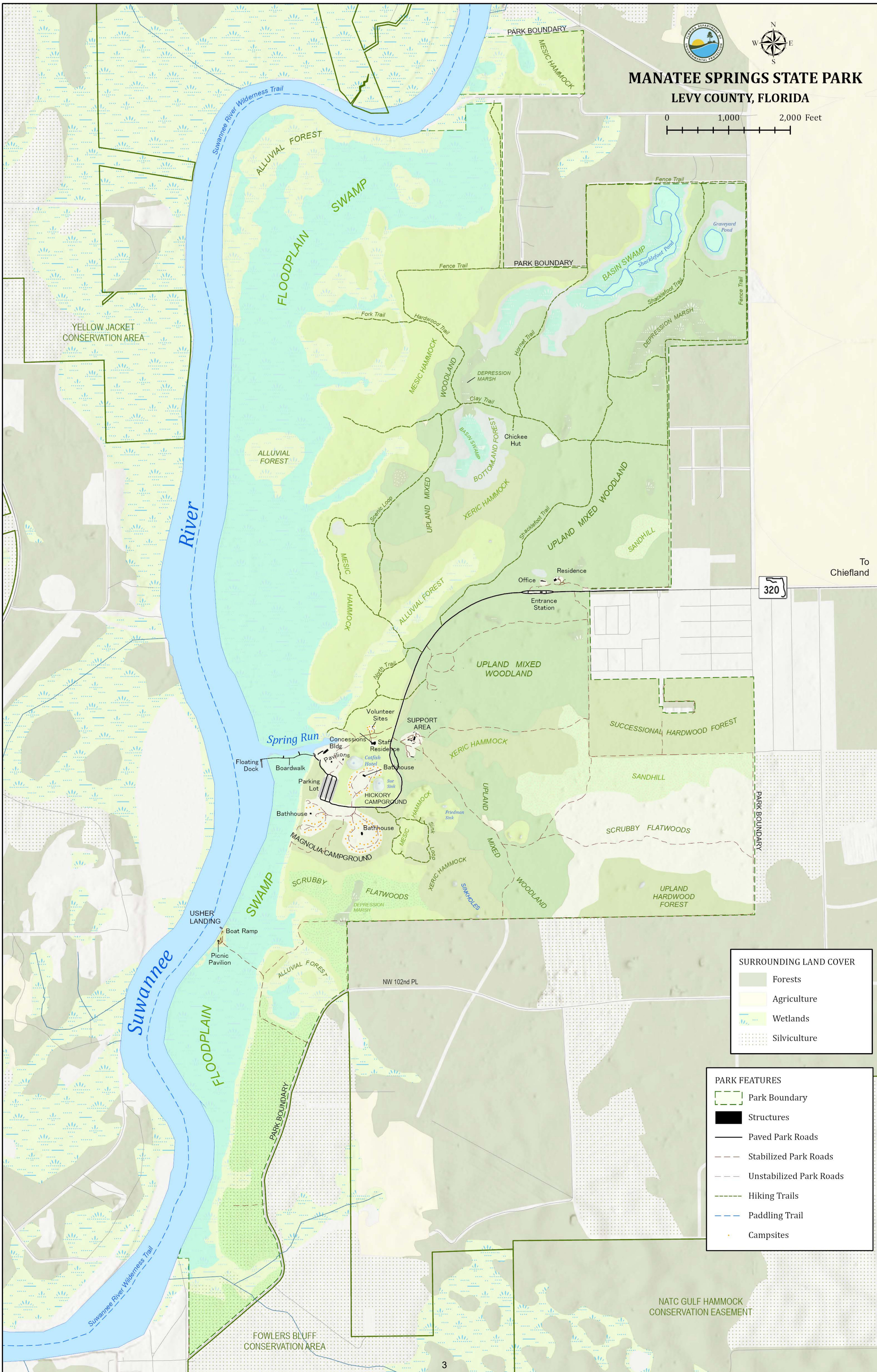
MANATEE SPRINGS STATE PARK

Park Chapter

SUWANNEE RIVER REGION


MANATEE SPRINGS STATE PARK
LEVY COUNTY, FLORIDA
0
1,000
2,000 Feet
N
S
E
W
PARK BOUNDARY
MESIC HAMMOCK
Suwannee River Wilderness Trail
ALLUVIAL FOREST
FLOODPLAIN
SWAMP
Fence Trail
Graveyard Pond
BASIN SWAMP
Shacklefoot Pond
Shacklefoot Trail
Fence Trail
DEPRESSION MARSH
Fork Trail
Hardwood Trail
Hornet Trail
MESIC HAMMOCK
WOODLAND
DEPRESSION MARSH
Clay Trail
YELLOW JACKET CONSERVATION AREA
ALLUVIAL FOREST
BASIN SWAMP
BOTTOMLAND FOREST
Chickee Hut
XERIC HAMMOCK
UPLAND MIXED
Scenic Loop
Shacklefoot Trail
UPLAND MIXED WOODLAND
SANDHILL
River
MESIC
HAMMOCK
ALLUVIAL FOREST
Office
Residence
Entrance Station
320
To Chiefland
North Trail
UPLAND MIXED WOODLAND
Volunteer Sites
SUPPORT AREA
Spring Run
Concessions Bldg
Staff Residence
Pavilions
Catfish Hotel
Bathhouse
Floating Dock
Boardwalk
Parking Lot
Sue Sink
HICKORY CAMPGROUND
XERIC HAMMOCK
SUCCESSIONAL HARDWOOD FOREST
SANDHILL
UPLAND
Friedman Sink
Bathhouse
Bathhouse
HAMMOCK
MESIC
Sink Loop
MIXED
SCRUBBY FLATWOODS
PARK BOUNDARY
MAGNOLIA CAMPGROUND
SCRUBBY
FLATWOODS
XERIC HAMMOCK
SINKHOLES
WOODLAND
UPLAND HARDWOOD FOREST
DEPRESSION MARSH
USHER LANDING
Boat Ramp
Picnic Pavilion
SWAMP
ALLUVIAL FOREST
NW 102nd PL
Suwannee
FLOODPLAIN
PARK BOUNDARY
SURROUNDING LAND COVER
Forests
Agriculture
Wetlands
Silviculture
PARK FEATURES
Park Boundary
Structures
Paved Park Roads
Stabilized Park Roads
Unstabilized Park Roads
Hiking Trails
Paddling Trail
Campsites
Suwannee River Wilderness Trail
NATC GULF HAMMOCK CONSERVATION EASEMENT
FOWLERS BLUFF CONSERVATION AREA

INTRODUCTION

LOCATION AND ACQUISITION HISTORY

Manatee Springs State Park is located in Levy County (see Vicinity Map). Access to the park is from State Road 320 near the city of Chiefland. The Vicinity Map also reflects significant land and water resources existing near the park.

Manatee Springs State Park was initially acquired on Jan. 6, 1949. Since this initial purchase, the state has acquired several additional parcels through the Land Acquisition Trust Fund and through P2000/Acquisitions and Inholdings programs. Currently, the park comprises 2,454.48 acres. The Board of Trustees of the Internal Improvement Trust Fund (Trustees) hold fee simple title to the park and on Jan. 23, 1968, the Trustees leased (Lease No. 2324) the property to the Division of Recreation and Parks (DRP) under a 99-year lease. In 1988, the Trustees assigned a new lease number (Lease No. 3634) to the park without making any changes to the lease terms and conditions. The current lease will expire on Jan. 22, 2067.

Manatee Springs State Park is designated single-use to provide public outdoor recreation and conservation. There are no legislative or executive directives that constrain the use of this property (see Appendix). A legal description of the park property can be made available upon request to the Florida Department of Environmental Protection (DEP).

SECONDARY AND INCOMPATIBLE USES

In accordance with 253.034(5) F.S., the potential of the park to accommodate secondary management purposes was analyzed. These secondary purposes were considered within the context of DRP's statutory responsibilities and resource values. This analysis considered the park's natural and cultural resources, management needs, aesthetic values, visitation and visitor experiences. It was determined that no secondary purposes could be accommodated in a manner that would not interfere with the primary purpose of resource-based outdoor recreation and conservation.

DRP has determined that uses such as water resource development projects, water supply projects, stormwater management projects, linear facilities and sustainable agriculture and forestry (other than those management activities specifically identified in this plan) would not be consistent with the management purposes of the park.

In accordance with 253.034(5) F.S., the potential for generating revenue to enhance management was also analyzed. Visitor fees and charges are the principal source of revenue generated by the park. It was determined that no additional revenue generating activities are appropriate during this planning cycle. Generating revenue from consumptive uses or from activities that are not expressly related to resource management and conservation is not under consideration.

PURPOSE AND SIGNIFICANCE OF THE PARK

Park Purpose

Manatee Springs State Park was acquired for the purpose of protecting and developing Manatee Spring and the surrounding area as an exceptional public outdoor resource-based recreation space for Florida residents and visitors.

Park Significance

- Manatee Springs State Park protects one of the largest first-magnitude springs in the lower Suwannee River basin that is a refuge for West Indian manatees and the end point of 6.3 miles of mapped aquatic caves that exit to a 1,200-foot spring-run stream.

- The park protects miles of shoreline along the Suwannee River, including an extensive mosaic of floodplain swamp, alluvial forest and upland mixed woodland that play important roles in the watershed and floodplain

- 19 distinct natural communities provide habitat for seven imperiled plant species, including the giant three birds orchids, as well as 20 imperiled animal species, including the West Indian manatee, eastern indigo snake and gopher tortoise.

- A range of archaeological sites belonging to three broad eras are protected, including the pre-Columbian, early European contact and European frontier periods. William Bartram's memoirs recount his visit to Manatee Springs in 1774.

- Remarkable resource-based outdoor recreation opportunities are provided, including swimming, snorkeling, scuba diving, paddling, hiking and camping.

Central Park Theme

From the expansive forested uplands to the extensive aquatic cave system, Manatee Springs State Park is a tapestry of richly textured habitats connected by Florida's outstanding waters.

Manatee Springs State Park is classified as a state park in the DRP unit classification system. In the management of a state park, a balance is sought between the goals of maintaining and enhancing natural conditions and providing various recreational opportunities. Natural resource management activities are aimed at management of natural systems. Development in the park is directed toward providing public access to and within the park, and to providing recreational facilities, in a reasonable balance, that are both convenient and safe. Program emphasis is on interpretation of the park's natural, aesthetic, and educational attributes.

OTHER DESIGNATIONS

The unit is not within an Area of Critical State Concern as defined in section 380.05; Florida Statutes and is not presently under study for such designation. The park is a component of the Florida Greenways and Trails System, administered by the DEP Office of Greenways and Trails.

All waters within the park have been designated as Outstanding Florida Waters, pursuant to Chapter 62-302, Florida Administrative Code. Surface waters in this park are also classified as Class III waters by DEP.

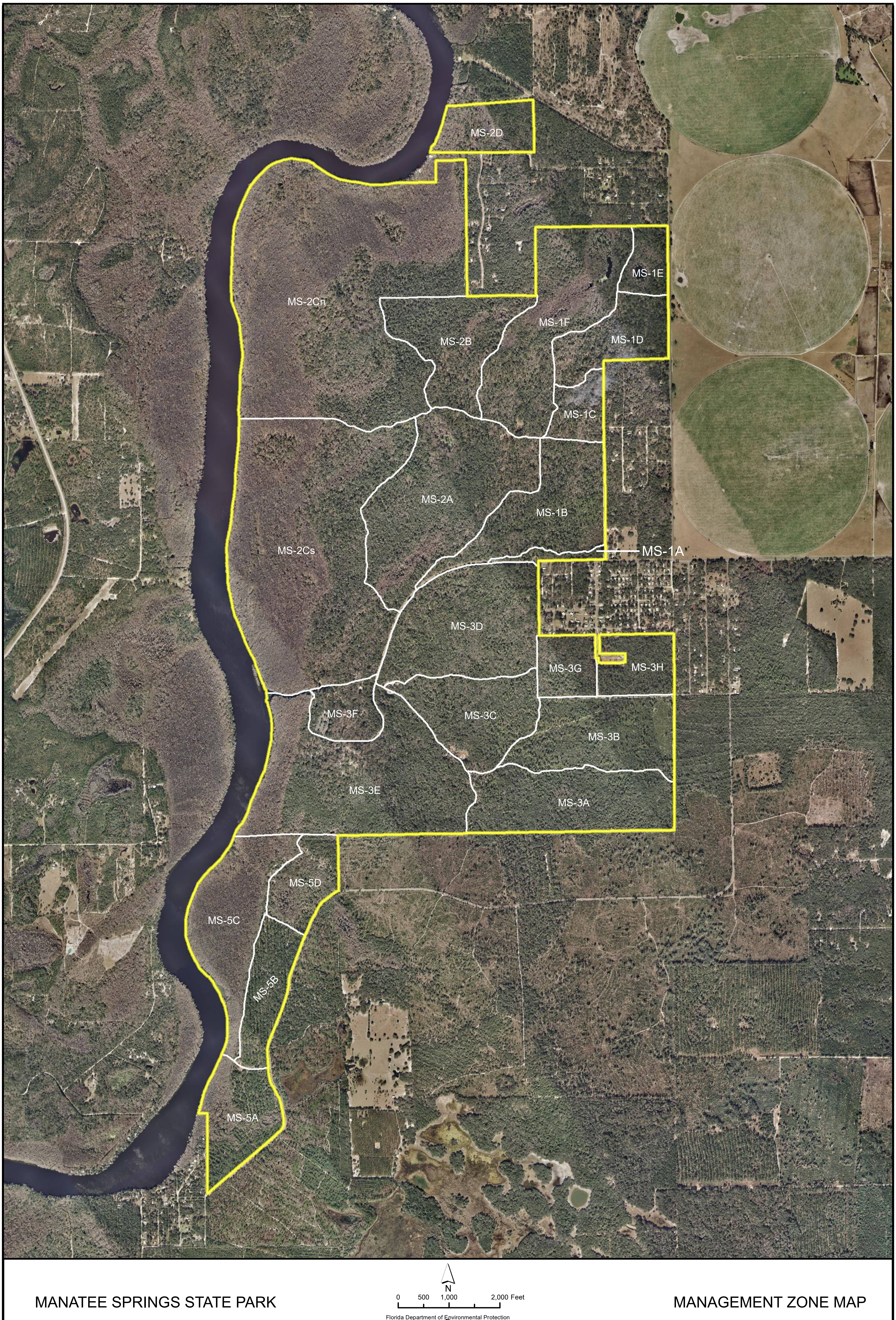
The park is adjacent to Big Bend Seagrass Aquatic Preserve as designated under the Florida Aquatic Preserve Act of 1975 (Section 258.35, Florida Statutes).

PARK ACCOMPLISHMENTS

- Installed waterfront aluminum staircases and Catfish Hotel stairways to improve safety.
- Met all annual prescribed fire goals.
- Met invasive plant removal goals.
- Repaired and updated multiple buildings.
- Offered interpretive programs on a weekly basis.

RESOURCE MANAGEMENT COMPONENT

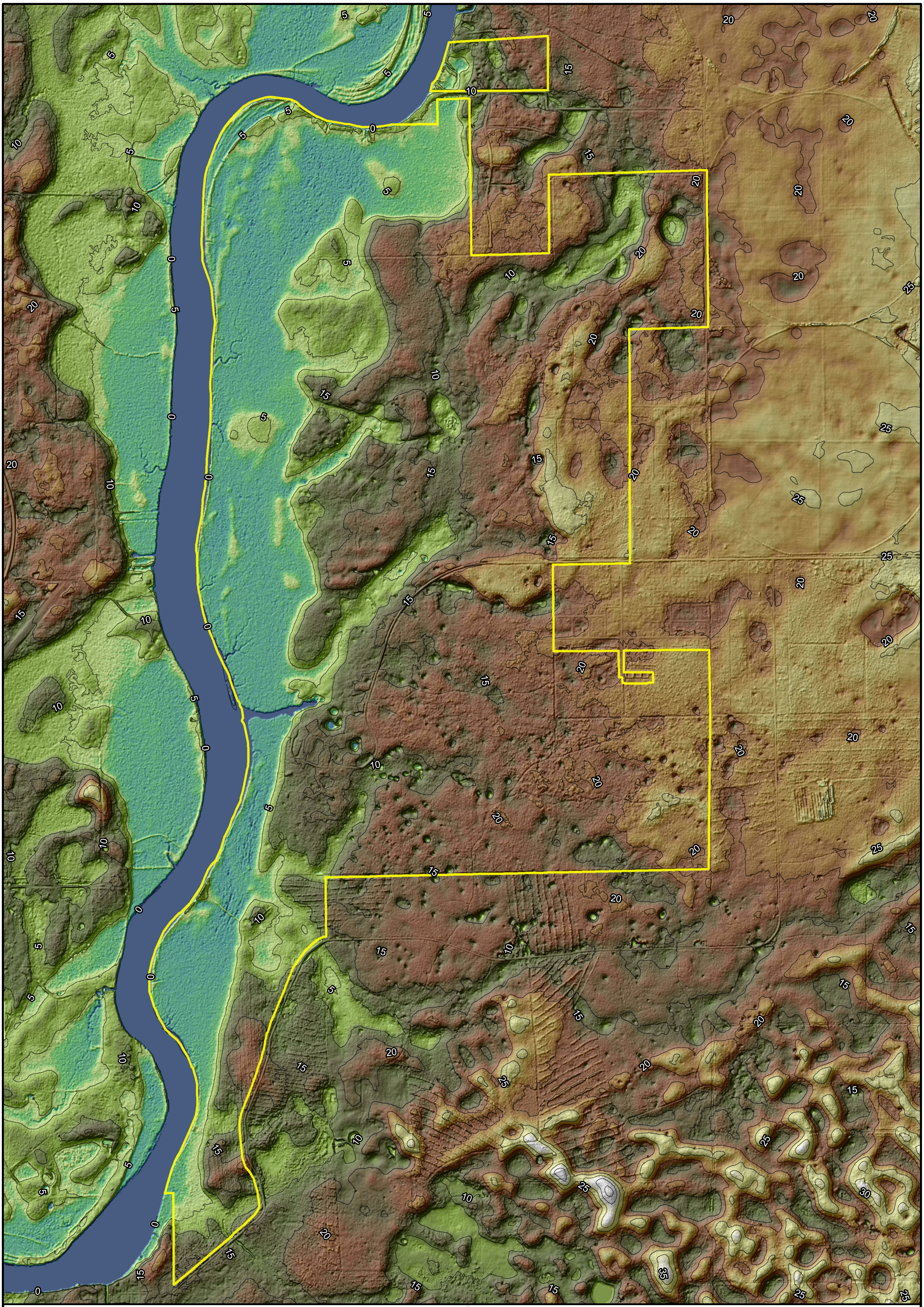
Management Zone	Acres	Management With Prescribed Fire	Contains Known Cultural Resources
MS-1A	9	8.64	N
MS-1B	102.14	100.53	Y
MS-1C	27.93	27.93	N
MS-1D	57.55	57.54	N
MS-1E	24.79	13.77	N
MS-1F	142.88	82.75	Y
MS-2A	176.07	98.95	Y
MS-2B	88.6	42.89	Y
MS-2Cn	441.54	8.79	Y
MS-2Cs	344.87	18.09	Y
MS-2D	41.03		Y
MS-3A	111	71.76	N
MS-3B	98.96	98.96	N
MS-3C	84.49	44.88	Y
MS-3D	136.26	128.12	Y
MS-3E	209.59	45.88	Y
MS-3F	33.58	0.16	Y
MS-3G	32.32	32.31	N
MS-3H	39.17	39.17	Y
MS-5A	61.73	34.13	Y
MS-5B	49.08	45.61	N
MS-5C	100.74	0.43	Y
MS-5D	42.37	14.5	N
SRWT-UnMapped-6	2.68		N



MANATEE SPRINGS STATE PARK

MANAGEMENT ZONE MAP

Florida Department of Environmental Protection
Division of Recreation and Parks
Date of aerial; 2016



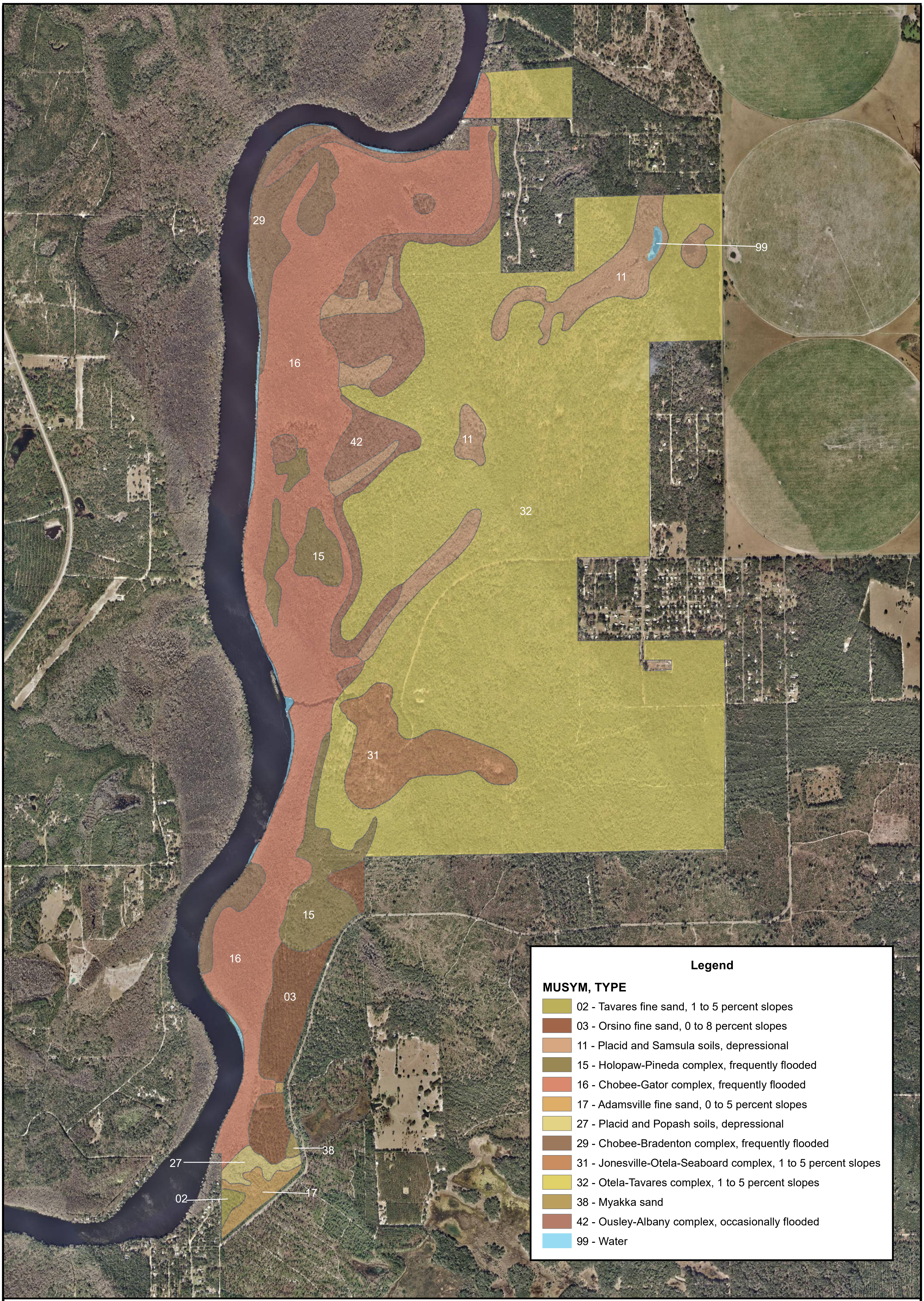
MANATEE SPRINGS STATE PARK

TOPOGRAPHIC MAP

N

0 750 1,500 3,000 Feet

Florida Department of Environmental Protection
Division of Recreation and Parks
Date of aerial; 2011



MANATEE SPRINGS STATE PARK

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Florida Department of Environmental Protection
Division of Recreation and Parks
Date of aerial; 2016

SOIL MAP

TOPOGRAPHY

Manatee Springs State Park is situated on the Pamlico Terrace within the Gulf Coastal Lowlands, a physiographic division of the Northern Geomorphic Zone of Florida. Characteristic features of the Gulf Coastal Lowlands include Pleistocene epoch marine terraces of variable thickness, limestone exposures, and remarkable karst topography (Fernald and Purdum 1998). Stream valleys that cut through the lowlands contain alluvial deposits formed during the late Pleistocene. Tertiary-age limestone may be exposed along the stream channels. Lower reaches of the valleys have likely been entrenched in limestone bedrock since the last significant rise in sea level. Further from the river, the lowlands mature into a karst plain heavily laden with numerous large sinkholes that capture and rapidly transport surface runoff directly into the Upper Floridan aquifer.

