CENTER FOR CONSERVATION INITIATIVES RESEARCH & MONITORING REPORT

2018-2021

A COMPILATION OF RESEARCH AND MONITORING CONDUCTED BY AGENCY, ACADEMIC, AND OTHER INVESTIGATORS IN COORDINATION WITH THE NATURE CONSERVANCY'S CENTER FOR CONSERVATION INITIATIVES

CENTER FOR CONSERVATION INITIATIVES | The Nature Conservancy

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INTRODUCTION

THE NATURE CONSERVANCY

Founded in the District of Columbia in 1951, The Nature Conservancy (TNC) currently impacts conservation in 79 countries, including all 50 states of the US. We have over one million members and have protected more than 125,000,000 acres of land and thousands of miles of rivers worldwide. TNC also operates more than 100 marine conservation projects globally. Our work focuses on the global priorities of Lands, Water, Climate, Oceans, and Cities. The Nature Conservancy's mission is to conserve the lands and waters on which all life depends.

CENTER FOR CONSERVATION INITIATIVES (CCI)

The Florida Chapter of The Nature Conservancy is establishing the Center for Conservation Initiatives (CCI) to address the state's environmental issues through four initiatives:

- Public Outreach - Connecting People & Nature
- Conservation Education & Training - Our Future Conservationists
- Science & Strategies - An Environment for Discovery & Solutions
- Natural Resource Stewardship - Advancing Natural Resource Management

Vision: The Center for Conservation Initiatives' vision is for the conservation of nature to be a fundamental and integral value of our community that is informed and underpinned by science and research.

Mission: The Center for Conservation Initiatives' mission is to advance conservation knowledge and action and inspire the next generation of conservation leaders.

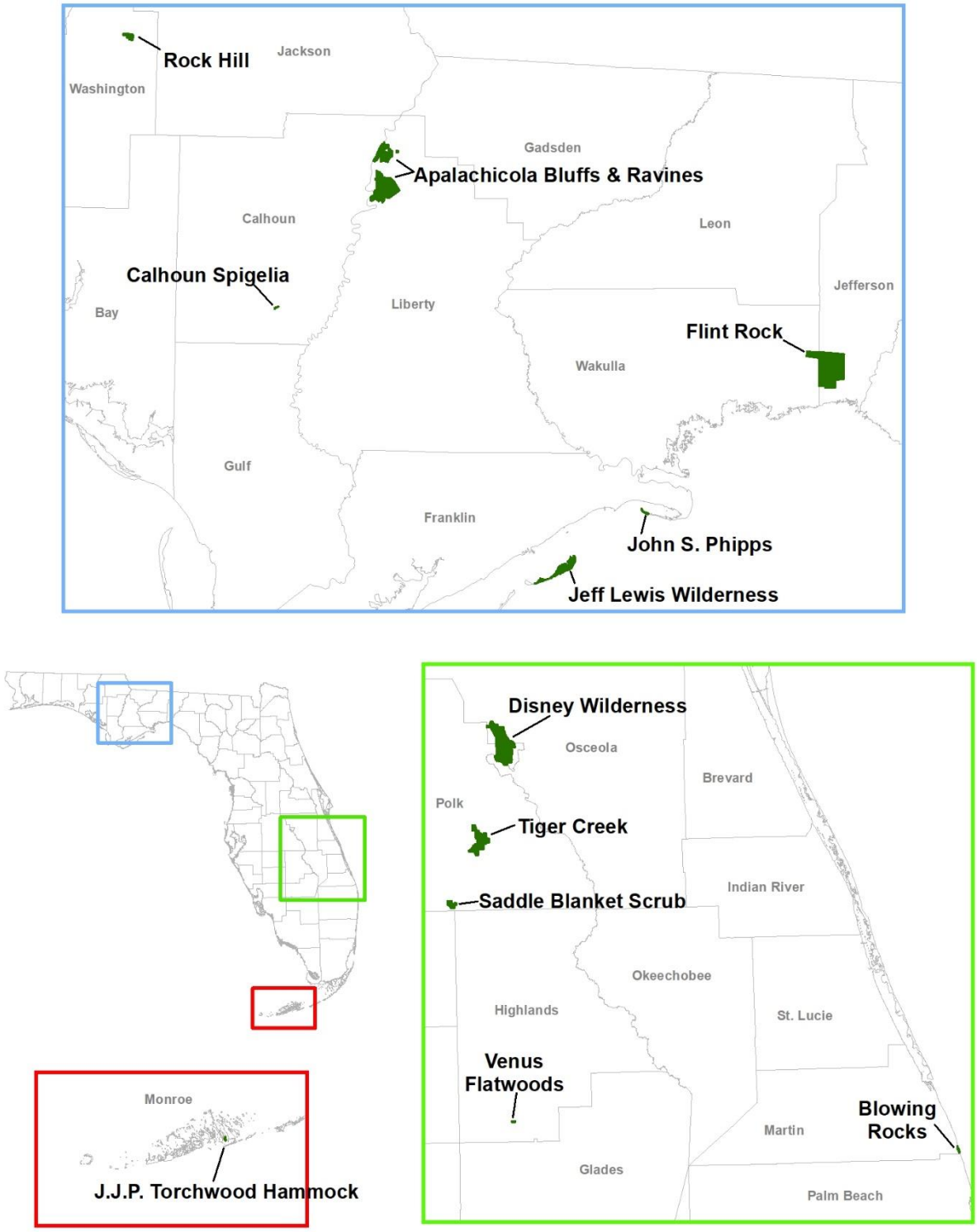
Four of the Chapter's preserves serve as CCI campuses, where most of the Center's on the ground programs, events, and strategies occur. Based on site location, history, and conservation strengths, each campus preserve has a unique conservation focal theme that is emphasized through the four CCI initiatives.

Campus Preserve Focal Themes

- Apalachicola Bluffs & Ravines Preserve: Working Forests
- Disney Wilderness Preserve: Connected Land, Water, and Communities
- Tiger Creek Preserve: Florida's Rare & Ancient Wilderness
- Blowing Rocks Preserve: Marine and Coastal Environment

Research is a critical component of the CCI Science & Strategy Focal Initiative. The goal of this initiative is to serve as a networked, site-based science and strategy platform for TNC and partners to investigate critical conservation questions, demonstrate strategies, and communicate with specific audiences. To achieve this goal, we are working to establish the CCI campuses as notable regional and national research sites by expanding research activity across the campus preserves. To provide access to additional species, ecological, hydrological, and geological research opportunities throughout the state, seven other Conservancy preserves are also open to researchers (Figure 1).

Figure 1. The Nature Conservancy preserves open to research in Florida.



The Conservancy's Florida Chapter has encouraged research and monitoring on its lands by academic, agency, and other investigators for over 30 years. Through 2007, research projects were documented in annual reports. In 2018, near the beginning of the CCI concept development, we identified research tracking and reporting as critical for establishment of the campuses as research hubs. Therefore, we have produced this report to document the research and monitoring conducted by our conservation and science partners on our Florida preserves from 2018 through March 2021 and will follow with annual updates.

We have divided this report into three sections. The first section contains brief descriptions of research projects, organized by preserve and then alphabetically by project title. These include 26 total projects, of which 22 are planned or ongoing and 4 have been completed. The researchers are from 10 universities, 2 state agencies, and 4 other science or conservation organizations.

The second section has descriptions of seven active or planned long-term monitoring projects across six preserves. These are organized by preserve(s) and then by project title. Online links to data are provided where available.

The third section contains a list of all completed research reports and publications generated from research and monitoring on TNC lands in Florida by academic, agency, and other investigators as well as by Conservancy staff since 1982. The list of 263 reports and publications is organized by preserve, then chronologically from most recent to oldest, and then alphabetically by author. Copies of or web links to the reports and publications are available from the Chapter's Florida Research Reports and Published Works online map at https://tnc.maps.arcgis.com/apps/webappviewer/index.html?id=7e275e0557664ae19894978ebaade8af.

RESEARCH PROJECTS

APALACHICOLA BLUFFS AND RAVINE PRESERVE

Survey for FNAI-tracked butterflies at Apalachicola Bluffs and Ravines

Florida Natural Areas Inventory, Tallahassee, FL.

Duration: 2020-2021

Objectives: To survey Apalachicola Bluffs and Ravines Preserve (ABRP) for the common roadside-skipper (*Amblyscirtes vialis*), the dotted skipper *(Hesperia attalus slossonae*), and the pepper and salt Skipper (*Amblyscirtes hegon*), and to evaluate the current suitability of the habitat at ABRP for the three butterfly species listed above.

Methods: Florida Natural Areas Inventory (FNAI) volunteers survey suitable habitat for the butterflies during the appropriate times of the year when the adult butterflies should be flying. When one is found, they collect a GPS point and attempt to photograph the butterfly for confirmation. Confirmed sightings are incorporated into the FNAI's Biotic Database in Tallahassee, Florida.

Progress/Results: ONGOING. Surveys are scheduled through December 2021.

BLOWING ROCKS PRESERVE

Anastasia formation documentation

Florida Geological Survey, Florida Department of Environmental Protection, Tallahassee, FL.

Duration: 2021

Objectives: To document the occurrence of outcrops of the Anastasia Formation at Blowing Rocks Preserve for the Florida Geological Survey's (FGS) ongoing mapping of the state's geological features. Outcrops on the northwestern edge of the preserve were recently exposed by Hurricane Dorian and thus had not been previously documented by FGS.

Methods: FGS will collect samples from the outcrops by the summer of 2021. Samples will be catalogued and entered into the FGS database of surficial outcrops of geologic formations.

Progress/Results: PLANNED. FGS has not yet conducted the sample collection at BRP as of March 2021.

Leatherback sea turtle tagging

Kelly Martin. Florida Leatherbacks Inc., Palm Beach Gardens, FL.

Duration: 2014-

Objectives: To mark, recapture, satellite track, and conduct genetic studies on leatherback sea turtles to better understand the size and health of the population as well as nest frequency, individual size, migratory pattern, and survival rates in Martin County. The project has four study areas: Jupiter Island/Blowing Rocks Preserve, Hutchinson Island, St. Lucie Inlet State Park, and Hobe Sound National Wildlife Refuge.

Methods: During the nesting season (March through June), nighttime surveys are conducted to locate nesting leatherbacks. Individuals are identified, tagged, and measured while nesting. Individuals not previously tagged are fitted with flipper and PIT tags, measured, and have a skin biopsy taken. Previously tagged leatherbacks are identified, checked for tag integrity, and measured. Tagging data is submitted to the Archie Carr Center for Sea Turtle Research at the University of Florida.

Progress/Results: ONGOING. In 2020, Florida Leatherbacks Inc. (FLI) encountered a total of 313 leatherbacks in Martin County. At Jupiter Island/Blowing Rocks, FLI encountered 192 leatherbacks, of which 178 were recaptures, and 14 were new (untagged) individuals. Tracked individuals can be followed on FLI's website at https://www.floridaleatherbacks.com/track-our-turtles.

Miami blue butterfly habitat assessment

Dr. Jaret Daniels. Florida Museum of Natural History, University of Florida, Gainesville, FL.

