial forest land where intensive site preparation and herbicides have greatly altered the groundcover, seedling stocking rates may increase up to 700 trees per acre. The strategy in these areas will be to restore the overstory first and use the shading of the trees to control the understory and groundcover. Groundcover restoration will then be initiated when the stand is opened up in the future.

If seedling survival is less than 50 percent, the site may be replanted at a stocking rate that when included with the surviving seedlings from the first planting and residual trees will not exceed the stocking rate outlined in this section.

No other plantings will be necessary unless a catastrophic loss of pines occurs in sandhills or flatwoods due to wind, fire, or insects. Planting of seedlings or other methods may be prescribed in the appropriate forest management prescription if the impacted area exceeds 10 acres in size, there are less than five longleaf pine or two other species of pine remaining per acre, and natural regeneration is unlikely. All planting or direct seeding will reestablish the same species of pine that occurred naturally on the site.

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## *Mechanical Manipulation*

Mechanical manipulation techniques may be used in pine flatwoods habitats to restore certain stands to the tree species that naturally occurred on the sites, and to thin young, unmerchantable stands to prevent significant canopy closure. These techniques include the use of machinery (e.g., tractor, logging equipment, mulching equipment, and bulldozer) or chainsaws and other hand tools to down unmerchantable trees.

When the use of heavy equipment is prescribed to treat an area to reduce undesirable trees, every effort will be made to minimize disturbance to the soil. Work in wet sites such as wet flatwoods will be conducted only during dry periods. To the extent possible, the movement of the tracked machinery will be in a forward or reverse direction or in a large circle so that the soil disturbance associated with turning is minimized.

Chainsaws or other hand tools may be used to thin dense young stands of trees or remove undesirable trees as prescribed in the forest management prescriptions.

Mechanical manipulation by tracked machinery will be limited to the restoration of mesic and wet flatwoods community understories. Techniques may also include mowing and mulching. Since soil disturbance resulting from heavy equipment has resulted in significant reductions of wiregrass and possibly other native plants in sandhill sites (Hebb 1971, Clewell 1971, Reinman 1985), bulldozers or other tracked machinery will not be used in the restoration or management of sandhill communities, except to maintain firelines or suppress wildfires.

When any mechanical manipulation (including logging) or mowing occurs in potentially occupied gopher tortoise habitat, a complete area survey of gopher tortoise burrows will be conducted no more than 90 days prior to the operation. Active and inactive-appearing burrows will be clearly marked and no heavy machinery will be permitted within a 25-foot buffer of each burrow. The exception will be gopher tortoise burrows on public road shoulders and grassy refuge roads. There no absolute buffer will be established, but all burrows will be clearly marked and care will be taken not to crush the burrow or strike the tortoise during the mowing operation.

Mowing using wheeled or hand-held machinery may be used around red-cockaded woodpecker cavity trees to reduce fuel loading and reduce the likelihood of damage to the cavity tree during prescribed burning or wildfire. Raking pine straw and other loose fuels from around cavity trees is another accepted practice, but care must be taken not to disturb the soil or uproot herbaceous plants, particularly wiregrass. Heavy machinery or vehicles are not permitted within 50 feet of red-cockaded woodpecker cavity trees unless on an established (numbered) refuge road.

To maintain appropriate habitat structure, hardwoods within 50 feet of red-cockaded woodpecker cavity trees will generally be removed by chainsaws, brushhooks, or light mechanized equipment such as brush-hogging or mulching. Mechanized equipment will not be used while the woodpeckers are nesting. Overstory hardwoods within the cluster will be reduced to 10 square-feet-per-acre in sandhill habitat and 5 square-feet-per-acre or less in flatwoods. Turkey, sand post, southern red, bluejack, and sand-live oaks are considered historic components of the sandhills and will be allowed to occur within the cluster individually and/or as natural oak inclusions. Generally, the largest and/or oldest of oaks will be retained as will those with cavities or other obvious wildlife value. These inclusions will be managed with prescribed fire and artificial cavities will not be installed near them.

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## *Herbicide Use*

Herbicide treatments of invasive and/or exotic plants will continue with approved chemicals, using the accepted methods of application. Label instructions for the safe use and disposal of the chemical will be strictly followed. On most sites, the use of herbicides for forest management objectives will be on a single tree/shrub treatment basis and as prescribed in the forest management prescription. Herbicide use within 50 feet of known rare and listed plants will be limited to single stem treatments.

The restoration of Panacea Field will be an exception due to the difficulty in eliminating Bahia grass. There herbicide treatments will continue throughout and Godfrey's blazing star and zigzag silkgrass will be seeded on the site if the plants do not reestablish naturally.

In recently acquired sites of industrial forest land where intensive site preparation and herbicides have been used, management may include broadcast herbicide application to effectively restore these areas. Care will be taken to avoid adverse impacts to any known rare plants and monitoring of those rare plants will be initiated.

To expand the use of adaptive management to further the development of forest management techniques, small-scale experimental studies of expanded herbicide treatments may be conducted with appropriate monitoring of target and non-target species (particularly rare plants). If, after monitoring, the experimental treatments are deemed acceptable, then the herbicide treatments may be approved for general use.

## *Special Considerations*

The red-cockaded woodpecker population of the refuge has been actively managed and has grown dramatically, particularly through cavity creation and translocations. Active groups are now found throughout most of the Panacea Unit. Future work will establish the woodpeckers in appropriate sites on the Wakulla and St. Marks Units as well. Additional recruitment sites (for artificial cavities) will be developed based on the habitat suitability of the cluster site, adequate spacing with other clusters or recruitment sites, adequate suitable foraging habitat, and future management constraints.

Guidelines for the management of habitat for red-cockaded woodpeckers can be found in the Red-cockaded Woodpecker Recovery Plan ([USFWS 2003b](#)), have been incorporated into this HMP, and will be used in the development of future forest prescriptions.

Striped newts and gopher frogs have been documented on the refuge in the 1970s ([USFWS 1980a](#)), but have not been found in recent years despite surveys by USGS ([Dodd et al. 2007](#)). Additional surveys will be conducted, and if the amphibians are deemed extirpated from the refuge, the reintroduction of the species will be evaluated and conducted if beneficial to the species. The ponds selected for the reintroduction sites may require habitat management and/or the removal of any fish populations.

Striped newts are typically found in longleaf-wiregrass communities that are best maintained through periodic fire. Breeding ponds must be protected from runoff and other factors that could impair water quality, and a large area of suitable upland core habitat should be protected and managed around the ponds, thus maintaining connectivity among the breeding sites. Furthermore, mechanical disturbance to native ground cover and soils must be avoided as this species spends much of its time under leaves and woody debris ([Johnson 2004, USFWS 2011b](#)).

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Management for the gopher frog would include prescribed fire, minimizing alterations in hydrology, and protecting gopher tortoise burrows from heavy equipment.

Sandhills will continue to be managed with frequent fire (particularly in the growing season) to promote herbaceous groundcover ([Davis 1985](#)) and reduce midstory and overstory oaks to benefit red-cockaded woodpeckers, gopher tortoises, and Bachman's sparrow ([James et al. 1997](#), [James et al 2001.](#), [Cox 2008](#)). However, turkey, sand post, southern red, bluejack, and sand-post oaks are natural components of the sandhills and provide important habitat features for several species of wildlife, including the fox squirrel and red-headed woodpecker ([Abrahamson et al 1990](#), [Greenberg and Simons 1999](#), [Conner and Godbois 2003](#)). Both mature pine and mixed pine-hardwood habitats are preferred by fox squirrels (Perkins and Conner 2004). Optimal fox squirrel habitat in southwest Georgia was determined to contain 12 square-feet-per-acre in hardwood basal area ([Perkins et al. 2008](#)). Fox squirrels prefer large, mature hardwood trees as refuge sites (Conner and Godbois 2003) and larger turkey oaks for nesting (Kantola and Himphrey 1990). The management of the sandhills under this HMP will be to reduce the oaks to a basal area in the range of 5 to 20 square-feet-per-acre, scattered as individuals and as clumped or clonal inclusions of oaks.

Cabbage palm flatwoods provide a unique opportunity for management. They are defined as stands containing 25 to 75 percent pine basal area and cabbage palmetto comprising over 75 percent of the non-pine basal area. While the natural succession and perpetuation of most refuge habitats are well known, the cabbage palm flatwoods is unique in that the natural regeneration and perpetuation of the association of the shade-intolerant pines and the shade-tolerant palm is not fully understood. The wildlife using this habitat and their response to management is also not fully known. When resources are available, a study of the wildlife and stand responses to experimental management techniques will be conducted and management will evolve through adaptive management techniques. Until then, management will consist of prescribed fire and thinning the pine overstory to allow for the development of large pine crowns for potential bald eagle nest sites.

### *Mixed Pine Stands*

Many mesic stands identified during forest inventories are transitions between flatwoods and hammocks. For this HMP, flatwoods stands are generally classified as those containing 75 percent or more pine basal area and less than 25 percent hardwood. Mesic hardwood hammocks are generally those stands comprised of at least 75 percent or more hardwood basal area and less than 25 percent pine. Those stands containing between 25 and 75 percent of pine and hardwood basal areas will be evaluated during the prescription process for overstory and midstory composition, understory composition, fire history, wildlife value, and the ability to prescribe burn the stand. Based on this assessment, the management of these stands will be outlined in the prescription to either manage as pine flatwoods using prescribed burning and other methods described in this section, or manage as hardwood hammocks and passively exclude fire.

In many cases, shrub bogs have developed from wet flatwoods where predominately dormant season fires have not been effective and allowed for conversion of herbaceous transition zones to wetland scrub-shrub ([Hess and Laniray 2008](#), [FNAI 2010b](#)). On newly acquired tracts that were former industrial forest lands, shrub bogs may have developed from cutover wetlands. These communities may now be important habitat for Swainson's and possibly Kentucky warblers, two priority neotropical migratory birds. Management of these shrub bog communities will continue to be by prescribed burning. It is also important to evaluate these stands for

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Swainson's and Kentucky warblers (and other priority birds such as the woodcock), as well as rare plants that may be relics from the historic habitat community. This information will be incorporated into the forest prescriptions to guide the management of particular shrub bogs.

Xeric hammocks may have also developed from ineffective prescribed burning or may be a result of natural fire shadows or irregular fuel composition ([Myers et al. 1997](#), [Greenberg and Simons 1999](#)). These communities will be evaluated during forest prescriptions and if these stands contain laurel oak (*Quercus hemisphaerica*) and/or water oak (*Q. nigra*), two weedy oaks that tend to reduce the fire regime and reduce diversity, these oaks may be eliminated by commercial harvest, herbicides (single stem treatments), girdling, or cutting. Commercial harvest or the use of herbicides and/or girdling will be the preferred methods rather than putting heavy fuels on the ground at one time. Sandhill oaks, hickories (*Carya* spp.), dogwoods (*Cornus florida*), live oaks (*Q. virginiana*), and other species will be retained for diversity and wildlife use.

### *Forest Access Roads*

The refuge currently maintains a road system that is adequate to provide the level of access needed by refuge staff, state fire suppression units, commercial timber contractors, and the general public. No additional permanent road construction is anticipated. Certain temporary roads created by timber contractors may be necessary. Any National Environmental Policy Act (NEPA) requirements would be completed before the activity is allowed. A Section 7 consultation would be conducted as may be required.

Additionally, all temporary roadwork will be in compliance with the most recent Silviculture Best Management Practices Manual produced by the Florida Forest Service. Temporary roads would be designed in such a way to avoid wetlands, archaeological and cultural sites, and other protected areas or natural resources. If a wetland may be impacted, the temporary road may be designed to cross the wetland at a right angle to minimize the area disturbed. Steps would be taken to mitigate the disturbance before, during, and after the temporary road is used. If adverse effects to wetlands are indicated or potentially substantial, such as a stream crossing, the impact to the wetland will be considered in the decision to conduct the habitat improvement activity. Under Section 107 consultation, the Regional Archaeologist will review any roadwork as well as any other non-emergency ground disturbance activity.

Once the use of a temporary road is completed, the contractor will be required to restore any damage to the soil or other habitat features. Usually this can be accomplished by simply closing the road by fencing or other barriers or signs and allowing the vegetation to recover. Old logging roads and trails that have been kept open by occasional use by the public or staff will be evaluated for closure during the development of the annual forest management prescriptions.

## **MESIC AND HYDRIC HAMMOCK STRATEGIES**

*Strategy 5.2.1:* By 2019, review the literature and consult with experts on the ecology of mesic and hydric hardwood and pine-hardwood hammock communities and options for the management of these community types.

*Strategy 5.2.2:* By 2020, evaluate management options (including fire) in hydric and mesic pine-hardwood and hardwood hammocks and, if warranted, initiate experimental overstory and/or midstory manipulation or other management on a small scale to evaluate the techniques and wildlife responses. Initial midstory and overstory manipulation (if desirable) should be by

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noncommercial tree removal (or deadening, without using heavy equipment) on up to four sites, of no more than 10 acres in size. A commercial sale to a small logging outfit without heavy equipment would also be acceptable. Adequate monitoring of species composition, structure, and bird and other wildlife responses must be in place before treatment.

The management of the pine habitats is a higher priority. Realistically, unless resources are dramatically increased, very little will be accomplished in the management of these hardwood stands over the next few years. The priorities over the next decade will be to: (1) Inventory these habitats when the rest of the compartment is inventoried to create a baseline database, and (2) establish point counts in areas exhibiting differences in habitat structure to determine bird use.

### **MARSH MANAGEMENT STRATEGIES**

Salt marsh will continue to be managed by allowing prescribed fire to enter salt and brackish marshes when conducting burns in the surrounding timber. When resources are available, a multi-year study will be conducted to determine the impacts of prescribed fires on priority birds in salt marshes.

Black needlerush areas (outside of the Wilderness) of up to 15-20 acres may be walked down with amphibious machinery to enhance foraging areas for wintering whooping cranes. Sites have been treated at the whooping crane pen and a portion of Stoney Bayou East.

Freshwater marshes will be burned as possible when prescribed fire is used in the surrounding pine habitats to maintain open herbaceous marshes to benefit frosted flatwoods salamander, wading birds, and other wetland wildlife. If a marsh on the St. Marks Unit does not burn when the surrounding pine stand(s) burn, the marsh will be burned at a later date under drier or more extreme conditions, if feasible.

### **SEAGRASS MANAGEMENT STRATEGIES**

Management programs that address scarring of seagrasses should be based on an approach that involves: (1) Education; (2) channel marking; (3) increased enforcement; and (4) limited-motoring zones. Aerial monitoring and photography of the managed area are essential in evaluating the effectiveness of a management program.

Work with the FDEP Big Bend Seagrasses Aquatic Preserve staff to educate the public, enforce seagrass scarring regulations, and reduce damage to the seagrass beds within the Executive Closure Area. Since propeller scarring is a major threat to the seagrasses and to wintering waterfowl that rely on the beds, the refuge will only maintain the current condition, but not improve, the saltwater boat ramp, channel, and tidal basin. Any improvements would tend to increase boat use especially at low tides when the seagrasses are most vulnerable to damage.

### **IMPOUNDMENT MANAGEMENT STRATEGIES**

*Strategy 5.5.1:* Unless there are higher priority needs for shorebirds and/or marshbirds, continue to manage at least five St. Marks Unit impoundments to provide important wintering and migratory stopover habitat for waterfowl, with special emphasis on black ducks, pintails, canvasbacks, and scaup.

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*Strategy 5.5.2:* Continue to manage at least two impoundments for north and south bound migratory shorebirds, while retaining high-quality habitat for waterfowl. Initiate experimental management of the Johnson Creek area for shorebirds if feasible.

*Strategy 5.5.3:* By 2016, monitor duck populations in coastal marshes and Apalachee Bay, with emphasis on black ducks and redheads. Determine hot spots of use and focus efforts to protect habitats and birds from disturbance. Limit disturbance to waterfowl in all habitats, especially in the impoundments and Executive Closure Areas. Pursue obtaining authority for jurisdiction of the water column in the Executive Closure Areas.

*Strategy 5.5.4:* By 2015, evaluate shorebird use of coastal habitats using the International Shorebird Survey protocol. Identify and implement management actions, including protecting important shorebird sites from human disturbance.

*Strategy 5.5.5:* Once wading bird rookery locations are known based on annual surveys, identify potential disturbance factors and minimize problems as much as possible.

*Strategy 5.5.6:* Evaluate marshbird use of coastal marshes and pools with particular emphasis on yellow, black, and king rails. Incorporate findings into the management of the impoundments and coastal marshes.

*Strategy 5.5.7:* Maintain at least two serviceable pumps and provide adequate resources to operate these in order to manipulate water levels and salinities in the impoundments.

*Strategy 5.5.8:* Include impoundment management in annual habitat prescriptions.

*Strategy 5.5.9:* Evaluate enhancement opportunities for wood storks, such as stocking, producing forage fish and water level manipulation.

*Strategy 5.5.10:* Investigate the possibility of using artificial nesting structures for wading birds in freshwater habitats.

*Strategy 5.5.11:* Stock impoundments with native strains of freshwater fish as needed to maintain the fishery, especially after significant droughts and saltwater introductions.

*Strategy 5.5.12:* Survey refuge waters for the Suwannee River bass.

Currently, four techniques are primarily used in the impoundment management program: water level manipulation, prescribed fire, salinity manipulation, and herbicides. Generally, a combination of these four techniques is used to maintain the targeted habitat conditions in a particular impoundment for decades. However, when the vegetation in an impoundment develops beyond what can be controlled through these four methods, a major rehabilitation may be required and mechanical methods may be used to set back succession.

### *Water Level Manipulation*

Water level manipulation is the primary technique used to manage the impoundments. Appropriate water levels are the key habitat characteristics that determine wildlife use. Water level fluctuations are used for both vegetation control and to provide targeted wildlife habitat. In general, water levels are held high in spring and summer to retard the establishment and spread of perennial nuisance plants, primarily cattail and knotgrass. The deeper water promotes the

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growth of beneficial submerged plants and enhances forage and sport fish populations. Variations in elevation within the impoundments ensure that adequate feeding habitat is available for nesting heron, egret, and other wetland species even at full pool levels. Meanwhile, partial drawdowns during fall and winter provide maximum habitat utilization by wintering waterfowl and shorebirds, wading birds, and other wetlands species.

The impoundments are drained via gravity flow (or pumping), and filled using similar methods with freshwater (or saltwater) or by retaining rainfall. The sources of water used for filling and the water level control capabilities vary among the impoundments.