Two geomorphic zones located just east of the Gulf Coastal Lowlands, namely Bell Ridge and Waccasassa Flats, are both of some importance to the Manatee Springshed, a description of which appears in the Hydrology section below. Waccasassa Flats is a high elevation plateau with low permeability, a characteristic that gives rise to numerous wetlands and streams whose waters flow westward off the flats, often funneling into the Upper Floridan through numerous small swallets. Bell Ridge is a Pleistocene-age beach ridge consisting of sandy overburden underlain with clastic Miocene sediments (Puri and Vernon 1964), with an elevation of about 70 feet above mean sea level (msl) and with very little surface drainage.

Topographic relief within the park is slight and slopes are gradual. Elevations range from less than 5 feet msl in the floodplain swamp along the Suwannee River to a maximum of about 25 feet msl on 2 knolls in the park. The park contains numerous karst features including springs, limestone outcrops, solution pipes and sinkholes.

By the time the state acquired the Manatee Springs property in 1949, numerous alterations of the natural terrain had already occurred. Several causeways had been constructed across lowland areas to facilitate vehicular passage. One such causeway was located in the Mead-Scott Tract, a southern extension of the park that is leased from the Suwannee River Water Management District (SRWMD). This causeway was removed in 1996 as part of a project to restore the natural floodway of the Suwannee River. At this time, the remaining causeways are necessary for public access or for park operations. Some of them may require additional or reengineered culverts or low water crossings to improve surface water conveyance.

Less obvious topographic disturbances in the park exist in the form of roads and firebreaks, fire plow scars, and spoil piles from past road maintenance. There are also dozens of relatively shallow ditches located in the floodplain swamp of the river. These ditches, oriented perpendicular to the river, extend linearly through a portion of the floodway and ultimately cut through the primary levee at the edge of the Suwannee River. The ditches may be byproducts of the cypress logging that took place in Suwannee River swamps in the early 20th century. In aerial photographs from 1940, the ditches are discernible as linear striations in the swampland. Apparently, felled trees were pulled to the river in the most direct line possible. Logs were then floated downstream for milling. Repeated use of the same pathways through the floodway would likely have formed linear ditches. Several of the ditches are deeper than can be satisfactorily explained by that interpretation, however. These ditches have low berms associated with them, perhaps indicating that they were deepened in an attempt to provide loggers with permanent hydrologic connections to the river channel.

After the land including and surrounding Manatee Springs became a state park, the topography of the headspring shoreline and upper spring run was modified several times in efforts to improve recreational access. A shallow children's swimming area was established along the north shoreline of the run just below the headspring. Over the years, erosion at this location caused the shoreline to recede significantly, eventually creating a scalloped cove.

In the early 1990s, an extensive area around the spring boil and along the upper part of the spring run was hardened with concrete bulkheads, stairs, and walkways in order to facilitate access for swimmers and divers, and to reduce bank erosion. This shoreline redesign succeeded at first, but the bulkheads gradually became undermined and bank erosion continued to be an issue, so an alternative approach was proposed.

Efforts to rehabilitate the natural shoreline in the shallow-water swimming area began in the early 2000s, when DRP staff implemented the initial phase of restoration by removing hardened structures and re-contouring the slope to a more natural state.

In 2008, the Manatee Springs Shoreline Restoration Project, funded by the FDEP Springs Initiative, was designed with the goal of continuing the long-term process of restoring all natural shorelines around the headspring and upper spring run, using best management practices (Jones Edmunds and Associates 2008).

SOILS

According to the USDA NRCS Web Soil Survey, (http://websoilsurvey.nrcs.usda.gov/), 12 soil types exist within Manatee Springs State Park (see Soils Map). The Appendix contains complete descriptions of these soils. However, a brief 2014 exploratory field investigation by NRCS staff found that at least one additional soil type, Apopka series, occurs in some of the pinelands in the northwest portion of the park (Robbins 2014). In addition, while the eastern portion of the park is broadly mapped as Otela-Tavares complex, the field exploration found unmapped areas of the Adamsville series along the sandhill and scrubby flatwoods natural communities' transition in the southeast area of the park. Additional mapping of soils within the park would benefit the understanding and management of the natural communities within this park.

Generally, upland soils in the park are moderately well-drained and sandy, whereas soils within the floodplain of the Suwannee River tend to be very poorly drained and mucky. The Levy County soil survey characterizes most of the soils in the park as very deep and nearly level to gently sloping, the exception being upland soils, predominantly of the Oleta-Tavares complex, in which limestone underlies the sand at a relatively shallow depth (Slabaugh et al. 1996).

Major soil disturbances in the park that are attributable to past management practices include at least three borrow areas that once supplied materials for road construction and other purposes. Two of these borrow sites were pits that have since been re-contoured and replanted with native species. The other, Red Dome, was disturbed sometime between 1963 and 1971. The site was abandoned prior to 2001. Oral history indicates that originally it was a dome of red clay. The site was mined to the level of the surrounding soil and used for road fill. Native vegetation is now becoming reestablished on the site.

Another type of soil disturbance, probably the result of historical logging activities, was the creation of ditches that extended from the river floodplain through the natural levee to the river (previously described in the Topography section). Past agricultural activities such as crop farming, turpentine production, and cattle ranching undoubtedly also caused soil disturbances in some areas of the park.

Present day sources of soil disturbance in the park include firebreak maintenance, feral hog rooting, timber harvesting, facilities construction, and public use, particularly in the main spring and spring-run area. Actions designed to reduce soil disturbance in the spring area have included restricting boat access in the spring- run, improving visitor access, and restoring shoreline vegetation. While these actions have significantly reduced human-induced shoreline erosion, recreational activities in the spring (e.g., swimming and foot traffic) still cause significant soil disturbance.

Erosion of bottom sediments in the spring regularly occurs in the primary swimming areas, particularly at public access points. Displacement of sandy sediments in natural springs has always been a common issue in parks that feature this type of recreational activity. Although foot traffic on the south shoreline of Manatee Spring has been partially mitigated by the use of bulkheads and designated access points, the seasonal variability of water depths continues to allow visitors to walk on the sandy spring bottom or stand on exposed limestone substrate. Soil erosion continues to gradually undermine stairs at the southern and westernmost access points to the spring.

Foot traffic is no longer permitted in what historically has been one of the most impacted areas along the south shore of the main spring. The soil in this area was stabilized with jute mesh, and natural vegetation could recover gradually. This has resulted in vegetative regrowth. Some of the only remaining aquatic vegetation in the system can be found downstream of this area.

A shallow area with a sandy beach on the north side of the spring run just downstream from the main spring continues to be used as a swimming area for children. Prior to the 1990s, this area was repeatedly replenished with beach sand in efforts to replace sand that had washed away during the busy swimming season. However, the installation of vegetated terraces at the children's swimming area in the 1990s has significantly reduced the loss of soil there. Limited erosion continues to occur though, so additional control measures may be needed in the future.

Soil erosion is also a concern in the Hickory Campground area because of the close proximity of two significant karst openings into the aquifer, Sue Sink and Catfish Hotel Sink. During typical rainfall events, storm water is carried directly into these two sinkholes. More details about this issue will be discussed below in the water quality section of Hydrology.

HYDROLOGY

Manatee Springs State Park is located in northwestern Levy County within the fifth and last reach of the lower Suwannee River basin (Suwannee River Water Management District (SRWMD) 2005). The Suwannee River and Manatee Spring are the two most prominent hydrological features of the park. The Suwannee's average flow is 7.1 million gallons per day (mgd). The river has been designated an Outstanding Florida Water (OFW) and is a Class III water body. Average annual rainfall for the lower Suwannee region approaches 60 inches per year (Fernald and Purdum 1998).

Manatee Springshed and its Sensitive Karst Features

Manatee Spring is a first-magnitude spring, one of the largest in the lower Suwannee River basin. It uniquely shares a portion of its watershed with its neighbor to the north, Fanning Spring. The Manatee headspring is located approximately 1,200 feet east of the Suwannee River. It is conical in shape and more than 25 feet deep, depending on river stage. Bordering the spring run are floodplain swamps with dense stands of bald cypress.

Springshed delineation within the Manatee-Fanning watershed began in the early 2000s with geostatistical analysis of groundwater wells that are scattered across the lower Suwannee River basin (Upchurch et al. 2005). Water managers have come to understand a considerable amount about the surface water and groundwater basin that contributes to the overall discharge of Manatee Spring (Scott et al. 2004; Upchurch and Champion 2004). However, it is important to understand that there is substantial overlap between the groundwater basins of Manatee and Fanning springs, depending on the season. Additionally, the actual extent of groundwater connectivity and the precise location of the divide between the two springsheds remains poorly defined. Because the groundwater divide between them is so indistinct, hydrologists often treat the Manatee and Fanning springsheds as one. At its greatest distance from east to west, the Manatee springshed measures nearly 18 miles, whereas the Fanning springshed extends more than 15 miles. The surface watershed and groundwater basin that together form the Fanning-Manatee springshed encompasses up to 450 square miles (SRWMD 2005). Of that figure, approximately 200 square miles are considered of major importance to Manatee Spring.

One unfortunate consequence of grouping the Manatee and Fanning springsheds as one unit is that this can perpetuate a misperception that flow properties of these two spring systems are the same. To the contrary, tidal cycles significantly influence spring discharge and flooding of wetlands at Manatee Spring, whereas Fanning Spring and its associated floodplain function ecologically as non-tidal wetlands (Light et al. 2002).

One prominent feature that defines the groundwater characteristics of Manatee Springs State Park is an unnamed transitional karst region situated between the Manatee springshed and the Waccasassa Flats to the east (Upchurch et al. 2005). This karst plain behaves very much like areas along the Cody Scarp to the north, where high groundwater recharge into numerous large sinkholes is a prominent characteristic (Upchurch 2002). The Cody Scarp is an outfacing, relict marine feature that constitutes the most persistent topographic break in the state (White 1970). The many incidences of subsidence and sinkhole collapse that occur along the Cody Scarp are also a common feature in other transitional karst areas, strongly influencing hydrologic characteristics of the region (Upchurch and Champion 2002). In the Manatee springshed, a large proportion of surface runoff, including that from Waccasassa Flats, drains across this unnamed transitional scarp, eventually disappearing into sinkholes and rapidly infiltrating the subsurface limestone conduits of the Upper Floridan aquifer (Upchurch and Champion 2004).

Groundwater within the Manatee springshed moves through a complex matrix of disjointed and sometimes linked underground conduits that may return the water to the surface through multiple karst features such as the main spring vent, Manatee Spring. Included among the more prominent karst openings at Manatee Springs State Park are named features such as Catfish Hotel, Sue Sink and Friedman Sink. All three features are significant entry points into the Manatee Springs aquatic cave system.

Manatee headspring is the endpoint for one of the longest and best explored interconnected aquatic cave systems in the world. This labyrinth is world-renowned for its complexity and length (Exley 1994). Professional divers have explored and mapped the aquatic caves at Manatee Springs over the past 50 years, providing a substantial knowledge base about this underground ecosystem. Most of those divers are now associated with the National Speleological Society Cave Diving Section (NSS-CDS), and they continue to map, maintain and promote conscious conservation of the park's aquatic cave system as a recreational, training and research destination.

By 2015, cave divers had mapped more than 33,000 feet (about 6.27 miles) of conduits within the Manatee Springs system, ranking it as the 14th-longest aquatic cave in the world (Gulden and Coke 2011; Poucher, unpublished report 2014). One of the more significant findings is that this maze of conduits is now known to extend southeasterly from the park toward the city of Chiefland. To attain a better hydrogeological understanding of the nature of conduit connections within the Manatee springshed, additional research will be required, particularly the use of dye trace technologies.

Dye trace research is an important tool in establishing the locations of definitive groundwater connections between surface water bodies (Aley 1999; Skiles et al. 1991). The only dye trace work completed in the Manatee-Fanning springshed to date occurred in 2009. Dye placed in a sinkhole 7 miles east of Manatee Springs in Chiefland appeared in less than six days at the Manatee headspring (Karst Environmental Services 2009). The dye trace work, in conjunction with cave mapping, supports the premise that surface runoff entering the Upper Floridan aquifer within the Fanning-Manatee springshed can travel through conduits as fast as 1.5 miles per day. Comparable studies, such as in the Ichetucknee springshed, have demonstrated even faster travel times (Champion and Upchurch 2003). These and other dye trace studies have revealed a direct link between surface/groundwater connectivity and rapid transport of surface runoff through karst features to exit points at springs (Hisert 1994; Hirth 1995; Karst Environmental Services 1997; Kincaid 1998; Butt and Murphy 2003; Butt 2005; Butt et al. 2006). The studies have also provided scientists with a better understanding of how surface contaminants can move through the Floridan aquifer (Macesich, 1988; Martin and Gordon 2000).

Water Quantity

The U.S. Geological Survey (USGS) first measured discharge at Manatee Spring in 1932. In recent years, the USGS has worked with the SRWMD to track discharge for this spring system (USGS, 2014; SRWMD, 2014). Automated satellite-based tracking of daily discharge for Manatee Spring at Station 02323566 began in 2001 and continues. Manatee Spring discharge is continuously monitored with real-time data uploaded via satellites, and the data are fully accessible to any interested parties (USGS 2014; SRWMD 2014).

In 2005, the SRWMD calculated a period-of-record median discharge for Manatee Spring of 204 cubic feet per second, with an average discharge of 189 cubic feet per second (SRWMD 2005). The minimum instantaneous flow ever recorded for Manatee Spring was 2 cubic feet per second on April 5, 2005, while the maximum was 546 cubic feet per second on Oct. 14, 2004 (USGS 2014). It is important to understand why the discharge at Manatee Springs is so highly variable.

When water scientists deployed instrumentation in 2001 to track Manatee Spring's flow on a daily basis, it rapidly became evident that the instruments were dramatically influenced by Gulf of Mexico tidal fluctuations and Suwannee River flooding (measured as river stage). Quite clearly, shifting tides in the gulf and significant Suwannee flood events are two major factors that can complicate the precise measurement of discharge at Manatee Spring. Both factors, whether individually or in combination, can significantly influence the velocity of groundwater discharge at Manatee Spring. Hence, they are critical to the discussion of water quantity at Manatee Springs State Park.

During periods of low flow along the Suwannee River, falling tides have little effect on the discharge of Manatee Spring. The spring essentially flows unconstrained. When tides are rising, however, they can significantly affect discharge by decreasing spring flow and increasing the probability of small-scale back flooding in associated floodplains (Light et al. 2002). Back flooding is especially ecologically important in floodplain wetland communities such as those associated with the Manatee spring-run.

Based on overall discharge, the Suwannee River is the second largest river in Florida (Berndt et al. 1998). Other than the Suwannee Sill water control structure, which is located where the Suwannee exits the headwaters of the Okefenokee Swamp, there are no dams along the entire length of the river, and natural flood events are common (Garza and Mirti 2003). These floods are typical of river systems like the Suwannee and often occur in response to large-scale surface water events (Pringle 1997; Diehl 2000; Garza and Mirti 2003).

In fact, the likelihood of the Suwannee flooding is directly proportional to the amount of rainfall within its basin. Typical high flows in the lower Suwannee River occur in March and April (Light et al. 2002). During significant flood events along the lower Suwannee, tides do not influence flow measurements taken at Manatee Springs State Park (Light et al. 2002).

River stage has been recorded on the Suwannee River since 1906, and it is important to understand that this 100-plus years of recordkeeping has provided water scientists with a unique dataset that has been used to determine historic flows at Manatee Spring (Verdi and Tomlinson 2009). During that period, water scientists have closely documented every major flood and drought that has affected the Suwannee River. From 1942 to 2013, 14 significant floods and nine major droughts were recorded in north peninsular Florida (Verdi et al. 2006; Verdi and Tomlinson 2009). Three of the most extreme droughts in the Suwannee River basin during this period occurred in 1954-56, 1998-2002, and 2010-12 (SRWMD 2014; Verdi et al. 2006). Numerous gauges at unique locations along the Suwannee track both river stage and discharge (USGS 2014; Verdi et al. 2006).

When the Suwannee floods, the high river stage affects spring-run tributaries (e.g., Manatee Spring) along its reaches, gradually "pushing back" against the head pressure in the Floridan aquifer that causes springs to flow. As the Suwannee back-floods into the Manatee spring run during high tides or when river flooding occurs, river and spring waters begin to mix (Katz et al. 1999). The extent of mixing, as determined by monitoring of water clarity in springs, can be a helpful tool in documenting changes in groundwater discharge in spring systems (Anastasiou 2006; District 2 files). Marked changes in water clarity can be observed within the Manatee spring run depending on factors such as clarity of the Suwannee River (i.e., tannic or clear), tidal influences and height of river stage. Partial or complete brownouts of the Manatee spring system may result. A complete brownout is considered to have occurred when tannic river water covers the entire spring run and headspring, with water visibility reduced to less than 4 feet. If the surface water pressure exceeds the groundwater head pressure, the springs at Manatee may even reverse flow and function as “siphons” or inflow points into the Upper Floridan aquifer (Gulley et al. 2011). In that respect, Manatee Spring can act as an estavelle, a type of spring whose fluctuations in discharge reflect a direct relationship between groundwater potential and river stage (Copeland 2003).

Park staff has documented all complete brownouts at Manatee Springs State Park since March 2003, but sporadic spring assessments (i.e., from photographs or qualitative assessments by staff or cave divers) extend the record back to 1973 (District 2 files; Exley 1994). During the period from 1973 to 2013, there were at least 21 complete brownout events at the Manatee headspring, with an occurrence rate at just over 8% of the time. In comparison, during that same period, Fanning Spring’s brownout occurrence rate was nearly three times greater than Manatee’s (20% with at least 53 complete brownouts).

This illustrates that the trend at Manatee Springs is for brownouts to be of much shorter duration with significantly less chance of flow reversal than occurs at Fanning Springs State Park, even though both springs are estavelles. Flow reversals, however, do occur at Manatee Springs State Park and have even been documented by staff twice in the past five years (District 2 files).

In April 2009, District 2 biologists and park staff implemented a more rigorous methodology for continuously tracking water quality/clarity in all District 2 springs. In the process, they coincidentally recorded the first flow reversal ever documented for Manatee Spring (District 2 files). The characteristics and timing of this flow reversal, during which tannic waters of the Suwannee River poured into the main vent at Manatee Spring, are noteworthy enough to deserve the brief description provided below.

Tannin-stained waters of the Suwannee River began to siphon into the aquatic cave system at Manatee Spring sometime in early April 2009. By April 11, river water was observed channeling as far back into the cave system as Friedman Sink, approximately 2,000 feet from the headspring. On April 21, 2009, cave divers observed that tannic river water was still “barely flowing out” of Catfish Hotel about 500 feet from the headspring. A second flow reversal event was documented at Manatee Spring on July 2, 2012. This event was also witnessed by divers.

Comparison of corresponding stage readings at the Suwannee River gauge at Manatee (USGS Station 02323566) and the Fanning Springs (Wilcox) gauge (USGS Station 02323500) reveals an interesting correlation between the gauges that may help indicate when flow reversals have occurred in the past.

According to the SRWMD, the location of the Wilcox gauge at the mouth of the Fanning spring run allows river levels at both Fanning and Manatee springs to be determined (SRWMD 2005). Records of the Suwannee River stage at the Wilcox gauge were first obtained in October 1930, while data collection at the Manatee gauge began in April 1982. Review of datasets from both river gauges has allowed water scientists to estimate the number of flow reversals that have taken place at the two spring systems over the past 70 years. A conservative estimate based on all available data from 1942 through 2013 is that Manatee Spring has probably reversed its flow as many as 12 times and Fanning Springs as many as 53 times during that period.