Duration: 2021- 2022

Objectives: To assess Blowing Rocks Preserve and several other locations in coastal Florida for potential conservation actions for the endangered Miami blue butterfly (*Cyclargus thomasi bethunbakeri*). These assessments will inform ongoing conservation and population restoration efforts for this butterfly. Based upon these assessments, a prioritized list of sites for habitat restoration and/or potential future conservation reintroductions of this butterfly will be created.

Methods: Staff from Fairchild Tropical Garden and Zoo Miami are conducting visual surveys to identify all plant species present in appropriate habitat patches and quantify plant abundance for target species (*Pithecellobium* spp., *Guilandina* spp., *Cardiospermum* spp., and nectar plant species).

Because Miami blue butterfly larvae are tended by ants, which provide protection from natural enemies in exchange for the larvae's sugar-rich secretions, ant surveys are conducted to help identify potential Miami blue butterfly habitat. Arboreal ants are surveyed by tapping a stick against plants to dislodge ants from targeted plants (*Pithecellobium keyense* and *Guilandina bonduc*). Depending on the abundance and extent of *P. keysense* and/or *G. bonduc* at the preserve, 1-10 ant sampling locations will be collected. A white sheet will be laid underneath plants, and specimens will be collected with a small hand-held aspirator. Non-ant bycatch will be immediately returned unharmed to the plant. Ant specimens will be preserved in ethanol and transported to the University of Florida for species identification. All specimens will be deposited and retained by the Florida State Collection of Arthropods (Gainesville, FL).

Progress/Results: ONGOING. Vegetation surveys began in March 2021 at Blowing Rocks Preserve.

CALHOUN SPIGELIA PRESERVE

Status survey of gentian pinkroot (*Spigelia gentianoides)* and damage assessment following Hurricane Michael; Jackson, Washington, and Calhoun Counties

Amy Jenkins. Florida Natural Areas Inventory, Tallahassee, FL.

Duration: 2020-2021

Objectives: The objective of this project is to estimate population size of gentian pinkroot for each conservation land where it is known to occur (Three Rivers State Park, Apalachee Wildlife Managed Area, Calhoun Spigelia Preserve, and Rock Hill Preserve). The Florida Natural Areas Inventory (FNAI) will incorporate the census data into its conservation database and utilize the data to update the global and state ranking of this species using the NatureServe Conservation Rank Calculator.

Methods: In May and June 2021, FNAI conducted population counts within 2.5 m radius plots distributed in known historical and current *S. gentianoides* locations and in other areas with suitable habits. Plants outside of plots were documented but did not contribute to population estimates. Two plots were placed at Calhoun Spigelia and 11 at Rock Hill.

Progress/Results: ONGOING. No plants, neither within nor outside of plots, were found at Calhoun Spigelia. Numerous plants were counted within the plots at Rock Hill, resulting in a population estimate of 1,536 individuals for the preserve. FNAI plans on re-surveying Calhoun Spigelia in 2021, in hopes of a reappearance of the species after a recent prescribed burn. A report was submitted to the Florida Forest Service for the project (FNAI 2021).

DISNEY WILDERNESS PRESERVE

Change detection of wetlands from 1941-2018 using remote sensing to understand landscape scale changes in the wetland ecosystems

Sarah Parker. Master's student, Department of Biology, University of Central Florida, Orlando, FL.

Duration: 2018 – 2021

Objectives: With the limited understanding of the long-term impacts of hydrological restoration in subtropical wetlands, this study aimed to address the lack of in-situ and landscape scale observations by utilizing multitemporal, multispectral Landsat TM imagery on a multi-scale framework to

1. Assess patch and landscape-scale dynamics before and after the hydrological restoration by analyzing landscape metrics and spectral responses of wetlands (from Parker and Weishampel 2019).
2. Explore utility of moderate resolution Landsat satellite imagery datasets for restoration monitoring of subtropical freshwater wetlands (Parker and Weishampel 2019).

Methods: Aerial imagery was preprocessed, segmented, and indexed (*i.e.*, Normalized Vegetation Index (NVDI)), and FRAGSTATS was used to evaluate the patch, class, and landscape scale dynamics of the preserve. Spectral trajectories from 1984-2018, around several years before and 20+ years after the hydrological restoration, were analyzed from multispectral Landsat Thematic Mapper imagery. The spectral properties of the wetlands were analyzed using nonmetric multidimensional scaling to elucidate patterns within and among the wetland types *(i.e*., cypress, bayhead, marsh) before and after the restoration.

Progress/Results: FIELDWORK COMPLETED. The different wetlands varied in the range and duration of vegetation changes between 1984 and 2010, especially around the time of restoration. Almost two decades since the restoration began, the wetlands displayed more decreases in NDVI than increases. The marsh and bayhead classes had the most mixed response while the cypress and mixed hardwood swamp showed mostly a decrease. The range and duration of the patch dynamics varied among wetland classes and patches (Parker and Weishampel 2019).

To better characterize these changes, further statistical analysis to quantify the changes seen in wetlands to better understand how the wetland plants responded to the hydrological restoration is in progress. (Parker and Weishampel 2019).

Ms. Parker presented at the 2019 Fall Meeting of the American Geophysical Union and plans to complete her thesis by the end of 2021.

Characterization of sinkholes in the Disney Wilderness Preserve using geophysics techniques

Dr. Xavier Comas. Department of Geosciences, Florida Atlantic University, Boca Raton, FL.
Dr. Francisco Gutierrez, Dept. Ciencias de la Tierra, Universidad de Zaragoza, Spain.

Duration: 2020

Objectives: To develop and assess techniques to improve the ability to map, characterize, monitor, and predict the spatial-temporal distribution and characteristics of sinkholes, allowing for more efficient risk management (Comas *et al.* 2021).

Methods: At two seasonal depression marshes (subsidence sinkholes) at the Disney Wilderness Preserve, Dr. Comas and his team used an array of near-surface geophysical methods to image the subsidence structures underlying the depression marshes, typically 100m across and with subdued geomorphic expression. Methods included ground-penetrating radar (GPR), electrical resistivity imaging (ERI), terrain conductivity, and shallow seismics, all constrained with data from the South Florida Water Management District's borehole at the Disney Wilderness Preserve (DWP) (Comas *et al.* 2021).

Progress/Results: COMPLETED. The sinkholes (depression marshes) in this study are related to deep-seated interstratal karstification of limestone and the ductile sagging of the overlying bedrock and cover formations (caprock-cover sagging sinkholes). This non-catastrophic progressive subsidence mechanism is recorded by synformal structures (basin structures with centripetal dips in 3D) with upward attenuation in the dip of cover deposits accumulated in the sinkholes (growth strata related to synsedimentary subsidence) (Comas *et al.* 2021).

The sagging subsidence mechanism and its progressive kinematic regime has relevant implications from the hazard perspective. This work illustrates the importance of correctly categorizing sinkholes for producing reliable hazard assessments. Imaging the internal structure of the sinkholes via geophysical data can be essential for the correct diagnosis of the subsidence style and sinkhole typology (Comas *et al.* 2021).

This study, along with similar data collected by Dr. Comas and his students in 2011-2017 from five additional depression marshes at DWP, shows correspondence between diameter of subsidence depressions and extent of sagging mechanism with depth as well as amount of passive bending: 1) depressional features with larger surface diameter show conspicuous sagging subsidence structures (bending with relief changes up to 10m) that extends throughout the entire lithological column (0-40m); and 2) depressional features with smaller surface diameter show gentle sagging structures (bending with relief changes of less than 5m) at deeper potions of the column (*i.e.*, 20m or more) (Comas *et al.* 2021).

A presentation on this project was given at the 2020 Fall Meeting of the American Geophysical Union.

Combining NEON and remotely sensed habitats to determine climate impacts on community dynamics

Dr. James Clark. Nicholas School of the Environment, Duke University, Durham NC.
Dr. Roland Kays. College of Natural Resources, North Carolina State University, Raleigh, NC.

Duration: 2018 – 2022

Objectives: To determine the impacts of climate change on forest seed production at three National Ecological Observatory Network (NEON) sites**:** the Disney Wilderness Preserve (DWP), Ordway-Swisher Biological Station, and the Talladega National Forest.

Methods: The Clark lab established six seed rain plots within each of three NEON plots in longleaf stands at DWP in June of 2018, amounting to 18 traps total. Each year a census is taken of trees greater than 2m tall in the 40x40 meter NEON plots surrounding the seed rain traps. Census includes growth measurements and cone production. To determine the wildlife that may be dependent upon seed production, 49 motion-activated trail cameras were deployed by Dr. Kays lab throughout DWP for the month of May 2019 and processed using eMammal.

Progress/Results: ONGOING. In 2019 and 2020, seed traps were collected along with crop counts of longleaf found within the NEON plots. A final seed collection and crop count is planned for fall of 2021.

The trail cameras collected 15,510 photos, capturing 1,038 animal detections. Seventeen species in total were photographed, with white-tailed deer by far the most abundant species at 58%. Wild boar appeared in 12% of the photographs and wild turkey in 10%. The camera surveys will not be repeated at DWP.

A paper on this project was published in 2021 (Clark *et al.* 2021). Seed and cone data from the three study sites were contributed to the continental Masting Interference and Forecasting (MASTIF) network, set up to evaluate how climate, habitat, and individual tree traits affect maturation and fecundity in trees. Using Disney and other MASTIF data from across the US, Dr. Clark led an analysis to determine how climate indirectly effects tree fecundity that comes through variation in tree size and growth (climate-condition interactions). A biogeographic divide was found, with the climate-condition interactions reducing fecundity in the western US and increasing it in the eastern US (Clark *et al*. 2021).

The epidemiology of reptile hosts and *Borreliaburgdorferi sensu lato* in Florida

Carrie de Jesus. PhD. student, Wildlife Ecology and Conservation Department, University of Florida, Gainesville, FL.

Duration: 2020

Objectives: To determine the role of native lizards in Florida in the epidemiology of Lyme disease in Florida by determining whether the lizards meet two criteria for host competency:

1. Are dog ticks (*Ixodes scapularis*) feeding on lizards in Florida?
2. Can lizards in Florida maintain a *B. burgdorferi s.l.* infection?

Methods: Lizards from two locations at the Disney Wilderness Preserve were collected using drift fences, pitfall traps, funnel traps, cover boards, and hand trapping in June of 2020. Caught lizards were mechanically constrained so that tail snips could be taken for blood and tissue samples. These samples will be examined for evidence of whether the Lyme disease bacterium disseminates throughout the lizard body. Lizards with ticks had their ticks removed with fine tipped forceps. Removed ticks were placed in molecular grade ethanol to preserve the DNA for pathogen testing. A scale sample was also taken from the tick attachment site. Scale samples will be used to determine if bacterium infections are localized after tick feeding. Lizards were released back into their environment after tissue, blood and tick samples were taken.

Progress/Results: FIELDWORK COMPLETED. Over a two-week survey period, 10 southeastern five-lined skinks and 2 eastern glass lizards were collected. One of the lizards had a tick attached. Lab work is currently in progress to determine presence of Lyme disease or other pathogens.

Evaluations of herbicide efficacy and selectivity on invasive *Scleria macrocarpa* in Florida wetlands

Alexandra Onisko. Master's student, Department of Agronomy, University of Florida, Gainesville, FL.

Duration: 2018 – 2021.

Objectives: To investigate efficacy, selectivity, and non-target damage of 10 herbicides on invasive *Scleria* species.