The East River Watershed is the only significant freshwater input into the impoundment system. Flows from the watershed are collected in East River Pool and used to flood all of the impoundments except for Lighthouse Pool (Figure 7). This gravity flooding from East River Pool and rainfall are the principal sources of freshwater for the managed impoundment system. At times, freshwater can also be shifted from Stoney Bayou Field, the swamp north of Stoney Bayou 2, and adjoining pools by gravity flow, but the amount of freshwater is extremely limited.

In a typical year, water levels in East River Pool (and the other minor freshwater options) only reach sufficient capacity to flood the other pools in the late winter and early spring, usually February through March. April and May typically bring drought and, coupled with exponential increases in evaporation and transpiration, water levels drop dramatically, especially East River Pool. Unless a tropical storm visits during the summer, water levels are barely maintained through the summer by afternoon thunderstorms.

Flapgates are used to flood Stoney Bayou 1 and Tower Pond with saltwater to be managed as brackish water impoundments. This capability to flood these pools with saltwater eliminates the reliance on the East River and allows Stoney Bayou 1 and Tower Pond to receive full drawdowns to provide foraging and loafing habitat for shorebirds and wading birds.

Typically Stoney Bayou 1 is drawn down in October and allowed to flush with the tides through the winter. A 4- to 5-hour delay in tide stage in the pool compared to the St. Marks River entrance allows the shorebirds to move to the area location (pool or coastal mudflat) with the appropriate water depth. Stoney Bayou 1 is then flooded in February to use as a conduit to flow water from East River to the Mounds Pools, Headquarters, Pond, and Picnic Pond (through Tower Pond). A diversion canal from East River to Mound 1 can also provide this conduit to flood the other pools, but repairs are needed to the water control structure (17) before this is a realistic option.

Tower Pond is usually drawn down twice during the summer to provide shorebird and wading bird habitat while Stoney Bayou 1 is flooded. It is briefly flooded for 6-7 weeks (typically late-May to mid-July) to allow invertebrates to build up in the substrate for foraging shorebirds in mid- to late-summer. By alternating the drawdowns of the two pools, shorebird habitat can be provided while each pool receives prolonged annual brackish water flooding to retard vegetation development on the mudflats.

Pumping may also be used to flood with saltwater (and sometimes freshwater), but is rarely used due to the cost of manpower and fuel. Lighthouse Pool is isolated and completely dependent on rainfall or saltwater pumping.

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## *Prescribed Fire*

Controlled burning is a relatively inexpensive management technique generally used to:

- Control brush and maintain herbaceous high marsh vegetation;
- Remove as much vegetation as possible prior to reflooding;
- Open perennial vegetation to enhance wading bird foraging; and
- Reduce vegetation prior to mechanical treatment.

Burning is often conducted in later winter/early spring to coincide with the burning of the levees, but may be conducted any time of the year. Burning is most effective during drawdowns and prior to any pumping or mechanical manipulation.

## *Salinity Manipulation*

In addition to the regular flooding of saltwater in Stoney Bayou 1 and Tower Ponds, saltwater is occasionally used to shock a freshwater to slightly brackish water pool to set back vegetation. This is generally done after cattail or other aquatic vegetation dominates too much of the impoundment and targeted wildlife use declines.

First, the pool is drawn down to reduce the freshwater and stress the aquatic system. Then, saltwater is pumped as quickly as possible to deep flood the vegetation. The treatment is the most effective when salinities in the bay are high (23 parts per thousand or higher) – during droughts. May is usually the best month for flooding with saltwater. The recent addition of flapgates at the head of Stoney Bayou Creek should provide a quicker, more effective shock of saltwater when the targeted pool is flooded through Stoney Bayou 1 with the tides then followed with pumping. The pool should then be kept flooded with the highest salinity possible for an extended period of one to two years.

The saltwater treatment is usually very effective in setting back freshwater vegetation, but has consequences. The freshwater fishery of the impoundment is basically eliminated until the pool freshens and fish are introduced through water flows from other pools or by stocking. An algae bloom also typically follows and remains for about two years unless the pool is flushed. The bottom-line is that the pool is lost as targeted wildlife habitat for about two years. After that time, the brackish water provides excellent conditions for the development of widgeon grass (*Ruppia maritima*) and muskgrass (*Chara* spp.), excellent waterfowl foods.

## *Mechanical Vegetation Control*

Mechanical vegetation manipulation on the refuge generally consists of disking/plowing with a wide-track tractor or marsh buggy. In the impoundments, this has been used in the past to make the saltwater treatments more effective by stressing the plants and exposing their roots. With the spread of knotgrass over extensive areas of some pools, disking coupled with herbicide, may be used in the future if saltwater alone proves ineffective.

Mechanical vegetation manipulation has also been used to open up the dense vegetation in Plum Orchard Pond in 1984, 1993, and 2011. In those years the wetland was pumped down and a bulldozer used to clear muck and emergent vegetation to make the site more pleasing to visitors.

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## *Chemical Vegetation Control*

Chemical vegetation control in the impoundments is primarily to manage cattail and invasive exotics. A combination of dry springs and inadequate sources of freshwater frequently results in shallow impoundment levels which are favored by cattails, and their encroachment presents a management issue. Without annual spot treatments, cattail would soon dominate shallow water areas, making them unsuitable for waterfowl, shorebirds, and wading birds. The most effective approach has been to focus treatments on one or two priority pools and make those pools the priority each year. Over time, the effort to maintain the cattail is reduced and more pools may be added in priority order until most pools will receive at least some treatment each year.

## **OTHER WETLAND MANAGEMENT STRATEGIES**

Use LIDAR imaging to evaluate the Johnson Creek Basin and water holding capabilities. Assess potential impacts to adjacent forested habitats at different flooding scenarios and evaluate current wildlife use. If management of the Johnson Creek Basin for shorebirds is determined to be the highest priority use, then initiate deep flooding with saltwater via flapgate and hold high water levels for an extended period (1-3 years) to kill emergent vegetation and promote mud flats in future drawdowns. Develop a schedule of drawdowns and flooding to provide preferred shorebird habitat at targeted periods of the year. Since this project is designed to benefit shorebirds, it is a moderate priority. Management of the impoundments on the St. Marks Unit is a higher priority due to their size, historical use, and management capabilities.

Use LIDAR imaging to determine the Levy Ditch Greentree Reservoir Basin and water holding capabilities. Document the historical hydrology to the extent possible, linking rainfall to the flooding of the basin. Inventory the tree composition and structure. Add a water gauge to monitor water levels when flooding occurs. When flooding does occur in the fall or winter, monitor waterfowl use. Due to the unreliability of flooding during the fall and winter, this project is a low priority.

## **EXOTIC PLANT MANAGEMENT STRATEGIES**

*Strategy 5.7.1:* Maintain and use systematic surveys, casual surveys, and historical data of terrestrial infestations and treatment areas in the refuge's GIS database to prioritize ongoing treatments, annually search for new infestations, and document successful eradication where possible. All species locations will be entered into the iMapInvasives database through partnership with staff at Florida Natural Areas Inventory ([iMapInvasives 2013](#))

*Strategy 5.7.2:* Maintain a watch-list of invasive non-indigenous plants (e.g., terrestrial and aquatic) that are known or suspected to be in the refuge area and a threat to resources.

*Strategy 5.7.3:* Continue partnerships within the framework of the FWC Panhandle Invasive Plant Working Group and with the Bureau's terrestrial specialists to share relevant treatment options and to continue receiving state funds and labor for treatments at low or no cost to the refuge.

*Strategy 5.7.4:* Work with adjacent landowners through the Apalachicola Regional Stewardship Alliance and the local community at large to provide education about the importance of eradicating non-indigenous invasive plant species, procedures to eliminate sources of these plants on private property, and preventive measures to ensure that private lands near the refuge do not become sources of exotic invasive plant propagules.

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*Strategy 5.7.5:* Reseed or replant native species after eradication or control measures have been performed if necessary.

*Strategy 5.7.6:* Continue partnerships within the framework of the FWC Panhandle Invasive Plants Working Group and with the Bureau's aquatic specialists to share treatment options and receive labor and financial assistance from the state.

*Strategy 5.7.7:* Provide educational signs and enforcement where necessary to ensure that visitors to refuge aquatic areas are aware of the threats posed by the most common and invasive exotic aquatics. These include hydrilla, Eurasian water-milfoil, Brazilian elodea, and water hyacinth. Focus on areas most susceptible but not yet infested with these species, such as the impoundments and spring runs and basins.

*Strategy 5.7.8:* Follow statewide standard operating procedures for chemical treatments of non-indigenous invasives plants as published in The University of Florida IFAS Extension booklet ([Langeland et al. 2013](#)) and Florida Exotic Pest Plant Council's management guide ([Kline and Duquesnel 2013](#)).

These strategies were developed to manage existing populations of exotic plants on the refuge. More detailed management tools, such as mechanical, biological, and chemical treatments for each species, can be found in management plans developed by the The University of Florida IFAS Extension ([Langeland et al. 2013](#)) Florida Exotic Pest Plant Council ([FLEPPC 2005](#), [FLEPPC 2008](#), [Kline and Duquesnel 2013](#)), The Nature Conservancy ([Tu et al. 2001](#)), and the Forest Service Southern Research Station ([Miller 2006](#)).

Reestablishing a native plant community following exotic plant treatments is essential in restoring the ecological character of the affected area. Many nonnative species are habitat generalists and/or pioneer species that thrive in disturbed habitats. By seeding/planting native species in cleared areas, the natural vegetative community has a head start, which can help suppress the colonization by exotic plants. In addition, revegetation efforts will minimize erosion and runoff, which can negatively affect water quality.

## **EXOTIC ANIMAL MANAGEMENT STRATEGIES**

*Strategy 5.8.1:* Continue to attempt to control the feral hog population through the refuge hunt program, trapping, and shooting by refuge staff. The feral hog is destructive to native habitats and wildlife populations. A special effort will be made on the St. Marks Unit where threatened frosted flatwoods salamander breeding ponds exist.

*Strategy 5.8.2:* Treat fire ant mounds in problem areas to reduce the infestation. The red imported fire ants are generally associated with man-altered landscapes, such as levees, road shoulders, and lawns.

*Strategy 5.8.3:* Consider the implementation of experimental management treatments to control the redbay ambrosia beetle when it arrives on the refuge. The redbay ambrosia beetle carries a fatal fungal wilt disease which primarily affects redbay and several other related species in the laurel family. If it were to become established on the refuge, it would likely lead to the local extirpation of redbays and related species.

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## HYDROLOGY AND WATER QUALITY MANAGEMENT STRATEGIES

*Strategy 5.9.1:* By 2015, conduct a hydrologic study and work with adjacent landowners to address water quality and quantity, hydroperiods, and direction of flow within the East River drainage basin.

*Strategy 5.9.2:* By 2015, evaluate ditches, roads, and other hydrological alterations in flatwoods salamander breeding habitat and begin restoring hydroperiods as desirable and feasible. Assess impacts to known breeding ponds before restoration is initiated.

*Strategy 5.9.3:* By 2020, conduct a refuge-wide hydrologic study to address historic water flows and current alterations and impediments, such as roads, ditches, and fire lines.

*Strategy 5.9.4:* By 2025, initiate the restoration of natural hydroperiods and drainage altered by refuge roads and fire lines.

The following management guidelines will be adopted (and incorporated into forest management prescriptions containing flatwoods salamander habitat) to reduce potential adverse impact to frosted flatwoods salamanders:

- Avoiding soil disturbance, rutting, and compaction during harvesting during wet conditions, by using low-ground-pressure equipment, such as tracked equipment; new logging roads/trails (if needed) for timber harvest should be closed and restored following harvest;
- Minimizing skid trail impacts through the use of avoidance, prescription planning, pallets, and bridges;
- Distributing pine tops along skid trails to minimize soil compaction and ground cover disturbance;
- Locating skid trails, if they are necessary, parallel-not perpendicular, to wetland edges to reduce alterations to wetland hydrology;
- Plugging ditches and restoring firebreaks that are causing negative effects (draining the wetland, disrupting sheet flow to the wetland, connecting the wetland to other waterbodies, etc.) to the hydrology of an isolated wetland breeding site or mesic/wet flatwoods or allowing the invasion of fish that may act as predators of flatwoods salamander larvae;
- Preventing siltation of wetlands from adjacent roads. This may require silt fencing or installation of wing ditches that move road drainage away from the breeding pond;
- Placing culverts under roads that are damming up natural drainage patterns; and
- Restoring deep plowlines or beds that prevent fire from burning into wetlands.

Once the lower portion of the East River drainage is acquired, the hydrological study and restoration of that important watershed will be a priority.

## SPECIAL MANAGEMENT CONSIDERATIONS

This section identifies items requiring special consideration when habitat management activities are being planned and conducted on the refuge to protect wilderness areas, cultural resources, FSA Conservation Easements, and the Florida National Scenic Trail.

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### *Habitat Management Strategies for Wilderness Areas*

As discussed in section 2.5.6, CCP ([USFWS 2006](#)) Goal 6, Wilderness - Objective 1 (page 104) is updated and revised by reference to read: Revise the Wilderness Plan by 2020. Baseline information and guidance in the 2012 program review ([McCarter 2012](#)) will be used for this task.

The Wilderness Act requires that wilderness be “untrammeled” (i.e., free from human manipulation). Thus, managers need to carefully consider the minimum tool, structure, or equipment necessary to achieve wilderness management objectives.

Wilderness areas historically have been managed in ways that minimize intentional human intervention. However, most known invasive plant control techniques are inherently manipulative. Invasive and nonnative plants are spreading. In the absence of control, they will continue to decrease the naturalness of wilderness ecosystems. Refuge managers face new challenges and conflicts in how to manage for and preserve natural conditions ([Asher and Harmon 1995](#), [Marler 2000](#), [Randall 2000](#), [Osborn et al. 2002](#)). Osborn et al. (2002) provides an overview of all components (planning, prevention, predicting spread, control/eradication) of invasive plant management, in particular how it relates to wilderness areas. Service Manual (610 FW 1 General Overview of Wilderness Stewardship Policy) stipulates that a minimum requirement analysis will be completed to determine minimum tool usage for future control and treatment efforts of nonindigenous invasives species (plants and animals) within the St. Marks Wilderness. Agency guidelines and standards and a minimum requirement decisions guide workbook accessed through the Arthur Carhart Wilderness Center website will be used to complete these determinations ([Arthur Carhart Wilderness Center 2012](#)).

Naturally ignited wildland fire is the commonly preferred fuels management strategy in wilderness ([Miller 2003](#)). Management-ignited, prescribed fire is being considered in some cases ([Landres et al. 2000](#)). Restoring the ecological role of fire to wilderness has proven difficult, as the majority of lightning-caused ignitions in wilderness is suppressed for myriad biophysical and social reasons ([Miller and Landres 2004](#), [Parsons and Landres 1998](#)). Federal land management agencies have found it difficult to implement successful wilderness fire management programs ([Parsons and Landres 1998](#), [Parsons 2000](#)). Legal and practical constraints, as well as philosophical differences over the appropriateness of manipulative restoration in Wilderness ([Cole 2000](#)), have combined to raise significant questions about the feasibility of ever fully restoring fire as a natural ecological process in most wilderness areas. The dilemma stems from the need, in some situations, to choose between two different core values of wilderness-wildness and naturalness-where this choice of one value will likely lead to the reduction or loss of the other value ([Parsons et al. 2003](#)).

On the refuge, naturally ignited wildland fires will be permitted on Thoms Island due to its isolation and limited probability that the fires will impact areas outside of the wilderness. Other naturally ignited fires in the St. Marks Wilderness will be carefully monitored and extinguished, if there is a significant threat of the fire adversely impacting adjoining refuge and/or private lands. Since the natural fire regime of much of the wilderness has been altered by extinguishing wildfires both in the wilderness and those outside that would have naturally spread into the wilderness, prescribed fire will be used to continue to introduce this natural process to the pine communities in the wilderness. The prescribed fires will be permitted to burn from these upland communities into the salt marsh, but the salt marsh (and the islands imbedded in the marsh) will not be actively ignited by the burning crew. The northwest corner of Thoms Island will also be occasionally prescribed burned, since gopher tortoises have been documented on the site and the fires will benefit this imperiled species.

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## *Archaeological and Cultural Resources*

Archaeological and cultural resources are an irreplaceable part of our heritage. The refuge is committed to the protection of all areas of significance or potential significance. Historical and archaeological sites on the refuge include Indian settlements, Spanish limestone quarries, the St. Marks Lighthouse, and Civil War salt production sites. These properties span a period of over 10,000 years, and many of them are listed or considered eligible for listing in the National Register of Historic Places.

The Regional Archaeologist will consult with the office of the State Historic Preservation Officer any time ground disturbing activities are scheduled. This consultation will determine the kinds of management activities which may be considered to have no effect on National Register or National Register eligible sites or archaeological sites, and those which may affect such properties. This consultation is for the purpose of complying with the National Historic Preservation Act of 1966 (Public Law 89-665), as amended, and its implementing regulation, 36 CFR 800 (Protection of Historic Properties).

Known archaeological and historical sites and areas deemed likely to contain as yet unidentified sites will be identified in any habitat management prescriptions and no actions will be prescribed that may adversely impact these sites. To prevent adverse or permanent soil disturbance, through activities such as fireline plowing, roadwork, and logging by heavy equipment, no activities would be conducted within a 50-foot perimeter of each site. Furthermore, should an unexpected archaeological site be discovered while conducting management activities, ground disturbing activities within the immediate vicinity of such finds (e.g., 50 feet) will be temporarily discontinued and consultation with the State Historic Preservation Officer and Regional Archaeologist will be initiated. The refuge will monitor activities at and around identified cultural sites and take measures to prevent site looting and vandalism.

Due to the sensitive nature of the area, the limited amount of pine habitat, and its isolation, no commercial harvest will be conducted at Mounds Station (Compartment S6).

### *Florida National Scenic Trail*

Any management activities within a 150-foot corridor on either side of the Florida National Scenic Trail will be in accordance with the Florida National Scenic Trail Certification Plan for St. Marks National Wildlife Refuge and the Cooperative Agreement between the Florida Trail Association and U.S. Fish and Wildlife Service concerning the development, maintenance, and operation of a segment of the Florida Trail across portions of the refuge.