River stage data alone, however, is insufficient in determining the occurrence of flow reversals at Manatee Springs. The highest stage recorded at the Manatee gauge during the 2009 Manatee flow reversal was 10.45 feet, with a corresponding stage of 14.22 feet measured at the Wilcox gauge. In contrast, the maximum stage at the Wilcox gauge during the 2012 Manatee flow reversal was 9.09 feet, more than 5 feet below the stage recorded in the 2009 reversal. Apparently, the head pressure at Manatee Spring was insufficient to prevent flow reversal during the lower flood stage of 2012, but adequate during the higher flood stage of 2009. It seems likely that flow reversal would have also occurred at Manatee Spring during the exceptional 100-year flood of 1973 when the Wilcox gauge recorded a maximum stage of 18.03 feet. But cave diving notes from Scheck Exley in that year clearly documented that Manatee Spring's aquatic caves were not being affected by the tannin-stained waters of the Suwannee River (Exley 1994). However, a prolonged period of complete brownout (estimated at 36 days) probably did occur at Manatee Spring in response to the very high stage recorded on the Suwannee at that time. Regardless of recent happenings, flow reversals at Manatee Spring during significant Suwannee floods prior to 1973 do not appear to have occurred at any point other than the record 1948 event when the river stage at Wilcox exceeded 21 feet.

Whether the evidence indicates that fluctuations in groundwater supply are natural (i.e., due to Atlantic multi-decadal oscillation) or anthropogenic (i.e., due to water supply withdrawals) is still unclear (Kelly 2004; Williams et al. 2011). Nonetheless, many water managers worry about the unsustainable depletion of groundwater resources in the Floridan aquifer (Bush and Johnston, 1988; Grubbs and Crandal 2007; Copeland et al. 2011). Concerns over decreased water supplies heightened during the recent droughts of 1998-2002 and 2010-12 as water scientists documented significant declines in spring discharge at nearly all of Florida's first-magnitude springs, including Manatee Spring (Copeland et al. 2011; Pittman 2012).

The discharge of Manatee Spring at base flow consists primarily of older groundwater ranging from 15 to 30 years in age (Katz et al. 1999). This older, deeper groundwater contains higher levels of limestone-based analytes (e.g., calcium, bicarbonate, etc.) than the younger, shallower upper Floridan or surficial aquifer because it has been in the aquifer longer. Water experts use these limestone-based analytes, as well as saline indicators such as chloride, strontium and conductivity, as diagnostic tools to ascertain the presence of saltwater encroachment (Neuendorf et al. 2005). The significance of saltwater encroachment at Manatee Springs will be addressed in the water quality overview below.

Many water management experts acknowledge that the two recent long-term droughts and increased consumptive use of groundwater have caused significant lowering of water tables and decreased spring flows across the state (Mirti 2001; Swihart 2011; Still 2010; Copeland et al. 2011). Water managers can now correlate specific regional drawdowns of the aquifer with shrinking springsheds and declining spring flows (Mirti 2001; Champion and Starks 2001; Grubbs and Crandall 2007; Grubbs 2011). Given the projected water supply needs for the area, the USGS predicts that groundwater levels throughout Florida, including those in the Manatee springshed, will continue to decline (Sepulveda 2002).

A recent statewide analysis of water quantity and quality variables compared groundwater and spring water parameters from 1991 to 2003 (Copeland et al. 2011). Specifically, during that period, analysis of rock-matrix and saline analytes indicated that the Floridan's freshwater "lens" had decreased significantly in volume and that significant saltwater encroachment had occurred throughout most of the state (Copeland et al. 2011). Coastal springs such as Manatee Spring also experienced lateral saline encroachment (Marella and Berndt 2005; Hydrogeologic Inc. 2011).

The major conclusion was that the drought of 1999-2001 had precipitated significant negative health trends in all spring systems in the state, including Manatee Springs, because of lowered groundwater levels, significant saline encroachment and simultaneous increases in groundwater use during one of Florida's worst droughts on record (Verdi et al. 2006).

The SRWMD is the state agency responsible for issuing water-use permits in the Manatee-Fanning springshed, and, in so doing, must ensure that proposed uses are in the public interest, which includes the conservation of fish and wildlife habitat and the protection of recreational values.

In 2005, the SRWMD completed its first Minimum Flows and Levels (MFL) guidance document for the lower Suwannee River basin, including Manatee and Fanning springs (SRWMD 2005). This MFL document recommended that for Manatee Spring to function adequately as a critical thermal refuge for Florida manatees (*Trichechus manatus latirostris*), spring discharge between Nov. 1 and April 30 should not fall below 130 cubic feet per second.

Scientists state that water quantity variables such as spring discharge velocity and water quality variables such as nitrate concentration are necessary parameters for understanding trends in the health of groundwater resources (Brown et al. 2008). Springs are considered to be excellent indicators of changes in groundwater quantity and quality over time. Indeed, Florida's springs have proven to act as the "canary in the coal mine," giving early warning about declines in health of the Floridan aquifer. The quality of spring water is extremely dependent on spring flow rates and groundwater levels, and it is very sensitive to changes in those parameters (Copeland et al. 2011; Wetland Solutions Inc. 2010). Even early researchers in the ecology of spring systems realized that the velocity of spring discharge is one of the most important factors in maintaining healthy, diverse spring ecosystems (Odum et al. 1953; Whitford 1956).

Water Quality

The two primary water quality issues at Manatee Springs are local/regional groundwater contamination and a corresponding significant decline in ecological health of the springs and spring-run stream. A vast amount of water quality data is available for Manatee Spring (SRWMD 2014; Hornsby and Ceryak 1998; Scott et al. 2004; USGS 2014). Many water management agencies collect, store and manage hydrological information that is accessible to all through a variety of web-based databases (USGS 2014; SRWMD 2014; DEP 2014b; DEP 2014c).

The unconfined nature of the Floridan aquifer in the Manatee Springs region makes it highly vulnerable to pollution from contaminants that may funnel through numerous karst features directly into the groundwater below (Cichon et al. 2004). The porous soils and multiple conduits and fractures in karst environments allow pollutants to move rapidly from the surface and into underground caverns and spring systems (Harden et al. 2008). Any deterioration of groundwater quality within the Manatee springshed could ultimately threaten sensitive water resources within Manatee Springs State Park. Significant sources of groundwater contamination in the Manatee springshed are fertilizers, animal waste, domestic wastewater and standard septic systems (Hallas and Magley 2008; Harrington et al. 2010).

Conventional septic systems are the most widespread method of wastewater disposal in the Suwannee River basin (DEP 2001). Relative to other sources of surface contaminants in the basin such as fertilizers, septic systems may contribute a smaller percentage of nutrient pollution. However, if on-site sewage treatment and disposal systems happen to be located near a spring, the percentage of nutrient pollution increases significantly (DEP 2001; Harden et al. 2008).

State and federal authorities have determined that the use of on-site sewage treatment and disposal systems in karst environments is of significant concern because it contributes to groundwater quality problems (EPA 2006). For more than a decade, research efforts throughout the state have continuously monitored and evaluated the effectiveness of these systems within karst environments, including at Manatee Springs State Park (Roeder 2004; Roeder et al. 2005; Chanton 2009). Two of the park's wastewater treatment systems, located at the two campground facilities, Hickory and Magnolia, were included in this research. Both facilities are located in proximity to the main spring as well as near prominent karst features, and both lie above the mapped aquatic cave system (Harden et al. 2008). In response to this research, DRP upgraded the campground septic systems using advanced treatment technologies, with a major emphasis on improving system performance and efficiency. Currently, there are several additional standard septic systems in the park that have not yet been upgraded to advanced treatment, including staff residences and administrative offices.

Surface water runoff from significant rainfall events may also be a source of groundwater pollution in the park. Wherever stormwater runoff is concentrated in the park, staff will follow best management practices in encouraging the growth of groundcover vegetation and capturing runoff from impervious surfaces via swales that divert flow away from sensitive aquatic resources.

One historic source of stormwater runoff that was mitigated successfully in the past decade is the old boat ramp located on the south side of the spring run just downstream from the designated swimming area at the headspring. Portions of the impervious paved road above the boat ramp were removed and the area restored using broad-based, vegetated dips and water bars to help disperse surface runoff and divert it away from the spring run into adjacent wooded areas.

Hickory Campground has long been a major water quality concern because of its proximity to two prominent sinkholes. This campground was designed and constructed long ago with little consideration given to treatment or attenuation of stormwater runoff. Runoff from the campground access road and from many of the campsites has historically flowed directly into Catfish Hotel Sink and Sue Sink, both hydraulically connected to the main spring. DRP has attempted to redirect runoff by building up the campsites and closing some of the campsites adjacent to the sinks. The closed sites may require additional revegetation measures to more effectively reduce stormwater runoff. The natural topography of the area and the proximity of the road and campsites to the sinks make it very challenging to achieve effective control of the situation.

The Manatee springshed contains numerous nonpoint sources of groundwater pollution located outside the park. Rural agriculture, primarily consisting of row crops and dairies, is the predominant land use in the springshed (SRWMD 2005). Levy County and Gilchrist County, both ranked among the highest in the state in silage corn production, use more than 5,700 tons of nitrogen fertilizer per year combined (Obreza and Means 2006). Nine dairies are located within the Manatee- Fanning Springshed, six of which are large enough to require industrial wastewater permits.

Scientists conducting nitrogen-15 isotope research at Manatee Spring have confirmed that heavy fertilizer use and the numerous large dairy operations in the region are the primary sources of the inorganic/organic nitrogen contamination of groundwater in the Manatee springshed (Katz et al. 1999; Albertin et al. 2007).

Nitrate levels in the Floridan aquifer in north Florida have increased by an order of magnitude over the past 50 years (Cohen et al. 2007; Upchurch et al.2007). Human activity, especially the use of inorganic fertilizer, has long been the leading cause of this nutrient enrichment. The small city of Chiefland in the Manatee springshed has an equally critical influence on water quality in the park.

For the past 25 years, water managers have monitored groundwater quality and levels in numerous wells throughout the state. More than 250 different wells are tracked for changes in groundwater quality in the Manatee-Fanning springshed alone (DEP 2014c). Some of these wells are monitored specifically to document changes associated with known contamination sites (Maddox et al. 1998). Of 188 wells in the Manatee springshed for which nitrate data was available, more than 57% had nitrate concentrations higher than 1 milligram per liter and over 5 percent had nitrate concentrations higher than the groundwater standard of 10 milligrams per liter (Harrington and Wang 2011). The highest nitrate concentration measured in a well within the Manatee springshed was 62 milligrams per liter. Naturally occurring background levels for nitrates in groundwater should be less than 0.01 milligrams per liter (Cohen et al. 2007).

There are eight sewage treatment facilities in the Manatee Springs region that discharge treated wastewater indirectly to groundwater via spray fields or settling ponds. The two largest facilities are in Chiefland, which produces 0.475 million gallons per day, and in Trenton, which produces 0.20 million gallons per day. In the Manatee-Fanning springshed there are at least 13 waste cleanup sites equipped with monitoring wells, and 100 other wells are used for monitoring of aquifer contamination (DEP 2014c). An additional 50 monitoring wells in the region provide background data about the Upper Floridan aquifer. DEP, in cooperation with the SRWMD, conducts long-term trend analyses on some of these groundwater wells. There is also a permanent surface water site, Station MAN 010C1, located at Manatee Spring on the Suwannee River. This station is part of the Temporal Variability Network program (DEP 2014d; Jenkins et al. 2010).

From 2000 to 2006, quarterly monitoring of surface water quality took place at 18 important springs in Florida, including Manatee Spring (DEP 2008). Reports from this monitoring work, referred to as Ecosummary, contain quarterly ecosystem health assessments. During the six-year Ecosummary monitoring period, nitrate-nitrite levels were consistently high at Manatee Springs, ranging from 1.3 to 3.6 milligrams per liter (Harrington and Wang 2011).

Elevated groundwater nutrients have contributed to significant declines in the ecological health of spring systems throughout Florida, including Manatee Springs (Jones et al. 1996; Munch et al. 2006; Cohen et al. 2007; Albertin et al. 2007; Wetland Solutions Inc. 2010). Studies suggest that the visible presence of nuisance algal biomass in a spring ecosystem is an indicator of an imbalanced distribution of aquatic flora (i.e., Rule 62-302.500 (48) (b) F.A.C.). The U.S. Environmental Protection Agency (EPA) states that water bodies with periphyton levels exceeding 150 milligrams per meter squared may be biologically impaired and may experience a decline in ecosystem health. There is now widespread recognition that, in response to nutrient enrichment, periphyton levels are increasing in nearly all of Florida's springs, and that this is a symptom of the declining ecological health of springs (Kolasa and Pickett 1992; Hornsby et al. 2000; Stevenson et al. 2007; Brown et al. 2008). The most notable evidence of the ecological decline of Manatee Spring was its dramatic shift in the 1980s and 1990s from a healthy ecosystem in which submerged aquatic vegetation (SAV) was dominant to the situation in 2014 in which algae had become dominant and SAV was almost absent.

In 1996, DEP initiated a formal statewide program for monitoring surface waters and groundwater, including those within the lower Suwannee River basin (Maddox et al. 1992; DEP 2009). This Integrated Water Resource Monitoring Program (IWRMP) took a comprehensive watershed approach based on natural hydrologic units. The 52 hydrologic basins in Florida were placed on a five-year rotating schedule, which allows water resource issues to be addressed at different geographic scales (Livingston 2003). In addition, the IWRMP assigned a water body identification number (WBID) to each water body. The WBID for Manatee Spring is 3422R. This watershed approach provides a framework for implementing Total Maximum Daily Load (TMDL) requirements that will attempt to restore and protect water bodies that have been declared impaired (Clark and DeBusk 2008).

According to DEP basin status and water quality reports for north Florida, several springs, including Manatee Spring, as well as sections of the lower Suwannee River basin, all became potentially impaired water bodies in 2003 because of excessive nutrients, total coliform bacteria, high mercury levels or low dissolved oxygen (DEP 2001; DEP 2003). Based on the Impaired Waters Rule (IWR), the EPA in 2003 verified that those water bodies were impaired, which meant that their surface water quality did not meet applicable state water quality standards as pursuant to the IWR in Chapter 62-303 Florida Administrative Code. This designation triggered a long chain of mandatory requirements that Florida would have to meet to achieve compliance with EPA regulations concerning polluted water bodies. For Manatee Springs, the compliance process started in 2008 with the assignment of a TMDL (Hallas and Magley 2008) and the completion of a Basin Management Action Planning (BMAP) in 2018. Manatee Spring lies within the Suwannee River Basin Management Action Planning (BMAP) region and a Springs Priority Focus Area (PFA), both regulated by DEP (DEP 2023).

Submerged Aquatic Vegetation

Inland freshwater Florida spring ecosystems like both Manatee and Fanning springs were once characterized by thick beds of five dominant submerged aquatic plants, including spring-tape (*Sagittaria kurziana*), American eelgrass (*Vallisneria americana*), southern waternymph (*Najas guadalupensis*), creeping primrosewillow (*Ludwigia repens*) and muskgrass (*Chara* sp.) (Whitford 1956). The presence of these five dominant SAV taxa have long characterized an ecologically healthy “underwater forest” within Florida’s spring ecosystems (Odum 1957; Wetland Solutions Incorporated 2010; Heffernan et al. 2010).

Historical narratives and photographic records of Manatee Spring illustrate that a high diversity of SAV (at least 10 species) once densely covered large areas of the spring bottom (District 2 files and various sources). At one time, American eelgrass (*Vallisneria americana*), springtape (*Sagittaria kurziana*) and Carolina fanwort (*Cabomba caroliniana*) once dominated the entire Manatee spring run.

In 1956, Manatee Springs was characterized as a healthy, hard mineral freshwater system containing both algal and SAV components (Whitford 1956). It is noteworthy that during that time a diverse assemblage of “attached” and “unattached” algae comprised more than 50% of the aquatic plant growth at Manatee Spring (Whitford 1956). In other words, a healthy Manatee Spring ecosystem should include a rich diversity of SAV balanced with a biologically diverse assemblage of algae and microscopic diatoms. Subsequent documentation of the SAV community at Manatee Spring indicates that the spring ecosystem remained intact and healthy through 1975 (Rosenau et al. 1977; District 2 files; Hinkle 2009).

The first major impact to SAV at Manatee Springs State Park occurred during the period from 1975-1985, when the park documented a significant shift in SAV cover in the spring and spring run from predominantly native SAV to SAV dominated by hydrilla (*Hydrilla verticillata*), a non-native accidently introduced from South America. Large-scale restoration efforts, including intensive chemical and mechanical treatments, were employed in the Manatee Springs system from 1985-1998 to control hydrilla and reset the SAV diversity back to historic conditions (Hinkle 2009).

Unfortunately, there were unavoidable events that occurred simultaneously with the restoration efforts. The Suwannee River experienced major flooding, which caused extended brownouts of the spring run, and Florida manatees visited the spring in significantly higher numbers, which resulted in greatly elevated grazing pressure on the SAV. Both phenomena severely hampered restoration efforts and restricted the regrowth of native SAV in the spring run.

From 1990-2004, DRP staff monitored SAV semiannually within the spring-run stream (District 2 files), measuring vegetative cover along several transects spanning the spring run that were set up by DRP between the headspring and the Suwannee River. The earliest known SAV map for Manatee Spring was produced in 1989 (Hinkle 2009).

In 2001, the park and the Florida Fish and Wildlife Conservation Commission (FWC) initiated a new experimental restoration technique to revegetate SAV in the Manatee Springs system (Smith and Mezich 2004). This novel technique used exclusion cages to isolate newly planted SAV from manatee grazing, with the idea that this would allow SAV roots ample space to grow undisturbed. Unfortunately, flooding of the Suwannee River in 2003 once again damaged all SAV in the spring run before the success of the technique could be evaluated. In the spring of 2003, SAV (limited to three species) covered only 1% of the entire Manatee Spring/spring-run bottom (Kurtz et al. 2003). Since the 2003 mapping, there have been no substantial positive changes to the SAV component at Manatee Springs State Park.

Water managers continue to debate the causes of the dramatic ecological shift at Manatee Springs from the highly diverse, SAV/algae-dominated system of the 1960s to the minimally diverse, benthic algae monoculture prevalent today. Nevertheless, it should be apparent that the ecological health of the Manatee Springs ecosystem is in marked decline (Harrington and Wang 2011; Copeland et al. 2011).

Objective A: Conduct/obtain an assessment the park's hydrological restoration needs.

- Action 1 - Continue to cooperate with other agencies and independent researchers in hydrological research and monitoring programs.
- Action 2 - Continue to monitor surface and groundwater quality at Manatee Spring and track water quality changes.
- Action 3 - Continue to monitor all on-site sewage treatment and disposal systems (OSTDSs) in the park for evidence of detrimental impacts to water quality in the aquatic cave system.
- Action 4 - Continue to monitor land-use or zoning changes in the region and offer comments as appropriate.
- Action 5 - Continue to cooperate with the SRWMD in monitoring Manatee Spring for compliance with established MFLs in order to ensure maintenance of historic flows.
- Action 6 - Perform dye trace studies within the Manatee springshed to further understand karst connections and determine groundwater sources for the spring and for other karst features in the park.

Three significant hydrological features in the park include the first-magnitude Manatee Spring, its associated aquatic cave system and the Suwannee River. The aquatic cave system at Manatee Springs

State Park is world famous and has been extensively mapped by the cave diving community. Numerous research and monitoring efforts by the SRWMD, DEP, USGS and experts in the cave diving community have produced an abundance of information documenting the Manatee Springs system (see details in the *Hydrology* section above).

DRP will continue to coordinate with and assist DEP, the SRWMD and independent researchers in monitoring water quality and quantity in the spring system and in numerous park monitoring wells, as well as other open-water karst features within the park. DRP staff will seek to increase the frequency of monitoring if changes in water quality or abnormal fluctuations in discharge are noted.

Since 1997, multiple factors, including non-native submerged aquatic vegetation (SAV), extreme drought, saltwater encroachment and increased groundwater consumption, have combined to cause a rapid deterioration in ecological health of Manatee Spring. Regulatory agencies have determined that the waters of Manatee Spring are impaired because of high levels of nitrogen and mercury and low levels of oxygen. SAV, once dominant in the spring and spring run, now covers only small sections of the spring bottom, with the remaining area either bare or blanketed with nuisance filamentous algae. Mitigation of on-site sewage treatment and disposal systems and stormwater runoff in the park, restoration of the spring ecosystem and protection of the Manatee springshed should remain high priorities. Although the water quantity and quality issues at Manatee Spring are complex, improvements are still achievable. The following hydrological assessment actions are recommended for the park.

The advanced treatment provided by the on-site sewage treatment and disposal systems that were installed at the Hickory and Magnolia campgrounds appears to have largely mitigated nutrient contamination of the groundwater within the aquatic cave system. DRP should continue to support continuous water quality monitoring of the aquatic cave system to ensure that the park’s on-site sewage treatment and disposal systems do not cause detrimental impacts. A long-term goal of DRP should be to replace all in-ground septic systems in the park with municipal sewer network connections or a modern wastewater treatment facility located well away from significant karst features.

Even though the Manatee/Fanning springshed has already been delineated, there are still gaps in understanding about the proximal sources of groundwater flow from the Floridan aquifer to the Manatee headspring. In order for water managers to be able to protect water quality and potentially restore spring flows to their historic levels, they will need to know the extent of the springshed. To facilitate that process, DRP should seek expertise and funding opportunities for dye trace studies to determine the groundwater sources for the spring and karst systems in the park. Previous dye trace studies in the region (e.g., delineation of the Chiefland Sink connection to Manatee Spring) have provided park management with invaluable information about the various sources of spring water and the timing of surface water/groundwater interactions that potentially affect spring water quality.

DRP will continue to monitor land-use or zoning changes within lands bordering the park. Major ground disturbances on neighboring properties or inadequate treatment of runoff into local streams could ultimately cause significant degradation of park resources. When appropriate, DRP will provide comments to other agencies regarding proposed changes in land use or zoning that may affect the park. In addition, DRP will closely monitor mining operations or large consumptive use permits in the Suwannee basin or Manatee springshed for significant changes that may adversely affect park resources.

DRP will continue to work closely with the SRWMD to ensure that MFLs developed for the lower Suwannee River, including Manatee Springs, are monitored conscientiously and that historic river flows are protected or restored if there is noncompliance with the MFL.