Methods: The Disney Wilderness Preserve (DWP) was one of three locations for this study. At one location on the preserve, 10 different herbicides were tested within 44 10x20 ft plots. They were compared to a control, and Induce® was the only surfactant used. Each application, including the control, was replicated 4 times. Line transect data was taken to document the impact of each treatment on the cover of *Scleria* and native vegetation. Data was collected 30 days, 60 days, 90 days, 6 months, and 1 year after treatment.

Progress/Results: FIELDWORK COMPLETED. At DWP, there were significant differences in effectiveness against *S. macrocarpa*, with the herbicides imazapic, imazomox, glyphosate, imazapyr, and diquat providing the best control. There were no observed differences in impacts to native vegetation cover, but imazomox resulted in the best native species recovery and recruitment. Ms. Onisko expects to complete her thesis by summer 2021.

Foliar traits and terrestrial ecosystems variability across NEON domains

Dr. Philip Townsend. Department of Forest and Wildlife Ecology, University of Wisconsin, Madison, WI.

Duration: 2019

Objectives: To develop, test, and validate the algorithms used to map vegetation traits using imagery from the National Ecological Observatory Network's (NEON) Aerial Observation Platform (AOP). This would result in the first comprehensive data set and methods for mapping vegetation biochemistry and physiology across the range of ecosystem types in the US and would enable characterization of how vegetation traits vary across space and time.

Methods: This study was conducted on a total of 19 NEON sites east of the Rockies. The methodology involved linking aerial imagery to ground measurements taken within two weeks of each other. Methods were consistent across all sites and vegetation types. Dr. Townsend's team collected samples of foliar biomass from the crowns of trees and areas of grass in selected plots. A potential plot was anywhere with a tree or vegetated surface that comprised at least a 3m radius circle (as seen from above) and was nearly homogenous in species. The priorities for plot selection were 1) homogenous, green vegetation big enough to be captured in the NEON AOP imagery; 2) enough plots to cover most of the species diversity at a site; 3) capture of a variety of microhabitats (varying slope, moisture conditions etc.); and 4) distribution across the landscape to smooth any uncertainty due to spatial variation. Methods for acquiring samples included pole pruners, line launchers (slingshot and bean bags), and rope saws.

The team then performed chemical, image, and other analyses on the biomass samples to correlate foliar functional traits to pixel signatures on processed NEON imagery. Foliar functional traits are chemical, physiological, and structural properties of leaves that influence biological processes associated with photosynthesis and primary production, plant defense, nutrient cycling, and litter decomposition.

Progress/Results: COMPLETED. Imaging spectroscopy and field measurements were successfully used to map 26 foliar functional traits in the 19 NEON study sites. Specific wavelengths were correlated with 17 foliar traits to produce models that performed well for most of the traits with independent validation.

A paper on this project was published in 2020 (Wang *et al*. 2020).

Insect services and disservices: impacts of dung beetles and fire ants on central Florida ranchlands

Dr. Roisin Stanbrook. Department of Biology, University of Central Florida, Orlando, FL.

Duration: 2019 – 2022

Objectives: To describe the distribution and abundance of dung beetles in central Florida and clarify their potential economic impact in ranchlands and grasslands across the state.

Methods: Uses data collected by the National Ecological Observatory Network's ground beetle trapping protocol using unbaited pitfall traps from 2014 to present.

Progress/Results: ONGOING. Fourteen species of dung beetle have been collected from Disney Wilderness Preserve thus far.

Potential mechanisms of population decline: anuran responses to prescribed fire in central Florida flatwood-marsh complexes

Ian Biazzo. Master's student, Department of Biology, University of Central Florida, Orlando, FL.

Duration: 2019-2022

Objectives: To test the effects of prescribed fire on anuran populations and examine the potential mechanisms of post-fire population decline in pine flatwoods and embedded depression wetlands. The research focuses on two levels of ecological hierarchy using a before-after-control-impact design: 1) the immediate and short-term mechanisms of changes in anuran populations after a burn using mark-recapture techniques, and 2) species composition at the assemblage level and effects of prescribed burns on diversity and abundance of frogs in the flatwoods and marshes.

Methods: In 2020, eight burn units with depression marshes were randomly selected for permanent study plots, four as control plots in units burned in 2018, and four as treatment plots in units to be burned in 2020. Within each plot, 1-meter-long PVC pipes were nailed vertically at 1.5 m high to trees surrounding wetlands to act as temporary refugia for frogs. The pipes are checked weekly for frogs. All frogs are identified to species, measured from snout to urostyle, sexed if possible, and given unique Visible Implant Elastomer (VIE) tags. The PVC pipes are removed 1-2 days before fires and replaced 1-2 days afterwards.

In 2021, a vertical occupancy study was added to test if different treefrogs partition habitat space and how fire impacts these partitions. For this study, PVC tree frog refugia pipes were set at 3 m, 6 m, and 9 m high on large pine trees in four of his study sites.

Progress/Results: ONGOING. Data collection will continue through 2021. A presentation is planned for the 9th International Fire Ecology and Management Congress in November 2021.

Resolving controls on lignin decomposition at the continental scale to reconcile classical and modern paradigms of soil organic matter

Dr. Steven Hall. Department of Ecology, Evolution, and Organismal Biology, Iowa State University, Ames, IA.
Dr. Samantha Weintraub. National Ecological Observatory Network (NEON), Boulder, CO.

Duration: 2019-2020

Objectives: To assess the biogeochemical controls on the decomposition of lignin vs. other litter constituents in soils spanning NEON core terrestrial sites. This research was funded by the NSF Macrosystems Biology and the Early NEON Science programs.

Methods: All field work was conducted by NEON field technicians within existing NEON plots. In August 2019, soil samples (approx. 5 g) were collected from NEON plots and then shipped to Dr. Hall's lab at Iowa State University. The lab team then mixed the soil with a small amount of ^{13}C-labeled lignin (5 mg ^{13}C at 99 atom percent) mixed with leaf litter. The small stable C isotope is measurable at the scale of the sample but undetectable at the ecosystem scale. The soil/lignin mixtures were each placed in a small bag and shipped back to NEON. Back at the preserve, the NEON field team placed each soil bag in the location from which it was collected. In August 2020, the soil bags were collected by NEON field staff and sent to Dr. Hall's lab for analysis.

Progress/Results: FIELDWORK COMPLETED. Data analysis is in progress.

Survivorship and productivity of Florida sandhill cranes on conservation lands and suburban areas in central Florida

Tim Dellinger, Florida Fish & Wildlife Commission, Tavares, FL.

Duration: 2019 – 2022

Objectives: This project has three objectives:

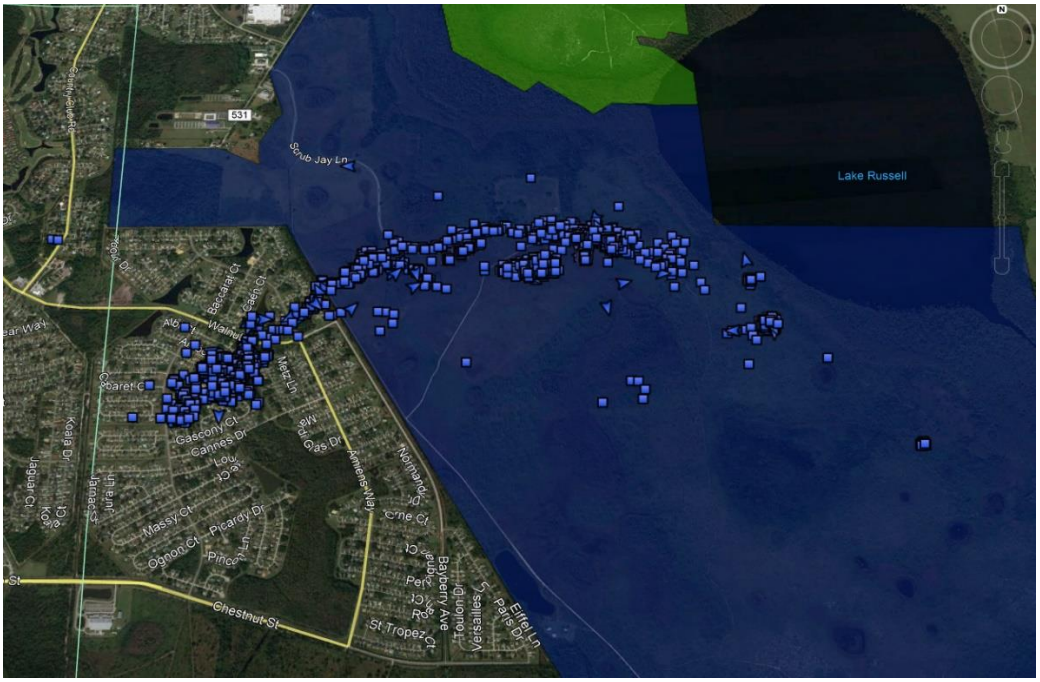
1. To identify threats cranes face in suburban and conservation areas in Marion to Highlands Counties.
2. To determine adult survivorship, productivity, and habitat use on conservation lands and suburban areas.
3. To determine vegetation associations used by Florida sandhill cranes in suburban habitats and conservation lands using movement data from radio-tagged individuals.

Methods: Adult Florida sandhill cranes are captured, fitted with a USFWS band and GSM cellular transmitter, and then released at the capture site. The transmitters collect up to 47 GPS locations during a 24-hour period with previous days' data available on demand. Tim uses a dynamic movement model to calculate utilization distributions (UDs) for all marked cranes and determine home range and core use areas for each transmitter-marked bird. Survival rates are calculated with the Kaplan-Meier estimator. Productivity data (e.g., laying date, hatching, brood size, fledging) are collected by examining daily movements of transmitter-marked birds and through occasional site visits during the breeding season.

Progress/Results: ONGOING. FWC tagged 23 cranes in suburban areas from Lake County south to Highlands County and 17 cranes in conservation areas from Marion to Highlands County. They also color-banded 69 suburban cranes to bolster survival data collected from transmitter-marked cranes.

At the Disney Wilderness Preserve (DWP), an adult crane was captured and fitted with a backpack transmitter on 12 December 2019 on the east side of the shop. Based on voice and behavior, the individual was a male. It was with its mate and colt at the time of capture. Throughout 2020, the tagged crane and its mate regularly roosted and foraged on DWP, using depression marshes, dry prairie, and mowed areas around the office and shop. The cranes also made daily foraging forays into the suburban area west of DWP almost daily (Figure 2.). Based on movement locations, FWC suspected that the tagged crane and its mate nested on DWP in 2020 but that the nest failed during incubation. For 2021, FWC plan to continue color-banding and deployment of transmitters. They will also complete home range calculations and determine habitat use.

Figure 2. Movement locations between 15 December 2019 - 11 August 2020 of an adult sandhill crane radio-tagged on Disney Wilderness Preserve. Map provided by Tim Dellinger, FFWCC.



Understanding the disease dynamics of an emergent protistan pathogen (*Dermomycoides* sp.) in Florida's amphibians

Matthew Atkinson. PhD. student, Department of Biology, University of Central Florida, Orlando, FL.

Duration: 2017 – 2021

Objectives: To assess the prevalence, intensity, and consequences of *Dermo* infections in Florida amphibian populations. It was predicted that disease dynamics would vary across wetland type and wetland community composition. This project was conducted at Disney Wilderness Preserve, Florida Forever (private), Gold Head Branch State Park (DEP), UCF Arboretum, and Rock Springs Run State Park (DEP).