The certification plan currently requires that: skid or temporary roads parallel to the trail will not be located within 50 feet of the trail; skid trails or equipment crossings (including tree planting equipment) will be perpendicular to the trail and only in designated locations; log loading decks will be no closer than 150 feet of the trail; no blazed trees will be harvested; the treadway, blazes, and trail signs will be protected from damage and restored if damaged; and tree rows of any plantings will be parallel to the trail.

In addition, the current Cooperative Agreement dated October 23, 1986, requires the coordination of any anticipated timber harvest within 50 feet of the Florida Trail with the appropriate Florida Trail Association Section Leader. If desirable, only low intensity management actions will be conducted within 100 feet of the trail. The outside edge of any log loading deck may be generally no closer than 100 feet from the trail and skidder or truck trails

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must cross the trail only at right angles and may not run parallel within 50 feet of the trail. In addition, no logging slash may be left within 50 feet of the Florida Trail.

*Farm Service Agency (FSA) Conservation Easements*

The St. Marks CCP Goal 1, Objective 1 (p. 81) includes a strategy to protect and manage these areas. It states that by 2014 the boundaries of each FSA would be mapped and a management plan developed. Through this HMP, this strategy is updated and revised. Management plans for the FSA easements will be completed by 2021.

**MANAGEMENT STRATEGY RESOURCES AND CONSTRAINTS**

*Necessary Resources*

Implementation of refuge goals, objectives, and their recommended strategies for successful accomplishment are dependent upon fiscal resources in the form of equipment, personnel, and contracts with universities or private sector resource professionals. Table 4 shows the estimated cost for achieving the management objectives.

**Table 4. Estimated costs for achieving habitat management objectives**

<b>RONs Title</b>	<b>Objectives</b>	<b>Recurring Base</b>	<b>Total First Year Need</b>
Develop the LMRD for Longleaf Pine	Pine Forest Objectives 1-5	\$168,847	\$168,847
Manage Forested Habitat	Pine Forest Objectives 1-6; Hardwood Objectives 1&2	\$97,911	\$97,911
LL Pine Ecosystem Restoration & Management Demonstration Area	Pine Forest Objectives 1-5	\$15,000	\$136,000
Conduct science-based inventorying and monitoring to ensure BIDEH	Pine Forest Objectives 3, 4, &6; Hardwood Objectives 1 & 2; Marsh Objective 1; Other Wetland Objective 1; Hydrology & Water Quality Objective 1; Wilderness Objective 1	\$118,458	\$118,458
Restore and manage LL pine ecosystem in the LMRD	Pine Forest Objective 2	\$97,911	\$97,911
Eradicate or control non-indigenous and invasive plants and animals	Invasive Plant Objectives 1 & 2; Wilderness Objective 1	\$120,000	\$315,810
Hydrological Restoration	Hydrology & Water Quality Objective 1	-	\$155,000
Survey, document, monitor, enhance T&E plants	Pine Forest Objectives 1, 2, & 6; Hardwood Objective 2	\$75,000	\$129,000
Provide Visitor, Resource, and Facility Protection (LE)	Seagrass Objective 1; Wilderness Objective 1	\$150,000	\$150,000
Document natural and cultural refuge resources and analyze and map refuge	Pine Forest Objectives 1-6; Hardwood Objectives 1 & 2	\$97,911	\$97,911
Provide quality visitor services and education programs	Wilderness Objective 1	\$97,911	\$97,911

Under current funding and staffing levels the implementation of this HMP will be limited. Impoundment management, invasives species management, and at least limited prescribed burning will likely continue under current funding levels. Additional funding and staffing will likely be required to implement pine forest inventory and management. Hardwood management is a lower priority and will not be accomplished without significant increases in resources.

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### *Management Constraints*

Development along the refuge boundaries increases the complexity of the prescribed fire program. Adjoining structures, busy roads, and smoke management issues often reduce the opportunities to burn many areas and may effectively eliminate the feasibility of burning some small tracts altogether.

### *Regulatory Compliance*

This document is a step-down plan from the St. Marks National Wildlife Refuge Comprehensive Conservation Plan approved in 2006 ([USFWS 2006](#)). This HMP is consistent with the goals and objectives of the CCP. The Environmental Assessment for the Draft Comprehensive Conservation Plan was written under NEPA guidelines. Therefore, an Environmental Action Statement documents the NEPA compliance for this HMP.

A Section 7 Biological Evaluation Form was also completed for the CCP and covers the goals and objectives of this HMP. Proposals for specific research and habitat management projects described in this HMP that may affect endangered species or wetlands will be evaluated in consultation with the Service's Panama City Ecological Services Field Office on a case-by-case basis.

Refuge compatibility determinations were prepared and approved for the CCP in 2006. No additional management or public uses are proposed in this HMP that would require a revision of the compatibility determinations. Some habitat management activities described in this HMP and in the CCP may be categorically exempt as they are normal refuge operations.

We anticipate that federal, state, and/or local permits will be required for some of the management activities described in this HMP. The Service will obtain these permits and comply with them and any restrictions or conditions described in the permit(s).

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## Appendix A. Refuge Forest Compartments, Acreage, and Prescribed Burn Units

Forest Compartment	Size (Forested Acres)	Prescribed Burn Units
<b>S1</b>	1,117	120,121,125,126
<b>S2</b>	3,100	109,122,127,129
<b>S3</b>	1,078	128,130,131, 132,133,134,135,136
<b>S4</b>	1,867	137,138,139,142
<b>S5</b>	2,224	140, 141, 142
<b>S6</b>	527	112, 114,115,116,117,119, 124
<b>S7</b>	349	103
<b>S8</b>	737	100,101,103
<b>S9</b>	1,724	100, 102, 104, 106, 107
<b>S10</b>	1,197	103, 105, 108, 148
<b>S11</b>	483	143, 144
<b>S12</b>	1,492	150, 151, 152, 153, 154
<b>W1</b>	1,328	207,208,209
<b>W2</b>	708	205, 206, 209, 210
<b>W3</b>	1,465	211, 212
<b>W4</b>	1,491	213
<b>W5</b>	748	215
<b>W6</b>	671	214, 217
<b>W7</b>	1,418	216, 218
<b>W8</b>	859	219
<b>W9</b>	751	200, 201, 203, 204
<b>W10</b>	559	201, 203
<b>P1</b>	985	400, 404, 405, 407
<b>P2</b>	1,074	401, 402, 403, 406 ,408, 409
<b>P3</b>	921	416, 417, 418, 421
<b>P4</b>	918	407, 410, 411, 412
<b>P5</b>	714	413, 414, 415
<b>P6</b>	1,807	300, 301, 302, 303, 309
<b>P7</b>	831	300, 307, 308,

<b>Forest Compartment</b>	<b>Size (Forested Acres)</b>	<b>Prescribed Burn Units</b>
<b>P8</b>	1,022	304, 310, 311, 319
<b>P9</b>	1,123	305, 306, 312, 313, 314, 315, 320
<b>P10</b>	557	316, 317, 318
<b>P11</b>	1,248	316, 321, 322, 326
<b>P12</b>	450	323, 324
<b>P13</b>	656	325, 329
<b>P14</b>	591	327, 328
<b>P15</b>	634	332, 335, 336,
<b>P16</b>	993	331, 334, 343
<b>P17</b>	807	330, 333,
<b>P18</b>	846	337,338
<b>P19</b>	979	340, 341, 342
<b>P20</b>	348	419, 420

## Appendix B. Proposed Forest Management Compartment Treatment Schedule and Commercial Harvest Guidelines.

### FOREST MANAGEMENT TREATMENT SCHEDULE

Each management unit is assigned a year of entry. Stands or compartments may be moved forward or pushed back in the schedule, depending on available personnel and need for management actions. Following the Order of Entry, a forest inventory will be conducted for each compartment. The inventory techniques will be described in the Inventorying and Monitoring Plan.

Fiscal Year	Compartments	Approximate Forest Acreage		
		Managed Pine	Wilderness	Total
2013	S7 S8 S9 S10	2,208	1,086	4,007
2014	P1 P2 P3	1,661	--	2,980
2015	P6 P7	1,639	--	2,638
2016	S12	1,145	--	1,492
2017	P8 P9	1,793	--	2,145
2018	P12 P13 P14	1,313	--	1,697
2019	W1 W3 W4	638	--	4,284
2020	W2 W9 W10	957	--	2,018
2021	S1 S2	1,272	--	4,217
2022	P10 P11 S6	1,279	527**	2,332
2023	W5 W6 W7 W8	1,417	--	3,696
2024	P4 P5 P20	895	348	1,980
2025	P18 P19 S5	612	2,224	3,933
2026	P15 P16 P17	1,808	--	2,434
2027	S3 S4 S11	1,011	7	3,428

*\*Since staff and funding shortages have limited the refuge's forest management activities over the last 15 years, stands or entire compartments in need of management may be moved forward in the schedule to an earlier prescription. With enough dedicated staff, this schedule can be accomplished or accelerated. Similarly, if funding and staffing is not increased in the future, this entry schedule will not be accomplished.*

*\*\* Although not wilderness, Mounds Station is included here since the forested habitats there will not be managed with commercial harvest.*

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## PREPARATION FOR COMMERCIAL TIMBER HARVEST

Data will be collected to compare current forest conditions to desired forest/future conditions (DFC). The data collected will be reflective of the DFCs. The following data will be collected during each compartment cruise:

- Timber volumes including basal area for sawtimber and pulpwood;
- Tree ages;
- Canopy conditions;
- Ground cover composition and cover;
- Number and size of snags per acre;
- Tree regeneration;
- Species composition of each canopy layer (overstory, midstory, understory, and ground cover);
- Quantity of woody debris;

Forest management prescriptions will contain the following information:

- Compartment map;
- Stand maps designating various habitat types and timber stands within the compartment;
- Description of compartment that includes physiological features (physical characteristics), such as general vegetation information, hydrology, and soil information;
- Timber data including tree species composition, sawtimber, and pulpwood volumes, stocking, age, condition, and basal area;
- Wildlife habitat parameters including plant composition and cover of the overstory, midstory, and groundcover; number of snags; presence of woody debris; and significant wildlife features (e.g., bald eagle nests, red-cockaded woodpecker cavities, and flatwoods salamander ponds);
- Desired future condition parameters;
- Prescription of silvicultural and other management treatments to be conducted in the compartment;
- Treatment maps designating the areas expected to receive silvicultural treatments and other management;
- Description of desired results;
- Estimated residual timber data for the treatment areas, such as basal area and number of trees;

After the prescription is written, it will be submitted to the Service's Regional Office for approval. Copies of prescriptions and all other information will be kept on file in the refuge office.

To determine which trees are designated for removal, the forester will follow sound silvicultural procedures prescribed in the compartment prescription. When marking trees to be removed or to be retained, at least two spots of paint (one on the stump at ground level and at least one on the tree trunk preferably at 8 feet) will allow the contractor to determine which trees are designated for removal during timber harvest and help the forester identify the stumps of marked trees during administration of the logging contract. In certain situations, the operator select method of harvest can be utilized in order to meet habitat objectives. Another situation is plantations where tree are planted in rows; in this case the first and last tree in a row can be marked to indicate which row of trees is to be removed.

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Timber marking is very subjective and varies from one timber marker to another. Though the compartment prescription gives the timber marker guidelines to follow, each individual timber marker has a different opinion on how to reach the desired results of the compartment prescription. One person marking trees in the treatment areas is acceptable; however, to ensure forest diversity and avoid possible bias, more than one person should be involved with the timber marking of treatment areas on the refuge if possible.

During the timber marking activities, many factors are considered before selecting a tree for removal. These factors may include species composition of the compartment, tree size, tree health and vigor, presence of regeneration, potential regeneration, canopy structure, number of cavities within the area, habitat value of the tree, mast production, tree age, other factors (e.g., residual cat-faced pines), and objectives of the compartment prescription. The compartment prescription designates how much timber volume or basal area to remove during a treatment, but the application of the prescription occurs during timber marking.

The timber harvesting operations will be defined by “marked trees.” Or, in the case of the operator select method, a boundary will be well-defined, in which the operator will clearly know where the harvest operation is confined.

The timber sale must satisfy certain conditions to be operable by a contractor. The refuge forester will be responsible for staying informed as to the details of the local markets surrounding the refuge in order to satisfy these conditions.

Timber harvest operations can occur anytime of the year. However, harvesting operations may be restricted during certain times. For instance, harvesting operations may be restricted during wet periods where excessive rutting may occur, or during sensitive wildlife breeding time frames, or when degradation of critical habitat could occur. Timber harvest will primarily be restricted to dry periods of the year to keep soil disturbance and damage to residual vegetation at a minimum. Harvesting operations will be postponed, modified, or relocated to another site (if another treatment area is available) in order to meet the refuge’s wildlife and habitat requirements.

The refuge will follow Silviculture Best Management Practices from Florida Department of Agriculture and Consumer Services administered by the Florida Forest Service. The refuge goal is to meet and, in most cases, exceed the guidelines stated in best management practices. Within the Primary Special Management Zones, commercial harvests will generally be prohibited unless specifically prescribed in the forest management prescription for a particular wildlife objective. Along the coastal forest/marsh interface where hydric conditions exist, the prohibition of commercial harvesting will generally extend to 150 feet inland to reduce the potential blowdown during tropical storms. These hydric conditions will be identified by the presence of saltmeadow cordgrass or other hydric indicator species.

Restrictions for the benefit of red-cockaded woodpeckers, frosted flatwoods salamander, the Florida National Scenic Trail, and cultural sites as outlined in the CCP, this HMP, and subsequent guidelines/plans will be incorporated into the forest management prescriptions and strictly enforced.

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## Logging Operations

Commercial timber harvest operations will primarily use existing roads. If construction of a road is needed for access a treatment area, it will be considered a temporary refuge road and will be restored when the logging is completed.

Logging operations will be allowed to use standard logging equipment during dry periods, use low-ground pressure equipment in wet areas or wet periods, or when necessary avoid logging operations during wet periods. If multiple treatment areas exist, loggers will be relocated to an area that is conducive to logging operations during that time period. Tree length or cut to length skidding is acceptable. Logging debris at loading decks shall be dispersed back into the stand where harvesting operations are being conducted, although some debris can be expected at the logging deck. Whether tree length or cut to length skidding, all debris is to be kept from piling up under unmarked trees. Other special conditions and/or restrictions, as determined by refuge staff, may be stated in the Timber Sale Bid Invitation under special conditions of sale.

In order to confirm harvest procedures and address any questions, a pre-entry conference will be held between the refuge manager and/or refuge forester, permittee, and/or the logging contractor, if different than the permittee. The permittee is to notify the refuge when harvesting operations begin and are completed.

Close inspection and supervision of all timber sales is necessary to ensure that harvesting operations meet the conditions of the special use permit and refuge objectives. Frequent inspections of harvesting operations will ensure that only designated trees are cut, and problems are rectified before becoming major issues. Timber harvesting operations may be suspended or restricted any time that continued operation might cause excessive damage to the forest stands, soil, wildlife habitat, or cultural resources. Reasons for suspension or restriction may include, but are not limited to, periods of high wildfire potential, insects or disease hazard, times when harvesting may interfere with essential refuge operations, refuge hunts, periods of heavy rains or wet conditions, which may cause rutting and erosion of soils, when harvesting operations present a safety hazard, or when harvest operations reveal new or may damage existing cultural resources. Furthermore, operations may be suspended or terminated if the permittee violates the conditions of the special use permit.

When harvesting is complete, the refuge forester or designated refuge staff will inspect the site for compliance with all requirements of the contract. If any deficiencies are found, the permittee will be notified and given reasonable time to achieve compliance. If full compliance is achieved, the permittee's performance deposit will be returned in full. If not, an amount to mitigate damages will be deducted from the performance deposit and the remaining amount returned.

## Monitoring

Upon completion of prescribed timber harvest operations, a sub-set of treatment areas will be monitored and evaluated at 1, 5, 10, and 15 years post-harvest. This allows for adaptive management decisions and actions based on how the silvicultural treatments deviate from the established desired forest/future conditions.

Geographical Information System (GIS) maps will be developed delineating the sites where harvesting actually occurred. These maps will be incorporated into the refuge GIS database and added to the forest management prescriptions where the harvesting was prescribed. Temporary roads will also be mapped to facilitate monitoring of the recovery of the habitat.

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## **Archaeological and Cultural Resources**

There are numerous cultural resources sites on the refuge that are fully protected under the Archaeological Resources Protection Act.

When a compartment comes under consideration for treatment, known archaeological sites and cultural resources in or near the treatment areas will be noted and sent to the Service's regional archaeologist with the forest management prescription for review. The regional archaeologist will coordinate the review and obtain clearance from the State Historic Preservation Office. Upon completion of all clearances, treatment will be implemented with an appropriate buffer established around the perimeter of any cultural sites.

It is possible that forest management activities on the refuge could disturb archaeological sites. In the event this happens, the harvesting operation will immediately cease and the regional archaeologist will be contacted. Also, the Timber Sale Bid Invitation, under special conditions of sale, addresses discovery of an undocumented archaeological site(s).

## **Aesthetics**

Aesthetics are important concerns for forest habitat managers. Thousands of visitors use the refuge every year for hunting, fishing, wildlife observation, or other compatible wildlife-dependent recreation. Since multi-aged pine management is more aesthetically pleasing than even-aged management systems, no specific modifications to management will be made along areas of high public use other than the consideration of aesthetics in the placement of log loading decks.

## **Forest Openings**

Forest openings on the refuge will be managed as temporary openings. The creation of gaps in the pine canopy will generally be limited to ¼-acre in size to maintain the continuity of the light fuels to promote frequent prescribed fire. Where advanced pine regeneration is present, slightly larger gaps (less than ½-acre) may be created when a few residual pines are left in the gap to provide needlecast. Advanced pine regeneration may also be released by removing a few pines on the south edge of a small natural gap to increase light to the young trees. Except for small stands (less than 5 acres) and when restoring slash and loblolly pine plantations to longleaf pine, created gaps will be limited to less than 5 percent of the stand.

## **Insects and Diseases**

Insects and diseases that may affect the forested habitat on the refuge can be most effectively controlled by promoting stand conditions favoring healthy, vigorous trees. Trees stressed by overstocking, flooding, drought, fire, etc., have an increased susceptibility to insects and diseases. Forest management activities, such as thinning, will help promote tree health and vigor by reducing competition and stocking, as well as maintaining tree species diversity.