Objective B: Conduct external coordination and education to address water quality and quantity concerns within the Manatee springshed.

- Action 1 - Continue to coordinate with agencies responsible for the protection and improvement of hydrological resources within the Manatee springshed.
- Action 2 - Pursue outreach opportunities and develop programming to educate the public about anthropogenic impacts to the Manatee/Fanning springshed.
- Action 3 - Continue to coordinate with and assist DEP, the SRWMD and independent researchers in the monitoring of water quality and quantity in open-water karst features in the park.

DRP will continue to engage with water management stakeholders to support education and awareness efforts designed to mitigate impacts to water quality and quantity at the regional level. Examples are Basin Management Action Plans (BMAPs), Springshed Protection Working Groups and other governmental and non-governmental organization affiliations such as the North Florida Springs Alliance.

Objective C: Restore natural aquatic habitat to approximately 3.17 acres of spring-run stream.

- Action 1 - Annually survey the spring-run stream for submerged aquatic vegetation (SAV).
- Action 2 - Examine the feasibility of conducting experimental plantings of submerged aquatic vegetation in the spring and spring-run stream.
- Action 3 – Initiate preliminary implementation measures for the Manatee Springs shoreline restoration project.

Research indicates that the 3.17-acre spring-run stream within Manatee Springs State Park is experiencing major anthropogenic impacts because of increased nutrients, reductions in groundwater flow and a near collapse of the submerged aquatic vegetation. The permanence of these impacts is unconfirmed, but the occurrence of the impacts has been documented for over 10 years.

Restoration of the spring-run stream is critically important for maintaining the site as a warm-water refugium for the endangered Florida manatee. Accordingly, DRP staff over the next 10 years will examine the feasibility of conducting experimental plantings of key species of SAV within Manatee Spring bowl and spring-run stream to replenish stocks that have severely declined since 2000.

DEP has historically funded several projects at Manatee that were closely tied to restoring natural shoreline features around the perimeter of the spring and spring-run stream. DRP should implement the Manatee Spring shoreline restoration project that has been designed to remove hardened bulkhead structures around the spring perimeter and restore the natural contours and slopes along the existing altered shoreline. This project is integral to spring-run stream ecosystem restoration and will help stabilize areas of soil erosion along the bank that have gradually undermined the structure at main public access points.

Although DRP has made significant progress in rectifying key erosion issues upslope of the springhead, additional boardwalks, stairs and parking area improvements are still needed in areas of high visitor use. Stormwater runoff from parking areas and service roads must be diverted away from the springhead and other sensitive karst features and into surrounding woodlands as much as possible to encourage natural attenuation and filtration. Water bars, broad-based dips, or other best management practices may be used strategically to slow down moving water and to minimize erosion during strong storm events.

Objective D: Improve water quality within approximately 33,000 feet of aquatic cave passages.

- Action 1 - Maintain semi-regular monitoring of established locations within the Manatee Springs cave system to track physical and biological changes.
- Action 2 – Ensure proper stormwater management to avoid runoff into nearby karst windows.
- Action 3 – Remediate identified point sources of contaminants such as septic tanks.
- Action 4 – Identify erosion-causing footpaths and delineate appropriately sensitive access points to karst windows.

Several sensitive karst features in the immediate vicinity of the Manatee headspring – Catfish Hotel, Sue Sink and Friedman Sink – require close monitoring and additional protective measures since they are situated near known sources of stormwater runoff and on-site sewage treatment and disposal systems leaching within the Hickory Campground. However, every karst feature in the park is critical in that each could conceivably funnel runoff directly into the 33,000-foot aquatic cave system and degrade the hydrological condition and function of the system.

DRP staff will regularly monitor areas of the park that are prone to erosion, including the more sensitive karst features such as Sue Sink, to ensure that they are not negatively affected by stormwater contamination. As mentioned above, in some areas such as Hickory Campground, very little soil overlies the often-exposed limestone bedrock where engineered stormwater retention will continue to be challenging.

Consistent with the above concerns, foot traffic-related erosion is also identified as a source of water quality impairment in the vicinity of the karst windows. DRP will investigate best management options to continue to improve public access to the park's two most popular visitor access points, Manatee headspring and Catfish Hotel Sink, while limiting access to other more sensitive karst areas.

As of 2014, several on-site sewage treatment and disposal systems associated with residences and administrative offices on park property had still not been upgraded to advanced treatment technology. Given that the entire park is underlain by unconfined Floridan aquifer and the most vulnerable portion of the Manatee Springs aquatic cave system, DRP should make it a top priority to upgrade all remaining septic systems to advanced treatment.

Objective E: Restore natural hydrology to approximately 7 acres of floodplain swamp, alluvial forest and basin swamp natural communities.

- Action 1 - Determine if the culverts on the Scenic Trail and along the north boundary of the park are adequate in size, number and height above grade to allow necessary water flow between wetlands.

Two areas in the park have culverts that need evaluation. In zone 2A, in the north-central portion of the park, a major hiking trail crosses a low area of alluvial forest. The culvert in this area may be restricting water flow to some degree because it is placed slightly above grade. The second area in need of evaluation is at the north end of the park in zone 1F where the park boundary crosses a basin swamp. A berm was constructed many years ago to facilitate access to this area. Staff should determine if additional culverts are needed and if existing culverts are on correct grade. A potential long-range solution would be to acquire the undeveloped property north of the basin swamp so that the park road could be placed outside the wetland, allowing for basin swamp restoration (see *Optimum Boundary* section).

Restoration will require identification and elimination of any improper pathways that breach floodplain wetlands or sensitive karst features. In addition, the park will continue to remove feral hogs from wetlands and significant karst openings in an effort to decrease the associated soil disturbance.

Objective F**:** Monitor impacts of visitor use on the aquatic cave system.

- Action 1 - Continue to monitor cave diving activities to determine the relationship between intensity of visitor use and ecological health of the aquatic cave system.
- Action 2 - Seek the expertise of cave experts in instituting a semiannual monitoring program for tracking troglobite populations and diver impacts within the Manatee Springs aquatic cave system.

DRP staff will continue to coordinate with cave experts in monitoring disturbance issues and will pursue the initiation of semiannual cave assessments. Cave assessment sites should include the Manatee headspring and Catfish Hotel entry points, two entrances that endure higher levels of recreational use than the rest of the system. DRP will work with an existing springs management team that has already provided numerous recommendations regarding use and management of the Manatee Springs cave system. The team consists of certified cave divers from the National Speleological Society Cave Diving Section as well as professionals with relevant expertise in aquatic cave biology and representatives from DEP. DRP will investigate all reports of vandalism discovered within the cave system.

With assistance from the springs management team, DRP will continue to develop and implement baseline survey and monitoring programs that assess biological and physical conditions in the Manatee Springs cave system. DRP staff will work closely with the team to establish standardized photo points in certain passages and rooms that are popular with cave divers and to monitor the points on a regular basis to track cave conditions. To protect sensitive cave fauna, assessments of the cave system must consider both natural and human impacts. If necessary, DRP will modify public access and establish science-based carrying capacities at the primary and secondary dive access points to the cave system. Hydrologic events will also be monitored to determine possible side effects on troglobite populations within the cave system.

The park will continue to use a diver check-in system to track daily cave use. Unauthorized access to the cave system by non-certified cave divers must be prevented out of concern for both the resource and for visitor safety. DRP will consult with cave diving organizations when making decisions about cave access.

DRP staff will coordinate with members of the National Speleological Society Cave Diving Section and the North Florida Springs Alliance in developing interpretive programs to educate cave divers about cave preservation and proper cave-diving etiquette. One objective should be the adoption of a series of guidelines for cave divers that identify detrimental activities within cave systems that should be forbidden or discouraged.

NATURAL COMMUNITIES

Limestone Outcrop

Only a few small limestone outcrops, all associated with sinkholes, are currently known to occur within the park. None are located on a public trail, two are close to a service road over the cave system, and one is located far from any trail or road. No invasive plants are present on the outcrops at this time. At least one imperiled plant, angle pod (*Gonolobus suberosus*), has been observed growing on the outcrops, and other rare or imperiled plant species may occur there as well. This community is in good condition.

Management of limestone outcrops will mainly entail protection from disturbances such as human intrusion, feral hog rooting and invasive plant infestations. The known outcrops in the park are within sinkholes that are relatively inaccessible to the public. If additional limestone outcrops are found, the park will take measures to prevent degradation by runoff and erosion, particularly near existing trails or roadways. Personnel involved in the control of invasive plants in sinkholes and upland hardwood or bottomland forests should consider it likely that limestone outcrops or boulders harboring rare plants are nearby and should minimize ground disturbance and overspray of herbicide as much as possible. Limestone outcrops discovered in the future will be mapped and surveyed for imperiled plant species.

Mesic Hammock

Mesic hammock at Manatee Springs State Park occurs primarily in the ecotone between wetland and upland natural communities. A typical example would be the strip of mesic hammock that separates upland mixed woodland from bottomland forest, alluvial forest or floodplain swamp along the Suwannee River. Mesic hammock also occurs in isolated islands in the floodplain swamp associated with the Suwannee River and in small areas of natural river levee.

Dominant canopy species include laurel oak, water oak (*Quercus nigra*), southern magnolia, pignut hickory and live oak. Common understory species may include saw palmetto, ranging in density from moderate to high, coastalplain staggerbush (*Lyonia fruticosa*), sparkleberry, highbush blueberry (*Vaccinium corymbosum*), American holly, wild olive (*Cartrema americana*) and horse sugar (*Symplocos tinctoria*). Very little cabbage palm is present. Groundcover is very sparse.

Areas of younger mesic hammock may be difficult to distinguish from successional hardwood forest that has developed because of fire exclusion and logging in the upland mixed woodland community. Canopy pines in the mesic hammock, however, are usually infrequent, and they typically are loblollies, not the remnant longleaf pine survivors that might be expected in fire-excluded upland mixed woodland or upland pine communities. Laurel oak, water oak and sweetgum (*Liquidambar styraciflua*), generally 25-35 years in age, and dense to moderately dense saw palmetto are the dominant species in young mesic hammock. The mesic hammock at Manatee Springs State Park is in good condition.

Management measures will be minimal except for ensuring that prescribed fires in adjacent pyrogenic communities penetrate sufficiently to keep volunteer loblolly pine seedlings thinned to natural background levels.

<u>Sandhill</u>
Dominant canopy species in the Manatee Springs State Park sandhill community include longleaf pine, turkey oak, sand post oak and sand live oak (*Quercus geminata*), with occasional southern red oak (*Quercus falcate*) present. The understory consists of younger individuals of the same species supplemented by a thick layer of myrtle oak. Sparkleberry (*Vaccinium arboreum*) and deerberry (*Vaccinium stamineum*) are representative shrubs, and saw palmetto (*Serenoa repens*) is very prevalent. The groundcover is very suppressed due to insufficient fire, and wiregrass and pineywoods dropseed are almost absent from the sparse herbaceous groundcover. Bracken fern is present. At Manatee Springs State Park, the sandhill community often grades into upland mixed woodland or scrubby flatwoods. While the dominance of turkey oaks over southern red oaks typically defines the boundary between sandhill and adjacent upland pine or upland mixed woodland communities at the park, this division is often indistinct and confusing due to the years of fire suppression before 2001 and the scarcity of wiregrass and other herbaceous species. The sandhill at Manatee Springs State Park is in poor condition due to the encroachment of sand live oak and a history of insufficient fire.

Off-site hardwoods, in particular sand live oak, dominate some of the sandhills that have experienced long-term fire exclusion. These areas do have many adult longleaf pines present, although some areas may need additional longleaf in the future. Hardwood reduction is needed to release suppressed herbaceous species, reduce competition with adult longleaf, and encourage continued longleaf pine recruitment. Along the management zone edges, selected sand live oaks will need to be mechanically removed and chemically treated. In the zone interiors, chemical or mechanical treatment of sand live oaks will enhance the effect of prescribed fire. Regular fire in a 2-3 year fire return interval is needed.

<u>Scrubby Flatwoods</u>
Dominant shrubs include sand live oak (*Quercus geminata*), myrtle oak (*Quercus myrtifolia*), Chapman's oak (*Quercus chapmanii*), saw palmetto (*Serenoa repens*), rusty staggerbush (*Lyonia ferruginea*) and tarflower (*Bejaria racemosa*). Cover by herbaceous species will often be well below 40%. The optimal fire return interval for this community is regionally variable, but areas may be prescribed fire may be applied as frequently as every 3-5 years when fire prescriptions are designed to achieve a mosaic of burned and unburned areas.

The largest areas of scrubby flatwoods community at Manatee Springs occur in the southeast part of the park and within the Mead-Scott tract to the southwest. In many areas of the park, the boundaries between scrubby flatwoods and other upland communities such as sandhill and upland pine can be difficult to distinguish. This is in part due to past fire suppression, logging and other human impacts.

According to a revised description of scrubby flatwoods published by the Florida Natural Areas Inventory (FNAI) in 2010, the shrub layer of that community consists of one or more species of scrub oak as well as a variety of other shrubs that are also found in mesic flatwoods. Sand live oak, myrtle oak,and Chapman's oak are the three scrub oaks that occur at Manatee Springs State Park. Scattered turkey oak also may be a minor component. Other shrub species common in the park's scrubby flatwoods include saw palmetto, rusty staggerbush (*Lyonia ferruginea*) and coastalplain staggerbush (*Lyonia fruiticosa*). Carolina indigo (*Indigofera caroliniana*) is also common, although this plant is not restricted just to scrub habitats. Longleaf pine is present. In some areas, loblolly pine (*Pinus taeda*) has invaded. Sand pine is not a component of the scrubby flatwoods at the park.

Scrubby flatwoods that contain this mix of scrub oaks occur in the southeast part of the park in zones 3A and 3B and within zones 5A, 5B and 5D in the Mead-Scott tract to the southwest. There are other areas of the park that now fit the new FNAI description of scrubby flatwoods but only contain one or two species of scrub oak. On the eastern edge of zone 1B is an area dominated by myrtle oak with a longleaf pine canopy. This may be sandhill that is being invaded by scrub oaks. Another very fire-suppressed area in the northeastern part of zone 2A may actually be scrubby flatwoods, but it is currently mapped as xeric hammock. This area has a closed canopy of sand live oaks, with some laurel oaks interspersed and an understory of palmetto that grades into a myrtle oak, sand live oak and longleaf pine area.

Prior to becoming part of Manatee Springs State Park, the scrubby flatwoods in the Mead-Scott tract were cleared and planted with slash pines at two separate times in the 1970s. Most of the tract was cleared and site-prepped with windrows and bedding in 1976-77. Over most of the site, windrows still alternate with four or more rows of pines planted on raised beds. The area has been treated with prescribed fire several times, and a small outbreak of pine beetles has opened the canopy. Longleaf pines are absent from the canopy.

In the park's southeastern area of scrubby flatwoods, the scrub oaks have reached canopy size in areas. Because of the relatively extreme conditions under which these oaks will ignite and burn, these areas have not burned completely in many years. In some areas, high fuel buildup in the scrubby flatwoods has contributed to the mortality of adult longleaf pines after prescribed fires. Mechanical treatment of fuel concentrations in these areas will facilitate prescribed fire, resulting in more complete combustion and perhaps protecting adult longleaf pines as well.

The condition of the scrubby flatwoods at Manatee Springs State Park ranges from poor to good, depending on the success of prescribed fires at penetrating the taller scrub oaks and top-killing canopy oaks. Some areas are deficient in longleaf pines. The area in zone 2A needs further investigation to delineate the ecotone and to determine if this area is actually fire-suppressed scrubby flatwoods.

Restoration of overgrown scrubby flatwoods to a more characteristic condition through prescribed fire alone has proven difficult due to the height of the scrub oaks and the limited conditions under which the zones will burn well. To speed up the restoration process, it will be necessary to mechanically treat overgrown sites to lower the fuel structure and open the closed canopy before initiating prescribed fires. Some areas may need plantings of longleaf pines. Windrows in the Mead-Scott zones should be removed and longleaf pines replanted. The preferred fire return interval for the scrubby flatwoods at Manatee Springs is 3-5 years.

<u>Sinkhole</u>
Sinkholes and depressions are numerous at Manatee Springs State Park. They range in nature from shallow depressions to deep chimneys. Several sinkholes and depressions in the park are superimposed over the subterranean cave system through which groundwater flows to the headspring (see Aquatic Cave section below for additional information). The slope-sided sinkholes contain mature vegetation typical of the surrounding natural communities. In general, they do not contain exposed limestone. Some sinkholes remain dry year-round, while others may hold water for a period of time after heavy rainfall events. Most of the park's sinkholes are in excellent condition, although some are being impacted by feral hogs.

Sinkhole management must emphasize protection of resources. Edges of sinkholes should be protected from disturbance, particularly that caused by feral hogs. Public access to sinkholes in general should be limited, and there should be no access to the more sensitive sinkhole sites. Regular monitoring of sinkholes for the presence of invasive plants and animals will be necessary.

Upland Hardwood Forest

Two forms of upland hardwood forest occur at Manatee Springs State Park. The more mesic form occurs around the Magnolia 1 and 2 campgrounds. Pignut hickory, southern magnolia, basswood (*Tilia americana*), sweetgum (*Liquidambar styraciflua*), laurel oak, live oak and bluff oak (*Quercus austrina*) are present. The dry upland hardwood forest variant occurs at the southeast end of the park, south of the scrubby flatwoods. Surveys in the mid-1800s described this community as scrub hammock with oak. It is currently in good condition.

Additional campsites and an upgraded septic system were added to the Magnolia 1 campground in 2015. The resulting disturbed areas in the mesic variant of the upland hardwood forest need to be replanted with species originally found on the site. Plants need to be protected from foot traffic until they are well established.

Upland Mixed Woodland

The upland mixed woodland community often serves as a transition zone between upland pine or sandhill and adjacent upland hardwood forest or mesic hammock. It is similar to upland pine in that it is fire-adapted, has longleaf pine as the dominant pine species and has a strong presence of southern red oak and mockernut hickory in the canopy, along with scattered sand post oaks. Unlike the upland pine community, however, upland mixed woodland typically lacks wiregrass as a dominant groundcover, and the oaks and hickories may be co-dominant with the longleaf pines. Due to a history of past logging at Manatee Springs, there are parts of this community that currently are dominated by loblolly pine rather than longleaf pine.

The groundcover of this community at Manatee Springs State Park often contains extensive amounts of blackseed needlegrass, some woodoats and essentially no wiregrass. Cherokee bean and early blue violet are common. Florida spiney-pod and Florida mountainmint occur here too. While this community is beginning to recover from years of fire suppression, it still needs prescribed fire on the shorter end of the fire return interval and some additional off-site hardwood treatment in selected areas.

Since this is a transitional community, upland mixed woodland is quite susceptible to succession to upland hardwood forest when there is a lack of fire. Because of its richer soils, it has often been converted to agriculture. Fortunately, such agricultural conversion was uncommon at Manatee Springs, although in limited areas there were small agricultural fields dating back to at least the 1850s. The park contains some very good examples of upland mixed woodland despite years of long-term fire suppression. Fortunately, the past decade of fire management has begun to reveal the true extent and nature of this community in the park.

There are still parts of this natural community that are quite fire-suppressed or lack longleaf pines. These areas need off-site hardwood removal, continued fire and planting of longleaf pines. In some cases, the transition between upland mixed woodland and what was probably sandhill, scrubby flatwoods or mesic hammock has been blurred due to the lack of fire.

Analysis of historical aerial photographs of the Manatee Springs area reveals that a decades-long exclusion of fire from most of this community has encouraged a gradual transformation from relatively open woodland to dense forest dominated by invasive off-site hardwoods. Those hardwoods have shaded out most of the herbaceous species. Sites that have reverted to such an extent may be considered to be in poor condition, or they have been reclassified as successional hardwood forest (as defined by FNAI), with the desired future condition being upland mixed woodland (see the Altered Landcover Types section that follows this Natural Communities section).

Chemical treatment of dense stands of off-site hardwoods will be critical to preparing overgrown upland mixed woodland sites for prescribed fire in very fire-suppressed sites. This will allow herbaceous species to begin recovering. Initial girdling efforts have concentrated on hardwood-invaded sites that happen to be adjacent to fair-to-good condition upland mixed woodlands. DRP needs to target additional upland mixed woodland remnants for restoration work. The condition of upland mixed woodland ranges from very good to poor.

Restoration and improvement of the upland mixed woodland community will entail the reintroduction of frequent fire (2-4 year return interval), the removal of off-site hardwood species and the planting of longleaf pines in some areas. DRP will need to conduct additional field surveys to verify the historic extent of this community. Documentation of the distribution of remnant species will be needed as well.

Upland Pine

Upland pine typically functions as an ecotone between the sandhill community and upland mixed woodland. At Manatee Springs State Park, it is likely that areas of upland pine occur in the matrix of upland mixed woodland at the park. However, these areas are not easily defined at this time. Broad expanses of characteristic upland pine species, particularly longleaf pine, southern red oak and mockernut hickory, occur in the northern part of the park, but wiregrass is noticeably absent in these areas. Currently, much of this area is mapped as upland mixed woodland with a few areas mapped as upland pine. Both communities are in a restoration phase. Many areas still have off-site hardwoods such as laurel oak and sweetgum that need to be removed. Most of these areas also are dominated by loblolly pine (*Pinus taeda*) and lack longleaf pine. Maps and surveys show evidence of human occupation by 19th-century homesteaders in this habitat in several areas of the park. At the very least, the human occupation has resulted in the removal of longleaf pine for timber and the creation of some crop fields in the mid-1800s. With continued application of fire on a 2-4 year return interval, the difference between upland pine and upland mixed woodland communities may become more apparent. The condition of this community in the park is difficult to determine but probably ranges from poor to fair. Upland pine areas will require additional hardwood reduction to release suppressed herbaceous species and encourage longleaf pine recruitment. This will require some chemical treatment of off-site hardwoods, primarily laurel oaks. Other than that, frequent prescribed fire in upland pine zones will be essential to maintaining community structure and ecological integrity. Once the marginal upland pine sites have been restored to a reasonably good condition, areas of former upland pine that have transformed into successional hardwood forest will be targeted for restoration as well. Longleaf pine will be planted in areas where loblolly pine currently dominates.