Methods: Eight wetlands across central Florida were included in the study, including two at the Disney Wilderness Preserve (DWP). The selected wetland sites were based on previous disease work conducted and/or the presence of gopher frogs (*Rana capito)* on the site. Dip-netting surveys were conducted to collect tadpoles at each wetland. At each of the two DWP study sites, five tadpoles per species per sampling trip were randomly selected for removal of tail clips to non-destructively sample for disease. Five of the ten individuals collected per site per species were destructively sampled to directly compare the detection and quantity of *Dermo* from liver samples compared to tail clip samples. Adults were also collected at the sample site. Toe clips were taken from all available individuals, and whole-body specimens were taken from every fifth individual captured during the sampling occasions. All whole-body specimens were then necropsied where mouth parts, tail/toe clips, intestine, skin swabs, spleen and liver from each specimen were collected. Animals were euthanized using an injection of MS-222 into the coelomic cavity, which is generally considered to be the most humane way of euthanizing amphibians. Additionally, only toe clips were taken of the adults for the following species: gopher frogs (*Rana capito*) and ornate chorus frogs (*Pseudacris ornata*). In addition to frogs, water samples were collected to determine the amount of *Dermo, Bd* and FV3 within the water column. While ponds were sampled, pH, water temperature, water level, hydroperiod type, canopy cover, soil type and other additional pond characteristics were taken. Up to five adult frogs per site per sampling trip were sampled, with toe clips and blood collected if possible, to test for the presence of *Dermo* in metamorphosed individuals.

Progress/Results: FIELDWORK COMPLETED. Field work is complete at the Disney Wilderness Preserve and other study areas. The presence of *Dermomycoides* at the preserve was confirmed from samples taken from the first field visit. Data analysis is in progress. Mr. Atkinson expects to complete his dissertation by the end of 2021.

FLINT ROCK PRESERVE

Management of titi in restoration of ephemeral wetlands

Dr. Pat Minogue. North Florida Research and Education Center, UF/IFAS, Quincy, FL.
Dr. Ajay Sharma. West Florida Research and Education Center, UF/IFAS, Milton, FL.

Duration: 2018-2021

Objectives: To identify herbicide treatments that provide acceptable titi (*Cyrilla racemiflora* L.) control without significant adverse effects on amphibians or their habitat.

Methods: The researchers implemented seven uniform replicated field studies at Flint Rock and the Apalachicola National Forest. They compared the effectiveness of selective herbicides (Rodeo, Habitat, Garlon 3A), applied alone or in mixes of different concentrations, with or without adjuvant, using three different application methods (foliar spray, cut-stump, and cut-stem) in controlling titi. Treatments at both sites were each replicated 10 times and included non-treated controls. After one year of treatment, they measured percent titi control at both preserves. At Apalachicola National Forest, they also assessed herbicide injury to non-target vegetation, particularly plants important to ephemeral amphibians.

Progress/Results: FIELDWORK COMPLETED. Date analysis is in progress. Based on the treatment results, the researchers have provided the following recommendations for the most effective herbicide or mix for each of the three application methods:

1. Direct foliar: 5% Rodeo (or less? with 1% MSO provides 80% titi rootstock mortality and 90% live height reduction
2. Cut stump: 50% Garlon 3A gives 60% rootstock mortality and 87% basal area reduction
3. Cut stem: Garlon 3A provide the poorest rootstock mortality (80%) compared to 97% for the average of the Rodeo + Habitat mixes. Use 50% for the best safety to non-target plants.

As for impacts to critical species, they found that Garlon 3A showed the least reduction of total ground cover and critical herbaceous species. Two mid-term reports have been produced (Minogue *et al*. 2020 and Minogue *et al*. 2021). A final report is in development with an expected due date of June 30, 2021.

JEFF LEWIS WILDERNESS PRESERVE

Changes to soil carbon cycling caused by mangrove encroachment of salt marsh

Dr. Josh L. Breithaupt. Coastal and Marine Laboratory, Florida State University, St. Teresa, FL.

Duration: 2020-2021

Objectives: To measure changes in soil carbon cycling that occur as mangroves encroach on and occupy habitat previously occupied by salt marshes.

Methods: This work is being conducted in present day mangrove and marsh locations to establish a historical context via soil core dating. A total of six soil cores will be collected on the eastern end of the preserve, three from marsh and three from mangrove locations. In addition to radiometric dating (using ^{210}Pb), the soil cores will be analyzed for content of total organic matter, organic & inorganic carbon, nitrogen, and phosphorus content.

In addition to the one-time collection of soil cores, monthly measurements will be made of pore-water nutrient (nitrate, nitrite, ammonium, and soluble reactive phosphorus) and carbon (dissolved organic and inorganic) content. Porewater will be collected from the top 30 cm of sediment using pore-water sippers inserted into the ground and extracted via syringe.

Simultaneous to pore-water collection, a portable infrared gas analyzer for measurement of CO_2 and CH_4 will be used to measure soil respiration. The gas analyzer will be positioned on a 30 cm PVC collar that will be inserted 1 cm into the soil surface 24 hours in advance to avoid ground-level disturbance artifacts in the gas flux measurements.

Soil cores will be collected using a gouge augur (2 cm diameter x 50 cm length) or with polycarbonate tubes (7 cm diameter × 50 cm length). The type of coring device will depend on the quality and cohesion of the soils at each site. Cores will be collected to a depth of 50 cm maximum, or to the depth of significant resistance (typically sand or bedrock).

Progress/Results: ONGOING. Dr. Breithaupt has collected all soil cores and continues the monthly porewater measurements. A paper with data from this study is in development.

JOHN J. PESCATELLO TORCHWOOD HAMMOCK PRESERVE

Shorebird nest monitoring

Kevin Christman. Florida Fish & Wildlife Conservation Commission, Panama City, FL.

Duration: Jul 2019- Sep 2019

Objectives: To determine nest and fledgling success of Wilson's plovers. Reliable population information is needed to determine the status of this species for potential state listing.

Methods: Weekly surveys were conducted to determine number of adults, number of nests, and number of fledglings. Data was entered into FWC's Florida Shore Bird Database.

Progress/Results: COMPLETED. FWC observed nine adults (5 males, 4 females), four nests, and two fledglings. Data is publicly available from FWC's Florida Shore Bird Database at https://public.myfwc.com/crossdoi/shorebirds/.

ROCK HILL PRESERVE

A dendroecological investigation into spatial and temporal patterns of longleaf pine (*Pinus palustris*) growth in Florida

Nicole Zampieri. PhD student, Department of Geography, Florida State University, Tallahassee, FL.

Locations: Rock Hill Preserve and Tiger Creek Preserve

Duration: 2018-2022

Objectives: This study has four objectives:

1. Determine the patterns of longleaf pine forest structure (density, size structure, age distribution) and how growth rates differ across natural communities.
2. Determine how a strong tropical cyclone (Hurricane Michael) affected forest structure in different natural communities.
3. Determine the relative effects of community type and interannual climatic variability on longleaf pine growth rates.
4. Determine the current and historical above-ground carbon storage potential of longleaf pines across their Florida range.

Methods: Sites were selected from the list FNAI's designated exemplary sites. Exemplary sites were chosen as excellent historically representative examples of the communities, based on fire regime, canopy structure, regeneration, and groundcover quality. Twenty-two sites in total

were sampled, two of which were on Conservancy preserves (Rock Hill and Tiger Creek Preserve). Rock Hill was selected for its Upland Pine exemplary site and Tiger Creek for Sandhill.

Data was collected on the density, size, and age structure of longleaf pine trees using modified variable area transects at each site. Within the transects, each tree was mapped with GPS and dbh, height, crown measurements were taken. Cores were collected from 13 trees at Rock Hill and 8 at Tiger Creek.

Surveys were conducted post-Hurricane Michael on several of the panhandle research sites to assess damage caused by the storm. Rock Hill was not included in the assessments.

Progress/Results: FIELDWORK COMPLETED. Data analysis is in progress. Preliminary results of this study are presented in Tables 1 and 2 below (Tables provided by N. Zampieri).

Table 1. Density estimates (in trees/ha) of longleaf pine at TNC preserves (2018)

Site	Community	Grass Stage	Juveniles (<15 cm dbh)	Mature: Small (15-30 cm dbh)	Mature: Medium (30-45 cm dbh)	Mature: Large (45+ cm dbh)	Overall tree density (not including grass)
Rock Hill	Upland Pine	113	22	19	65	11	117
Tiger Creek	Sandhill	6	0	9	19	0	28

Table 2. Age range of cored trees at TNC preserves

Size Classes	**Rock Hill**	**Tiger Creek**
Mature: Small (15-30 cm dbh)	25-74	24-43
Mature: Medium (30-45 cm dbh)	51-80	46-101
Mature: Large (45+ cm dbh)	86-88	NA

Status survey of gentian pinkroot (*Spigelia gentianoides)* and damage assessment following Hurricane Michael; Jackson, Washington, and Calhoun Counties

Amy Jenkins. Florida Natural Areas Inventory, Tallahassee, FL.

Duration: 2020-2021

Objectives: The objectives of this project are to

1. Estimate population size of gentian pinkroot for each conservation land where it is known to occur (Three Rivers State Park, Apalachee Wildlife Managed Area, Calhoun Spigelia Preserve, and Rock Hill Preserve).
2. Identify any potential habitat for gentian pinkroot within these conservation lands
3. Evaluate, photograph, and describe the habitat within each occurrence particularly describing structural damage that occurred during Hurricane Michael
4. Document presence and extent of invasive plant species in vicinity of the gentian pinkroot,

5. Incorporate all census data into FNAI's conservation database and utilize the data to update the global and state ranking of this species using the NatureServe Conservation Rank Calculator

Methods: In May and June 2021, the Florida NaturalAI conducted population counts within 2.5 m radius plots distributed in known historical and current *S. gentianoides* locations and in other areas with
suitable habits. Plants outside of plots were documented but did not contribute to population estimates. Two plots were placed at Calhoun Spigelia and 11 at Rock Hill.

Progress/Results: ONGOING. No plants, neither within nor outside of plots, were found at Calhoun Spigelia. FNAI counted numerous plants within the plots at Rock Hill, resulting in a population estimate of 1,536 for the preserve. They plan on re-surveying Calhoun Spigelia in 2021, in hopes of a reappearance of the species after a recent prescribed burn. A report was submitted to the Florida Forest Service for the project (FNAI 2021).

SADDLE BLANKET SCRUB PRESERVE

Ecology, habitat requirements and conservation of two ultra-rare Florida bees

Dr. Chase Kimmel. Florida Museum of Natural History, University of Florida, Gainesville, FL.

Duration: 2021

Objectives: This project will focus on two bee species: the blue calamintha bee (*Osmia calaminthae*), previously only known from four locations in Highlands County,
and the giant scrub plasterer bee (*Caupolicana floridana*), a species previously known only from two Florida counties. This project seeks to better understand the distribution, ecology, and habitat requirements through the following:

1. Determination of the current status and distribution of the blue calamintha bee and its known floral host, *Calamintha ashei*, in Florida.
2. Determination of the current status and distribution of the giant scrub plasterer bee.
3. Increased understanding of the key natural history characteristics and habitat requirements of each bee (including host density, potential additional floral hosts, nesting and foraging behavior, etc.).
4. Evaluation of the future distribution and vulnerability of the blue calamintha bee and its floral host.
5. Development of basic species monitoring and habitat management recommendations to help safeguard existing populations.