Most of the disease and insect damage found on the refuge presently is limited to individual trees or small groups and should not pose a threat to the health of the forest. The presence of tree diseases and insects is a normal occurrence in the forest. Many neotropical bird species forage on insects that damage trees, while other wildlife species forage on the conks and other fruiting bodies of various diseases. Portions of trees damaged by insects and diseases may eventually develop into cavities available for wildlife use.

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Due to the wildlife value of snags, the salvage harvest of dead and dying trees as a result of fire, insects, disease, flooding, or wind will generally not be permitted except where the trees pose a safety risk to staff and visitors. When the loss of trees occur over an extensive area (5 acres or more) a salvage harvest may be conducted. This harvest may be included with an ongoing commercial harvest or, more likely require an expedited harvest while it is still commercially feasible. Any salvage harvest will leave a minimum of 15 of the largest standing dead and dying trees per acre, scattered across the site.

### **Administration of Sales – Conditions Applicable to Timber Harvesting Permits**

Each harvesting operation is different; circumstances will dictate what statements are relevant for a particular harvesting operation. The following statements may be included when attaching special conditions for commercial harvesting to a bid invitation:

- Except where specifically authorized by a special use permit, all regulations governing activities on national wildlife refuges in general and specific public use regulations for St. Marks NWR (including littering, possession and use of firearms, and protection of wildlife) apply.
- Each bidder must submit with each bid or have on file in the refuge office, a current statement demonstrating financial responsibility to show the bidder's ability and the ownership or control of necessary equipment to carry out harvesting operations on the basis herein specified. The bidder needs to show the ability to properly construct and/or maintain roads (i.e., crawler tractor, road grader), have and maintain authorized/proper harvesting equipment for the job (i.e. feller buncher, skidder, forwarder, de-limber, yarder/processor).
- A pre-entry conference with the harvesting contractor/permittee will be held prior to any work being done in the designated harvesting area. The pre-entry conference is held to ensure the harvesting contractor/permittee understands permit conditions and thus avoids conflicts.
- Silviculture; Best Management Practices of Florida are to be observed at all times, unless superseded by refuge regulations or by these special conditions.
- The refuge manager, refuge forester, or designee shall have the authority to stop timber harvesting operations anytime justifiable reasons develop.
- Damage assessment judgements will be evaluated and appraised by the refuge forester or designee.
- The harvesting contractor/permittee will have access to only those lands described and shall conduct harvesting operations during daylight hours only Monday through Friday. Harvesting operations on Saturday, or Sunday, or on federal holidays must be approved by the refuge manager.
- The harvesting contractor/permittee and their employees (any person working the harvesting operation and are not refuge staff) shall do all in their power to prevent and suppress forest fires caused by their employees or equipment. The harvesting contractor/permittee must notify refuge personnel immediately if an incident involving fire occurs. The harvesting contractor/permittee shall be liable for all fire suppression costs resulting from harvesting operations.
- All harvesting operations will be within the boundaries specified and coordinated with the refuge forester or designee.

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- The surrounding acreage outside the harvesting area and wetlands within the sale area are off-limits to mechanized disturbance. For instance, the off-limit areas may contain (and are not limited to) mesic and hydric hammocks; basin, dome, or floodplain swamps; basin, depression, or salt marshes; and flatwoods lakes or swamp lakes. Archaeological sites are also off-limit areas and will be clearly identified by an appropriate means to ensure harvesting operations do not enter into such a site. Unless harvesting operations have been approved where critical habitat exists, critical habitat may also be considered an off-limit area.
  - Dispose of refuse/litter as instructed by the refuge forester or designee. The harvesting contractor/permittee will not litter. Littering violations will be handled under 50 CFR 27.94 (a) and carries a fine of \$100 per incident upon conviction.
  - Clean-up of oil, hydraulic fluid, and other contaminants as a result of the harvesting operation is the responsibility of the harvesting contractor/permittee. The harvesting contractor/permittee will ensure all vehicles and equipment used or at the harvesting site are in proper working order so not to leak fluids on the ground.
  - All logging debris at loading decks shall be dispersed back into the stand where harvesting operations are being conducted. Keep all debris from piling up under residual trees. Keep debris 4 feet from the base of residual trees. Some debris is expected at the logging deck; however, if the refuge forester or designee deems excessive debris has accumulated, the debris shall be removed from the logging deck.
  - Trees may be de-limbed and topped at the point of felling (cut to length skidding); however, debris is to be treated in the same manner as stated in the previous paragraph. If tree length skidding is preferred, then the harvesting contractor/permittee and their employees must ensure residual trees are not be used for de-limbing. Damage to residual trees from de-limbing shall be assessed a penalty.
  - Overall, stump height shall be no more than 3 inches off ground level. If in the judgment of refuge forester or designee excessive stump heights are being left above 3 inches off ground level, those stumps will be assessed a penalty and the harvesting contractor/permittee shall cut the stump to the required height. Stump heights will be measured on the side adjacent to the highest ground. A stump should display a stump mark to show the tree was slated for removal-the marking will have been from refuge personnel.
  - All marked trees must be cut, unless operator select method is utilized, or row thinning is utilized (all trees in the designated row must be removed). In the event any marked trees are not cut by permittee, or trees are left standing in a designated row, a penalty may be assessed.
  - Harvesting operations will not be permitted when wet ground conditions could result in excessive rutting or severe soil compaction. The harvesting contractor/permittee will fill any excessive ruts (deemed by the refuge forester or designee) made as a result of the harvesting operation. The refuge forester or designee retains the right to stop harvesting operations at any time during inclement weather, or if violations to the special use permit occur.
  - Only marked or designated trees shall be cut, unless otherwise agreed on by both parties. Utmost care shall be exercised to protect all other trees and vegetation from damage. Additional trees marked by refuge personnel for roads or loading sites will be paid for at bid price. Unmarked trees which are cut or injured through carelessness shall be paid for at double the market value stumpage price. Additional damages may be assessed or merchandising methods adjusted based on the severity of the damage.

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- Trees and tops cut shall not be left hanging or supported by any other living or dead tree or brush. Any tree that becomes lodged when cut shall be immediately rendered unlodged and felled flush to the ground. All tree tops and other logging debris will be removed from roads, roadside ditches, trails, firebreaks, fields, streams, and drainages immediately after felling.
  - When a harvesting operation is adjacent to private land, all logging debris will be pulled back onto the refuge to avoid damage to private property.
  - Each compartment or section of the harvesting area must be completed before relocating to another compartment or section unless wet weather conditions dictate otherwise, or other special condition that could cease harvesting operations in that area. Any relocation must be approved by the refuge forester or designee.
  - If there is a potential for excessive skidding damage, then skidding lengths can be shortened by refuge forester or designee.
  - Roads must be maintained to pre-harvest condition or to the standards described under special permit conditions. The harvesting contractor/ permittee will be responsible for maintaining the haul roads during harvesting operations and the purchase of any additional material (i.e., Florida DOT approved #57 stone) for road repairs during or after the timber sale. After harvest operations are complete all other refuge roads utilized by the logger will be graded (i.e., with a motor grader) and left in the same or better condition before harvest operations started, unless stated otherwise.
  - Main haul roads and loading deck locations will be determined by the refuge forester or designee and discussed with the harvesting contractor/permittee before construction of any roads and/or decks. All such roads will be permanently closed by harvesting contractor/permittee upon completion of operations, unless specified otherwise.
  - The harvesting contractor/permittee will remove artificial barriers, such as straw bales, silt fence barriers, plugs, dams, or bridges constructed by the harvesting contractor/ permittee upon completion of the harvesting operations.
  - Vehicles and other equipment will be operated in a safe manner at all times. Both refuge personnel and the visiting public use the refuge roads. Posted speed limits on refuge roads will be observed and strictly enforced. Roads used for harvesting operations may have reduced speed limits due to equipment size and weight. The refuge forester or designee will keep the harvesting contractor/permittee appraised of speed limits.
  - The harvesting contractor/permittee will be responsible for placement of DOT-approved road signs at highway access points that can be viewed by both oncoming lanes of traffic that state (Caution Log Trucks Entering and Leaving Highway) or an approved variation. Also, road signs may be required at the entry where harvesting operations are taking place. The refuge forester or designee and the harvesting contractor/permittee will discuss where additional road signs may be needed.
  - Should previously unrecorded cultural resources or human remains be found on Fish and Wildlife Service-owned land, harvesting operations will be halted immediately at that location. The refuge law enforcement officer and forester, refuge manager, or designee are to be contacted at once.
  - The harvesting contractor/permittee shall protect all known (identified on the ground) archaeological sites against disturbance, destruction, or damage during harvesting operations. If, during the course of the harvest operation, the harvesting contractor/permittee notices illegal excavation or archaeological resources removal activities, this information shall be immediately provided to the refuge law enforcement officer and forester, refuge manager, or designee.

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- If, during the course of the harvest operations, the harvesting contractor/permittee deliberately damages a recorded site, the harvesting contractor/permittee will be responsible for the site damage assessment, mitigation, and legal consequences.
  - Harvesting operations are allowed under normal or dry operating conditions. Harvesting operations are not allowed under wet conditions where excessive rutting or severe soil compaction is likely. Also, harvesting operations may not be allowed if harvesting is taking place at specific locations during sensitive wildlife breeding (or other) time frames.
  - For safety reasons and to minimize conflict, the harvesting contractor/ permittee may need to cease logging operations during refuge hunts. Ceasing logging operations during refuge deer gun quota hunts is area-dependent, and actual "Bid Invitation" under special conditions will specify if a harvesting operation must cease.
  - The U.S. Government accepts no responsibility to provide right-of-way over private lands for materials sold under this contract.
  - A three part security system will be used for load tracking. The first part is for the harvesting contractor/permittee's records, the second part will be placed in an on-site lock box, and the third part shall be stapled to the load scale ticket and returned to the St. Marks NWR forester's office.
  - Scale tickets from the mill(s) will be released directly to the refuge for all timber upon request.
  - In the event of a temporary wood processing facility closure, natural disaster, or an event that is uncontrollable by the harvesting contractor/permittee that prevents harvest operations, the length of special use permit may be extended at the discretion of the refuge manager.

### *Sale Folders*

A sale folder will be prepared and maintained for each individual timber sale. The folder shall contain copies of the data collected for the sale. This should include (as applicable) tally sheets, volume estimates, hard copies of electronic data summaries, maps, bid invitations, special use permits, payment records, correspondence with harvesting contractor/permittee, sale compliance inspection notes, copies of deposit checks, and payment transmittal forms. The sale folder shall be kept in a separate folder within the management unit folder for each individual management unit, thus keeping all information pertaining to a management unit within a single file.

### *Bid Invitations*

Commercial harvesting operations (timber sales) are the most practical method available for creating and maintaining desired forest habitat conditions. All timber sales will be conducted in accordance with the requirements listed in the Refuge Manual, and the guidelines and specifications detailed in the St. Marks NWR CCP, St. Marks NWR HMP, and forest management prescriptions.

Small sales (estimated receipts less than \$2,500) will be negotiated as authorized by Fish and Wildlife Service policies. The refuge forester will make a reasonable effort to obtain at least three bids from potential buyers. These bids will be documented and a permit will be issued to the successful high bidder.

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Larger timber sales (estimated receipts more than \$2,500) will be conducted through a formal bid procedure. Invitations to bid will be prepared and administered by refuge personnel. Formal bid invitations will be sent to all prospective bidders. Bid invitations will contain the following information:

- A formal bid information form containing sales information and estimated volumes (when applicable), which the bidder fills out, signs, and returns to the refuge.
- Maps of general sales location information and detailing all sales units.
- General conditions applicable to harvest of forest products.
- Special conditions applicable to the timber sale.
- Certificate of Independent Price Determination.
- Equal Employment Opportunity Clause (Form 3-176).
- Information on dates when prospective bidders can evaluate sales areas before bid opening.

### *Bids and Performance Deposits*

For all bid sales, a bid opening date and time will be set to occur at the refuge headquarters. All bids received prior to the opening time will be kept, unopened and locked in the refuge cashier's safe, until the specified opening time. Any bids received after the specified opening time will not be accepted. The refuge retains the right to reject any and all bids, particularly those that are incomplete or otherwise unacceptable.

A \$500 bid guarantee must accompany all bids received through the formal bid process. This deposit is to ensure the sincerity of the bidder's intention to purchase the offered sale at the bid price. In the event the successful bidder chooses not to purchase the offered timber, the bid deposit will be forfeited to the Federal Government. When the successful bidder is named, all unsuccessful bidders' deposits will be immediately returned. The successful bidder's deposit will be returned when a performance guarantee is submitted. The performance guarantee is a deposit of 10 percent of the estimated value of the sale up to a maximum of \$20,000 and must be received before any activities proceed. Depending on the size of the sale or potential for damage, more than 10 percent of the appraised value may be justified as a deposit; the amount of the deposit will be stipulated in the bid invitation. The performance guarantee will be retained by the Federal Government in a holding account to cover any damages caused by the successful bidder, their agents, employees, or their producers. The balance of the deposit will be refunded to the successful bidder when the sale is completed.

Small sales through the negotiated process will also require a performance guarantee deposit to be received by the Federal Government prior to any timber harvest.

### *Special Use Permit*

Upon selection of a successful bidder by the refuge manager or designated representative, a special use permit will be issued containing information relevant to the timber sale, such as terms of payment, authorized activities, general and special conditions, and location map. The refuge manager or designated representative, upon receipt of payment, signs the permit, if the value is within their warranted authority. If the value is above that amount, an authorized representative of the Service's Regional Director signs the special use permit.

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### *Payment for Forest Products and Administration of Receipts*

In the case of lump sum sales, the successful bidder (hereafter referred to as the permittee) will have 10 days after receipt of the harvesting permit to make total payment, or in the event of a consumer scale sale (pay as cut), the performance guarantee will be considered as prepayment for the first operating period and after each subsequent operating period, payment will be made to the Federal Government in the amount indicated by actual scale tickets for that period. In no case will harvesting operations begin prior to payment. The purpose of an advance payment is to encourage the permittee to begin harvesting operations as quickly as possible and is Departmental policy. All payments will be in the form of a cashier's check payable to U.S. Fish and Wildlife Service.

In some cases, timber products may be sold by mill scale. That is, the products will be sold according to the volume of products delivered to a mill, as scaled by that mill. In mill scale sales, payment will be made according to the units scaled at a negotiated price per unit. Payments will be made on a time schedule specified on the special use permit. All payments will be accompanied by mill scale tickets or other documentation confirming the volume of forest products removed from the refuge.

Refuges are authorized to enter into Timber for Land Exchanges. In this process, land within the approved acquisition boundary may be purchased indirectly through exchange of normal timber sale volumes.

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## Appendix C. St. Marks National Wildlife Refuge Soils

### *Nutall Series*

The soils of the Nutall series consist of poorly drained and very poorly drained, nearly level soils that occur on broad, poorly defined drainageways, on floodplains, and in depressions in the flatwoods. These soils have a seasonal high water table between depths of 0 to 10 inches for 6 to 8 months. Depressional and flooded soils are subject to inundation for 4 to 6 months and 6 to 8 months during the year, respectively, and have a water table between 0 and 12 inches for most of the remaining time. Typically, the soils have a black fine sand surface layer about 4 to 6 inches thick. The next layer to about 9 inches is very dark gray and light gray fine sand. The subsurface layer is fine sand about 8 inches thick. The upper part is light gray and the lower part is brown. The subsoil, about 13 inches thick, is light greenish-gray sandy loam. Limestone bedrock occurs at about 30 inches. Available water capacity is low in the surface layers and medium in the subsoil. Permeability is rapid in the surface layers and slow in the subsoil. Organic matter content and natural fertility are low.

### *Tooles Series*

The soils of the Tooles series are also poorly drained and very poorly drained, level soils that occur in the same areas as the Nutall series, with which it is often in complex. These soils have a seasonal high-water table between depths of 0 and 10 inches for 6 to 8 months. Depressional soils have water up to 24 inches above the surface for 8 to 10 months. Flooded soils have up to 48 inches of water above the surface for 6 to 8 months. The water table in the depressional and flooded soils is between 0 and 10 inches most of the remaining time. Typically, the series has a black fine sand 5 to 10 inches thick. The next layer, which ranges from 2 to 8 inches thick, is very dark gray and light gray fine sand. The subsurface layer is fine sand about 23 inches thick. The subsoil is light greenish-gray, sandy clay loam to 46 inches, where the limestone bedrock occurs. Available water capacity is low and permeability rapid in the surface layers and high and slow, respectively, in the subsoil. Organic matter and natural fertility are both low.

### *Chaires Series*

This series is comprised of poorly drained soils that are found on broad, nearly level flatwoods. A seasonal high-water table is within depths of 10 inches for 1 to 3 months and within 10 to 40 inches for 6 months or more in most years. Depressional soils have water up to 24 inches above the surface for 4 to 6 months. A water table exists between 0 and 12 inches for most of the remaining time. Typically, the surface layer is a dark brown fine sand 7 to 9 inches thick. The subsurface layer is dark grayish-brown and light gray fine sand to a depth of 28 inches. The upper part of the subsoil is a variety of dark brown fine sands to 54 inches. The lower subsoil is gray and light greenish-gray sandy clay loam. Available water capacity is very low in the surface layers and ranges from low to high in the subsoil. Permeability is rapid in the surface layers and upper part of the subsoil, but slow in the lower part of the subsoil. Organic matter is moderately low. Natural fertility is low.

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### *Bayvi Series*

The Bayvi soils are very poorly drained soils that occur in tidal marshes and are flooded daily by normal high tides. In Jefferson County, this series is represented by Bayvi muck, which is typically comprised of a 5-inch-thick black muck surface layer and subsurface layers of black mucky loam sand to 17 inches, and very dark grayish-brown sand to 31 inches. The underlying material is grayish-brown sand to 53 inches and gray sand to 80 inches. The permeability is moderate in the surface and rapid in the underlying layers. The available water holding capacity is high in the surface and very low in the underlying layers. Organic matter is high in the surface and low in the underlying layers. Natural fertility is low.

### *Isles and Estero Series*

Isles and Estero soils are also poorly drained tidal marsh soils that are undifferentiated from the Bayvi soils in the Wakulla County survey.

### *Ridgewood Series*

Ridgewood fine sand, 0 to 5 percent slopes, represents this series on the refuge. It is found in the vicinity of Mounds Station, in the northeastern and northwestern corners of the Wakulla Unit, and commonly throughout the Panacea Unit.