Xeric Hammock

Xeric hammock occurs in only a limited area at Manatee Springs State. Its canopy is dominated by sand live oak, laurel oak, pignut hickory (*Carya glabra*) and wild olive. Depending on the origin of the xeric hammock, other species such as sand post oak (*Quercus margaretta*), turkey oak (Quercus *laevis*) or Chapman's oak may also be present. Understory species may include sparkleberry (*Vaccinium* *arboreum*), deerberry (*Vaccinium staminium*), rusty staggerbush (*Lyonia ferruginea*) and saw palmetto. Xeric hammock at Manatee Springs Stae Park seems to have developed in localized settings in zones 2A, 3C and 3E where there has been a long period of fire exclusion possibly combined with logging of longleaf pines.

In zone 2A, the effects of fire exclusion may have been enhanced by the fire shadow created by a basin swamp to the north. The xeric hammock at Manatee Springs State Park is at an intermediate stage in development. Aerial photographs from 1949 show habitat that appears to be several different natural communities. In zones 3C and 3E, the 1940s aerial photographs show what looks like sandhill where xeric hammock occurs today. This area currently has a closed canopy of sand live oak with mature longleaf pines emerging above it. In the portion of 2A currently mapped as xeric hammock the aerial photos show a signature that appears to be scrubby flatwoods. While these habitats may be xeric hammock today, the desired future condition will be the historic community type, in this case probably sandhill or scrubby flatwoods depending on the zone. Its condition ranges from fair to good.

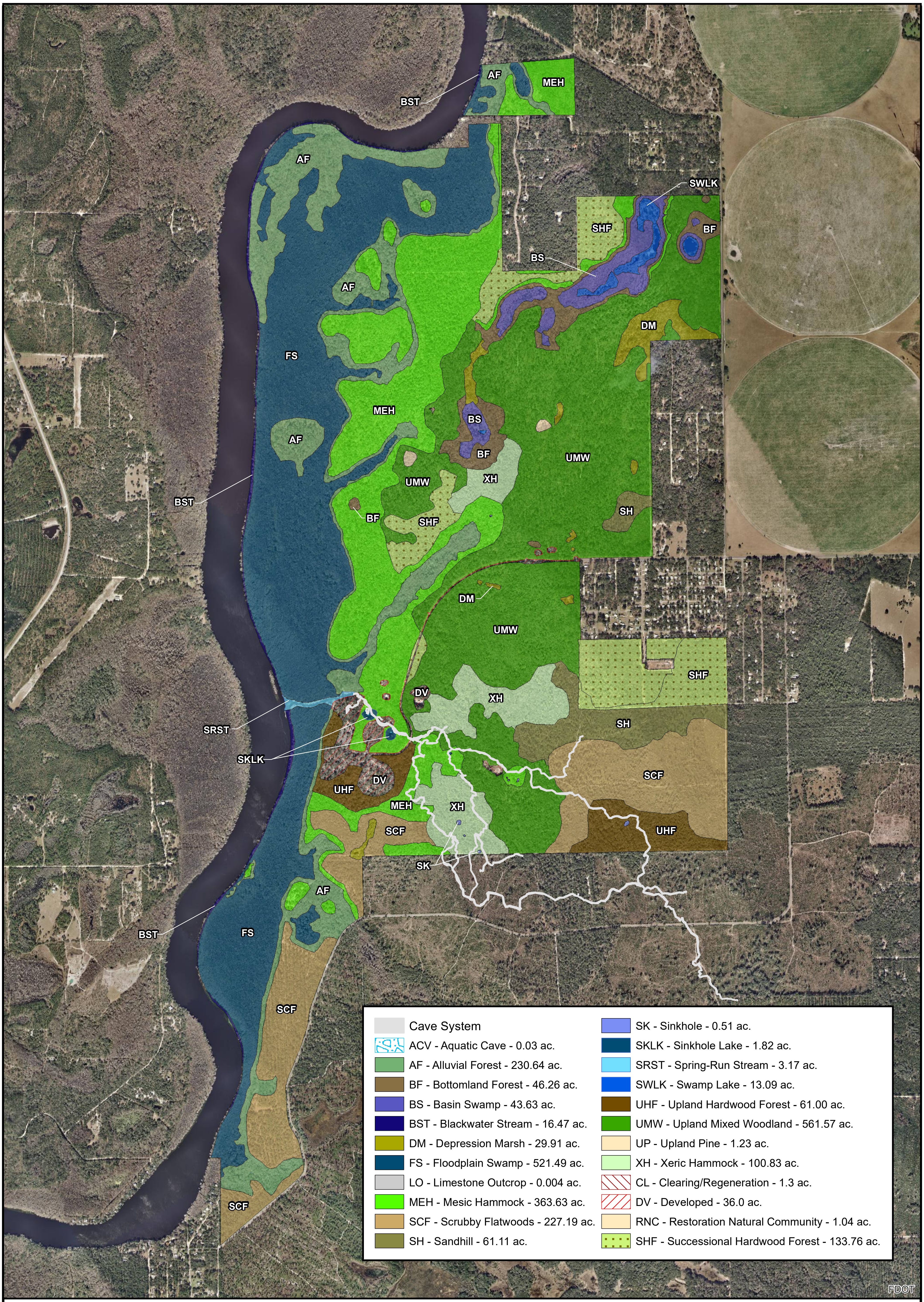
District 2 biologists need to conduct more extensive evaluations of the xeric hammock in zone 2A to verify that the historic community was indeed scrubby flatwoods. A restoration plan for this area would be developed from the findings. Xeric hammock in zones 3C and 3E will need selective use of chemical and mechanical treatment combined with prescribed fire to return these areas to the desired future condition of sandhill. Fire from the surrounding natural communities should be encouraged to burn into the xeric hammock on a 2-4 year return interval and be allowed to extinguish on its own.

<u>Alluvial Forest</u>
At Manatee Springs State Park, this community occurs as a narrow band of lowland roughly paralleling the Suwannee River. Topographic relief determines the community's frequency of inundation, which is the primary basis for distinguishing alluvial forest from floodplain swamp. Alluvial forests occur at slightly higher elevations than floodplain swamps and tend to flood annually. Floodplain swamps, on the other hand, are generally flooded for most of the year. In addition to the hardwood species mentioned above, some tupelo (*Nyssa spp*.) and bald cypress (*Taxodium distichum*) may be present in alluvial forests at the park. Butterweed (*Packera glabella*) is common.

There is a short causeway on the Scenic Trail that crosses a narrow arm of the alluvial forest community northeast of the headspring. Although the causeway has a culvert or two, it may impede sheetflow drainage through the forest.

While selective logging likely occurred in the past, the alluvial forest in the park is currently in excellent condition. The primary threat is damage from feral hogs and invasive plants.

Park staff will regularly scout the forest for any occurrences of Chinese tallowtree (*Triadica sebiferum*) or Japanese climbing fern (*Lygodium japonicum*) and will promptly treat any populations discovered. Park staff will also periodically monitor roads and trails that pass through alluvial forest, checking for signs of erosion or feral hog rooting. DRP will evaluate the causeway that cuts through the alluvial forest near the headspring to determine whether additional culverts or lowering of existing culverts may be needed to improve sheetflow through the forest.



MANATEE SPRINGS STATE PARK

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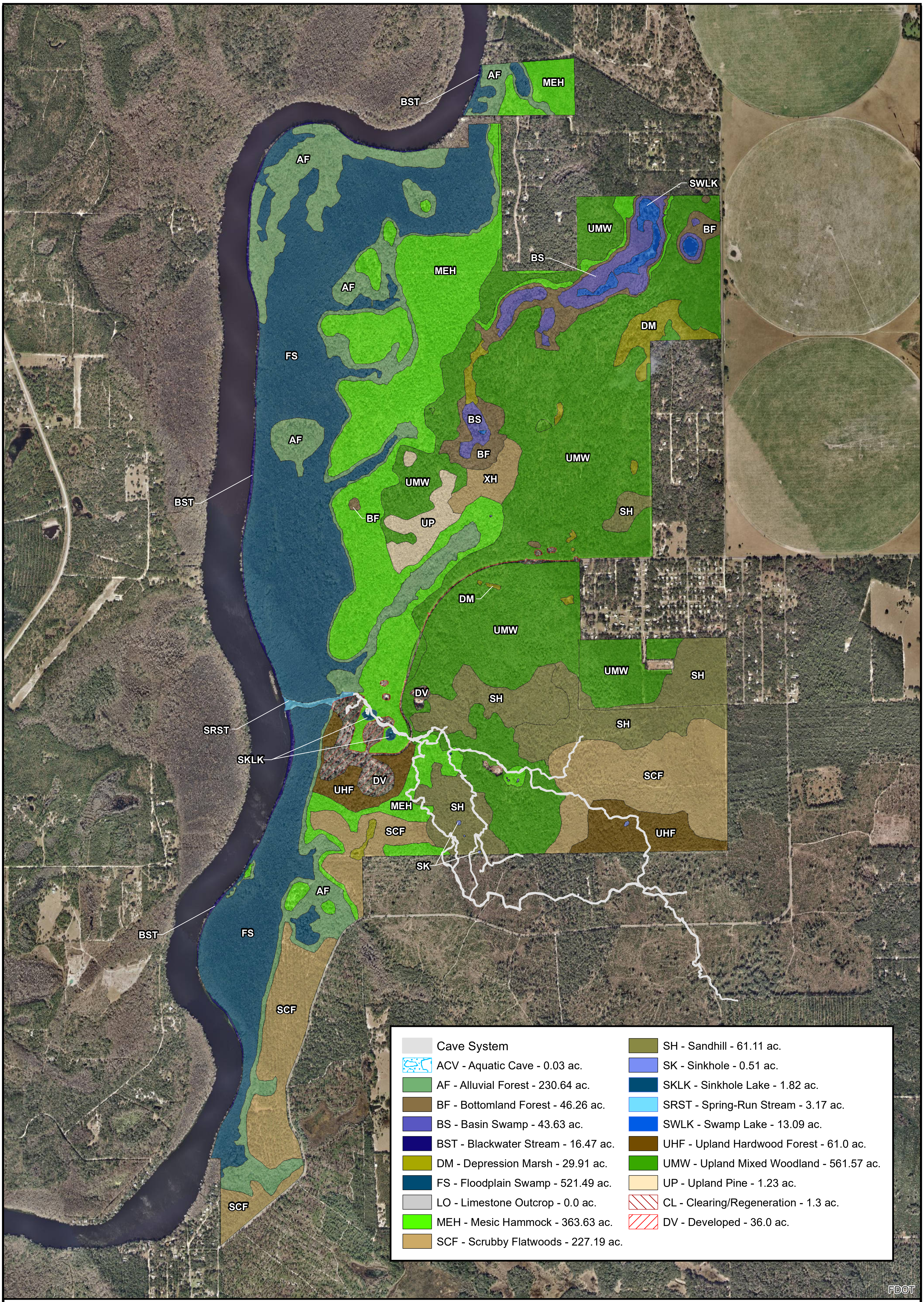
Florida Department of Environmental Protection
Division of Recreation and Parks
Date of aerial; 2016

NATURAL COMMUNITIES MAP
EXISTING CONDITIONS



MANATEE SPRINGS STATE PARK

Florida Department of Environmental Protection
Division of Recreation and Parks
Date of aerial; 2016

NATURAL COMMUNITIES MAP
DESIRED FUTURE CONDITIONS

Basin Swamp

Basin swamps occur primarily at the north end of the park. They often are surrounded by a fringe of bottomland forest that grades into upland mixed woodland or upland pine as the elevation increases. One of the basin swamps surrounds the swamp lake at Shacklefoot Pond. Cypress trees are still dominant despite evidence of previous logging.

A long causeway at the north boundary of the park cuts through basin swamp and impacts Shacklefoot Pond. A solution to this significant habitat disruption should be sought. Possibilities include installing more culverts or acquiring a parcel to the north that contains the isolated fragment of basin swamp and a fringe of uplands. The latter action would allow removal of the causeway and rerouting of the road around the swamp and into the uplands. For the most part, the basin swamps in the park are in very good condition. They would be in excellent condition if the causeway at the north end of Shacklefoot Pond were to be removed.

Prescribed fires will be allowed to burn into the edges of basin swamps to maintain the natural ecotone between them and surrounding uplands. Removal of off-site loblolly pines may be necessary to improve the condition of some of the basin swamps. Restoration of the natural hydrological regime may require adding culverts or removing or modifying existing causeways or roads.

Bottomland Forest

This community primarily occurs in fringes around basin swamps. In some cases, it occupies quite a narrow band. There may be disjunct areas in addition to the fringes as the uplands grade down to alluvial forest in the northern half of the park. Bottomland forest also appears to occur in broad shallow depressions within some areas of the uplands. Delineation of additional areas of this community between the uplands and the river and within the uplands themselves may be beneficial to the understanding of the mosaic of natural communities at Manatee Springs State Park. The bottomland forests in the park are in good condition. Sweetgum, water oak, swamp chestnut oak, loblolly pine and live oak are characteristic species for this community in the park.

Bottomland forests flood less frequently than alluvial forests (FNAI 2010). In some areas, bottomland forest may act as a transition zone between floodplain and upland community types. These transition zones may be too narrow to map depending on the relative slope of the terrain.

Prescribed fires will be allowed to burn into the edges of bottomland forests to help maintain the natural ecotone between them and adjacent uplands. Removal of off-site loblolly pines may be necessary in some areas to improve the condition of the bottomland forests. Monitoring for signs of invasive plant species and feral hogs will be ongoing.

Depression Marsh

Depression marshes at Manatee Springs State Park occur as small, scattered, isolated and mainly herbaceous wetlands set in a forested matrix. These marshes are shallow and often do not fit FNAI's standard description in that they may not be rounded, often do not have concentric bands of marsh vegetation around them and may lack deeper portions containing open water. Recurring drought and flood events from 1998 through 2012 have caused these marshes to experience large fluctuations in water level. Typically, however, the marshes remain dry throughout the year. Depression marshes are important as ephemeral wetlands for many amphibian and invertebrate species.

Invasion of the depression marshes by loblolly pine and buttonbush is countered by prescribed fire and natural flooding. However, adaptable invaders such as loblolly pine and water oak remain in some of the depression marshes despite the application of fire. Typically, these are older trees that became established when management policy was to exclude fire from the marshes. Reductions in the regional water table may lead to more frequent droughts and additional encroachment by hardwoods, eventually encouraging succession of the depression marshes to mesic hammock. The depression marshes at Manatee Springs State Park are currently in fair condition.

Depression marshes should be treated with prescribed fire at the same time as adjacent fire-type natural communities. Maintenance of a natural ecotone is important, as is keeping the marshes free of invasive species. Removal of well-established loblolly pines and oaks may require additional measures such as felling or herbiciding.

Floodplain Swamp

Floodplain swamps at Manatee Springs State Park occur adjacent to the Suwannee River and the Manatee spring run. Bald cypress and swamp tupelo are the dominant tree species. Both are adapted to long-term flooding, which is the expected condition in Suwannee River floodplain swamps except during droughts.

As in the basin swamps, large cypress trees were logged out many years ago. Evidence of this appears in 1940 aerial photographs in which ditches are discernible as linear striations in the swampland. Apparently, felled trees were pulled to the river by oxen in the most direct line possible. Today, the only indications of past logging activities are occasional stumps or logs. Reforestation of the community has progressed such that complete recovery is likely. Floodplain swamp is relatively resilient, and little additional management will be necessary for it to recover from historical impacts. The floodplain swamp at the park is in very good condition.

Park staff will continue to monitor river access points and visitor-use areas within the floodplain swamp for erosion issues and mitigate impacts as needed. The swamps need to be monitored regularly for signs of invasive plants and animals, including feral hogs.

Sinkhole Lake

The park contains several sinkhole lakes. Two of the most accessible are Catfish Hotel and Sue Sink, which are open to divers and connect to the park’s extensive aquatic cave system. Catfish Hotel is accessible to all divers and is subject to considerable use. Friedman Sink usually has little to no water visible and is probably better classified as a sinkhole that leads to an aquatic cave. Friedman Sink is remote, and divers must request permission from park management to enter it. Due to heavy usage, erosion control measures including access stairs are in place at Catfish Hotel. In general, the sinkhole lakes at Manatee Springs State Park are in good condition.

The edges of sinkhole lakes need to be protected from impacts that could accelerate erosion and sedimentation. Increased erosion can cause a decline in water quality, especially if a karst window is present. Protection of the quality and quantity of groundwater and surface water feeding the sinkhole lakes is an additional management consideration.

Swamp Lake

Shacklefoot Pond and Graveyard Pond in the northern part of the park are swamp lakes. Another swamp lake exists in zone 2A. The swamp lakes are presently in very good condition. An agricultural area just north and east of the park may pose a potential threat to the water quality of the swamp lakes, however. This area has several large, center-pivot irrigation systems. In the past, liquefied manure was applied to the fields through the irrigation system to produce forage. Today, cows graze the irrigated pastures.

The shorelines of the swamp lakes may need protection from excessive uses that could accelerate erosion. Protection of the quality and quantity of waters contributing to the swamp lakes is another important management consideration. Currently the sources of potential impact are located outside the park boundary.

Blackwater Stream

The Suwannee River, a typical blackwater stream, forms the western boundary of the park and provides about 3 miles of river frontage. The Suwannee is renowned worldwide, having both scenic and historic significance. The river is undammed except for a low sill dam where it leaves the source waters of the Okefenokee Swamp in Georgia. Nutrients are of particular concern in the river since a significant increase in nitrate levels has been detected throughout the Suwannee River basin. Maintenance of historic flows and levels in the river is another top concern. Despite these issues, the blackwater stream within the park is considered to be in fair to good condition.

Hydrilla (*Hydrilla verticillata*), a noxious invasive plant, is established in the Suwannee River. Fortunately, it does not flourish in the dark, tannin-stained waters as well as it does in clearer waters. The hydrilla in the Suwannee, however, is almost impossible to eradicate completely, and the possibility of it spreading into clear spring runs is a constant threat.

The continuation of frequent water quality and quantity monitoring is a critical management priority. Monitoring will primarily be accomplished in cooperation with DEP and the SRWMD. The continued monitoring and mitigation of riverbank erosion will remain important management activities as well.

Spring-Run Stream

Manatee Spring, one of a relatively few first-magnitude spring systems in Florida, is fed by the Floridan aquifer primarily through a single, large aquatic cave opening at the headspring. It discharges to a short spring-run stream which joins the Suwannee River about 1,250 feet to the west. When the Suwannee River is under extreme flood conditions, Manatee Spring and its spring-run stream can reverse flow and the cave system can act as an estavelle, with tannic surface water pushing into the Floridan aquifer.

In 1956, Manatee Spring was characterized as a healthy, hard-mineral freshwater system containing a rich and diverse complement of submerged aquatic vegetation (SAV) and algal species (Whitford 1956). Manatee Spring's benthic ecosystem appeared to remain intact and healthy through at least 1975.

For many years, the non-native plant hydrilla (*Hydrilla verticillata*) severely impacted the Manatee spring-run stream. Hydrilla rapidly outcompeted and replaced native SAV as it expanded in abundance throughout the spring run. Park staff, volunteers and other state agencies expended considerable effort in removing hydrilla from Manatee Spring using manual, chemical and mechanical methods. In the past 10 years, several brownout events at the spring have negatively impacted the hydrilla, and it is currently not present in the spring or spring run. Additional information about past hydrilla removal in the park is provided above in the *Hydrology* section.

Since 2000, DRP has documented the nearly complete collapse of SAV in the Manatee spring run. As of 2014, the spring run was dominated by a dense monoculture of nuisance benthic algae with very few remnants of native SAV. The *Hydrology* section above describes the deteriorating condition of the spring-run stream in the park and the various factors that may have contributed to its decline. Based on these factors, plus recently declining flows, the Manatee spring-run stream is considered to be in poor condition.

DRP will continue to cooperate with the cave diving community and coordinate the numerous research projects associated with the river, Manatee Spring and its springshed. Additionally, DRP staff will document and track water clarity at select karst features in the park as a rapid response technique for identifying significant changes that might be occurring in this natural community. Staff will monitor and mitigate any storm water runoff or other contamination threats occurring on slopes above the springs and in communities adjacent to the springs. Monitoring of the spring-run stream for impacts from invasive plants and animals will also be necessary.

DRP will continue to work with appropriate state and federal agencies such as DEP, the SRWMD, the Florida Forest Service (FFS) and the U.S. Fish and Wildlife Service (USFWS) in seeking ways to restore the ecological health of the park's spring system. Priority management efforts should include restoration of natural shoreline contours (i.e., Manatee Springs shoreline restoration project), re-establishment of native SAV in the spring-run stream, protection of water quality, maintenance of historic spring flows that allow continued manatee access to this critical warm-water refuge, and the upgrade of septic systems in the park to advanced treatment technology.

<u>Subterranean Cave – Terrestrial and Aquatic</u>
The Manatee Springs aquatic cave system is one of the longest in Florida and has been extensively explored, with more than 6 miles of passages mapped to date. The Manatee headspring, Catfish Hotel, Sue Sink and Friedman Sink all provide access to the aquatic cave system. Generally speaking, the cave system extends southeasterly from the headspring well beyond the park boundary. It is now known that some sinkholes east of the park within the city of Chiefland are directly connected to the Manatee Springs cave system (Karst Environmental Services 2009). Several other surface depressions and sinkholes occur along the known path of the system.

The Manatee Springs aquatic cave system appears to be in fair to good condition depending on the level of use by divers. Much of the information available to DRP biologists about the recreational use of these caves and impacts associated with that use is derived from communications with volunteer cave divers. The National Speleological Society Cave Diving Section is an active volunteer group at the park and is a consistent source of data, but, as of 2014, a formal assessment of the overall health of the Manatee Springs cave system had not taken place. In general, however, it is known that narrower passages experience higher levels of damage, whether from equipment scraping walls, divers disturbing the clay or silt substrate, or from exhaled air bubbles dislodging fauna clinging to cave surfaces. Damage to the clay or silt layers may persist for long periods of time. This detracts from the natural beauty of the caves and may have unknown consequences for troglobites.