Methods: Bee surveys will be conducted in areas where high densities of host plants occur. Bees will be hand netted, contained in a small enclosure, photographed, have hair samples removed from them for genetic work, and released at the point of capture. Pollen remnants left

in the container will be analyzed to confirm host plant as well as determine if additional host plant pollen is present. If non-destructive genetic sampling procedures do not yield sufficient DNA, one bee will be taken as a voucher specimen towards the end of the season.

In addition to bee surveys, researchers will also look for a nest of each bee. If a nest is found, whisker stakes or flagging will be temporarily used to mark the nest location. If a nest excavation is warranted, The Nature Conservancy will be contacted for permission for ground disturbance activities.

A habitat assessment will be conducted in areas where there are high densities of host plants as well as in areas where the bees are found.

Progress/Results: PLANNED. Field work will begin in spring of 2021.

TIGER CREEK PRESERVE

Demographics and population mapping of *Hartwrightia floridana*

Stephanie Koontz. Research Assistant, Archbold Biological Station, Venus, FL.

Duration: 2018-2019.

Objectives: The study had three main objectives:

1. Search former FNAI element occurrence records to confirm the species presence,
2. Search for and map new populations of *Hartwrightia floridana*, and
3. Establish permanent plots to monitor annual reproductive output and changes in cover of *H. floridana* across habitats and in response to land management

Methods: Fourteen 1-meter radius circular plots were placed where *H. floridana* individuals occurred within Tiger Creek Preserve's one known location. Plots were established randomly along a baseline transect through the population, stratified by 10 m intervals at a random distance (< 5 m) and perpendicular direction from the baseline. Within the plot, the percent cover of *H. floridana* (0%, trace (<5%), 10%, 20%, through 100%) was estimated, and the total number of reproductive stems was counted

Progress/Results: COMPLETED. Mean cover of *H. floridana* was 12.5% in 2019. Mean number of stems was 36 per plot. Because of the COVID pandemic, no data was collected in 2020. Funding for the project was discontinued, so the project was terminated by Archbold Biological Station. Plot markers were removed in spring of 2021.

A dendroecological investigation into spatial and temporal patterns of longleaf pine (*Pinus palustris*) growth in Florida

Nicole Zampieri. PhD student. Department of Geography, Florida State University, Tallahassee, FL.

Locations: Rock Hill Preserve and Tiger Creek Preserve

Duration: 2018-2022

Objectives: This study has four objectives:

1. Determine the patterns of longleaf pine forest structure (density, size structure, age distribution) and how growth rates differ across natural communities.
2. Determine how a strong tropical cyclone (Hurricane Michael) affected forest structure in different natural communities.
3. Determine the relative effects of community type and interannual climatic variability on longleaf pine growth rates.
4. Determine the current and historical above-ground carbon storage potential of longleaf pines across their Florida range.

Methods: Sites were selected from the list FNAI's designated exemplary sites. Exemplary sites were chosen as excellent historically representative examples of the communities, based on fire regime, canopy structure, regeneration, and groundcover quality. Twenty-two sites in total were sampled, two of which were on Conservancy preserves (Rock Hill and Tiger Creek Preserve). Rock Hill was selected for its Upland Pine exemplary site and Tiger Creek for Sandhill.

Data was collected on the density, size, and age structure of longleaf pine trees using modified variable area transects at each site. Within the transects, each tree was mapped with GPS and dbh, height, crown measurements were taken. Cores were collected from 13 trees at Rock Hill and 8 at Tiger Creek.

Surveys were conducted post-Hurricane Michael on several of the panhandle research sites to assess damage caused by the storm. Rock Hill was not included in the assessments.

Progress/Results: FIELDWORK COMPLETED. Data analysis is in progress. Preliminary results of this study are presented in Tables 1 and 2 below (Tables provided by N. Zampieri).

Table 1. Density estimates (in trees/ha) of longleaf pine at TNC preserves (2018)

Site	Community	Grass Stage	Juveniles (<15 cm dbh)	Mature: Small (15-30 cm dbh)	Mature: Medium (30-45 cm dbh)	Mature: Large (45+ cm dbh)	Overall tree density (not including grass)
Rock Hill	Upland Pine	113	22	19	65	11	117
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Table 2. Age range of cored trees at TNC preserves

Size Classes	**Rock Hill**	**Tiger Creek**
Mature: Small (15-30 cm dbh)	25-74	24-43
Mature: Medium (30-45 cm dbh)	51-80	46-101
Mature: Large (45+ cm dbh)	86-88	NA

Description and natural history of a new species of *Ellipes* (Orthoptera: Tridactylidae) from the Northern Lake Wales Ridge

Brandon Woo. Undergraduate, Department of Entomology, Cornell University, Ithaca, NY.

Duration: August 2018

Objectives: To describe an upland pygmy mole cricket thus far only known from Tiger Creek Preserve and A.D. Broussard Catfish Creek Preserve State Park.

Methods: Pygmy mole crickets were hand collected from the sand surface and by digging them from their sand trails after rains. All specimens were deposited at the Cornell University Insect Collection.

Progress/Results: COMPLETED. Mr. Woo collected 13 specimens of a new species of *Ellipes nr-eisneri* and 9 specimens of the Archbold pygmy mole cricket (*Neotridactylus archboldi*). Tiger Creek is the only documented location where the two species exist in the same habitats. Photographs of numerous individuals of the new species were posted on BugGuide.net: https://bugguide.net/node/view/1575492/bgimage. A paper describing the new *Ellipes* species is currently in development.

Ecology, habitat requirements and conservation of two ultra-rare Florida bees

Dr. Chase Kimmel. Florida Museum of Natural History, University of Florida, Gainesville, FL.

Duration: Mar-Dec 2021

Objectives: This project will focus on two bee species: the blue calamintha bee (*Osmia calaminthae*), previously only known from four locations in Highlands County, and the giant scrub plasterer bee (*Caupolicana floridana*), a species previously known only from two Florida counties. This project seeks to better understand the distribution, ecology, and habitat requirements through the following:

1. Determination of the current status and distribution of the blue calamintha bee and its known floral host, *Calamintha ashei*, in Florida.
2. Determination of the current status and distribution of the giant scrub plasterer bee.
3. Increased understanding of the key natural history characteristics and habitat requirements of each bee (including host density, potential additional floral hosts, nesting and foraging behavior, etc.).
4. Evaluation of the future distribution and vulnerability of the blue calamintha bee and its floral host.
5. Development of basic species monitoring and habitat management recommendations to help safeguard existing populations.

Methods: Bee surveys will be conducted in areas where high densities of host plants occur. Bees will be hand netted, contained in a small enclosure, photographed, have hair samples removed from them for genetic work, and released at the point of capture. Pollen remnants left in the container will be analyzed to confirm host plant as well as determine if additional host plant pollen is present. If non-destructive genetic sampling procedures do not yield sufficient DNA, one bee will be taken as a voucher specimen towards the end of the season.

In addition to bee surveys, researchers will also look for a nest of each bee. If a nest is found, whisker stakes or flagging will be temporarily used to mark the nest location. If a nest excavation is warranted, The Nature Conservancy will be contacted for permission for ground disturbance activities.

A habitat assessment will be conducted in areas where there are high densities of host plants as well as in areas where the bees are found.

Progress/Results: PLANNED. Field work will begin in spring of 2021.

LONG-TERM MONITORING PROJECTS

STATEWIDE

Florida Automated Weather Network (FAWN) stations on TNC preserves

University of Florida's Institute of Food and Agricultural Sciences (UF/IFAS), Gainesville, FL.

Duration: 2021-

Objectives: To obtain real-time weather from automated weather towers at Apalachicola Bluffs & Ravines Preserve, Disney Wilderness Preserve, and Tiger Creek Preserve. These towers will be installed and maintained by UF/IFAS as part of their state-wide FAWN network, which provides weather data from 42 stations to support the agricultural and research communities. In addition to the FAWN standard sensors, the towers will include equipment to provide KBDI and other data useful for prescribed fire and other preserve management.

Methods: A 30' fixed tower supporting sensor arrays and associated infrastructure including power and communication installation and use, to provide the following comprehensive data at each of the three preserves:

- Soil temperature at 10 cm
- Air temperature at 60 cm, 2 meters, and 10 meters
- Wind speed and direction at 10 meters; wind direction standard deviation, and min/max wind speed
- Global solar radiation
- Barometric pressure
- Wet bulb temperature at 2 meters
- Dewpoint temperature at 2 meters
- Vapor pressure, saturated vapor pressure, and vapor pressure deficit at 2 meters
- Fuel temperature and moisture at 30 cm
- Keetch-Byrum Drought Index (KBDI) sensors at 2 meters

Progress/Results: PLANNED. Installations of the towers and sensors at the three preserves is planned for fall/winter of 2021. The proposed locations at each of the three preserves are shown in Figures 3-5. The Conservancy will apply for a Town of Jupiter permit to include Blowing Rocks Preserve in the project.

Figure 3. Location of the proposed FAWN weather station at Apalachicola Bluffs and Ravines Preserve.

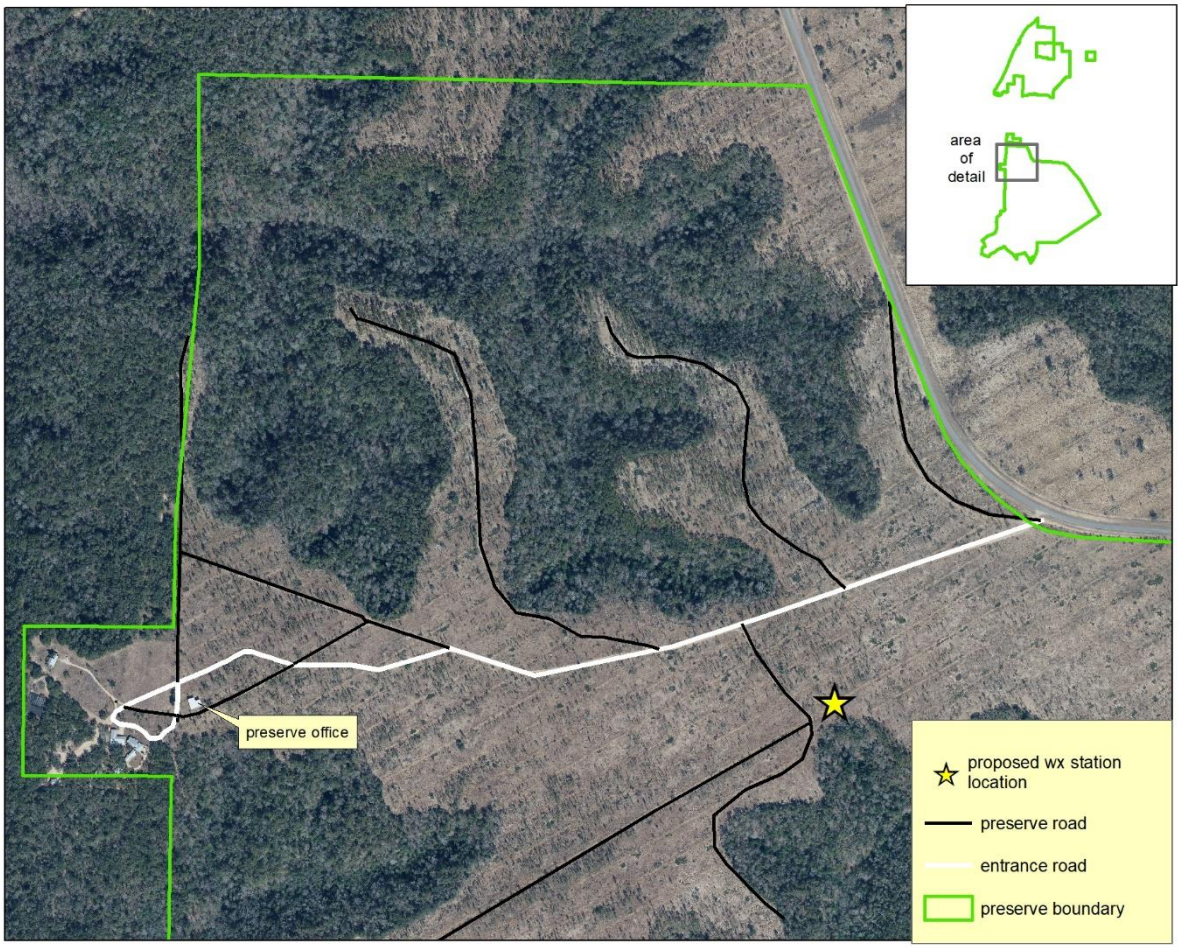


Figure 4. Location of the proposed FAWN weather station at Disney Wilderness Preserve.