### *Ortega Series*

This series consists of moderately well-drained, nearly level to gently sloping soils that occur on low knolls in the flatwoods and uplands. On the refuge, Ortega sand, 0 to 5 percent slopes, is often found in the vicinity of Ridgewood fine sand. A seasonal high-water table is between depths of 60 to 72 inches for more than 6 months in most years, and within depths of 42 to 60 inches for 1 to 2 months of most years during heavy rainfall periods. Available water capacity is low and permeability rapid. There is a low quantity of organic matter. A typical cross-section of the series would reveal a 5-inch grayish-brown fine sand surface layer, underlain by layers of very pale brown fine sand to depths of about 48 inches and white fine sand between depths of 48 and 82 inches.

### *Hurricane Series*

The Hurricane series consists of somewhat poorly drained, nearly level to gently sloping soils that occur in high flatwoods and low uplands. A seasonal high-water table is within depths of 18 to 42 inches for 2 to 4 months, and within 30 to 72 inches for the majority of the year. The surface layer is a grayish-brown sand with light brown and light gray subsurface layers that extend to depths of more than 50 inches. Below the subsurface layers are organic-coated sand layers of dark brown, reddish brown, and black. Organic matter content and natural fertility are low.

### *Croatan Series*

The Croatan mucks are very poorly drained, nearly level, organic soils that are found in association with Dorovan mucks in marshes in Compartment W2.

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### *Dorovan Series*

The Dorovan mucks are very poorly drained, nearly level soils that are located in marshes in Compartment W2 in association with Croatan mucks.

### *Moriah Series*

This series consists of somewhat poorly drained, moderately permeable, nearly level soils of the flatwoods. The water table is within a depth of 18 to 36 inches for 2 to 5 months in most years. Small, low areas of thin soil may pond briefly following heavy rains. In a representative profile, the surface layer is gray fine sand 8 inches thick with a 17-inch thick fine sand subsurface layer that is yellowish brown in the upper part and white in the lower part. The subsoil is a yellow fine sandy loam that extends to fractured limestone bedrock at 50 inches. Both organic matter content and natural fertility are low.

### *Pilgrims Series*

The Pilgrims series consists of moderately deep over limestone, slowly permeable, nearly level soils of low uplands. These soils are saturated between the depth of 18 to 36 inches for 2 to 5 months per year. Typically, the surface layer is dark grayish-brown fine sand 6 inches thick. The subsoil is a light yellowish-brown sandy clay that extends to the fractured limestone bedrock at 24 inches. Organic matter content and natural fertility are both low.

### *Lakeland Series*

The Lakeland series are deep, excessively drained, nearly level to gently undulating, strongly acid, sandy soils that occur on summit positions in the uplands. Depth to the water table exceeds 80 inches. It typically consists of a very dark grayish-brown or dark gray sand surface layer over deep yellowish-brown sand.

### *Leon Series*

The Leon series consists of poorly drained, nearly level soils that occur on flatwoods in the Wakulla and Panacea Units. A seasonal high-water table is within depths of 10 inches of the surface for 1 to 3 months and at depths of 10 to 40 inches for more than 6 months in most years. The surface layer is typically very dark gray sand 3 inches thick over a 12-inch thick gray and light gray sand subsurface layer. The subsoil is black, dark reddish brown, light brownish-gray or very dark brown sand to 80 inches or more deep. Organic matter content and natural fertility are low.

### *Rutledge Series*

The Rutledge series are very poorly drained, nearly level soils that occur in shallow depressions and natural drainageways. The water table is above or near the surface for 4 to 6 months of the year, and is subject to ponding after periods of heavy rainfall. Typically, these soils have an 8-inch thick black loamy sand surface layer, a 10-inch thick very dark gray loamy sand subsurface layer, and a mottled grayish-brown substratum to 60 inches.

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### *Scranton Series*

This series consists of nearly level, poorly drained soils that are found on flatwoods in the Panacea and Wakulla Units. The seasonal high-water table is within depths of 10 inches of the surface for 1 to 3 months, and at depths of 10 to 40 inches of the surface for more than 6 months in most years. In a representative profile, the surface layer is black loamy fine sand about 9 inches thick. The underlying layers include dark grayish brown loamy fine sand in the upper 15 inches, grayish-brown fine sand in the next 4 inches and light gray and white fine sand in the lower 32 inches. Organic matter content and natural fertility are low.

### *Lutterloh Series*

The Lutterloh series consists of somewhat poorly drained, slowly permeable soils that are low in organic matter and natural fertility. Typically, the soil has a 7-inch thick grayish brown surface layer, a light gray and white fine sand subsurface layer to a depth of 59 inches, and a subsoil that is gray fine sandy loam in the upper 12 inches and light gray heavy sandy clay loam below.

### *Otela Series*

The Otela series are deep, moderately well-drained soils, low in organic matter and natural fertility. The profile is typically a dark grayish-brown fine sand surface layer about 8 inches thick with a 42-inch thick fine sand subsurface layer that is brown to a depth of 21 inches, very pale brown to a depth of 32 inches and white to a depth of 50 inches. The subsoil is brownish-yellow fine sandy loam in the upper 11 inches, mottled brownish-yellow sandy clay loam in the next 3 inches, and mottled light gray sandy clay loam below.

### *Mandarin Series*

The Mandarin series consists of somewhat poorly drained nearly level soils that occur in areas slightly higher than adjacent flatwoods. Typically, these soils have gray fine sand surface and subsurface layers less than 30 inches thick over brown organic-coated sandy layers about 14 inches thick. Below this, to depths of 73 inches, are layers of gray or white loose fine sand underlain by a layer of black organic-coated fine sand.

### *Plummer Series*

This series is represented on the refuge by Plummer fine sand in a small area in Compartment P2.

### *Pottsburg*

The Pottsburg soils are poorly drained, moderately permeable soils that occur on nearly level landscapes in the flatwoods. The water table is at depths of less than 12 inches for 1 to 4 months and at a depth of 12 to 40 inches for 4 months or longer during most years. Typically, these soils have a gray fine sand surface layer, about 3 inches thick. Below this to depths of 80 inches is fine sand. The upper 7 inches is brown, the next 24 inches is grayish brown, the next 23 inches is light gray, and the lower 23 inches is dark reddish brown.

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### *Surrency Series*

This series consists of very poorly drained nearly level soils that occur in level upland drainageways and flatwood depressions in Compartment P18. Organic matter content and natural fertility are low. In a typical profile, the surface layer is black loamy sand, 12 inches thick. The subsurface layer is grayish-brown and dark grayish-brown sand, 20 inches thick. The subsoil extends to 65 inches or more. It is light gray sandy loam in the upper part and grayish-brown sandy loam below. Yellowish and brownish mottles are common.

### *Maurepas Series*

The soils of the Maurepas series are represented on the refuge by Maurepas muck, frequently flooded. These soils are located in the tidally influenced marshes along the Sopchoppy, Ochlockonee, Dead Rivers, and Buckhorn Creek.

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## Appendix D. Select Wilderness Policy/Guidance

Under the Wilderness Act, wilderness areas “shall be administered for the use and enjoyment of the American people in such a manner as will leave them unimpaired for future use and enjoyment as wilderness, and so as to provide for the protection of these areas, the preservation of their wilderness character, and for the gathering and dissemination of information regarding their use and enjoyment as wilderness.”

Sixteen principles of wilderness stewardship are derived from the Wilderness Act of 1964. They are:

- Manage wilderness as a distinct resource with inseparable parts;
- Manage the use of other resources and activities within wilderness in a manner compatible with the wilderness resource;
- Allow natural processes to operate freely within wilderness;
- Attain the highest level of primeval wilderness character within legal constraints;
- Preserve wilderness air and water quality;
- Produce human values and benefits while preserving wilderness;
- Preserve outstanding opportunities for solitude or a primitive and unconfined recreation experience in each wilderness;
- Control and reduce the adverse physical and social impacts of human use in wilderness through education or minimum regulation;
- Favor wilderness-dependent activities when managing wilderness use;
- Exclude the sight, sound, and other tangible evidence of motorized or mechanical transport wherever possible within wilderness;
- Remove existing structures and terminate uses and activities not essential to wilderness management or not provided for by law;
- Accomplish necessary wilderness management work with the minimum tool;
- Establish specific management direction with public involvement in a management plan for each wilderness;
- Harmonize wilderness and adjacent land management activities;
- Manage wilderness with interdisciplinary scientific skills; and
- Manage special provisions provided for by wilderness legislation with minimum impact on the wilderness resource.

The Statement of Policy, Section 2(a), in the 1964 Wilderness Act states that wilderness areas “shall be administered for the use and enjoyment of the American people in such manner as will leave them unimpaired for future use and enjoyment as wilderness, and so as to provide for the protection of these areas, the preservation of their wilderness character.” Congressional intent for the meaning of wilderness character is expressed in the Definition of Wilderness, Section 2(c) of the 1964 Wilderness Act (Scott 2002). Landres et al. (2005) applied this legal definition to identify four tangible qualities of wilderness that make the idealized description of wilderness character relevant and practical to wilderness stewardship:

- *Untrammeled*—The Wilderness Act states that wilderness is “an area where the earth and its community of life are untrammeled by man,” and “generally appears to have been affected primarily by the forces of nature.” In short, wilderness is essentially unhindered and free from modern human control or manipulation. This quality is degraded by modern

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human activities or actions that control or manipulate the components or processes of ecological systems inside the wilderness.

- *Natural*—The Wilderness Act states that wilderness is “protected and managed so as to preserve its natural conditions.” In short, wilderness ecological systems are substantially free from the effects of modern civilization. This quality is degraded by intended or unintended effects of modern people on the ecological systems inside the wilderness since the area was designated.

- *Undeveloped*—The Wilderness Act states that wilderness is “an area of undeveloped Federal land retaining its primeval character and influence, without permanent improvements or human habitation,” “where man himself is a visitor who does not remain” and “with the imprint of man’s work substantially unnoticeable.” This quality is degraded by the presence of structures, installations, habitations, and by the use of motor vehicles, motorized equipment, or mechanical transport that increases people’s ability to occupy or modify the environment.

- *Solitude or a primitive and unconfined type of recreation*—The Wilderness Act states that wilderness has “outstanding opportunities for solitude or a primitive and unconfined type of recreation.” This quality is about the opportunity for people to experience wilderness; it is not directly about visitor experiences per se. This quality is degraded by settings that reduce these opportunities, such as visitor encounters, signs of modern civilization, recreation facilities, and management restrictions on visitor behavior.

## Appendix E. FSA Easements Managed by St. Marks NWR

*Conservation easements and fee-title property in Florida managed by St. Marks NWR*

Identifier	County	Fee Acres	Easement Acres
FG1	Gadsden	0.00	50.88
FG2	Gadsden	0.00	34.00
Fee1	Madison	95.54	0.00
FM1	Madison	0.00	354.41
FM2	Madison	0.00	85.76
FM3	Madison	0.00	56.02
FM4	Madison	0.00	267.85
FS1	Suwannee	0.00	50.00
<b>TOTAL</b>		<b>95.54</b>	<b>898.92</b>

*Conservation easements in Georgia managed by St. Marks NWR.*

Identifier	County	Easement Acres
GB1	Brooks	208.42
GB2	Brooks	14.20
GB3	Brooks	55.28
GD1	Decatur	12.47
GD2	Decatur	132.07
GG1	Grady	53.35
GT1	Thomas	57.84
GT2	Thomas	61.75
GT3	Thomas	22.42
<b>TOTAL</b>		<b>617.81</b>

## Appendix F. Exotic Plants on St. Marks NWR

Common Name	Scientific Name	Florida Exotic Pest Plant Council Category
Mimosa, Silk Tree	<i>Albizia julibrissin</i> <sup>1</sup>	I
Coral Ardisia	<i>Ardisia crenata</i> <sup>1</sup>	I
Camphor-tree	<i>Cinnamomum camphora</i> <sup>1</sup>	I
Wild Taro	<i>Colocasia esculenta</i> <sup>1</sup>	I
Winged Yam	<i>Dioscorea alata</i> <sup>2</sup>	I
Air-potato	<i>Dioscorea bulbifera</i> <sup>1</sup>	I
Water-hyacinth	<i>Eichhornia crassipes</i> <sup>3</sup>	I
Hydrilla	<i>Hydrilla verticillata</i> <sup>3</sup>	I
Cogon Grass	<i>Imperata cylindrica</i> <sup>1</sup>	I
Lantana, Shrub Verbena	<i>Lantana camara</i> <sup>1</sup>	I
Glossy Privet	<i>Ligustrum lucidum</i> <sup>1</sup>	I
Chinese Privet, Hedge Privet	<i>Ligustrum sinense</i> <sup>1</sup>	I
Japanese Honeysuckle	<i>Lonicera japonica</i> <sup>1</sup>	I
Japanese Climbing Fern	<i>Lygodium japonicum</i> <sup>1</sup>	I
Chinaberry	<i>Melia azedarach</i> <sup>1</sup>	I
Nandina, Heavenly Bamboo	<i>Nandina domestica</i> <sup>2</sup>	I
Sword Fern	<i>Nephrolepis cordifolia</i> <sup>2</sup>	I
Skunk Vine	<i>Paederia foetida</i> <sup>2</sup>	I
Torpedo Grass	<i>Panicum repens</i> <sup>1</sup>	I
Water Lettuce	<i>Pistia stratiotes</i> <sup>3</sup>	I
Kudzu	<i>Pueraria montana</i> <sup>2</sup>	I
Mexican Petunia	<i>Ruellia brittoniana</i> <sup>2</sup>	I
Chinese Tallow Tree	<i>Sapium sebiferum</i> <sup>1</sup>	I
White-flowered Wandering Jew	<i>Tradescantia fluminensis</i> <sup>2</sup>	I

Common Name	Scientific Name	Florida Exotic Pest Plant Council Category
<b>Tung Oil Tree</b>	<i>Aleurites fordii</i> <sup>2</sup>	II
<b>Alligator Weed</b>	<i>Alternanthera philoxeroides</i> <sup>2</sup>	II
<b>Eurasian Water-milfoil</b>	<i>Myriophyllum spicatum</i> <sup>3</sup>	II
<b>Golden Bamboo</b>	<i>Phyllostachys aurea</i> <sup>1</sup>	II
<b>Chinese Brake Fern</b>	<i>Pteris vittata</i> <sup>1</sup>	II
<b>Castor Bean</b>	<i>Ricinus communis</i> <sup>2</sup>	II
<b>Purple Sesban, Rattlebox</b>	<i>Sesbania punicea</i> <sup>1</sup>	II
<b>Chinese Wisteria</b>	<i>Wisteria sinensis</i> <sup>1</sup>	II
<b>Malanga, Elephant Ear</b>	<i>Xanthosoma sagittifolium</i> <sup>1</sup>	II

**Legend:**

<sup>1</sup>confirmed on refuge, treatment underway

<sup>2</sup>known or suspected to be present in proximity to refuge (watch-out list)

<sup>3</sup>aquatic invasive confirmed on or adjacent to refuge in state waters

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## Appendix G. Desired Future Conditions of Selected Habitats

### GENERAL INFORMATION

The qualitative and quantitative descriptions of Desired Future Conditions (DFCs) listed below have been adapted to best represent the optimum habitat conditions that are expected to result from long-term implementation of this HMP. In most cases conditions will rarely fit neatly into all quantified parameters described for that habitat type during the implementation of this HMP. Rather, these descriptions have been developed as a guide towards management direction and emphasis rather than a static endpoint. The majority of quantifiable habitat parameters listed within these DFCs has been locally adapted to best fit expected conditions at St. Marks NWR and is primarily derived from the following resources of existing habitat data, monitoring protocols, and management recommendations:

Carr, S. C., Robertson, K. M., & Peet, R. K. (2010). A vegetation classification of fire-dependent pinelands of Florida. *Castanea*, 75(2), 153-189.

Florida Fish and Wildlife Conservation Commission. (2004). *Objective based vegetation management: WMAs and WEAs*.

<http://myfwc.com/conservation/terrestrial/obvm/managed-area/>.

Accessed: March 2013.

Florida Natural Areas Inventory and Florida Fish and Wildlife Conservation Commission (2007). *Objective-Based Vegetation Management (OBVM) Program Vegetation Monitoring Standard Operating Procedure*.

[http://myfwc.com/media/119340/OBVM\\_Monitoring\\_Standard\\_Operating\\_Procedure.pdf](http://myfwc.com/media/119340/OBVM_Monitoring_Standard_Operating_Procedure.pdf).

Accessed: March 2013.

Florida Natural Areas Inventory (2010b). Guide to the natural communities of Florida: 2010 edition. Florida Natural Areas Inventory, Tallahassee, Florida.

<http://www.fnai.org/naturalcommguide.cfm>.

Accessed: March 2013.

Florida Natural Areas Inventory (2010c.). *Reference Natural Communities*.

<http://www.fnai.org/reference-natural-communities.cfm>.

Accessed: March 2013.

Simons, R.W., S.W. Vince, and S.R. Humphrey. (1989). Hydric hammocks: a guide to management. USFWS. Biological Report. 85 (7.26 Supplement). 89 pp.

### *Sandhills*

#### **Location**

Sandhill is located on approximately 5,600 acres of refuge lands with the majority occurring along relict dune systems from Purify Creek Road southwest to Buckhorn Creek and the Sopchoppy River. A few smaller stands are also located in the Wakulla Unit on either side

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of Coggins Branch east of State Route 365, but no sandhills are present on the refuge east of the Wakulla River.