The Manatee Springs cave system harbors a number of rare troglobite species that exist only within aquatic caves. These include the pallid cave crayfish (*Procambarus pallidus*), the Florida cave amphipod

(*Crangonyx grandimanus*) and Hobbs' cave amphipod (*Crangonyx hobbsi*) (Lynch 1984; Franz et al. 1994). Very little is known about the population dynamics or ecology of these organisms, although their populations can vary greatly over time and space.

Periodic monitoring of the aquatic caves by cave divers will allow park staff to track changes and assess impacts, particularly at the Manatee headspring and Catfish Hotel Sink. Research dives throughout the cave system will provide DRP with detailed information about cave conditions. Monitoring for signs of erosion on slopes above the sinkhole lakes will also be necessary, and the park will need to mitigate problem areas promptly to prevent movement of silt into the aquatic caves.

Clearing

There are no current plans to convert the entire clearing, which is located in an area south of the shop, to its original natural community. It has been in a cleared condition since at least 1949. The cleared area has bare soil and is used by the park to store brush for prescribed fire. The footprint of the area should be reduced, if possible, to allow native vegetation to recolonize the edges. Prior to 2001, a variety of debris including concrete had been deposited in this area. By 2010, most of this material had been removed and disposed of, but a small amount of concrete remains.

Developed

Manatee Springs State Park contains various developed areas, including a ranger station, an administrative office, two residences, a main swimming area at the headspring with a children's swimming area nearby, a bathroom and concession building at the headspring, concrete reinforcement around the headspring, a canoe launch, a playground, pavilions, two full service campgrounds, two youth camps, a shop, a former residence site adjacent to the shop, a paved park drive, and two boat ramps located at the north and south ends of the park. For a complete list of facilities refer to the *Land Use Component*.

Standard septic systems in the park should be upgraded to advanced treatment technology, with a high emphasis placed on improving system performance and efficiency. Removal of concrete reinforcement structures at the headspring and restoration of natural shoreline will be in accordance with the engineering plan outlined in the Manatee Springs State Park Springhead Shoreline Restoration Study (Jones Edmunds 2008).

Restoration Natural Community

The park contains a small area of restoration natural community that is embedded within a larger expanse of upland mixed woodland. The desired future condition is upland mixed woodland, and it should be treated with prescribed fire with the surrounding natural community.

Longleaf pines should be planted in this area. Regular prescribed fire is important.

Spoil Area

The only spoil area in the park, Red Dome, is located in zone 2Cs. The desired future condition for the site is upland mixed woodland.

Apparently, the site had traditionally been used to mine or store red clay until there was a need for it locally.

The site has a layer of bare reddish soil. Native vegetation is beginning to recolonize the area. Fire creeps into the site when the surrounding community is burned.

The site needs further evaluation to determine if the red soil is spoil or an exposed deposit of red clay, as well as what impacts it might have on the ability of the area to be restored to upland mixed woodland. It should continue to be treated with prescribed fire as part of the surrounding upland mixed woodland community.

Successional Hardwood Forest

The long-range plan for former upland mixed woodland, upland pine and sandhill areas that are now overgrown with off-site hardwoods is to restore them to the natural communities that originally existed there. Substantial effort will be required to restore these communities to a satisfactory level. The desired future condition, after the initial phase of hardwood treatment and prescribed fire, will be a pine community (as defined by FNAI) that contains an assortment of representative species such as longleaf pine, southern red oak and mockernut hickory. It will have an increasingly diverse herbaceous groundcover of native species and most of the invading off-site hardwoods (e.g., laurel oak) will have been eliminated from the restoration area. Many of these areas will need additional plantings of longleaf pine once the invading hardwoods have been removed (see the Desired Future Conditions Map in the Natural Resource Management, Natural Community Restoration section of this plan). The areas may also need restoration of groundcover species.

Humans have had a significant historical and archaeological influence on Manatee Springs. The most prominent recent influences have been the logging of longleaf pines and fire suppression. In some areas, longleaf pines are obscured within forests that have a mixed canopy dominated by laurel oak, sand live oak and live oak. These species may be intermixed with southern red oak, sand post oak or turkey oak. The amount and diversity of remnant native groundcover in these areas is unknown at this time. However, similar areas in the park have responded well to a combination of chemical treatment of off-site hardwoods and prescribed fire.

Analysis of historical aerial photographs and surveyor's notes from the 1840s reveals that pinelands once occupied many of the successional hardwood sites at Manatee Springs. Fortunately, minimal land clearing for agriculture occurred at Manatee Springs in the past, thus many of the native groundcover species may still be present in a suppressed state. Application of prescribed fire and removal of off-site hardwoods should help in the recovery of the native groundcover.

Zones 2A, 2B, 3D, 3G and 3H have areas mapped as successional hardwood forest. All these zones have remnant longleaf pines in a matrix of off-site hardwoods and desirable hardwoods. In zone 2A, the successional hardwood forest is adjacent to upland mixed woodland that is in fair condition.

All zones containing successional hardwood forest (2A, 2B, 3D, 3G and 3H as shown in the Existing Natural Communities Map), require a combination of restoration actions. Areas that still contain longleaf pines need to be mapped, and off-site hardwood species such as laurel oak, sweet gum, live oak and sand live oak need chemical treatment. Some road edges may need to have trees mechanically removed for safety reasons, followed by the application of prescribed fire. Zones in which chemical treatment is used should be burned very soon after the hardwoods are dead. The first prescribed fire should follow within six months of tree mortality. The fire return interval should be relatively short so that large volumes of fuel do not accumulate. During the initial phase of restoration, the fire return interval should be two years. Later in the restoration process, the fire return interval will fall within the range listed for the target natural community.

After the first cycle of prescribed fire, restoration areas may need to be evaluated to determine whether they will need longleaf pine plantings. Two prescribed fire cycles will probably be needed before managers can determine how much groundcover restoration will be necessary. Off-site hardwood treatments will likely continue over several years.

Objective A: Maintain 1,115 acres within the optimum fire return interval***.***

- Action 1 - Annually update the unit prescribed fire plan.
- Action 2 - Annually maintain firelines and fire management equipment.
- Action 3 - Manage fire-dependent communities by applying prescribed fire to 280-520 acres annually.

Prescribed Fire Management		
Natural Community	**Acres**	**Optimal Fire Return Interval (Years)**
Upland Mixed Woodland	562	2 - 4
Scrubby Flatwoods	227	3 - 5
Sandhill	61	2 - 3
Successional Hardwood Forest	134	2 - 3
Depression Marsh	30	2 - 10
Xeric Hammock	101	2 - 4
Upland Pine	1	2 - 3
Restoration Natural Community	1	2 - 4
Annual Target Acreage	280 - 520	

Six fire-dependent natural community types occur within the park: sandhill, upland mixed woodland, scrubby flatwoods, xeric hammock, upland pine and depression marsh. Other natural communities may also be affected by fire to some extent, particularly when they border a fire-maintained community type. Successional hardwood forest is an altered landcover type within the park that has a desired future condition of either upland mixed woodland, upland pine or sandhill, depending on location. A fire return interval of 2-3 years is recommended for these areas. The park contains a small area of restoration natural community that is imbedded within a larger expanse of upland mixed woodland. It should be treated with prescribed fire along with the surrounding natural community. The xeric hammock natural community in the park is likely derived from advanced successional scrubby flatwoods and sandhill. The recommended fire return interval is 2-4 years so that it can be burned with adjacent fire-type communities until full restoration to sandhill or scrubby flatwoods is attained. The annual targeted burn acreage for the park is 278 to 520 acres.

The eastern half of the park is dominated by upland mixed woodland, a rare natural community which typically has both longleaf pine and hardwood species as codominants in the canopy. Upland mixed woodland occurs on richer soils than sandhill and typically has a much richer groundcover. However, upland mixed woodland can quickly become dominated by off-site hardwoods in the absence of fire. Restoration of a natural fire regime to the park's upland mixed woodlands is a high priority.

The scrubby flatwoods community occurs mainly in the southern end of the park. Previous attempts to apply prescribed fire to this community have achieved varying degrees of success. However, recent mowing of parts of the scrubby flatwoods has allowed increased penetration by prescribed fires. Additional hardwood removal and mowing will likely be necessary to continue re-establishment of a natural fire regime.

Many species of wildlife and plants within the park are dependent on periodic fires to maintain their natural habitats. Species such as the gopher tortoise have suffered due to past land uses and lack of adequate fire in much of the upland mixed woodland and sandhill areas. As prescribed fire in these areas becomes more frequent, conditions should improve for gopher tortoises and all the species that shelter within gopher tortoise burrows. Other species such as the southern fox squirrel and eastern indigo snake are very rare or absent in the park. Rehabilitation of the fire-dependent natural communities will improve conditions for these imperiled species as well. There are many imperiled plant species associated with the upland mixed woodland natural community. Additional imperiled plant species may be discovered during the course of restoration efforts as the groundcover is burned and the canopy opens up.

Park staff will coordinate with local FFS staff in development of a plan that addresses wildfire suppression within the park boundaries. The wildfire suppression plan may contain an element regarding rehabilitation of fire plow lines or other similar impacts of fire suppression.

Objective B: Conduct natural community improvement activities within 250 combined acres of upland mixed woodland, upland pine, and successional hardwood forest.

- Action 1 – Continue or initiate habitat improvement activities in the upland mixed woodland/upland pine/successional hardwood forest communities in zones 1B, 1C, 1D, 2A, 3C, 3D, 3G and 3H. These areas need selective chemical treatment of off-site hardwoods.
- Action 2 – Plant longleaf pines in areas that lack sufficient numbers.
- Action 3 – Follow up any herbicide treatment with prescribed fire as soon as the hardwoods are dead, or within six months. Continue to apply prescribed fire to the areas on the shorter end of the fire return interval.

The upland mixed woodland and upland pine communities are the highest priority for a habitat improvement project at Manatee Springs State Park. An initial community restoration treatment has already been completed in zones 1B and 1D and part of zone 1C. Natural community improvement actions are now needed in additional zones. These zones contain upland pine, upland mixed woodland communities with intact, diverse, native groundcover. Treatment of off-site hardwoods in the zones occurred in 2005, and the park subsequently applied prescribed fire to the zones several times. Follow-up treatment of remaining off-site hardwoods is needed.

Successional hardwood forest or hardwood encroachment occurs in zones 1F, 2A, 2B, 3C, 3D, 3G and 3H. All successional hardwood areas have off-site or overly-dense hardwood species mixed with longleaf pines and desirable hardwoods such as southern red oak, turkey oak, sand post oak and mockernut hickory. Invading hardwood species include sand live oak, live oak, laurel oak and sweet gum. In some areas, the groundcover is either very suppressed or possibly absent.

The density of off-site or invading hardwood species needs to be reduced while preserving desirable hardwoods and longleaf pines. All hardwood treatments need initial follow-up with prescribed fire within six months. Thereafter, fire should occur on the shorter end of the fire return interval during the early years of the restoration activities. At this time, it is not known if it will be necessary to plant groundcover species.

The park also needs to plant longleaf pines, particularly where off-site loblolly pines now dominate. It may also be necessary to remove some loblolly pines from these areas. Because of years of fire suppression, the true boundary between upland pine and upland mixed woodland can be difficult to determine. The different community types in the zones will become more clearly delineated as restoration progresses.

Prescribed fire is an especially important maintenance and restoration activity for these zones. During the active phase of habitat improvement, the zones should be treated with prescribed fire on the shorter end of the fire return interval. After the initial hardwood treatment, zones should be burned within six months of treatment, preferably during the winter so that heavy fuel loads do not accumulate and re-sprouting hardwoods are killed. Once zones have been burned several times after hardwood treatments, the prescribed fire emphasis should be on growing season fires to aid in the control of hardwood sprouts and encourage diversification of groundcover species.

Chemical and mechanical retreatment of hardwood sprouts, particularly in areas where they tend to create fire shadows, will also be a critical part of the maintenance aspect of this habitat improvement project. Monitoring requirements for the project will include checking for the reappearance of hardwood sprouts, tracking the survival of longleaf pine tubelings and observing the natural regeneration and recovery of the groundcover. In some areas, it may be necessary to replant some groundcover species. This will be determined after evaluating the responses of the upland mixed woodland/upland pine communities and successional hardwood forest to hardwood treatments and fire.

Objective C: Conduct natural community improvement activities on 107 acres of scrubby flatwoods***.***

- Action 1 - Mechanically treat scrubby flatwoods in zones 3A and 3B.
- Action 2 - Follow mechanical treatment with prescribed fire within six months of treatment.
- Action 3 - Evaluate methods to improve the scrubby flatwoods in the Mead-Scott tract, including the potential removal of windrows and off-site hardwoods.

The scrubby flatwoods in zones 3A and 3B are overgrown with scrubby oak species, which makes applying prescribed fire to the zone very difficult except under extreme conditions. Mechanical treatment is needed to reduce the stature of scrub oaks and enhance the ability to use fire effectively in the zones and return this community to good condition. Mowing and mechanical treatment should be followed by burning within six months. Longleaf pines will be planted in areas that respond well to the treatment. DRP staff will monitor longleaf pine survival. After the mowing and initial prescribed fire treatments, the fire return interval for the scrubby flatwoods at Manatee should be 3-5 years (unless Florida scrub-jays recolonize the area, in which case the return interval should be adjusted to fit their ecological needs). The scrubby flatwoods in the Mead-Scott tract (zones 5A and 5B) may also need removal of off-site hardwoods and windrows to improve the effects of prescribed fire.-

Objective D: Conduct natural community improvement activities on 18 acres of depression marsh.

- Action 1 - Remove loblolly pines encroaching on depression marshes.

Loblolly pines are invading depression marshes in zones 1D and 1F. In many cases, they have reached a size where prescribed fires will no longer control them. Water uptake by the invading pines is modifying the natural hydrology of the marshes. The loblolly pines should be felled to prevent further growth. Treatment should be followed by prescribed fire within six months.

Objective E: Convert up to 30 acres of xeric hammock to either sandhill, upland pine or scrubby flatwoods natural communities as determined through appropriate evaluation.

- Action 1 - Evaluate the xeric hammock in zone 2A to determine its original natural community.
- Action 2 - Evaluate xeric hammock in zone 3C and 3E for selective off-site hardwood treatment.
- Action 3 - Develop guidelines for restoring xeric hammock to the original natural community where appropriate.

Several areas of xeric hammock occur in the park. Some zones, including 3C and 3E, are indicative of years of fire suppression in a mix of sandhill and upland pine. Other areas that appear to be xeric hammock (part of zone 2A) are less clear in their origin.

In zones 3C and 3E, laurel oak, sand live oak, and other off-site species have encroached into the sandhill habitat in the absence of fire. These areas require selective treatment of off-site hardwoods to allow fire to more effectively penetrate the zone.

Zone 2A needs further evaluation of the xeric hammock before any actions are taken. Aerial photos from the 1930s indicate the habitat appears to be scrubby flatwoods. Guidelines for restoration of this area should be developed, if appropriate, after further evaluation of the zone.

IMPERILED SPECIES

Perhaps the most significant imperiled species at Manatee Springs State Park is the spring's namesake, the Florida manatee. Manatee sightings in the spring run and in nearby sections of the Suwannee River have steadily increased over the past several decades. The increase is especially noticeable during the colder winter months when the mammals often congregate either in the spring run or in the river at the mouth of the run. During the winter months, manatees are present in small numbers within or near the spring run on most days. As many as 10 to 20 manatees may use the warm waters of the spring run during periods of colder weather. Manatee Springs State Park and Fanning Springs State Park to the north are both important warm-water refugia for the population of manatees that uses the Suwannee River in winter months (Taylor 2006). Park staff and volunteers currently record manatee sightings within or adjacent to the park on a daily basis.

While manatees are protected by law wherever they occur, manatees seeking refuge within the park are afforded the added benefit of enforcement of manatee protection laws by park staff and volunteers. Harassment or inadvertent disturbance of manatees by park visitors is discouraged, and visitors may learn about manatee protection through educational kiosks and informal discussions with park staff. In 1992, the spring run was closed to motorized vessels to protect manatees and help preserve the spring-run community. The year-round prohibition of motorized boat traffic in the spring run adds another dimension of protection, preventing possible conflicts between boats and visiting manatees. Additional protective measures may include closure of the spring run to all watercraft during cold weather events from Dec. 1-March 31 to help reduce the chances of disturbing manatees within this critical warm-water refuge. Canoes and kayaks are still able to launch at the park's boat dock on the Suwannee or from the boat ramps located at the north and south ends of the park.

The headspring may be closed to scuba diving during cold weather events to reduce the possibility that divers would discourage manatees from entering the headspring. Air bubbles discharged from scuba equipment may disturb manatees (FWC 2012). Scuba divers are still able to enter the spring system at an adjacent sinkhole known as Catfish Hotel. Both scuba divers and swimmers are asked to maintain a minimum 50-foot distance from manatees year-round within the swimming area. DRP staff will work with the USFWS and FWC to assess the need for additional protective measures for manatees, such as seasonal restrictions for certain recreational uses.

In addition to the spring and spring run, the park has jurisdiction over sovereign submerged lands of the Suwannee River within 400 feet of the park boundary. This authority may be exercised to enforce park rules within that area to provide additional protection for manatees in the vicinity of the park boundary. Due to the increased use of the spring run and adjacent portions of the Suwannee River by manatees, no entry and idle speed no wake zones were established in 2003. These are located at the mouth of the spring run and along the edge of the Suwannee River. Additional protection measures near the mouth of the spring run may be necessary to further reduce disturbance of manatees during cooler weather.

Another imperiled species that occurs within the Suwannee River adjacent to Manatee Springs State Park is the Gulf sturgeon (*Acipenser oxyrinchus desotoi*), a federally threatened subspecies of the Atlantic sturgeon. At certain times of the year, sturgeon are readily apparent in the park as they spontaneously leap from the water during their journey to and from spawning grounds in the upper Suwannee River. Interpretive materials at the park inform visitors about the life history of the Gulf sturgeon.

The Manatee Springs cave system contains three imperiled invertebrate species, the Alachua light-fleeing cave crayfish (*Procambarus lucifugus*), the North Florida spider cave crayfish (*Troglocambarus maclanei*) and the Hobbs' cave amphipod (*Crangonyx hobbsi*). While individual animals inhabiting the larger caves within the park may be subject to impacts from cave divers, these species are probably widespread within areas of the Floridan aquifer that are beyond the reach of normal cave exploration. Perhaps of greater concern for these troglobitic species is the influence of groundwater quality and quantity.

To protect sensitive cave fauna, effective management of the cave systems must include regular assessments of both natural and human impacts. Research divers at Manatee Springs State Park regularly monitor public cave diving activities to determine if they have any negative influence on the caves. Education of the cave diving community about the vulnerability of cave fauna to human disturbance, whether deliberate or incidental, will be an essential element of cave protection. In addition, any genuine effort to preserve the cave system and its inhabitants must include long-term protection of the water sources of Manatee Springs, particularly within the spring recharge area.

The imperiled King's hairstreak (*Satyrium kingi*) was recently discovered in the park. It is found in mesic hammock and feeds on sweetleaf (*Simplocos tinctoria*). This occurrence of the species is a new record for Levy County.

Other imperiled animal species in the park include the gopher tortoise (*Gopherus polyphemus*) and short-tailed snake (*Lampropeltis extenuata*), inhabitants of xeric fire-maintained uplands. These and other sandhill or upland pine species in the park have endured periods of fire suppression and extensive alteration of natural communities. There are also historical records of eastern indigo snakes (*Drymarchon couperi*) in the park, although none have been observed recently. All these species would benefit from increased application of prescribed fire and additional restoration of the sandhill, upland pine and upland mixed woodland natural communities.

The Suwannee alligator snapping turtle (*Macrochelys suwanniensis*) inhabits both the spring-run stream and blackwater river communities. Like the gopher tortoise, the Suwannee alligator snapping turtle was historically harvested for food. They are currently protected from harvest, and possession is prohibited without a permit from FWC. Recent regulation changes have also prohibited the sale of all freshwater turtles taken from the wild.

In June 2010, the North American Freshwater Turtle Research Group (NAFTRG) began a long-term monitoring project on the freshwater turtles of Manatee Springs State Park. During the monitoring, which occurs at least twice a year, the turtles are marked, measured and released.

According to anecdotal accounts, a population of Florida scrub-jays (*Aphelocoma coerulescens*) long ago occupied the scrubby flatwoods area south of the park drive (Younker 1991). There have been no recent confirmed sightings of scrub-jays in the vicinity, but park personnel monitor the scrubby flatwoods habitats, and limited call surveys were conducted at the park in 2014. A remnant population likely survives further south in Levy County near Cedar Key Scrub State Reserve. The scrubby flatwoods will be managed with prescribed fire and mechanical treatments to maintain a suitable condition for scrub-jays and other species native to scrubby flatwoods.

Seven imperiled plant species have been recorded in the park. In general, these require minimal management other than protection from recreational or operational impacts. A floristic study that was completed in 1999 vouchered several of the imperiled species (Gulledge 1999). The two orchid species were documented by staff after completion of the floristic study. At the present time, human activities do not appear to have affected imperiled plant species within the park. To safeguard populations of imperiled plants from possible future development, however, staff will regularly survey and map those populations. Proper natural systems management, including the use of prescribed fire and the maintenance of natural hydroperiods in wetland areas, should suffice to preserve the imperiled plant species.

The table below contains a list of all known imperiled species within the park and identifies their status as defined by various entities. It also identifies the types of management actions currently being taken by DRP staff and identifies the current level of monitoring effort. The codes used under the column headings for management actions and monitoring level are defined following the table. Explanations for federal and state status as well as FNAI global and state rank are provided in the Appendix.