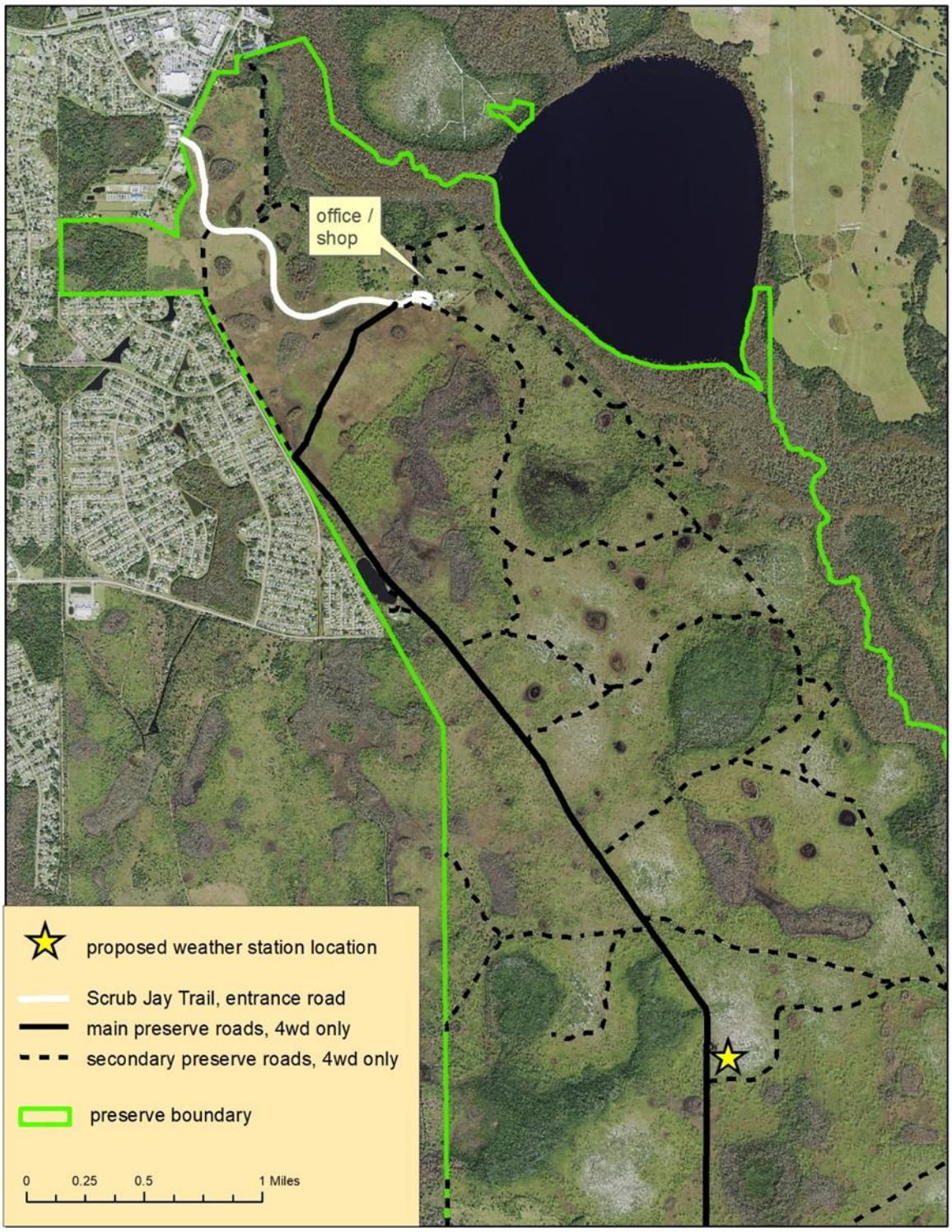
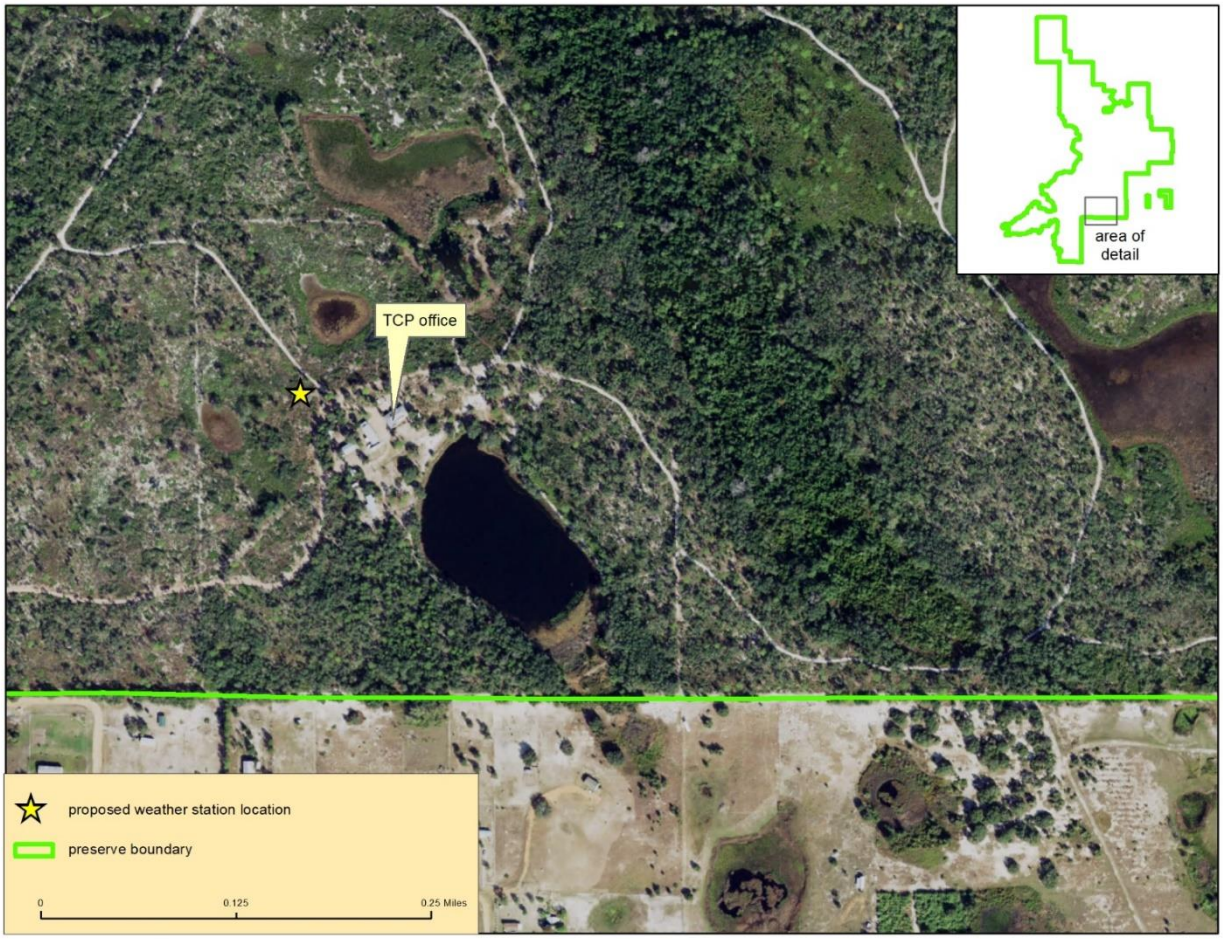


Figure 5. Location of the proposed FAWN weather station at Tiger Creek Preserve.



DISNEY WILDERNESS PRESERVE

Long-term isolated wetland monitoring on the Disney Wilderness Preserve

South Florida Water Management District, West Palm Beach, FL.

Duration: 1995-present

Objectives: To document isolated wetland hydrology and the natural variation in hydroperiods and water levels due to seasonal and climatic changes. These wetland monitoring sites serve as reference sites for comparison with wetlands influenced by groundwater withdrawals from water supply well fields. The Disney Wilderness Preserve (DWP) is one of seven such sites that have been established throughout south Florida.

Methods: The project includes: 1) aerial photography analysis to determine past changes in vegetation communities in the vicinity of the wetland monitoring sites; 2) biological characterization involving field inventories of plants, macroinvertebrates, fish, and amphibians; 3) shallow groundwater monitoring wells that assess each wetland's hydrology; 4) water level recorders within each wetland monitoring well; 5) a complete weather station on the preserve; and 6) weather and water level data collection and compilation.

Six wetlands were selected for study at the preserve in 1995 (Figure 6). Initial sampling began in 1996, including the biological inventories. Installation of shallow groundwater monitoring wells, water level recorders and satellite feed weather station occurred in 1997. Surface water, groundwater and weather data continue to be collected at the Disney Wilderness Preserve (DWP). The weather data include rainfall, humidity, temperature, air pressure and light.

Additional water level monitoring wells were installed at deeper levels in the aquifer to further characterize the groundwater dynamics on a regional scale. These wells were constructed to depths of 10 ft, 36 ft and 90 ft in the surficial aquifer; 122 ft and 184 ft in the Mid Hawthorn; and 450 ft in the upper Floridan aquifer. Aquifer performance tests were conducted to determine interactions between the levels.