### **Overall appearance**

There is an open canopy of longleaf pine (*Pinus palustris*) in multiple age classes with trees up to 22 inches diameter and approximately 65 feet tall. The subcanopy is sparse, composed of young longleaf pine and mature turkey oak (*Quercus laevis*) and sand post oak (*Q. margaretta*) up to 50 feet tall. There may be scattered clonal clumps or domes of sand live oak (*Q. geminata*) infrequently dispersed throughout the stand. There is abundant regeneration of longleaf in the grass-stage. The shrub layer is moderately dense, covering approximately 15 percent of the ground, and generally less than 3 feet tall. Dominant shrubs are bluejack oak (*Q. incana*), turkey oak, sand post oak, gopher apple (*Licania michauxii*), dwarf live oak (*Q. minima*), and runner oak (*Q. pumila*). Other occasional shrubs are saw palmetto (*Serenoa repens*), greenbriar species (*Smilax spp.*), common persimmon (*Diospyros virginiana*), dwarf huckleberry (*Gaylussacia dumosa*), winged sumac (*Rhus copallinum*), low bush blueberries (*Vaccinium myrsinites and darrowii*), and sparkleberry (*Vaccinium arboreum*). The herbaceous layer is diverse and moderately dense to dense, dominated by wiregrass (*Aristida stricta* var. *beyrichiana*). Other dominant species are narrowleaf silkgrass (*Pityopsis graminifolia*), panic grasses (*Panicum spp.*), beard grasses (*Andropogon spp.*), Godfrey's blazing star (*Liatris provincialis*), blackberry (*Rubus cuneifolius*), partridge peas (*Chamaecrista spp.*), pinweeds (*Lechea spp.*), crotons (*Croton spp.*), asters (*Aster spp.*), wild indigos (*Baptisia spp.*), and milkpeas (*Galactia spp.*). Other common herbs include sidebeak pencil flower (*Stylosanthes biflora*), brackenfern (*Pteridium aquilinum*), elephant's foot (*Elephantopus spp.*), white-topped aster (*Sericocarpus tortifolius*), Michau's croton (*Crotonopsis linearis*), rattlebox (*Crotalaria spp.*), poor joe (*Diodia teres*), lovegrasses (*Eragrostis spp.*), oblongleaf twinflower (*Dyschoriste oblongifolia*), skeletongrasses (*Gymnopogon spp.*), sweet goldenrod (*Solidago odora*), sensitive briar (*Mimosa quadrivalvis*), queen's delight (*Stillingia sylvatica*), Eastern silver aster (*Symphotrichum concolor*), and crowngrasses (*Paspalum spp.*). Rare plants noted at the site include Godfrey's blazing star and zigzag silkgrass (*Pityopsis flexuosa*).

### **Indicator species**

Florida ticktrefoil (*Desmodium floridanum*), Coastalplain palafox (*Palafoxia integrifolia*), Dollarleaf (*Rhynchosia reniformis*), Hairy lespedeza (*Lespedeza hirta*).

### **Structural characteristics**

The herbaceous layer is diverse and is encountered in at least 25 percent (typical range is 25-40 percent) of point intercepts in any given vegetation plot. Wiregrass forms a moderately dense groundcover of no less than 10 percent by point intercept but varies considerably in amount of cover, ranging up to as much as 80 percent cover. Midstory and overstory hardwoods present do not exceed 20-square-feet of basal area and many show signs of advanced age, fire scars and cavities or other deformations used as den sites by wildlife.

### **Resources of Concern**

Rare plants present include Godfrey's blazing star (*Liatris provincialis*) and zigzag silkgrass (*Pityopsis flexuosa*). Refuge records 2011 include red-cockaded woodpecker, Bachman's sparrow, brown-headed nuthatch, red-headed woodpecker, gopher tortoise, fox squirrel, and northern bobwhite.

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## Indicators of management

Evidence of frequent prescribed fire can be found throughout this community type; most sites have been burned within the last 2-to-3 years and few sites have gone more than 4 years without being burned under prescription. There is evidence of historic plow lines, but signs of recent ground disturbance by mechanized equipment is limited to boundary lines.

Metric	Desired Future Condition Range of Values for Longleaf Pine Sandhills
Basal Area of Pine (square feet per acre) higher if pines are larger than 20" DBH	30-60
Pines exhibiting "flat topped" crowns	25-50%
Pines over 5" DBH less than 10" DBH	15-40%
Pine Regeneration (per acre)	10-100
Bare Ground (%)	1-10
Ground cover (1-3' in height)(%)	60-90
Herb Cover (%)	25-75
Wiry Graminoid Cover (%)	>10
Weedy Species Cover (%)	<2
Woody Shrub Height (average max height, feet)	<3
Shrub Cover (%)	10-20
Basal Area of hardwood (square feet per acre)	5-20
Snags ( over 10" DBH per acre)	2-5

### *Scrubby Flatwoods*

#### **Location**

Scrubby flatwoods are located on approximately 515 acres of refuge lands, principally in scattered stands between Otter Lake and Ochlockonee Bay, northwest of Otter Lake, in the vicinity of Skipper Bay, and near the terminus of Lighthouse Road near Mounds Pools I, II, and III. This localized and relatively uncommon habitat type occurs primarily on Ridgewood and Hurricane series fine sands with a few associations on Leon and Scranton and Mandarin fine sands. Florida Natural Areas Inventory lists a location on St. Marks NWR near Ochlockonee Bay as a reference natural community for scrubby flatwoods.

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## Overall appearance

The overall appearance of scrubby flatwoods is an open canopy of widely spaced pine trees exceeding 10" DBH and a highly variable shrubby understory (both in height and spatial extent) dominated by scrub oaks, saw palmetto, and openings of barren white sand. The canopy is predominately uneven-aged mature slash pine (*Pinus elliotii*), with occasional longleaf pines (*P. palustris*) co-dominant, and reproduction is evident in scattered dense areas of saplings within canopy gaps of up to one-half acre. Larger midstory trees (over 4" DBH) are a relatively rare component of the community, but where present are typically small clonal domes of sand live oak (*Quercus geminata*).

## Indicator species

Indicator species for scrubby flatwoods include Chapman's oak (*Q. chapmanii*), myrtle oak (*Q. myrtifolia*), sand live oak, rusty staggerbush (*Lyonia ferruginea*), and red basil (*Calamintha coccinea*).

## Structural characteristics

The herbaceous layer rarely exceeds 10 percent of point intercepts in any given vegetation plot. Graminoid, herb, and forb diversity is relatively low and dominated by scattered wiregrass (*Aristida stricta* var. *beyrichiana*), capillary hairsedge (*Bulbostylis ciliatifolia*), vanillaleaf (*Carphephorus odoratissimus*), and sandyfield beaksedge (*Rhynchospora megalocarpa*). Shrub cover is heterogeneous in both extent and height, typically covering 10-40 percent of plots and averaging 2 to 8 feet high. Dominant shrub species include Chapman's oak, myrtle oak (*Q. myrtifolia*), sand live oak (*Q. geminata*), and rusty staggerbush. Other rhizomatous dwarf shrubs (less than 3 feet) are common and include dwarf live oak (*Quercus minima*), runner oak (*Q. pumila*), shiny blueberry (*Vaccinium myrsinites*), Darrow's blueberry (*V. darrowii*), and dwarf huckleberry (*Gaylussacia dumosa*). A defining characteristic of this community type is the relatively high percentage of exposed bare ground (up to 20 percent typically), comprised of subxeric nutrient-poor sands. Hardwood midstory is sparse to absent and rarely exceeds 10 square-feet-per-acre (ft<sup>2</sup>/ac). The pine overstory is comprised mainly of 10"+ DBH trees at 20-60 square-feet-per-acre (ft<sup>2</sup>/ac).

## Resources of concern

Rare plants present and protected within this community include: scare-weed (*Baptisia simplicifolia*), Godfrey's blazing star (*Liatris provincialis*), and zigzag goldenaster (*Pityopsis flexuosa*). Refuge records 2011 include: gopher tortoise, brown-headed nuthatch, red-headed woodpeckers, and eastern towhee.

## Indicators of management

Evidence of frequent prescribed fire can be found throughout this community type; most sites have been burned within the last 2-to-3 years and few sites have gone more than 4 years without being burned under prescription, although due to the uneven fuel loading, evidence of variable fire intensity or large unburned patches in recent burns are visible. There is evidence of historic plow lines.

Metric	Desired Future Condition Range of Values for Scrubby Flatwoods
Basal Area of Pine (square feet per acre)	20-70
Pines Exhibiting "Flat topped" crowns (%)	25-50
Pines over 5" DBH less than 10" DBH (%)	15-40
Pine Regeneration (per acre)	5-50
Bare Ground (%)	10-20
Ground cover (1-3' in height) (%) 25-75% herbaceous, <60% woody, <40 % saw palmetto	60-80
Herb Cover (%)	1-10
Wiry Graminoid Cover (%)	1-10
Weedy Species Cover (%)	<2
Woody Shrub Height (average max height, feet)	2-8
Shrub Cover (%)	10-40
Basal Area of hardwood (square feet per acre)	10-20
Snags (per acre)	1-4

### Mesic Flatwoods

#### Location

Mesic Flatwoods are located on approximately 6,300 acres of refuge lands, with the majority occurring between Goose Creek Bay and Skipper Bay east of U.S. 98 and between Otter Lake and U.S. 319. Mesic flatwoods that grade into wet flatwoods also occur on the St. Marks unit, particularly near Port Leon and north of Aucilla Tram Road.

#### Overall appearance

The overall appearance of the mesic flatwoods is an open woodland of large (12- to 24-inch diameter), sometimes flat-topped longleaf pine (*Pinus palustris*) over scattered shrubs and a diverse herbaceous understory. The canopy is uneven-aged mature to older-mature longleaf pine, and reproduction is evident in scattered dense areas of saplings within canopy gaps of up to one-third-acre. Other pine species present as a minor component of the overstory and in transitional areas to wet flatwoods communities include slash pine (*P. elliottii*), Pond pine (*P. serotina*), and loblolly pine (*P. taeda*). Shrubs are scattered or moderately continuous, and average 10 to 20 percent cover. In drier sites, the shrub layer is dominated by abundant runner oaks—dwarf live oak (*Quercus minima*), runner oak (*Q.*

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*pumila*), and saw palmetto (*Serenoa repens*); while in wetter sites, gallberry (*Ilex glabra*) 2-to-3 feet tall is common. A diversity of other shrubs may be present, the most common including shiny blueberry (*Vaccinium myrsinites*), dwarf huckleberry (*Gaylussacia dumosa*), blue huckleberry (*G. frondosa* var. *tomentosa*), pineland St. John's wort (*Hypericum suffruticosum*), wax myrtle (*Myrica cerifera*), and winged sumac (*Rhus copallinum*). Woody vines, particularly earleaf greenbrier (*Smilax auriculata*), sarsaparilla vine (*S. pumila*), and muscadine (*Vitis rotundifolia*), are common or occasional, but sparse in cover.

### **Indicator species**

Indicator species for North Florida Mesic Flatwoods include Florida dropseed (*Sporobolus floridanus*) and hairy wicky (*Kalmia hirsuta*).

### **Structural characteristics**

The herbaceous layer is exceptionally diverse and is encountered in at least 25 percent (typical range is 25 to 40 percent) of point intercepts in any given vegetation plot. Wiregrass (*Aristida stricta* var. *beyrichiana*) and Florida dropseed forms a consistent groundcover of no less than 10 percent by point intercept, but varies considerably in amount of cover, ranging up to as much as 80 percent cover. Characteristic shrubs include saw palmetto (*Serenoa repens*), gallberry, coastalplain staggerbush (*Lyonia fruticosa*), and fetterbush (*L. lucida*). Rhizomatous dwarf shrubs, usually less than 3 feet tall, are common and include dwarf live oak, runner oak, shiny blueberry, Darrow's blueberry (*V. darrowii*), and dwarf huckleberry. The herbaceous layer is predominantly grasses, including wiregrass, dropseeds (*Sporobolus curtissii*, *S. floridanus*), panicgrasses (*Dichanthelium* spp.), and broomsedges (*Andropogon* spp.), plus a large number of showy forbs.

### **Resources of Concern**

Scare-weed (*Baptisia simplicifolia*) (refuge records 2011), red-cockaded woodpecker, Bachman's sparrow, brown-headed nuthatch, northern bobwhite, red-headed woodpecker, and frosted flatwoods salamander.

### **Indicators of management**

Evidence of frequent prescribed fire can be found throughout this community type; most sites have been burned within the last two to three years and few sites have gone more than four years without being burned under prescription. There is evidence of historic plow lines, but signs of recent ground disturbance by mechanized equipment are limited to areas along the refuge boundary.

Metric	Desired Future Condition Range of Values for Mesic
Basal area of pine (square feet per acre); higher if pines are larger than 20")	40-70
Pines exhibiting "flat-topped" crowns (%)	25-50
Pines over 5" DBH less than 10" DBH	15-40%
Pine regeneration (stems/acre)	10-100
Basal area of hardwood (square feet per acre)	0-10
Ground cover (1-3' height) (%) (25-75% herbaceous, <60% woody, <40 % saw palmetto)	70-100
Snags (>10" DBH)	2-5
Weedy species cover (%)	<2
Woody shrub height (average max height, feet)	<3
Shrub cover (%)	<25
Exotic plant species cover (%)	0

### *Wet Flatwoods*

(exclusive of calcareous savanna phase wet flatwoods east of Goose Creek Bay)

### **Location**

Wet flatwoods occupy 1,142 acres of refuge lands in numerous small stands fringing marsh or hardwood swamps from Goose Creek Bay west to Skipper Bay, in several fragmented stands within the Otter Creek drainage, and predominately west of Buckhorn Creek near the Sotchoppy River.

### **Overall appearance**

The overall appearance of the wet flatwoods is an open savannah of large, sometimes flat-topped pines over a carpet of grasses, sedges, and a large diversity of forbs. Canopy pines present typically include longleaf pine (*Pinus palustris*) and slash pine (*P. elliottii*), but may also include loblolly pine (*P. taeda*) and pond pine (*P. serotina*), particularly in habitats adjacent to coastal ecosystems, such as salt marsh, maritime hammock, and hydric hammock. Canopy trees are large (greater than 10 inches in diameter) well-spaced pines that are fairly even in distribution, although some of the oldest trees are stunted in radial growth due to the hydric conditions. Uneven-aged pine regeneration is common. Shrubs and clumps of saw palmetto (*Serenoa repens*) are uncommon and concentrated mainly in the ecotone leading upslope to mesic flatwoods. The shrub layer is patchy and dynamic in relation to recent fire history and includes species such as gallberry (*Ilex glabra*), wax myrtle

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(*Myrica cerifera*), coastal sweetpepperbush (*Clethra alnifolia*), and fetterbush lyonia (*Lyonia lucida*). The herbaceous layer is dense and exceptionally diverse. It is mainly composed of wiregrass (*Aristida stricta* var. *beyrichiana*), but a host of other species is present. A few of the most common are witchgrass (*Dichanthelium* sp.), toothache grass (*Ctenium aromaticum*), purple bluestem (*Andropogon glaucopsis*), yellow colic-root (*Aletris lutea*), savannah meadowbeauty (*Rhexia alifanus*), yaupon blackberry (*Seymeria cassioides*), and Florida dropseed (*Sporobolus floridanus*).

### **Indicator species**

Purple bluestem (*A. glaucopsis*), bushy bluestem (*A. glomeratus*), toothache grass (*Ctenium aromaticum*), parrot picture plant (*Sarracenia psittacina*), pine lily (*Lillium catesbaei*), sundews (*Drosera* spp.).

### **Structural characteristics**

The herbaceous layer frequently exceeds 40 percent of point intercepts in any given vegetation plot and is composed of wiry graminoids, such as wiregrass, beakrushes, and panic grasses. Characteristic shrubs include saw palmetto (*Serenoa repens*) and gallberry (*Ilex glabra*) and rarely occupy more than 10 percent of cover or exceed 3 feet in height. A tall shrub to midstory may be present, particularly near ecotones with embedded depressional wetlands with a history of fire exclusion. Within these areas, myrtle-leaved holly (*Ilex myrtifolia*), titi (*Cyrilla racemiflora*), and buckwheat tree or black titi (*Cliftonia monophylla*) are common. Midstory hardwood species including pondcypress red maples and swamp tupelo may be present, particularly in near-coastal sites, but do not generally exceed 5 square feet per acre (ft<sup>2</sup>/ac) and are most frequently found in transition zones to other habitat types. The pine overstory is relatively open, with canopy cover typically less than 25 percent and basal area rarely exceeding 40ft<sup>2</sup>/acre.

### **Resources of Concern**

Wet flatwoods or ecotones between wet flatwoods and other habitat types harbors one of the refuge's richest assemblages of rare plants, including or potentially including: spoonleaf sundew (*Drosera intermedia*), wiregrass gentian (*Gentiana pennelliana*), nightflowering wild petunia (*Ruellia noctiflora*), and Chapman's sedge (*Carex chapmanii*). The Henslow sparrow, red-cockaded woodpecker, and brown-headed nuthatch are also resources of concern.

### **Indicators of management**

Evidence of frequent prescribed fire can be found throughout this community type; most sites have been burned within the last two to three years and few sites have gone more than four years without being burned under prescription. There is evidence of historic plow lines, but signs of recent ground disturbance by mechanized equipment are limited to areas along the refuge boundary.

Metric	Desired Future Condition Range of Values for Wet Flatwoods
Basal area of pine (square feet per acre)	5-40
Pines exhibiting "Flat-topped" crowns (%)	40-60
Pines over 5" DBH less than 10" DBH (%)	10-30
Pine regeneration (per acre)	0-20
Bare ground (%)	<2
Ground cover (1-3' in height) (%) 70-95% herbaceous, <20% woody, <5% saw palmetto	90-100
Herb cover (%)	>40
Wiry graminoid cover (%)	>20
Weedy species cover (%)	<2
Woody shrub height (average max height, feet)	<3
Shrub cover (%)	<20
Basal area of hardwood (square feet per acre)	0-10
Snags (per acre)	1-2

*Wet Flatwoods*  
**(calcareous savanna phase ([Carr et al. 2010](#)),**

*Cabbage Palm Flatwoods*  
**([FNAI, 2010c](#)).**

### Location

This variant of wet flatwoods (hereafter referred to as cabbage palm flatwoods) occupies approximately 5,900 acres of refuge lands in five groupings of stands between Goose Creek Bay and the Aucilla River, where the limestone substrate is at or near the surface and overlying sands are of minimal thickness. These stands generally fringe the coastal marshes and contain numerous inclusions of cypress domes, herbaceous-dominated depression marshes, and larger forested basin swamps. In many cases, the transition zone from cabbage palm flatwoods grades into hydric hammock where hydroperiod is longer or into mesic flatwoods where soil depth and permeability are greater. West of Goose Creek Bay, the St. Marks Formation limestone gradually dips deeper below the surface and is overlain by increasingly deeper sands on an east-west gradient. In these areas, typical longleaf pine-dominated wet flatwoods occupy low, flat and poorly drained sites often with an impermeable hardpan that contributes to a seasonally high water table. Both community variants will be managed similarly.