Imperiled Species Inventory						
Common and Scientific Name	**Imperiled Species Status**				**Management Actions**	**Monitoring Level**
	FWC	**USFWS**	**FDACS**	**FNAI**		
PLANTS						
Florida jointtail grass *Coelorachis tuberculosa*			LT	G3, S3	4,9	Tier 1
Angularfruit milkvine *Gonolobus suberosus*			LT		1	Tier 1
Cardinal flower *Lobelia cardinalis*			LT		4,9	Tier 1
Florida milkvine *Matelea floridana*			LE	G2, S2	1	Tier 1
Giant orchid *Pteroglossaspis ecristata*			LT	G2G3, S2	1	Tier 1
Florida mountainmint *Pycnanthemum floridanum*			LT	G3, S3	1	Tier 1
Threebirds orchid *Triphora trianthophoros*			LT			Tier 1
INVERTEBRATES						
Hobbs' cave amphipod *Crangonyx hobbsi*				G2G3, S2S3	4,9,10	Tier 1
American sand-burrowing mayfly *Dolania americana*				G4, S2	4,9	Tier 1
Umber shadowfly *Neurocordulia obsoleta*				G5, S2	4,9	Tier 1
Alachua light-fleeing cave crayfish *Procambarus lucifugus*				G1G2, S1S2	4,9,10	Tier 1
King's hairstreak *Satyrium kingi*				G3G4, S2	2, 4	Tier 1
North Florida spider cave crayfish *Troglocambarus maclanei*				G1G2, S1S2	4,9,10	Tier 1

Imperiled Species Inventory						
Common and Scientific Name	**Imperiled Species Status**				**Management Actions**	**Monitoring Level**
	FWC	**USFWS**	**FDACS**	**FNAI**		
FISH						
Gulf sturgeon *Acipenser oxyrinchus desotoi*	FT	LT		G3T2T3, S2?	4,9	Tier 1
REPTILES						
American alligator *Alligator mississippiensis*	FT(S/A)	SAT		G5,S4	10,13	Tier 1
Eastern indigo snake *Drymarchon couperi*	FT	LT		G3, S2?	1,6,10,13	Tier 1
Gopher tortoise *Gopherus polyphemus*	ST			G3, S3	1,6,13	Tier 1
Short-tailed snake *Lampropeltis extenuata*	ST			G3, S3	1,6	Tier 1
Suwannee Alligator snapping turtle *Macrochelys suwanniensis*	ST	PT		G2, S2	4,9,10	Tier 3
BIRDS						
Florida scrub-jay *Aphelocoma coerulescens*	FT	LT		G1G2, S1S2	1	Tier 1
Little blue heron *Egretta caerulea*	ST			G5,S4	4,9	Tier 1
Tricolored heron *Egretta tricolor*	ST			G5,S4	4,9	Tier 1
Wood stork *Mycteria americana*	FT	LT		G4,S2	4,9	Tier 1
MAMMALS						
Rafinesque's big-eared bat *Corynorhinus rafinesquii*				G3G4, S1	10,13	Tier 1

Imperiled Species Inventory						
Common and Scientific Name	**Imperiled Species Status**				**Management Actions**	**Monitoring Level**
	FWC	**USFWS**	**FDACS**	**FNAI**		
Florida manatee *Trichechus manatus lasirostris*	FT	FT		G2G3T2, S2S3	4,9,10,13	Tier 2

Management Actions:

1. Prescribed Fire
2. Invasive Plant Removal
3. Population Translocation/Augmentation/Restocking
4. Hydrological Maintenance/Restoration
5. Nest Boxes/Artificial Cavities
6. Hardwood Removal
7. Mechanical Treatment
8. Predator Control
9. Erosion Control
10. Protection from visitor impacts (establish buffers)/law enforcement
11. Decoys (shorebirds)
12. Vegetation planting
13. Outreach and Education
14. Other

Monitoring Level:

Tier 1.
Non-Targeted Observation/Documentation: includes documentation of species presence through casual/passive observation during routine park activities (i.e. not conducting species-specific searches). Documentation may be in the form of Wildlife Observation Forms, or other district specific methods used to communicate observations.

Tier 2.
Targeted Presence/Absence: includes monitoring methods/activities that are specifically intended to document presence/absence of a particular species or suite of species.

Tier 3.
Population Estimate/Index: an approximation of the true population size or population index based on a widely accepted method of sampling.

Tier 4.
Population Census: A complete count of an entire population with demographic analysis, including mortality, reproduction, emigration, and immigration.

Tier 5.
Other: may include habitat assessments for a particular species or suite of species or any other specific methods used as indicators to gather information about a particular species.

Objective A: Update baseline imperiled species occurrence list

- Action 1 - Continue to inventory the park to update imperiled species lists.

Objective B: Monitor and document five imperiled animal species in the park***.***

- Action 1 - Develop and implement monitoring protocols for the three troglobitic species that are known to occur in the Manatee Springs cave system.
- Action 2 - Continue existing monitoring protocols for two imperiled animal species, the Suwannee alligator snapping turtle and the Florida manatee.

As described in Hydrological Management Objective C, Action 3, DRP staff will work with research divers and the North Florida Springs Alliance to develop and implement monitoring protocols for the Hobbs' cave amphipod, Alachua light-fleeing cave crayfish and North Florida spider cave crayfish.

The park will continue to assist the North American Freshwater Turtle Research Group with survey and monitoring of freshwater turtles in the park, particularly the Suwannee cooter and Suwannee alligator snapping turtle. Daily monitoring of manatees within the spring run and adjacent Suwannee River will continue. This will allow the park to document seasonal use patterns and continue providing on-site enforcement of manatee protection measures. Data will continue to be shared with other agencies involved in manatee conservation.

Objective C: Monitor and document two imperiled plant species in the park.

- Action 1 - Develop monitoring protocols for two selected imperiled plant species, including Florida milkvine and Florida mountain mint.
- Action 2 - Implement monitoring protocols for the two imperiled plant species listed in Action 1 above.

Florida milkvine and Florida mountainmint are fire-adapted species native to upland mixed woodland, a rare natural community in north Florida. These plant species will be monitored to document their responses during ongoing restoration efforts in the upland mixed woodlands at Manatee Springs State Park. Monitoring protocols will be developed and implemented using GPS technology to document locations and estimate population numbers.

INVASIVE SPECIES

Manatee Springs State Park is fortunate to have very few invasive plants. Given the low numbers of invasives and the relatively isolated location of the park, it is possible that staff could eliminate all of the invasive plants within park boundaries.

The species of greatest concern within the park are cogongrass (*Imperata cylindrica*), Chinese tallowtree (*Triadica sebiferum*) and Japanese climbing fern (*Lygodium japonicum)*. Cogongrass should be treated twice per year, in the fall before frost and in the spring.

It is particularly important that Manatee Springs State Park adopts preventative measures to keep invasives from inadvertently entering the park. Those measures should include developing and putting into practice guidelines for inspecting equipment that enters the park to ensure that mowers, logging equipment and other types of equipment are clean and free of soil, plant material and invasives. Any fill or limerock used in the park should be derived from an invasives-free site. Park staff should be aware of the locations of any invasives in the park and not spread them inadvertently when disking fire lines or mowing, or, in the case of climbing fern, carry propagules on vehicles or clothing.

It is also important that staff survey the park regularly for the presence of invasive plants, particularly areas that are less frequently visited. Regular surveys will enable identification of new infestations before they have a chance to spread and cover larger areas. Newly discovered infestations of invasives should be treated promptly so that the plants do not have a chance to spread.

The park should also continue its program of public outreach and education about invasive plants. This may help encourage neighbors to remove invasives from their properties close to the park.

The most significant invasive animal at Manatee Springs State Park is the feral hog. Since adoption of the previous management plan, at least 403 feral hogs have been removed from the park. Feral hogs are damaging and often kill adult and young longleaf pines, destroy native groundcover and sometimes damage sinkholes in the park. The severity of their impact is increasing, and control efforts should increase proportionately.

The grass carp is an invasive species present in the Suwannee River and the Manatee spring-run stream. The carp are removed when opportunity arises. Nuisance animals that are removed occasionally by park staff include nine-banded armadillos and raccoons. Occasionally, feral dogs and cats or other companion animals appear in the park and are removed as needed.

In 2002, the red bay ambrosia beetle (*Xyloborus glabratus*) was first detected in the United States in southeast Georgia. The beetle carries the fungal pathogen *Raffaelea lauricola*, which it transmits to red bay trees (*Persea borbonia*) and other species in the *Lauraceae* family, causing laurel wilt disease and death. The beetle and its associated pathogen spread rapidly, and by 2005 it had appeared in Duval County. In 2010, the disease was discovered in Levy County and at Manatee Springs State Park. Since that time, many of the adult red bays in the park have died. The beetle (and laurel wilt) has now spread throughout most of Florida and into many neighboring states. At Manatee Springs State Park, although most of the adult red bays have been top-killed, the trees continue to re-sprout from their roots. It may be that members of the *Lauraceae* family will continue to survive in shrub form as the remnant tree root systems continue to resprout. At this point, much remains unknown about the long-term impacts of this disease on red bays and other *Lauraceae*. The park should continue to restrict the movement of firewood into and out of the park and educate visitors about the issue.

Species Name Scientific Name - Common Name	FLEPPC Category	Distribution	Zone ID
Albizia julibrissin - Mimosa	I	Single Plant or Clump, Scattered Plants or Clumps	MS-1A, MS-1B
Ardisia crenata - Coral ardisia	I	Single Plant or Clump	MS-1A
Cinnamomum camphora - Camphor-tree	I	Scattered Plants or Clumps	MS-1B, MS-1E
Imperata cylindrica - Cogon grass	I	Single Plant or Clump, Scattered Dense Patches	MS-1B, MS-1C, MS-1D
Lantana camara - Lantana	I	Single Plant or Clump	MS-5A
Lygodium japonicum - Japanese climbing fern	I	Linearly Scattered	MS-2Cn, MS-2D
Melia azedarach - Chinaberry	II	Scattered Plants or Clumps	MS-1A
Nephrolepis cordifolia - Tuberous sword fern	I	Single Plant or Clump	MS-1E, MS-1F
Pistia stratiotes - Water-lettuce	I	Scattered Plants or Clumps Dense Monoculture	MS-3F
Sapium sebiferum - Chinese tallow tree	I	Scattered Plants or Clumps	MS-1A, MS-3G

Objective A: Annually treat 0.5 acres of invasive plant species.

- Action 1 - Annually develop/update the invasive plant management work plan.
- Action 2 - Implement the annual work plan by treating 0.5 infested acres in the park annually and continuing maintenance and follow-up treatments as needed.
- Action 3 – Treat all cogongrass infestations twice annually.

Manatee Springs State Park is fortunate to have very few acres infested with invasive plants. It is possible that staff could completely eradicate invasive plants from the park. All known infestations should be treated every year.

Objective B: Prevent the introduction and spread of invasive plants into the park.

- Action 1 - Develop and adopt preventative measures to avoid introduction and spread of invasive plants into the park.

Invasive plants are often introduced or spread to natural areas on equipment, in fill dirt or mulch and in ornamental plantings. The park should develop and implement a protocol to inspect equipment and fill dirt and ensure that any equipment or materials entering the park is free of invasives.

Objective C: Survey the entire park for invasives at least twice over 10 years.

- Action 1 - Develop and implement a method to survey the entire park for invasive plants twice over the course of 10 years.

In parks such as Manatee Springs State Park where few invasive plants occur, early detection of invasives through vigilant surveying becomes especially important. Park surveys should be conducted with the goal of finding any new infestations quickly so that they can be promptly treated.

Objective D: Implement control measures on two invasive animal species in the park.

- Action 1 - Continue to remove feral hogs from the park.
- Action 2 - Develop and implement a plan to remove grass carp from the park as needed.

Feral hog rooting that has caused observable damage to native groundcover species and pine trees in the park is increasing. The park should evaluate its current methods of controlling hogs and implement additional methods to increase the number of hogs removed. Efforts should focus on finding methods that capture the entire sounder.

CULTURAL RESOURCES

Prehistoric and Historic Archaeological Sites

Manatee Springs State Park has 21 archaeological sites and two resource groups recorded with the Florida Master Site File (FMSF). Because it contains a first-magnitude spring and borders the Suwannee River, an important transportation corridor and productive resource, the Manatee Springs area has long been occupied by humans.

Archaeological sites within the park belong primarily to three broad eras: 1) the pre-Colombian era, 2) the early period of European contact and 3) the frontier period of European settlement in Florida during the 1800s. Very little information is available for many of the archaeological sites, either because they do not contain diagnostic artifacts or because they have not yet been studied.

When William Bartram visited the area in 1774, he described Seminoles living at a village called Talahasochte near what is now Clay Landing (Bartram 1928). Earlier native peoples inhabited the area around the headspring as well as other areas along the river.

Bullen and Goggin studied several Native American sites (LV32 and LV37) in the park during the 1950s (Bullen, 1953). They found evidence of human habitation from several periods including the Archaic, Deptford and Weeden Island periods. One site appeared to have been inhabited intermittently for more than 1,000 years. At least two, and probably three, village sites covering multiple eras and two possible mounds (LV112 and LV139) are located within the park. A number of sites represent isolated finds (LV626) or low-density lithic scatters (LV33 and LV624) or have sparse information provided by the site recorders (LV85 and LV86). This makes these sites very difficult to interpret. Several sites have not been excavated but were recorded based on local informants' long-term knowledge of past conditions and artifact occurrences (LV776 and LV777).

Site excavations in the 1950s indicate that the native peoples' diet consisted of animals and plants that still occur in the area today. Artifacts found in one site show that the inhabitants' diet included deer, black bear, possum, striped skunk, rabbit, coot, wild turkey, box turtle, gopher tortoise, sea turtle, alligator, various fishes, freshwater mussels, oysters and others. Charred remains of pignut hickory nuts indicate that these were also consumed.

The period of territorial European settlement at Manatee Springs began in the early 1800s. The area was surveyed as early as 1829. The General Land Office (GLO) Early Records are available from the Land Boundary Information System (LABINS 2003). A survey from 1849 by surveyor A. H. Jones shows settlers' homesteads and fields (Verrill 1976). Several of these homestead properties were granted to men who had served in the Florida Indian Wars (Andy Moody personal communication).

The Bryant and Hardee families were listed in the 1867 census of Levy County (Verrill 1976). The locations of their historic homesteads (LV754, LV755 and LV757) within what is now Manatee Springs State Park have been determined by park ranger Andy Moody and recorded with the FMSF. In addition, Moody has found and recorded the location of an agricultural field used by Bryant (LV820) and a clay pit (LV812) used for chinking the chimney at the Hardee Homestead. He is also the discoverer of the Shackleford Homestead (LV756) and the Military Homesteader Trail (LV819).

An interesting resource group, also discovered by Moody, is LV693 (Fat Lighter Survey Markers). These consist of fat lighter posts carved and used to mark surveyed sections and quarter sections Knetsch (2006). They may date from the homesteader period in the 1800s when the park was originally surveyed.

Mock Field (LV892) is on property homesteaded by Redden Mock beginning about 1870 (Andy Moody personal communication). The field is visible but somewhat overgrown in an aerial photograph from 1940. The homesite has not been found but is thought to be within the park boundary. Descendants of the family believe Redden Mock and his wife are buried on the property along with some of their children. The location of the gravesites is unknown.

The rich natural resources of Manatee Springs State Park and its prime location along the Suwannee River make it likely that there are other historic and prehistoric sites remaining to be discovered.

Six archaeological surveys and monitoring projects have been conducted in the park and submitted to the FMSF (Hughes 2004; Moody 1998, 2003; Roberson 2005a, b; Smith and Price 2012). These surveys covered specific areas within the park and did not constitute a comprehensive archaeological survey. A predictive model for the park was also completed in 2012 (Collins et al.) If Phase 1 surveys occur at the park in the future, they should focus on high-sensitivity areas identified by the predictive model.

All the archaeological sites except LV112 are currently in good condition. The eastern slope of LV112 was disturbed by heavy equipment at some point in its history, and a woods road currently passes close by the site, so its condition is only fair. At least two sites in the park have been looted in the past.

Sites LV37 (Old Clay Landing) and LV777 (Usher Landing) should be checked regularly for evidence of looting. The portion of LV37 on private property adjacent to the park has been looted in recent years. Site LV112 in the southern part of the park is located close to a woods road that may also serve as a firebreak. The road/firebreak at LV112 should be moved farther away from the site to better protect it from disturbance. LV32, LV85 and LV86 are located in areas that receive heavy use from day visitors or campers. While these sites are in good condition, intensive recreational development has the potential to negatively affect them.

LV776, which is adjacent to a public road, could be impacted by any repaving or road widening projects that take place near the site.

Park management will develop and implement procedures for regular monitoring of all cultural sites. Sites that have been looted in the past should receive more frequent visitation to ensure that no further looting occurs. Any disturbances should be documented. As the park continues its prescribed fire and ecological restoration programs, more cultural sites may become visible. Park staff should check zones periodically for evidence of new archaeological sites so that they can be recorded promptly with the FMSF and protected from ground disturbance and looting. The firebreak/woods road near the mound at LV112 should be rerouted a sufficient distance from the mound to protect it from inadvertent damage that might occur during routine road or firebreak maintenance.

Historic Structures

Manatee Springs State Park has seven historic structures recorded with the Florida Master Site File (FMS). All were built between 1955 and 1967 to serve the needs of the park.

The condition of the historic structures is mostly fair. The condition of the concession/bath building (LV896) is poor. It should be upgraded or replaced. None of these buildings are currently slated for demolition. All need ongoing maintenance.

Recent repairs to the park manager’s residence (LV898) include a new roof, replacement of interior water lines and removal of asbestos on electrical lines. Pending repairs include brickwork repair, an electrical upgrade and interior ceiling repairs. The assistant park manager’s residence needs a new roof, an electrical upgrade and tile replacement. The concessionaire building needs a new roof, an electrical upgrade and new decking for the picnic deck. Repairs to the concession building are the responsibility of the concessionaire. Septic systems at the manager’s and assistant manager’s residences need to be upgraded.

Periodic maintenance should be performed to keep the structures from deteriorating. New roofs and the other repairs outlined above are needed to bring the structures to good condition.

Collections

Manatee Springs State Park does not have a collection and no collection materials are currently deemed appropriate for the park. However, in the future it may be desirable to consider archiving some significant park operations materials to be maintained for future reference.

The park does not maintain any collections.

Park staff should prepare a brief statement of collections indicating that no collection items are deemed appropriate for the park.

Cultural Sites Listed in the Florida Master Site File					
Site Name and FMSF #	**Culture/Period**	**Description**	**Significance**	**Condition**	**Treatment**
LV32 Manatee Springs	Historic/Prehistoric	Archaeological Site	NE	G	P
LV33 New Clay Landing	Prehistoric	Archaeological Site	NE	G	P
LV37 Old Clay Landing	Prehistoric	Archaeological Site	NE	G	P
LV85 Manatee Springs A	Unknown	Archaeological Site	NE	G	P
LV86 Manatee Springs B	Unknown	Archaeological Site	NE	G	P
LV112 No Name	Prehistoric	Archaeological Site	NE	F	P
LV139 Shacklefoot Pond Mound	Prehistoric	Archaeological Site	NE	G	P
LV624 Magnolia Campground	Prehistoric	Archaeological Site	NS	G	P
LV626 Manatee Springs State Park Isolated Find	Prehistoric	Archaeological Site	NE	G	P
LV754 Bryant Homestead	19th Century	Archaeological Site	NE	G	P
LV755 Bryant Homestead 2	19th Century	Archaeological Site	NE	G	P
LV756 Shackleford Homestead	19th Century	Archaeological Site	NE	G	P
LV757 Hardee Homestead	19th Century	Archaeological Site	NE	G	P
LV776 Roberson	Prehistoric	Archaeological Site	NE	G	P
LV777 Usher Landing	Prehistoric	Archaeological Site	NE	G	P
LV785 Springside	Early to Mid-20th Century	Archaeological Site	NE	G	P
LV812 Hardee Clay Chinking Pit	19th Century	Archaeological Site	NE	G	P

Cultural Sites Listed in the Florida Master Site File					
Site Name and FMSF #	**Culture/Period**	**Description**	**Significance**	**Condition**	**Treatment**
LV817 Manatee Springs S.P. Magnolia 1 Bathroom Survey	Prehistoric Historic Unidentified	Archaeological Site	NE	G	P
LV819 Military Homesteader Trail	1839 or earlier	Resource Group	NE	G	P
LV820 Bryant Agricultural Field	1850 or earlier	Archaeological Site	NE	G	P
LV825 Manatee Springs Flat	Unknown	Archaeological Site	NE	G	P
LV892 Mock Field	Late 19th & early 20th Century	Archaeological Site	NE	G	P
LV893 Fat Lighter Survey Markers	Early 19th Century	Resource Group	NE	G	P
LV896 Concession/Bath Building #053003	1961	Historic Structure	NE	P	RH
LV897 Assistant Manager Residence Bldg. #53007	1961	Historic Structure	NE	F	RH
LV898 Park Manager Residence Bldg. #053004	1961	Historic Structure	NE	F	RH
LV899 Picnic Pavilion Bldg. # 53006	1955	Historic Structure	NE	F	RH
LV900 Garage Utility Bldg. # 053010	1961	Historic Structure	NE	G	RH
LV901 Shop Bldg. #053012	1965	Historic Structure	NE	F	RH
LV902 Magnolia 2 Bathhouse Bldg. # 053015	1967	Historic Structure	NE	F	RH

Objective A: Assess and evaluate 23 of 23 recorded cultural resources in the park.

- Action 1 - Complete 23 assessments/evaluations of archaeological sites.

Staff should be familiar with the location of and potential threats to the cultural resources within the park. As part of the assessment process, the park should have records for each site in the park, a plan to visit the sites regularly to check for looting or other damage, and a methodology to record the condition and any changes to the sites.

DRP will develop and implement a protocol to monitor archaeological sites at Manatee Springs State Park. Frequency of visitation should be based in part on existing threats to the site such as looting, fire line maintenance and feral hog activity.

No Historic Structure Reports (HSRs) are recommended for the the park. No stabilization of historic or archaeological sites is needed at this time.

Objective B: Compile reliable documentation for all recorded historic and archaeological resources.