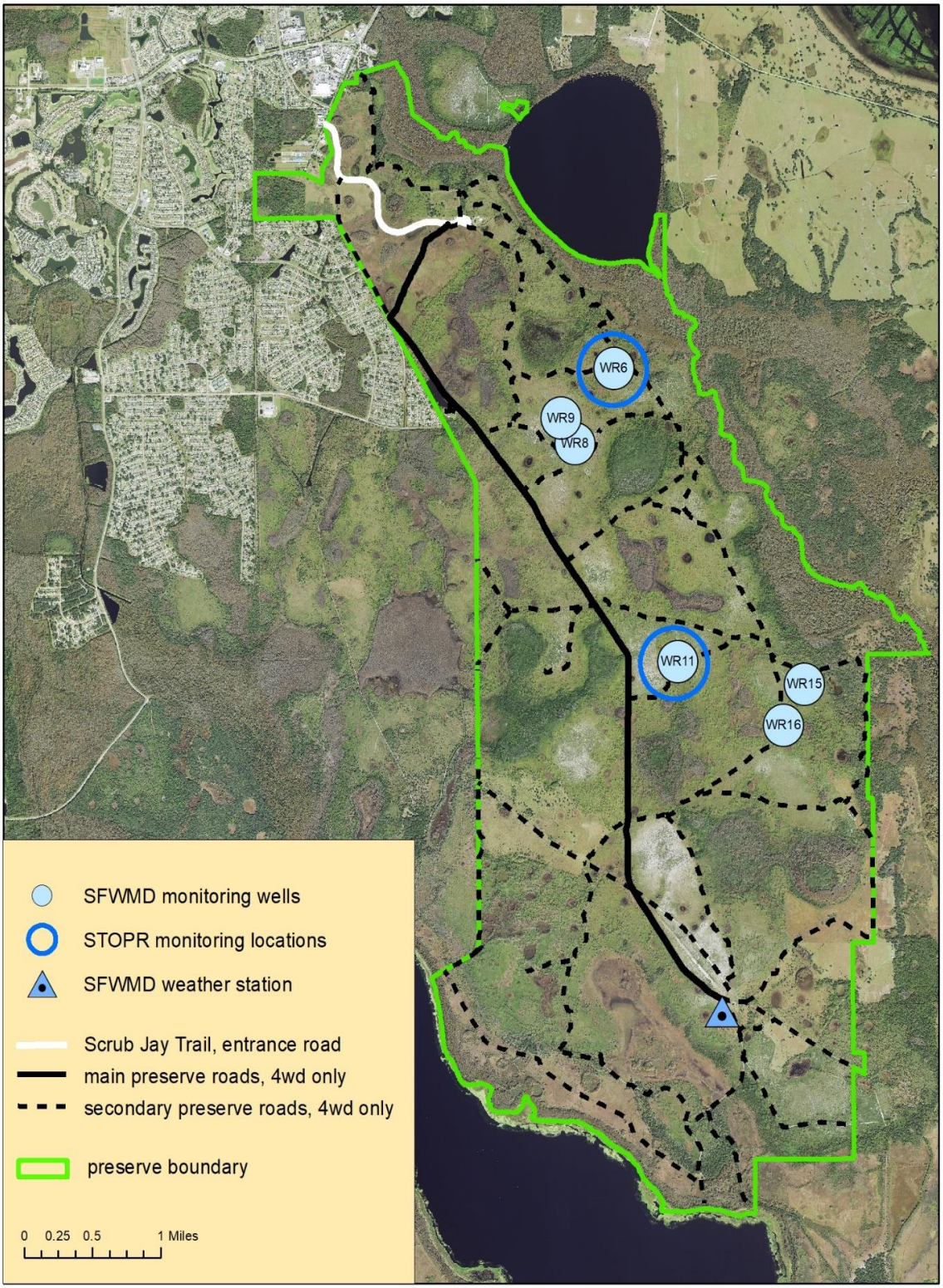
The water level data from these wells and others monitored by the South Florida Water Management District (SFWMD) are being used to develop a groundwater/surface water interaction model. This model will estimate impacts of future groundwater withdrawals occurring in metro-Orlando on the wetlands being monitored on the preserve. Results of the modeling will be incorporated into regional planning for the Kissimmee Valley.

In 2007, the SFWMD issued five different public water supply permits to five utility companies (collectively known as the STOPR Group) in the central Florida region and required the utility companies to construct a total of 39 monitoring wells throughout the Central Florida region. Two of these reference monitoring sites are located on DWP. The SFWMD agreed to allow the

STOPR group to use the existing well facilities within two wetlands (WR 6 and WR 5) that have continued to be monitored by the District under the "Isolated Wetlands Program." Monitoring site WR 6 (a.k.a. Site 21 by the STOPR Group) is an herbaceous wetland located in Osceola County. WR 15 (a.k.a. Site 10 by the STOPR Group) is a cypress dome with a wet prairie fringe located in Polk County. The SFWMD continues to collect the water level data, and the STOPR Group is responsible for one vegetative transect within each wetland. In the event that the SFWMD budget for continued monitoring within these wetlands is not approved in the future, then it will be the STOPR Group's responsibility to collect the water level data from these two sites.

Progress/Results: ONGOING. Well and vegetation monitoring data from the South Florida Water Management District is available by request. Weather data is publicly available at DBHYDRO Browser (sfwmd.gov). The DWP weather station ID is WRWX.

Figure 6. SFWMD and STOPR well and SFWMD weather station locations at Disney Wilderness Preserve.



National Ecological Observatory Network (NEON)

Battelle. NEON Program HQ, Boulder, CO.

Duration: 2012 – present

Objectives: The National Science Foundation's National Ecological Observatory Network (NEON) is a continental-scale observation facility operated by Battelle to collect long-term open access ecological data to better understand how ecosystems are changing throughout the US. The Disney Wilderness Preserve (DWP) is one of NEON's 47 terrestrial field sites across 20 ecoclimatic domains. NEON has an additional 34 aquatic sites throughout the US.

Methods: NEON uses standardized data collection and processing methods at all field sites. As at all NEON terrestrial field sites, data is collected via three different methods: 1) airborne remote sensing, 2) automated instruments, and 3) observational sampling. NEON's data collection methods can be found at https://www.neonscience.org/data-collection.

Airborne remote sensing: Using payload sensors on light aircraft, surveys are conducted annually at each site during peak greenness to provide quantitative information on land cover and changes to ecological structure and chemistry (NeonScience.org). The primary sensors include

1. Discrete and full-waveform LiDAR, which provides three-dimensional structural landscape information.
2. Imaging spectrometer, which allows discrimination of land cover types and vegetation chemical content.
3. High-resolution digital camera for spatially accurate and detailed contextual information (NeonScience.org).

Automated instruments: A micrometeorological tower at all terrestrial sites, including DWP, collects continuous weather and climate data, including fluxes of carbon, water, and energy between the terrestrial ecosystem and the atmosphere (NeonScience.org). The tower location at DWP is shown in Figure 7. Phenocams are mounted at the top and bottom of each tower to capture above- and below-canopy phenology (NeonScience.org). Soil sensors in an array near the tower measure soil chemical and physical properties at various depths and at the soil surface (NeonScience.org).

Observational sampling: Throughout the year, NEON scientists collect field data from permanent plots at DWP (Figure 7) and all other terrestrial sites. Data focuses on sentinel taxa that indicate ecosystem health and provide data relevant to public health (NeonScience.org). The sentinel taxa fall into six groups:

1. Breeding land birds: Bird observations are made to capture interannual variation in avian abundance, diversity, and distribution (NeonScience.org). All bird species observed are recorded using point count methods

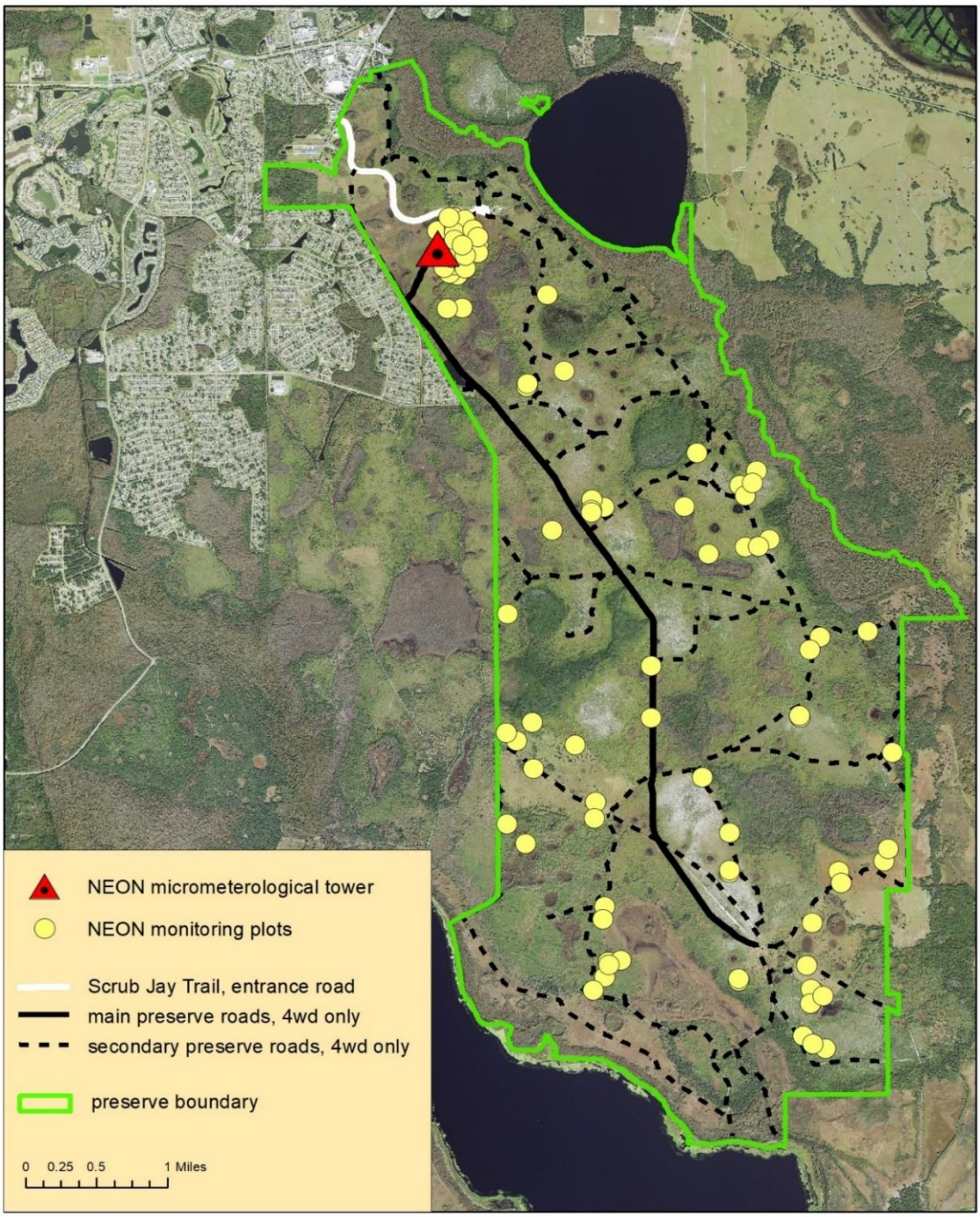
2. Ground beetles: NEON field scientists collect beetles with pitfall traps distributed across the site. Traps are deployed every two weeks during the time of year when beetles are most active. Each beetle is identified to species or morphospecies. A subset of the beetles is DNA barcoded.
3. Terrestrial plants: NEON collects data on plant biomass and productivity, plant diversity, plant phenology, and plant chemical properties within permanent 40 x 40-meter plots distributed across terrestrial field sites. NEON field scientists conduct field sampling annually, but data frequency and schedule vary among the data types, reflecting the requirements of specific data products and protocols (Neonscience.org).
4. Small mammals: NEON defines small mammals as nocturnal, flightless, above-ground foragers, and weighing 5-600 grams. NEON uses Sherman box traps deployed for one-three consecutive nights for at least four times per year. For each captured small mammal, species, sex, age, reproductive status, weight, hind foot length and other species-specific measurements are recorded. Blood is drawn from some individuals for pathogen testing, and the presence and abundance of ticks on each individual is determined. Individuals are tagged, using either ear tags or Passive Integrated Transponder (PIT) tags. All data collection is conducted in the field for quick release of the animals after capture. NEON collects a subset of the trapped animals for use as voucher specimens. All handling and processing have been approved by Battle' Institutional Animal Care and Use Committee (IACUC). After field collection, NEON scientists conduct lab analyses for DNA sequencing and rodent-borne pathogen status.
5. Soil microbes: NEON collects different types of soil data at different frequencies (1-5 years) depending on the data type. For each sampling, three soil cores are taken from 10 permanent plots. Up to three sampling periods may occur within a sampling year during peak greenness and during seasonal transitions. Data collection and analyses produce the following data products: soil temperature, litter depth, moisture, pH, stable isotopes, and inorganic nitrogen pools and transformations; and soil microbe biomass, marker gene sequences, community composition, and metagenome sequences.
6. Ticks: NEON field scientists collect ticks using 1 m^2 drag cloths dragged around the perimeter of each 40x40m vegetation plot. Ticks that cling to the cloth are counted and categorized by species, sex, and life stage (neonscience.org). Testing for pathogens is conducted on a subset of the ticks, and a smaller subset are archived.