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## Overall appearance

The overall appearance of cabbage palm flatwoods is an open savannah of large, sometimes flat-topped slash pines over a carpet of hydrophytic grasses, sedges, and a large diversity of forbs. Canopy pines present typically include slash pine (*Pinus elliotii*), but may also include infrequent loblolly pine (*P. taeda*) and pond pine (*P. serotina*), particularly in habitats adjacent to coastal ecosystems, such as salt marsh, maritime hammock, and hydric hammock. Longleaf pines (*P. palustris*) are occasionally co-dominant in stands grading to mesic flatwoods. Cabbage palms (*Sabal palmetto*) and pondcypress (*Taxodium ascendens*) are a frequent midstory and sub-canopy component, particularly within transition zones to depressional wetlands and cypress domes. Canopy trees are large (greater than 10 inches in diameter), well-spaced pines that are fairly even in distribution. Uneven-aged pine regeneration is common, but not uniform in distribution and can be found in gaps of up to 1/2-acre. Shrubs and clumps of saw palmetto (*Serenoa repens*) are uncommon and concentrated mainly in the ecotone leading upslope to mesic flatwoods. A few other shrubs are occasional, including gallberry (*Ilex glabra*) and wax myrtle (*Myrica cerifera*). The herbaceous layer is dense and exceptionally diverse. It is composed of beakrushes (*Rhynchospora spp.*), rosette grasses (*Dichantherium spp.*), panic grasses (*Panicum spp.*), sawgrass (*Cladium jamaicense*), saltmeadow cordgrass (*Spartina patens*), and sand cordgrass (*Spartina bakeri*).

## Indicator species

Fewflower milkweed, redtop panic grass, southeastern sneezeweed, cabbage palm, cypress panicgrass.

## Structural characteristics

The herbaceous layer is exceptionally diverse and is encountered in at least 25 percent (typical range is 25-50 percent) of point intercepts in any given vegetation plot. Wiry graminoids, such as beakrushes, panic grasses, and rosette grasses, form a consistent groundcover of no less than 10 percent by point intercept, but varies considerably in amount of cover, ranging up to as much as 80 percent cover. Characteristic shrubs include saw palmetto (*Serenoa repens*) and gallberry (*Ilex glabra*) and rarely occupy more than 20 percent of cover or exceed 3 feet in height. Midstory hardwood species including cabbage palm, pondcypress red maples, and swamp tupelo are common, but do not generally exceed 20-square-feet-per-acre (ft<sup>2</sup>/ac) and are most frequently found in transition zones to other habitat types. The pine overstory is more dense in near-coastal habitats than sites more typical of wet pine savanna, but rarely exceeds 80-square-feet-per-acre (ft<sup>2</sup>/ac).

## Resources of Concern

Wet flatwoods or ecotones between wet flatwoods and other habitat types harbor one of the refuge's richest assemblages of rare plants, including or potentially including: spoonleaf sundew (*Drosera intermedia*), wiregrass gentian (*Gentiana pennelliana*), nightflowering wild petunia (*Ruellia noctiflora*), and Chapman's sedge (*Carex chapmanii*) (refuge records 2011).

## Indicators of management

Evidence of frequent prescribed fire can be found throughout this community type; most sites have been burned within the last two to three years and few sites have gone more than four years without being burned under prescription. There is evidence of historic plow lines, but

signs of recent ground disturbance by mechanized equipment are limited to the refuge boundary and roads. Critical habitat for the frosted flatwood salamander occurs throughout much of this habitat. Evidence of ground disturbance near these areas or any similar potentially suitable breeding pond habitat within the cabbage palm flatwoods matrix generally is localized to areas greater than 1,500 feet from potential breeding ponds.

Metric	Desired Future Condition Range of Values for Cabbage Palm Flatwoods
Basal area of pine (square feet per acre)	40-70
Pine regeneration (per acre)	1-20
Bare ground (%)	<2
Herb cover (%)	>25
Wiry graminoid cover (%)	>10
Weedy species cover (%)	<2
Woody shrub height (average max height, feet)	<3
Shrub cover (%)	<20
Basal area of hardwood (square feet per acre)	<10
Basal area of cabbage palms and cypress (square feet per acre)	<15
Snags (per acre)	2-5

*Hardwood Hammock*  
(Hydric and Mesic Hammock)

**Location**

Hydric hammocks on the refuge are generally near-coastal and part of a larger regional belt of Gulf Coastal hammocks comprised of cabbage palm and hardwood dominated forests fringing coastal salt marshes from Wakulla to Pasco Counties along Florida’s Big Bend. Large, contiguous stands of hydric hammock exist on the refuge on both sides of the Aucilla River, but all hydric hammock between the Aucilla and Pinhook Rivers is in federal wilderness area. Additional extensive hydric hammock exists fringing the wilderness area from the Pinhook River through much of the St. Marks Unit west to Lighthouse Road. Further west, large portions of the eastern Wakulla Unit are hydric hammock, grading into mesic hammock on the northern boundary of the refuge between the Wakulla River and Spring Creek. West of Spring Creek, both hydric and mesic hammocks are only minor components of the landscape, associated primarily with freshwater drainages between Alligator Lake and Otter Lake, Buckhorn Creek, and the Sopchoppy River. Hardwood hammock forests typically coincide with Tooles-Nutall-Chaires fine sands east of Spring Creek where limestone is frequently at or near the surface. West of Spring Creek, deeper, poorly drained sands such as Rutledge and Pottsburg support smaller, less contiguous stands of hardwood hammock.

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## Overall appearance

Hydric hardwood hammocks are found in their natural condition with little evidence of human disturbance. Occasional natural disturbances including wind storms, stormwater surges from tropical storm events, insects, diseases, and fires that penetrate the drier margins of this ecosystem shape the vegetation patterns. The typically wet conditions render extensive fires uncommon, but large snags and lightning-struck trees are visible throughout the forest.

Coastal variant: This vegetation is heavily influenced by maritime conditions such as saltwater inundation and salt spray caused by storms, and is distinguished by a dominance of live oak, cabbage palm, and red cedar in the canopy and subcanopy. Slash pines (*Pinus elliottii*) and loblolly pines (*P. taeda*) are common. Typical shrubs include yaupon, wax myrtle, groundsel tree (*Baccharis halimifolia*), marsh elder (*Iva frutescens*), and Spanish bayonet (*Yucca aloifolia*). In some areas slash pines may dominate coastal hydric hammocks, especially nearest the salt marsh, and on small islands, forming an emergent canopy.

## Indicator species

Cabbage palm, red maple, diamond leaf oak (*Quercus laurifolia*), live oak (*Q. virginiana*), Florida elm, American hornbeam, sedges (*Carex* spp.), spikegrasses (*Chasmanthium* spp.), and spruce pine (*P. glabra*).

## Structural characteristics

The forest canopy is multi-layered and contains occasional super-emergent pine trees. Hammocks with little evidence of fire typically exhibit a complex multi-layered structure and contain a greater variety of co-dominant species such as sweetgum, swamp laurel oak, southern red-cedar, Florida elm, sweetbay, swamp tupelo, American hornbeam, and red maple. Canopy closure averages 75-90 percent. Shrub cover is patchy and variable, occupying on average 25-50 percent of the stand, and in some areas of canopy gaps up to 1/2-acre, the shrub layer is extremely dense. The most common shrubs are wax myrtle (*Myrica cerifera*) and yaupon (*Ilex vomitoria*). Less common but characteristic shrubs are Virginia willow (*Itea virginica*), dwarf palmetto (*Sabal minor*), and swamp dogwood (*Cornus foemina*). The herbaceous layer is generally a relatively minor component of hammocks occupying less than 25 percent of the forest floor, except within transition zones where frequent fire enters from adjacent habitats managed with fire. Herbs typically includes saw grass (*Cladium jamaicense*), spikegrasses (*Chasmanthium latifolium*, *C. nitidum*, and *C. laxum* var. *sessiliflorum*), millet beaksedge (*Rhynchospora miliacea*), switch cane (*Arundinaria gigantea*), lizard's tail (*Saururus cernuus*), and string lily (*Crinum americanum*). Southern shield fern (*Thelypteris kunthii*) or Virginia chain fern (*Woodwardia virginica*) can be abundant.

## Resources of Concern

Florida corkwood (*Leitneria floridana*), bay starvine (*Schisandra glabra*), Florida willow (*Salix floridana*) (refuge records 2011), swallow-tailed kites, Kentucky warbler, Swainson's warbler, wood thrush, woodcock, and rusty blackbird.

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## Indicators of management

Evidence of infrequent but generally low-intensity prescribed fire can be found within transition zones of this community type to more upland communities; many transition zones have been burned within the last three years and few have gone more than six years without low intensity prescribed fires entering them. There is little evidence of fire in the interior portion of the hammocks. There is little evidence of historic plow lines, and no sign of recent ground disturbance by mechanized equipment. The forest floor is generally free of rooting disturbance and feral hog impacts are minimized through active hog removal efforts and recreational hog harvests. Impacts from invasive plant removal may be evident.

Metric	Desired Future Condition Range of Values for Mesic and Hydric Hammock
Basal area of pine (square feet per acre)	0-20
Basal area of hardwood (square feet per acre)	40-100
Canopy age distribution (all trees)	80% mature-old growth, 15% sapling, 5% reproduction
Canopy closure (%)	60-80 %
Leaf litter and bare ground (%)	20-75%
Herb cover (%)	0-30%
Weedy species cover (%)	<2
Woody shrub height (average max height, feet)	<16
Shrub cover (%)	25-50%
Exotic plant species cover (%)	0
Number of canopy hardwood species per stand	>15

*Shrub Bog*  
(and associated isolated depression wetlands)

### Location

Shrub bog is found on St. Marks NWR primarily west of Goose Creek Bay on the border of swamps, in streamhead drainages, and in flat, poorly drained areas. It often is embedded in depressions within mesic and wet flatwoods communities or forms the border between the mesic or wet flatwoods communities and dome swamp, basin swamp, or hydric hammock communities. Soils of shrub bogs frequently have an organic muck layer of varying depth at the surface underlain by sand or loamy sands. Characteristic soil series include Rutledge, Donovan, and Surrency.

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## Overall appearance

Shrub bog consists of dense stands of broadleaved evergreen shrubs, vines, and short trees, one to five meters tall depending on time since fire, with or without an overstory of scattered pine or bay trees, growing in mucky soil where water is usually less than a foot deep. Characteristic shrubs include titi (*Cyrilla racemiflora*), black titi (*Cliftonia monophylla*), fetterbush (*Lyonia lucida*), large gallberry (*Ilex coriacea*), gallberry (*I. glabra*), wax myrtle (*Myrica cerifera*), and sweet pepperbush (*Clethra alnifolia*), often laced together with laurel greenbrier (*Smilax laurifolia*). Other shrubs that may be present include red chokeberry (*Photinia pyrifolia*), Virginia willow (*Itea virginica*), swamp doghobble (*Leucothoe racemosa*), and myrtle dahoon (*Ilex cassine* var. *myrtifolia*). Taller pines, either pond (*Pinus serotina*), slash (*P. elliotii*), or loblolly (*P. taeda*), may be present, but do not form a closed canopy.

Although it may share many species with wet flatwoods, shrub bog differs in usually having few or no slash or longleaf pines and is also differentiated from basin, dome, and floodplain swamps which support canopies of hydrophitic trees. Shrub bogs, in contrast, are characterized by having only occasional canopy-sized trees of swamp hardwoods such as loblolly bay (*Gordonia lasianthus*), sweetbay (*Magnolia virginiana*), swamp bay (*Persea palustris*), pond cypress (*Taxodium ascendens*), and red maple (*Acer rubrum*). Saw palmetto (*Serenoa repens*) is rare or absent in the shrub layer, and a peat layer is typically present on the soil surface, usually supporting sphagnum moss.

Most importantly from a management perspective, shrub bog is distinctive from wet prairie and by the dominance of shrubby, instead of graminoid species. The presence of remnant clumps of wiregrass can be used to distinguish a shrub-invaded wet prairie from a natural shrub bog, since light-loving wiregrass would not be able to become established or maintain itself in a natural shrub bog community. Several lines of evidence indicate that shrub bog species have invaded bordering wet prairies and wet flatwoods in the absence of frequent fire. Aerial photographs from the 1930s to 1950s often show a light-colored band of grasses around swamps and shrub bogs in the panhandle that is replaced by dense shrub vegetation on current aeriels. Senescent wiregrass (*Aristida stricta* var. *beyrichiana*) can occasionally be found among titi shrubs in shrub bogs where it is too shady for wiregrass to have originated.

## Indicator species

Titi, black titi, sweet pepperbush, fetterbush, large gallberry, laurel greenbrier, pond pine.

## Structural characteristics

The herbaceous layer rarely exceeds 5 percent of point intercepts in any given vegetation plot and is typically confined to patchy openings in the shrub sub-canopy. Graminoid, herb, and forb diversity is relatively low. Shrub cover is heterogeneous in both extent and height, typically covering 40-90 percent of plots and averaging 8-16 feet high. A defining characteristic of this community type is a layer of sphagnum moss carpeting exposed organic soils and mucks. Overstory pines and hardwoods are sparse and rarely exceed 20-square-feet-per-acre (ft<sup>2</sup>/ac).

## Resources of Concern

Swainson's warbler, Kentucky warbler

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## Indicators of management

Wildland fires starting in the surrounding pinelands burn to the edges of shrub bogs, but burn through them only during drought periods, probably on the order of every 10-20 years. The shrubs and bay trees respond to fire by re-sprouting, either from root crowns or rhizomes. During droughts the peat may become dry enough to burn completely, killing the shrubs and producing a mosaic of open-water areas and sedge-dominated marshes alternating with shrub bogs. Historic firelines are visible as linear depressions in and around shrub bogs, but there is no evidence of recent fireline construction.

Metric	Desired Future Condition Range of Values for Shrub Bogs
Basal area of pine (square feet per acre) higher if pines are larger than 20" DBH	10-20
Leaf litter and bare ground (%)	90-100
Ground cover (1-3' in height) (%)	0-10
Herb cover (%)	0-5
Wiry graminoid cover (%)	0-5
Weedy species cover (%)	<1
Woody shrub height (average max height, feet)	<20
Shrub cover (%)	40-90
Basal area of hardwood (square feet per acre)	0-10
Snags ( over 10" DBH per acre)	≤1

### *Marine and Estuarine Wetlands*

#### Location

Marine and estuarine wetlands comprised of salt marsh, coastal berm, coastal grasslands, and salt flats extend along the entire Gulf-facing boundary of the refuge from the Aucilla River to Ochlocknee Bay. These habitat types coincide with very poorly drained Bayvi sands. East of Spring Creek, surface outcrops of St. Marks and Suwannee formation limestone are common.

#### Overall appearance

Salt marsh is a largely herbaceous community that occurs in the portion of the coastal zone affected by tides and seawater and protected from large waves, either by the broad, gently sloping topography of the shore or by location along a bay or estuary. Saltmarsh cordgrass (*Spartina alterniflora*) dominates the seaward edge and borders of tidal creeks, areas most frequently inundated by the tides. Needle rush (*Juncus roemerianus*) dominates higher, less frequently flooded areas. The landward edge of the marsh is influenced by freshwater influx

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and fire originating from the uplands and may be colonized by a mixture of high marsh and inland species, including sand cordgrass (*S. bakeri*), saw grass (*Cladium jamaicense*), saltmeadow cordgrass (*S. patens*), knotgrass (*Paspalum distichum*), and salt grass (*Distichlis spicata*). A border of salt-tolerant shrubs, such as groundsel tree (*Baccharis halimifolia*), saltwater falsewillow (*Baccharis angustifolia*), marsh elder (*Iva frutescens*), and Christmas berry (*Lycium carolinianum*), often marks the transition to upland vegetation or low berms along the seaward marsh edge. Extensive, nearly barren, hypersaline sand flats are interspersed within the high marsh as a result of periodic flooding and evaporation of saltwater.

### **Indicator species**

Saltmarsh cordgrass, black needle rush, saltgrass, saltwort, perennial glasswort, seaside oxeye, saltmeadow cordgrass, marsh elder, Christmas berry.

### **Structural characteristics**

The majority of the habitat type is dominated by extensive stands of black needlerush that may reach 100 percent cover in many locations. Overstory canopy cover of pines, cedar, live oaks, and cabbage palm is nearly absent and confined almost exclusively to inclusions of isolated maritime hammock or cabbage palm wet flatwoods that often occur on slightly elevated limestone outcroppings higher than the surrounding marsh. Bare ground is unevenly distributed and may cover extensive portions of high marsh and typically occurs over less than 5 percent of the habitat type as a whole. A shrub component is typically only present on slightly elevated seaward berms fronting the open Gulf or within transition zones between the high marsh component and forested wetlands such as hydric hammock, but within these areas, a moderate to extensive (15-40 percent) shrub cover is common.

### **Resources of Concern**

Salt marshes on the refuge contain the vast majority of known habitat and populations of Godfrey's spiderlily (*Hymenocallis godfreyi*), endemic to Wakulla County (refuge records, 2011), seaside sparrow, black rail, salt marsh sparrow, Nelson's sparrow, Wilson's plover, diamond-backed terrapin, and cultural sites.

### **Indicators of management**

Evidence of wildland fire can be found in this community type; many sites have been burned within the last 10 years, particularly on the upper transition zones to pine-dominated habitat types such as cabbage palm wet flatwoods. There is little evidence of historic plow lines, but any past ground disturbance is persistent and typically results in localized changes in vegetation composition. There are complete and partial levees and evidence of levee construction evident.