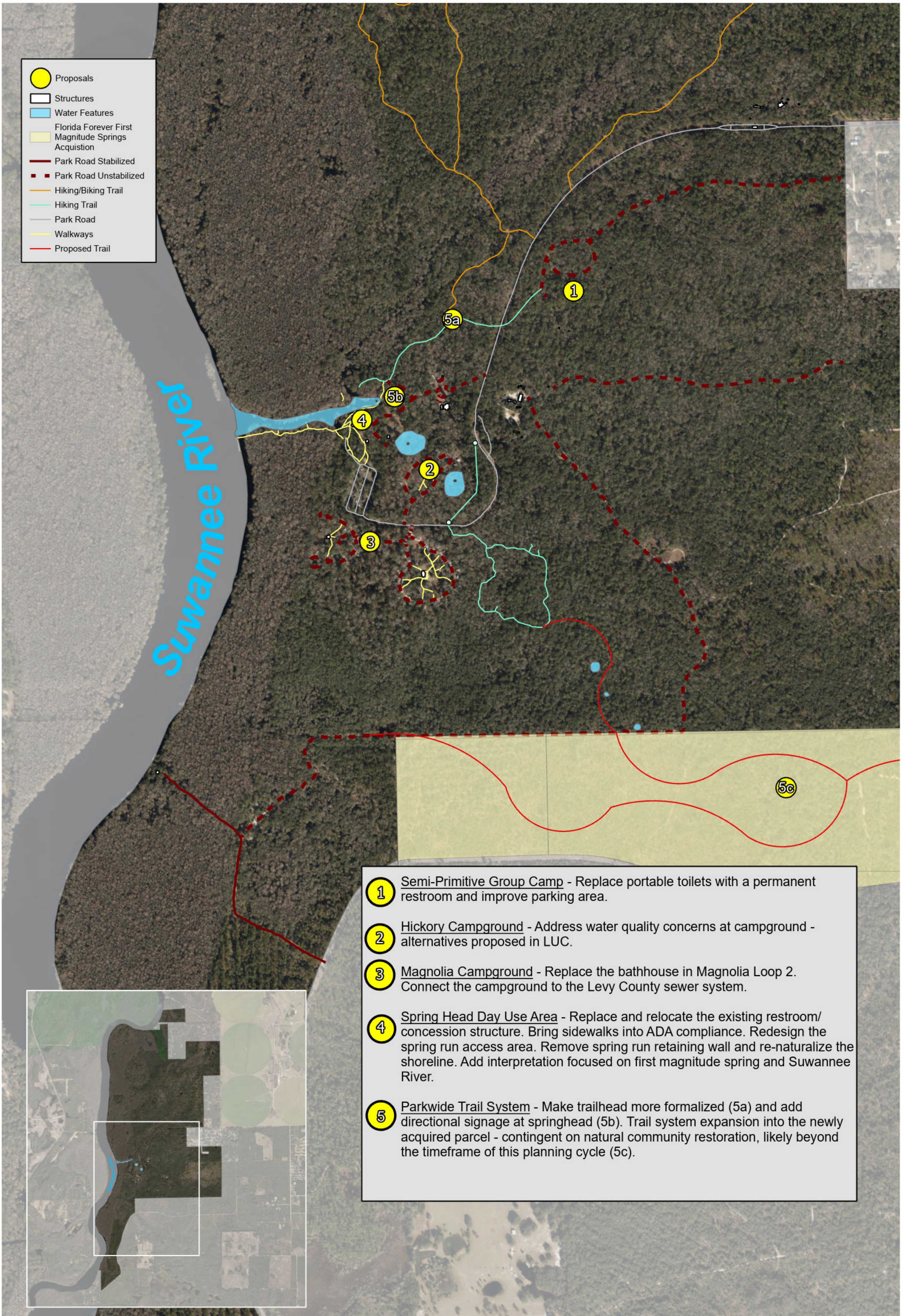
- Action 1 - Ensure all known sites are recorded or updated in the Florida Master Site File.
- Action 2 - Conduct Phase 1 archaeological survey for at least one priority area identified by the predictive model or other previous studies.

The predictive model for Manatee Springs State Park has identified 42% of the park as within high-sensitivity areas for archaeological sites. If any significant ground disturbance is planned for these areas, a Level 1 survey should be conducted before disturbance begins. Alternatively, if funding is available, a Level 1 survey could be conducted in high-sensitivity areas of the park that have not been previously surveyed. Additional knowledge of early homestead sites and Native American sites will increase understanding of the cultural and natural resources of the park.

Objective C: Bring seven of 23 recorded cultural resources into good condition.

- Action 1 - Design and implement regular monitoring programs for all cultural sites in the park.
- Action 2 - Implement protection, stabilization and other maintenance measures based on site evaluations.

The park should monitor all cultural resources on a regular basis. If a protocol and schedule does not yet exist, park staff will develop and implement one. Staff will develop and implement a maintenance protocol for the historic structures so that their conditions do not deteriorate. No restoration is needed for any of the park’s archaeological resources at this time.



1. Semi-Primitive Group Camp - Replace portable toilets with a permanent restroom and improve parking area.

2. Hickory Campground - Address water quality concerns at campground - alternatives proposed in LUC.

3. Magnolia Campground - Replace the bathhouse in Magnolia Loop 2. Connect the campground to the Levy County sewer system.

4. Spring Head Day Use Area - Replace and relocate the existing restroom/ concession structure. Bring sidewalks into ADA compliance. Redesign the spring run access area. Remove spring run retaining wall and re-naturalize the shoreline. Add interpretation focused on first magnitude spring and Suwannee River.

5. Parkwide Trail System - Make trailhead more formalized (5a) and add directional signage at springhead (5b). Trail system expansion into the newly acquired parcel - contingent on natural community restoration, likely beyond the timeframe of this planning cycle (5c).

Manatee Springs State Park

Conceptual Land Use Plan

0 500 1,000 Feet

N

LAND USE COMPONENT

VISITATION

Manatee Springs State Park protects one of Florida's first-magnitude springs, which discharges around 150 million gallons of water daily. The park's aquatic resources make it a top destination for swimming, snorkeling and paddling. The springs are situated within a karst landscape that connects to the Floridan aquifer. Approximately 6.3 miles of aquatic caves may be explored by certified cave divers. The park's namesake, Manatee Spring, is both the interpretive and geographic centerpiece of the park. The park's primary day-use area is situated along the Manatee spring-run stream. Extending from the springhead day-use area is a boardwalk that stretches for about 1,200 feet and runs parallel to the spring run. The boardwalk allows for an immersive experience into the floodplain swamp.

Hiking trails meander through the alluvial and upland mixed woodland forests within the park, while three campground loops are available for overnight guests. Camping is also available for larger groups and park volunteers.

Trends

Park visitation is relatively high year-round. However, the summer months, particularly July and August, see the strongest visitation, as the park is a prime swimming destination. Visitation declines marginally in the fall and winter months, but the presence of manatees in the spring run and the camping opportunities in the park ensure that cool-season attendance remains strong.

EXISTING FACILITIES AND INFRASTRUCTURE

Existing facilities in Manatee Springs State Park are concentrated in several primary use areas. The springhead day-use area includes a concession building, a 1,274-foot boardwalk extending to a floating dock on the Suwannee River, picnic pavilions, paddling launch and several platforms for fishing, swimming, and scuba diving.

The paddling launch and swimming area are separated by a floating buoy line. These areas are kept separate to avoid user conflicts.

Mobility mat extends from the boardwalk to a cement walkway leading to the swimming area.

A peripheral use area, Usher Landing, is located in the southern portion of the park. A stabilized road through scenic floodplain swamp connects Usher Landing to 102nd Place, a rural road that leads to dispersed residential areas. A picnic pavilion and launch for small watercraft are found at this location.

Camping is available at two campgrounds and includes three camping loops which allow for 46 RV/tent campsites and 32 tent-only campsites. Two semi-primitive group campsites are also available just north of the administrative support area.

Two sinkholes, Catfish Hotel and Sue Sink, are adjacent to the Hickory Campground. Catfish Hotel is used by scuba divers and has a large wooden platform with stairs providing access to the water from the day-use area. No diving occurs in Sue Sink except for emergency access. Swimming is not allowed in either sink.

The park currently includes two administrative support areas. One is located immediately east of the springhead day-use area and includes one residence and several support structures. Another is adjacent to the entrance station on State Road 320 and also has a residence.

Facilities Inventory

Springhead Day-Use Area	
Concessions and Restroom Building	1
Boat Dock	1
Pavilions – Small	3
Stages	1
Parking Areas	5
Parking Spaces	167
Canoe/Kayak Launch	1
BBQ Shelters	3
Playgrounds	1
Volleyball Courts	1
Dump Stations	2
Shower Stations	1
Swimming/Diving Platforms	1
Boardwalk (Length – Feet)	1,274
Concession Building	1
Picnic Pavilions	2
Fishing Platforms	3
Observation Platform	1
Campgrounds	
Primitive Group Campsites	2
RV/Tent Sites	46
RV/Trailer Only Sites	2
Tent-Only Sites	32
Drive-In Sites	72
Amphitheaters	1
Bathhouses	3
Firewood Shelters	2
Primitive Restrooms (Privies)	2
Administrative Support Area	
Ranger Entrance Station	1
Staff Residences	2
Maintenance Shop	1
Storage Structures	7
Pole Barns	1
Carport	1
Pumphouses	3
Volunteer Laundry Building	1
Firewood Shelter	1
Volunteer Campsites	12
Primitive Restroom	1
Roads and Trails	
Hiking/Biking Trail Mileage	10.4
Paved Road Mileage	2.1
Stabilized Road Mileage	1.1
Unstabilized Road Mileage	20.2

CONCEPTUAL LAND USE PLAN

Detailed Conceptual Land Use Plan Objectives

Eight use areas at Manatee Springs State Park are listed below for improvements to be implemented within the 10-year planning cycle. Specific plan details are available in the next section.

Springhead Day Use Area
Objective: Update facilities and redesign spring-run access area.
Actions:

- *Relocate/replace the existing restroom/concession structure.*
- *Redesign the spring-run access area.*
- *Remove the spring-run retaining wall and restore the shoreline.*
- *Create and implement an interpretive plan focused on the first-magnitude spring and Suwannee River.*

Restrooms and Concession Building
The existing restroom/concessions structure at the day-use area is due for replacement. The new restroom and concession building should be set back farther from the springhead. While the majority of use of the restroom is by visitors to the springhead (i.e., swimmers), other user types should be considered in the design and placement of a new structure (e.g., hikers using the proposed nearby trailhead).

Boardwalk
The boardwalk through the floodplain swamp that connects the day-use area to the floating dock on the Suwannee River represents one of the most significant natural features and interpretive opportunities in the park. Currently, a paddlecraft rack, paddling ramp and mobility mat are located directly adjacent to the entrance of the boardwalk. The entrance to the boardwalk should be redesigned such that it is clear of paddling launch infrastructure, refining the sense of arrival into the alluvial forest. Landscape design considerations should make the site more compatible with the adjacent entry to the boardwalk that serves a passive interpretive purpose where natural scenery, serenity and aesthetics should be prioritized.

Spring-Run Walkway and Swimming Access
Improvements to the shorelines of the spring run are needed, including the replacement of a deteriorating retaining wall along the south bank of the spring run. Walls and walkways along the south bank of the spring run need repair/renovation due to erosion and structural degradation. Design elements should prioritize protection and restoration of the spring run's sensitive resources and facilitate safe water access. Previous engineering studies (Jones Edmunds and Associates 2007) have been conducted for reconstruction of the walkway and restoration of the natural shoreline along the spring run. Stabilization measures should avoid hardened infrastructure such as concrete and sheet piling and instead consider a more sustainable approach that better preserves the natural shoreline – emphasizing riparian restoration. Restoration elements may include the protection and installation of cypress trees and aquatic vegetation that are native to this site and help mitigate erosion, preserve natural elements and enhance viewshed. Primary walkways connecting the facilities in the springhead day-use area should be upgraded for universal accessibility.

Finally, the significance of the first-magnitude spring and its role as a warm-water refugia for manatees that use the Suwannee River in the winter should be highlighted Interpretive planning is needed to determine the most effective way to connect visitors to the meaningful and relevant themes in the Springhead Day Use Area. The type, design, quantity and placement of interpretive elements to deepen understanding will be specified during this additional planning process. Improvements should also include a parkwide map for orientation and to demonstrate hydrological connectivity.

Hickory Campground

<u>Objective: Address water quality concerns at campground.</u>

<u>Actions:</u>

- *Assess and implement measures to eliminate impacts to the spring and underlying aquatic caves. Alternatives include infrastructure upgrades or facility relocation.*

Through past land use planning cycles, Hickory Campground has been adapted with the intent of reducing its impact on the sensitive karst environment in which it is situated – decreasing its footprint and minimizing the intensity of visitor use. The number of campsites has decreased from 24 to 20, and the campground was converted to only accommodate tent camping.

The bathhouse in the center of the campground loop is substantially aged and, like other park facilities, is supported by a septic system. While this system has been upgraded with advanced technology designed to improve the breakdown of solids and the elimination of nitrogen, it still consists of a drain field component. Gradual leaching of remaining nutrients and other contaminants into groundwaters remains a concern within this porous limestone substrate. Future measures to improve protection of water quality within the spring and underlying aquatic cave system include the conversion of the Hickory Campground bathhouse from septic to sewer (Levy County sewer system). Installation of the sewer line must consider all available data regarding the location of underlying aquatic cave conduits and their depths beneath the ground surface. The new bathhouse should be built further south closer to the park drive to provide a safe distance from the nearby sinkholes.

Additionally, stormwater runoff originating from the campground needs to be accurately patterned. This should be observable during storm events. If it is determined that significant stormwater runoff is entering either of the adjacent sinkholes, particularly via gullies or washouts associated with unsanctioned paths, then measures should be investigated and implemented to effectively redirect and slow the downslope movement of water. If connecting this campground to central sewer is unfeasible or the site is determined to be unsuitable for other reasons, then relocation should be discussed. Site relocation to the semi-primitive group camp or one of the Magnolia Loops could be explored.

Magnolia Campground

<u>Objective: Update facilities.</u>

<u>Actions:</u>

- *Replace the bathhouse in Magnolia Loop 2.*
- *Connect the campground to the Levy County sewer system.*

The bathhouse in the western loop of Magnolia Campground is aged and not connected to sewer. Removal of the existing facility and construction of a new bathhouse that is connected to the Levy County sewer system is recommended.

Semi-Primitive Group Camp

Objective: Update facilities.

Actions:

- *Replace portable toilets with a permanent restroom.*
- *Improve parking area.*

To improve the camping experience, a small permanent restroom should be constructed and connected to central sewer. Additionally, the parking area could be improved through stabilization and parking spot delineation. If Hickory campground is ever abandoned, tent camp sites could potentially be relocated to this location.

Parkwide Trail System

Objective: Unify park-wide trail system.

Actions:

- *Create a more formal trailhead.*
- *Add directional signage to bring attention to trail connecting the springhead to the trailhead.*
- *Create new trails from Sink Trail Loop to newly acquired southern parcel in coordination with restoration activity.*
- *Create and implement an interpretive plan for trailheads and trail system.*

Interpretive planning is necessary to determine the most effective way to connect visitors to meaningful and relevant themes along the park's trail system and trailheads. The type, design, quantity, and placement of interpretive elements to deepen understanding will be specified during this additional planning process. The following are concepts and topics to provide guidance.

Northern

Most of the mileage in the current trail system exists in the northern portion of the park and begins and ends at the North End trailhead. The current kiosk at this trailhead displays various fliers that describe wildlife, park policies and safety hazards. This trailhead kiosk should be replaced with a wayfinding map to orient visitors and contextualize the hiking experience in relation to the park's significant hydrological and ecological attributes. This plan provisions moderate trailhead capacity improvements as necessary to accommodate trail users.

There is a trail that connects the day-use area to the North End trailhead but is lacking signage to direct visitors to the entry point. This disconnect between the day-use area and entry point for the northern trails could be alleviated with directional signage at the short boardwalk that leads to the trail. Signage could be placed closer to the parking area as well to let visitors know that hiking trails are accessible at the springhead.

Central

The only hiking trail within the central portion of the park is the Sink Trail Loop, located south of the springhead day-use area. The small trailhead for this existing loop offers a stabilized parking area and should be utilized as a link to the proposed trails to the south (see description below). Extending south from the existing Sink Trail, a new single-track trail should wind through the uplands between the numerous sinkholes. While the proposed trail should be aligned to avoid the erodible edges of the sinkholes and discourage errant access to the sensitive slopes, visual access and interpretation are essential aspects of the intended hiking experience.

Southern

The southern portion of the park, which consists largely of the Mead-Scott tract, currently contains no designated hiking trails. It is recommended that a winding, immersive hiking trail be created to connect the Sink Trail Loop in the central portion of the park to the newly acquired 288-acre tract between the current southern park boundary and Northwest 102nd Place. Although the new acreage will require natural community restoration, it predominantly consists of uplands and is anticipated to become suitable for southward expansion of the park's hiking trail network. Precise trail alignment is contingent upon mapping existing natural communities and desired future conditions of the new acquisition. Due west of the new acquisition, a trail may traverse a small area of depression marsh via an existing management road and link to a segment of the scenic unpaved causeway road through alluvial forest. The destination of this proposed out-and-back trail segment would be the Usher Landing site that offers views of the Suwannee River. Given the low volume of vehicles (i.e., boaters) accessing this road, modest use of this road segment by hikers is considered viable. The existing shelter at Usher Landing is well suited for interpretation of the river, alluvial forest, and greater floodplain ecosystem. The only other visual access to the Suwannee River and alluvial forest within Manatee Springs State Park is via the boardwalk that stems from the springhead day-use area.

Configuration of an expanded trail network in the southern portion of the park must be sensitive to the complex and delicate hydrology, utilizing existing management roads to cross wetlands. Design elements for altogether new sections of trail should prioritize single-track trail aesthetics and maximize views through the natural community types that are not seen elsewhere in the park. Considering this trail system expansion is contingent on natural community restoration, it is not likely to be completed within this planning cycle timeframe.

OPTIMUM BOUNDARY

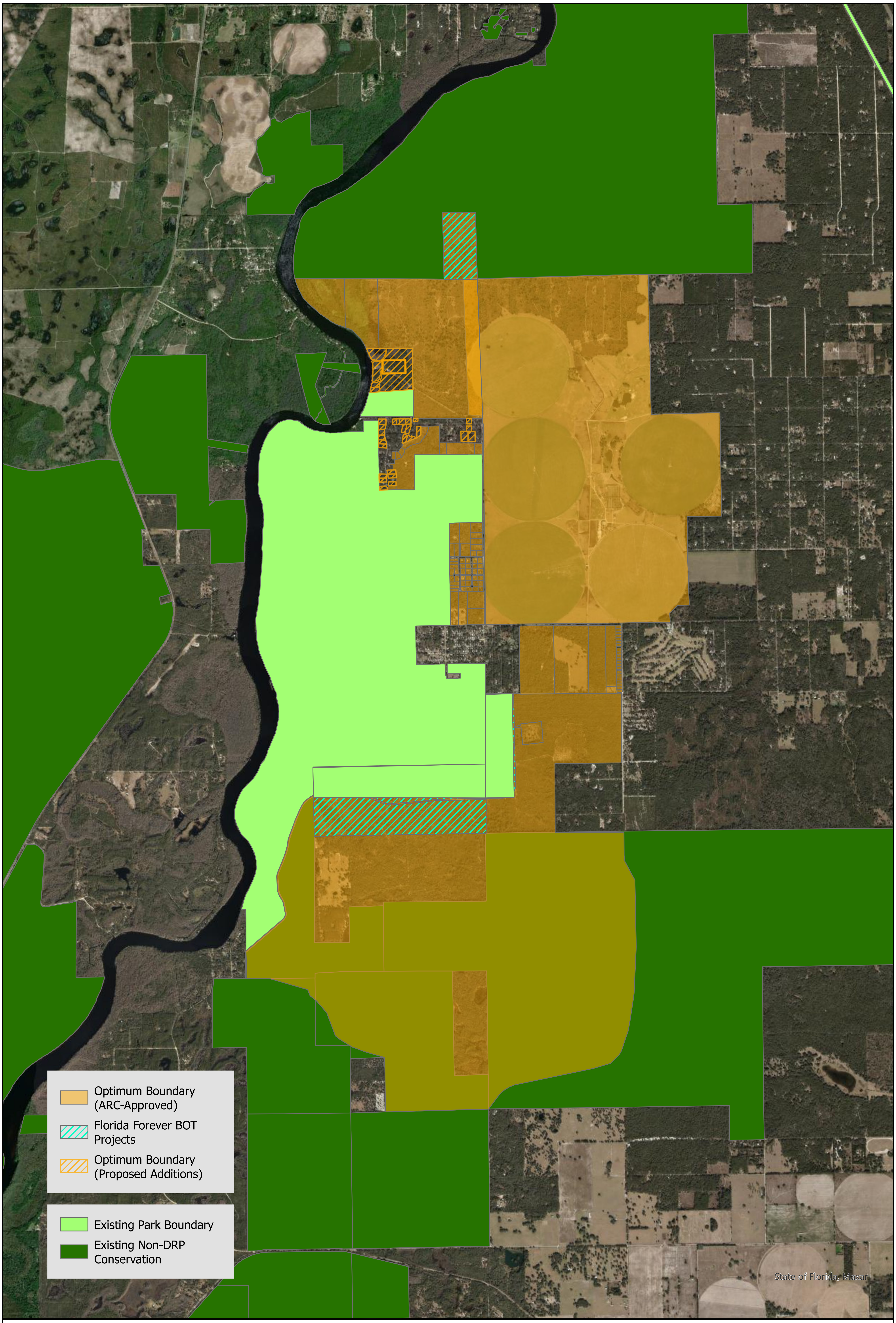
A large tract to the south of the park is included in the optimum boundary to further buffer water resources with additional conservation lands. Adjacent lands include subterranean and surface drainage routes into the springhead, as well as wetlands that are hydrologically connected to the spring recharge area.

There is a small group of parcels separating the current approved optimum boundary from the existing northern park boundary which are proposed for inclusion so that the boundaries are contiguous.

If acquired, the over 2,000 acres of agricultural lands to the northeast of the park within the current approved optimum boundary would further buffer water resources from surrounding agricultural operations. These cleared agricultural lands also represent ideal habitat to engage in longleaf pine restoration efforts. This land would also connect the existing park boundary to Andrews Wildlife Management Area, which connects to Fanning Springs State Park's optimum boundary. If acquired, this optimum boundary would complete a large wildlife corridor that extends all the way to the Gulf of Mexico.

DRP has a long-term sublease with Levy County regarding a boat ramp situated to the north of Manatee Springs State Park. If the county were ever to discontinue managing this boat ramp, DRP would reincorporate it back into the park boundary.

The park boundary should also extend about 50 feet into the Suwannee River to facilitate further protection of adjacent water resources and the manatee populations that depend on them.



Manatee Springs State

Optimum Boundary Map