<b>Metric</b>	<b>Desired Future Condition Range of Values for Tidal Marsh</b>
Basal area of pine (square feet per acre)	0
Basal area of hardwood (square feet per acre)	0
Canopy closure (%)	0
Bare ground (%)	0-15% includes salt flats
Herb cover (%)	85-100%
Weedy species cover (%)	0
Woody shrub height (average max height, feet)	4-15
Shrub cover (%)	0-40%
Exotic plant species cover (%)	0

## Appendix H. Impoundment Water Regimes and Facilities

### PART 1. SUMMARY OF TYPICAL TARGET IMPOUNDMENT WATER LEVELS

Impoundment	Water Level (Feet, MSL)	Timeframe
East River Pool	5.0 - 6.0	Year-round
Mounds 1	4.5 3.25	Mar 1 – Sep 15 Sep 15 – Feb 15
Mounds 2	4.0 - 4.5	Year-round
Mounds 3	4.5 3.25	Mar 1 – Oct 1 Oct 15 – Feb 15
Stoney Bayou 1	5.0 Open Gates (tidal)	Mar 1 – Oct 1 Oct 15 – Feb 15
Stoney Bayou 2	4.0 2.25	Mar 15 – Oct 15 Oct 30 – Mar 1
Headquarters Pond	5.0 4.0	Mar 1 – Nov 15 Dec 1 – Mar 1
Tower Pond	4.0 - 5.0 Open Gate (tidal)	Oct 10-Mar 1 & May 20-July 10 Mar 1-May 20 & July 10- Oct 10
Picnic Pond	4.0 - 5.0 3.0 - 4.0	Mar 1 – Nov 1 Dec 1 – Feb 15
Lighthouse Pool	Generally no manipulation	
Plum Orchard Pond	Generally no manipulation	
Stoney Bayou Field	Generally no manipulation	
Stoney Bayou (East)	None Possible	
Johnson Creek	To be determined - currently no manipulation (tidal)	
Levy Ditch	No manipulation	

## PART 2. CONCRETE WATER CONTROL STRUCTURES (WCS)

WCS	Construction Date	Bottom Elevation (MSL)	Bay Width (inches)	Stoplog Length (inches)	Location (N=North W=West S=South E=East)
1	1980	0.00	60	62	Under C-59 at East River Pool
2	1980	0.00	60	62	NE Stoney Bayou 2
3	1980	0.00	60	62	NW Stoney Bayou 2 at Div. Canal
4	1980	0.00	96	98	Under crossdike N of Stoney Bayou 2
5	1980	-1.00	96	98	Under crossdike SE of Stoney Bayou 2
6	1980	-1.00	96	98	Stoney Bayou (E) E of Stoney Bayou 2
7	1980	0.00	60	62	SE Stoney Bayou 1 at Stoney Bayou 2
8	1980	-1.00	96	98	Stoney Bayou 1 E of Pump Station
9	1980	0.00	96	98	Stoney Bayou (E) at Deep Creek
10	1980	0.00	60	62	Stoney Bayou 1 at Pump Station
11	1980	0.00	60	62	Mounds 1 at Pump Station
12	1980	0.00	60	62	Mounds 3 at Pump Station
13	1980	0.00	60	62	S end Mounds 1 at Mounds #2
14	1980	-1.00	60	62	Mounds 3 at Horns Creek
15	1980	0.00	60	62	NE Mounds 2 at Mounds #3
16	1978	0.00	60	62	Under C-59 at Mounds #1
17	1966	0.00	61	64	Div. Canal at East River and Mounds 1
18	1966	0.00	60	62 <sup>3</sup> / <sub>4</sub>	<b>a)</b> East River Pool at Div. Canal
19	1958	+1.00	60	63 <sup>1</sup> / <sub>2</sub>	<b>b)</b> East River Pool N of spillway
20	1997	-1.50	61	63 <sup>1</sup> / <sub>4</sub>	NW Stoney Bayou 1 at Div. Canal
21	1941	+2.00	54	57 <sup>1</sup> / <sub>2</sub>	<b>c)</b> South end Picnic Pond at C-59
22	1942	+2.00	54	57 <sup>1</sup> / <sub>2</sub>	<b>c)</b> Aucilla Tram at C-59

Notes: Also a 190-foot concrete spillway with overflow level of 6.5 feet Mean Sea Level (MSL) in East River Pool (constructed in 1965); 2 80-foot concrete spillways with overflow level of 2 feet below the top of the dike in Stoney Bayou East (constructed in 2008); and a 14 flapgate WCS (48-inch diameter) connecting Stoney Bayou 1 to Stoney Bayou Creek (constructed in 2008).

**a)** structure contains 4 bays; **b)** structure contains 8 bays; **c)** structure contains 6 bays (2 deep, 4 shallow)

**PART 3. CORRUGATED METAL PIPES WITH FLASHBOARD RISERS (CMP)**

<b>CMP</b>	<b>Location</b>	<b>Riser Width (inches)</b>	<b>Stoplog Width (inches)</b>	<b>Pipe Diameter (inches)</b>	<b>Material</b>	<b>Date</b>
1	Stoney Bayou Field – SE corner - S	33 ½	37	30	aluminum	2002
2	Stoney Bayou Field – SE corner - E	33 ½	37	30	aluminum	2002
3	Headquarters Pond & Mounds 2	39 ½	43	30	aluminum	2005
4	Headquarters Pond under C-59	33 ½	37	24	aluminum	1993
5	Tower Pond & Mounds 3	39 ¼	43	30	aluminum	1987
6	Tower Pond to salt marsh	39 ½	43	30	aluminum	1999
7	Tower Pond & Picnic Pond	39 ¼	43	30	aluminum	1987
8	Lighthouse Pool – NW corner	27 ½	31	30	aluminum	1999
9	Johnson Creek	32 ½ (2 bays)	35	48	aluminum	2005
10	Levy Ditch	27 (2 bays)	30 ½	60	coated galvanized	1971

**PART 4. IMPOUNDMENT AND OTHER MANAGED WETLANDS DESCRIPTIONS, MANAGEMENT, USES, AND WATER SUPPLIES.**

Impoundment	Acres	Management Focus	Public Use	Drawdown	Water Supply	Exceptions to General Water Level Maintenance
East River Pool	245	Principal freshwater source for other pools. Wading Birds, Waterfowl, Fish	Principal freshwater fishing; bird watching & canoeing, Florida Trail	Gravity drained via WCS 17, 18 & 19.	Rainfall, East River Swamp runoff. Only impoundment with significant watershed	Periodic drawdowns prior to impoundment rehabilitation, reduced water levels during timber operations in adjacent pinelands
Mounds 1	133	Fresh to brackish water. Wading birds, Waterfowl, Fish	Adjacent to Lighthouse Rd (C-59), used for wildlife observation and fishing	Gravity flow via WCS 16 & 17	Rainfall, gravity fresh water flow from East River Pool. Salt water via pump from Stoney Bayou Creek, brackish water via gravity-flow from Stoney Bayou 1 or Mounds 3	Periodic drawdowns and/or deep flooding for habitat rehabilitation.
Mounds 2	129	Freshwater. Waterbirds, Waterfowl, Marsh birds	Adjacent to Lighthouse Rd (C-59), used for wildlife observation and fishing	Via gravity flow using WCS 13, Mounds 1, WCS 15, Mounds 3 or Headquarters Pond CMP, providing one of these is also being drained. Complete drainage of northcentral portion requires ditching & pumping	Rainfall, freshwater gravity flow from East River Pool through Mounds 1. Salt or brackish water gravity flow via Mounds 1 or 3.	Water levels depend on management in Mounds #1. Periodic drawdowns or deep flooding for rehabilitation projects.
Mounds 3	309	Brackish to fresh water. Wading Birds, Waterfowl, Shorebirds	Wildlife observation, fishing	Drained via gravity flow through WCS 14	Rainfall, fresh water by gravity flow from East River Pool through Stoney Bayou #1, salt water via pump station from Stoney Bayou Creek	Periodic drawdowns and/or deep flooding for habitat rehabilitation. Use of impoundment for gravity flooding adjacent pools with salt/brackish water.
Stoney Bayou 1	301	Brackish to fresh water. Shorebirds, Wading Birds, Waterfowl	Wildlife observation, fishing	Drained by gravity using WCS 8 & flapgates	Rainfall, fresh water by gravity flow from East River Pool, salt water via flapgates and/or pump from Stoney Bayou Creek	Deep flooding for habitat rehabilitation. Use of impoundment for gravity flooding Stoney Bayou 2, Mounds 1 or 3 with salt/brackish water.

Impoundment	Acres	Management Focus	Public Use	Drawdown	Water Supply	Exceptions to General Water Level Maintenance
Stoney Bayou 2	286	Fresh to brackish water. Wading Birds, Waterfowl, Fish	Wildlife observation, fishing, Florida Trail	Drained via WCS 5 using gravity flow	Rainfall, fresh water by gravity flow from East River Pool, Stoney Bayou Field, and swamp north of pool. Salt water via pump	Periodic drawdowns and/or deep flooding for habitat rehabilitation.
Headquarters Pond	18	Fresh water. Wading Birds, Waterfowl	Wildlife observation tower	Drained via CMP under C-59, complete drawdown requires pump.	Rainfall, fresh water by gravity flow from Mounds 2	Periodic drawdowns for habitat rehabilitation.
Tower Pond	20	Brackish water. Shorebirds, Wading Birds,	Wildlife observation along Tower Pond Trail	Drained via CMP to salt marsh.	Rainfall, flapgate in CMP, and gravity flooding via Mounds 3 or Picnic Pond	Occasional prolonged deep flooding.
Picnic Pond	57	Brackish to fresh water. Wading Birds, Waterfowl, Marsh birds	Wildlife observation, fishing, & picnicking	Only partial drawdown possible using gravity, otherwise via pumping	Rainfall & gravity flooding with brackish water from Mounds 3 through Tower Pond, when feasible. Brackish water can also be pumped via borrow canal to south.	Periodic drawdowns during habitat and facility rehabilitation projects
Lighthouse Pool	28	Wading Birds, Waterfowl, Shorebirds	Wildlife observation	Pumping only	Rainfall and pumping salt water from adjacent boat canal	CMP kept open for outflow. Pumping during drawdowns for rehabilitation projects.
SE Section of Stoney Bayou Field	70	Fresh water. Marsh birds and Wading birds	Limited sportfishing, dike is segment of Florida Trail & refuge walking trail	Partially using gravity flow via East River, Stoney Bayou 1 or 2 or North of Stoney Bayou 2 when one of those is lower. Complete drawdown requires pumping.	Rainfall & gravity flow from East River, Stoney Bayou 1 & 2.	Used as source of fresh water for flooding Stoney Bayou 1 or 2. Periodic drawdowns for habitat rehabilitation.

Impoundment	Acres	Management Focus	Public Use	Drawdown	Water Supply	Exceptions to General Water Level Maintenance
<b>Other Managed Wetlands</b>						
Stoney Bayou (East)	302	Brackish water. WCS left open to allow tidal flushing and to reduce possibility of levee blow-out. Marsh birds, Wading birds, Shorebirds	Dike is part of Florida Trail & refuge trail	Gravity flow via WCS 6 & 9.	Rainfall, Stoney Bayou 2, Gum Swamp and adjoining pine flatwoods runoff, limited tidal inflow via WCS 6 & 9 and break-throughs under dike	None
Plum Orchard Pond	4.5	Fresh water. Wading Birds, Marsh Birds, Alligators	Reserved for wildlife observation, nature study & photography.	Only via portable pump	Rainfall	Periodic drawdowns for habitat rehabilitation.
Levy Ditch	50	Management suspended. Fresh water. Waterfowl, Wading birds	None	Oak flats drained by gravity via CMP	Rainfall and runoff from adjacent lands	None. Management suspended.
Johnson Creek	30	Brackish water. Management to be developed. Shorebirds, Wading birds	None	Drained via flapgates on CMP	Salt water via flapgates	Occasional prolonged deep flooding.

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## Appendix I. Environmental Action Statement

Within the spirit and intent of the Council on Environmental Quality's regulations for implementing the National Environmental Policy Act (NEPA), and other statutes, orders, and policies that protect fish and wildlife resources, I have established the following administrative record and determined that the following action is categorically excluded from NEPA documentation requirements consistent with 40 CFR 1508.4, 516 DM 2.3A, 516 DM 2 Appendix 1, and 516 DM 6 Appendix 1.4.

### **ACTION AND ALTERNATIVES**

The action is the approval and implementation of the Habitat Management Plan (HMP) for St. Marks National Wildlife Refuge (NWR). This HMP is a step-down management plan providing the refuge manager with specific guidance for implementing goals, objectives, and strategies identified in the Comprehensive Conservation Plan for St. Marks National Wildlife Refuge (2006).

In the Comprehensive Conservation Plan (CCP), the preferred alternative was to manage the refuge in this manner:

Many objectives and strategies focus on maintaining and restoring native communities, particularly longleaf pine. The development of the refuge as a Land Management Research and Demonstration Area will assist the refuge in becoming a leader in longleaf pine research and conservation, it will enable the sharing of that knowledge with others to benefit both private and publicly owned lands. Programs to control or eradicate terrestrial and aquatic nonindigenous and invasive plants were proposed, as is nuisance animal control. Hydrologic studies and land conservation will maintain the integrity of refuge resources, including threatened, rare, and imperiled species, and the impoundments to benefit migratory birds" (St. Marks NWR CCP 2006, page 80).

The CCP defined goals, objectives, and strategies to achieve the stated action. The actions further detailed in this HMP have been identified, addressed, and authorized by the CCP for St. Marks NWR. These include:

A land protection objective: Emphasize and encourage the protection of additional conservation lands, outside the current acquisition boundary, that are critical to the management of refuge-protected resources (CCP Goal 1, Objective 1, page 81).

Habitat Management Plan: Develop a Habitat Management Plan to update and incorporate relevant strategies and information from the Forest Management and Water Management Plans commensurate with the objectives outlined in the CCP (CCP Goal 1, Objective 2, page 82).

Invasive Animal and Plant Control: Eradicate or control terrestrial, non-indigenous and invasive plants. Eradicate or control aquatic, non-indigenous and invasive plants. Eradicate or control terrestrial, exotic and invasive animals (CCP Goal 1, Objectives 3-5, pages 82-84).

Wetlands: Protect natural wetlands and aquatic habitats and restore natural hydroperiods for the benefit of native wildlife with an emphasis on trust species (CCP Goal 1, Objective 7, pages 84-85).

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Forest Management: Continue to restore and maintain open multi-aged, historic pine communities with low diverse understories (CCP Goal 1, Objectives 10 and 11, pages 85-87).

Threatened, endangered, rare and imperiled species: Conserve and enhance populations of threatened, endangered, rare, and imperiled plants and animals and their native habitats (CCP Goal 2, Objectives 1 through 15, pages 87-91).

Migratory Birds: Provide high-quality habitat for migratory birds (CCP Goal 3, Objectives 1 through 5, pages 91-95).

Categorical Exclusion(s).

Categorical Exclusion Department Manual 516 DM 6, Appendix 1, Section 1.4 B (10), which states “the issuance of new or revised site, unit, or activity-specific management plans for public use, land use, or other management activities when only minor changes are planned. Examples could include an amended public use plan or fire management plan.”

Consistent with Categorical Exclusion (516 DM 6, Appendix 1, Section 1.4 B (10)), this HMP is a step-down management plan which provides guidance for implementation of the general goals, objectives, and strategies established in the CCP, serving to further refine those components of the CPP specific to habitat management. This HMP does not trigger an Exception to the Categorical Exclusions listed in 516 DM 2, Appendix 2.

Minor changes or refinements to the CCP in this activity-specific HMP include:

- Habitat management objectives are further refined by providing numerical parameter values that more clearly define the originating objective statement;
- Habitat management objectives are not presented in the exact numerical order or wording as they appear in the CCP. Some CCP objectives were reworded in this HMP to combine related objectives. Some of the CCP objectives that were complex or complicated have been divided or separated to improve clarity for the reader in this HMP;
- Specific habitat management guidance, strategies, and implementation schedules to meet the CCP goals and objectives are included (e.g., location, timing, frequency, and intensity of application); and
- All strategies are consistent with the CCP and serve to provide the further detail necessary to guide the refuge in the application of the intended strategies for the purpose of meeting the habitat objectives.

With the approval of this HMP, it will revise and update the corresponding sections of Chapter IV of the CCP as referenced above.

Permits/Approvals

As called for by the Endangered Species Act, an Intra-Service Section 7 Consultation was conducted and signed (July 13, 2005) during the CCP process. The determination was a concurrence that the CCP may affect, but is not likely to *adversely* affect, the following species: Gulf sturgeon; flatwoods salamander; American alligator; loggerhead, green, leatherback, and Kemp’s ridley sea turtles; eastern indigo snake; piping plover; bald eagle; wood stork; red-cockaded woodpecker; Florida manatee; purple bankclimber; and Ochlockonee moccasinshell.

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See pages 145 through 152 of Appendix III, Legal Mandates of the St. Marks National Wildlife Refuge Comprehensive Conservation Plan (2006), for a full list of federal laws, mandates, executive orders, and presidential proclamations under which the CCP was developed. These include:

Executive Order 11988 - Floodplain Management (1997);  
Executive Order 11990 - Protection of Wetlands (1997);  
Form DI-711, Intergovernmental Notice of Proposed Action (i.e., letter to the State of Florida Clearinghouse (July 13, 2006); and  
The National Historic Preservation Act (1966).

### **Public Involvement/Interagency Coordination**

This HMP is a step-down of the approved CCP for St. Marks NWR. The development and approval of the CCP included appropriate NEPA documentation and public involvement. A summary of public scoping and involvement can be found on page 75 and in Appendix XIII of the CCP for St. Marks (2006). A notice of intent to initiate the development of a CCP was published in the *Federal Register* on April 28, 2000. Approximately 100 people attended the six public scoping meetings held in August 2000 in the following communities: Panacea, St. Marks, Perry, Monticello, Tallahassee, and Crawfordville. Additionally a mailing was sent to 400 persons to educate them about the planning process and to gauge their interests and concerns about the refuge. Written comments were received between April 28 and October 22, 2000, from 85 persons and 5 organizations.

A Draft Comprehensive Conservation Plan and Environmental Assessment (Draft CCP/EA) was published in 2006, which proposed management alternatives and evaluated the environmental consequences of implementing each alternative. A notice of availability of the Draft CCP/EA was published in the *Federal Register* on January 20, 2006. A public review period was held from January 20 through March 31, 2006. During the public review period for the Draft CCP/EA, public meetings were held in Tallahassee and Crawfordville.

#### Supporting Documents.

Supporting documents for this determination include relevant office file material and the following key references:

U.S. Fish and Wildlife Service. (2009). St. Marks National Wildlife Refuge, Fire Management Plan.

U.S. Fish and Wildlife Service. Reinman, J.P. (1989). A Wildlife Management Plan for the Forested Uplands of St. Marks National Wildlife Refuge. St Marks National Wildlife Refuge, St. Marks, Florida.

U.S. Fish and Wildlife Service. (2006). St. Marks National Wildlife Refuge Comprehensive Conservation Plan. Atlanta, Georgia. 350 pp.

U.S. Fish and Wildlife Service. (2006). Draft Comprehensive Conservation Plan and Environmental Assessment for St. Marks National Wildlife Refuge, Atlanta, Georgia. 385 pp.

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Terry Picozzi 10/23/13  
Refuge Manager Date

James Dwyer 10/23/2013  
Project Leader Date

Bridget Warner 11/20/2013  
Regional Refuge NEPA Coordinator Date

Samuel 12/2/13  
Chief, NWRS, Southeast Region Date

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**Habitat Management Plan  
St. Marks National Wildlife Refuge**

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**September 2013**