Progress/Results: ONGOING. NEON is a 30-year project with data collection at the Disney Wilderness Preserve proposed for the entire project period. All data collected from DWP and other NEON sites is publicly available online at https://data.neonscience.org/data-products.

As of April 2021, at least 25 papers have been published on studies using NEON data from DWP: Brown *et al.* 2021, Clark *et al.* 2021, Delwiche *et al*. 2021, Fiorella *et al.* 2021, Hantak *et al*. 2021, Kang *et al.* 2021, Messer and Raber 2021, Parker 2021, Patel *et al*. 2021, Weinstein *et al.* 2021,

Brown *et al.* 2020, Fisher *et al.* 2020, Ritter 2020, Shu et al. 2020, Wang *et al.* 2020, Weinstein *et al.* 2020a, Weinstein *et al.* 2020b, Ayres 2019, Nave *et al.* 2019, Ritter *et al.* 2019, Sorensen 2019, Weiglen 2019, Gaynor *et al.* 2018, Hoekman *et al*. 2017, Ghabbour *et al.* 2015, and Loescher *et al.* 2014.

Figure 7. NEON tower and monitoring plot locations at Disney Wilderness Preserve.



USGS seismic station at the Disney Wilderness Preserve

US Geological Survey, Albuquerque Seismological Laboratory, Albuquerque, NM.

Duration: 1997-present

Objectives: To maintain a seismic station in central Florida as part of the Global Seismograph Network (GSN). The objectives of the GSN are to provide real-time earthquake information for emergency response personnel, provide engineers with information about building and site response to strong shaking, and provide scientists around the world with high-quality data needed to understand earthquake processes and structure and dynamics of the solid earth.

Methods: The Disney Wilderness Preserve has one of over 100 GSN stations worldwide. The station ID is IU/DWPF and is located at the southern end of the Dorm Pond (Figure 8). Installation was conducted in 1997, and operation began in 1998. USGS installed IRIS Type II seismic sensors over a 162 m borehole. Data is transmitted real-time using satellite telemetry. Station data is available from the Incorporated Research Institutions for Seismology (IRIS) website: https://ds.iris.edu/ds/nodes/dmc/data/#requests.

Progress/Results: ONGOING. At least 14 publications have been produced using data from the DWPF station: Baer 2020, Ringler *et al.* 2020, Sobolev *et al.* 2020, Heyburn *et al*. 2018, Ritzwoller and Feng 2018, Tary *et al.* 2018, Ye *et al*. 2016, Ringler 2015, Groos *et al*. 2012, Ringler *et al.* 2012, Gonzalez *et al.* 2011, Liang 2008, Bensen *et al.* 2007, and Gonzalez *et al.* 2007.

Figure 8. Location of the USGS seismic station at Disney Wilderness

Water quality monitoring on Reedy Creek and Lake Russell at the Disney Wilderness Preserve

Reedy Creek Improvement District (RCID), Lake Buena Vista, FL.

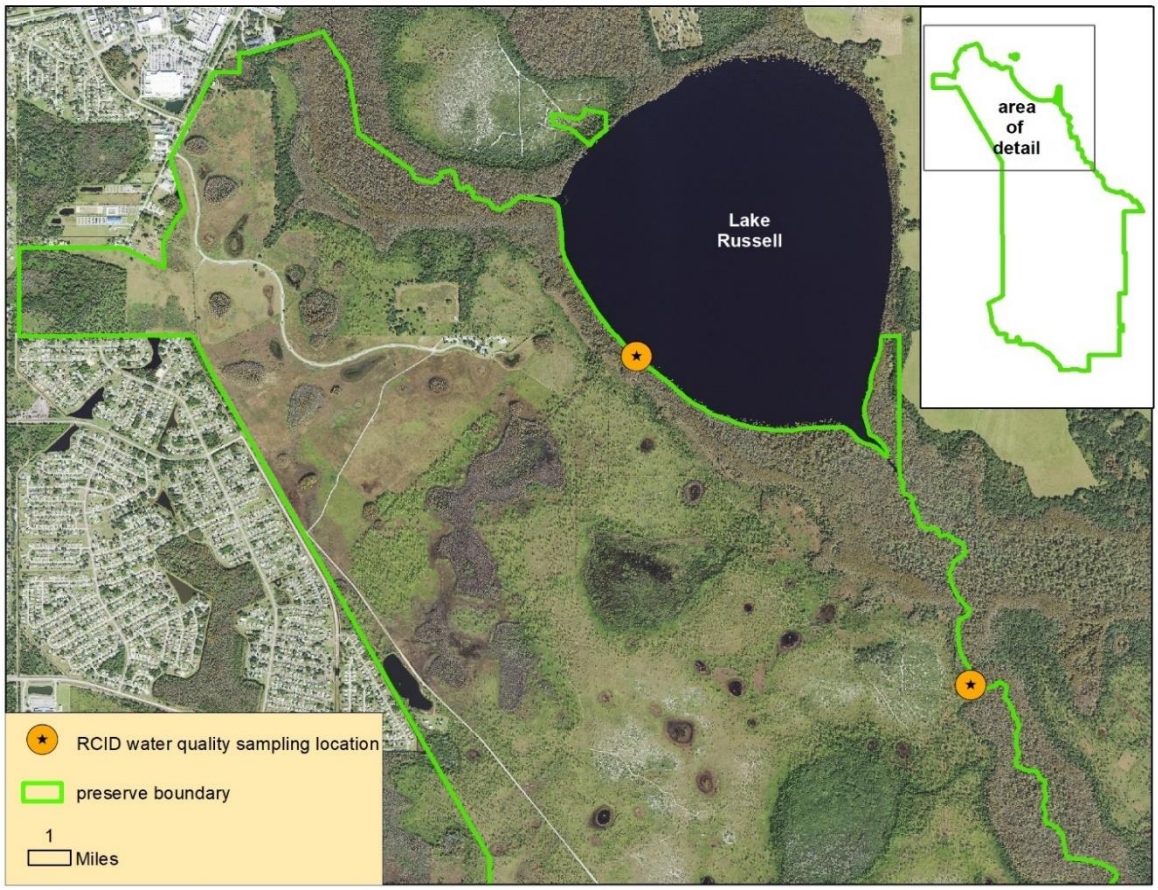
Duration: 1998-present

Objectives: Water quality monitoring for routine ecological health and urban impact assessment. Sampling is part of RCID's program for is watershed analysis, total maximum daily load, National Pollutant Discharge Elimination System, and surface water monitoring.

Methods: RCID Environmental Services performs water quality monitoring on two sampling sites, collected quarterly at the Disney Wilderness Preserve (Figure 9). Analyses include chlorophyll, bacteria, general chemistry, metals, pesticides, volatile organic compounds, semi-volatile organic compounds, and field parameters.

Progress/Results: ONGOING. Data is available from the Reedy Creek Improvement District by request.

Figure 9. Location of RCID water quality monitoring at Disney Wilderness Preserve.



JEFF LEWIS WILDERNESS PRESERVE AND JOHN S. PHIPPS PRESERVE

Shorebird and seabird monitoring

Florida Fish & Wildlife Commission, Tallahasee, FL.

Duration: 2013 - present

Objectives: To determine the distribution, status, and trends of the 20 species of shorebirds and seabirds in Florida through long-term monitoring across the state. This project is part of FWC's Florida Shorebird Alliance, which consists of regional partnerships that work locally to survey and monitor important shorebird and seabird nesting sites.

Methods: FWC conducts monthly site visits in May through August of each year to determine the numbers of breeding pairs, nest locations, and outcomes as well as to determine the locations of brood-rearing habitat. Monitoring is conducted following FWC's Breeding Bird Protocol for Florida's Shorebirds and Seabirds (https://public.myfwc.com/crossdoi/shorebirds/PDF-files/BreedingBirdProtocol.pdf).

Progress/Results: ONGOING. Data is publicly available from FWC's Florida Shore Bird Database at https://public.myfwc.com/crossdoi/shorebirds/.

SADDLE BLANKET SCRUB PRESERVE AND TIGER CREEK PRESERVE

Central Florida Water Initiative (CFWI) long-term wetland monitoring

Southwest Florida Water Management District, Bartow, FL.

Duration: 2021 - present

Objectives: To collect ground water and wetland vegetation data to inform regional water supply planning and regulations. The Central Florida Water Initiative (CFWI) is a collaborative water supply planning effort among the Florida Department of Environmental Protection, the Florida Department of Agriculture and Consumer Services, water management districts, water utilities, and other stakeholders in Orange, Osceola, Polk, Seminole, and Lake Counties. Southwest Florida Water Management District (SFWMD) is the CFWI monitoring lead for Polk County. SFWMD personnel will maintain the recorders at Tiger Creek Preserve and conduct the vegetation and soil monitoring. The project is currently planned for a duration of twenty years or more.

Methods: Tiger Creek and Saddle Blanket Scrub are two of 107 sites to be in established in the CFWI monitoring by 2025. Two surficial aquifer wells with continuous water level and rainfall recorders will be installed at each preserve, all four in uplands and within 50m of a wetland

(Figures 10 and 11). In addition, vegetation and soil data will be collected every five years along transects extending across the wetlands. The soils and vegetation data will be used in conjunction with the surficial aquifer water level and rainfall data to determine trends in wetland boundaries and for calibration and verification of regional water models.

Progress/Results: PLANNED. The planned installations for 2020 were halted due to the COVID pandemic. SWFWMD is planning for installations at both preserves in summer 2021.

Figure 10. Location of CWFI monitoring wells and vegetation transects at Saddle Blanket Scrub Preserve.

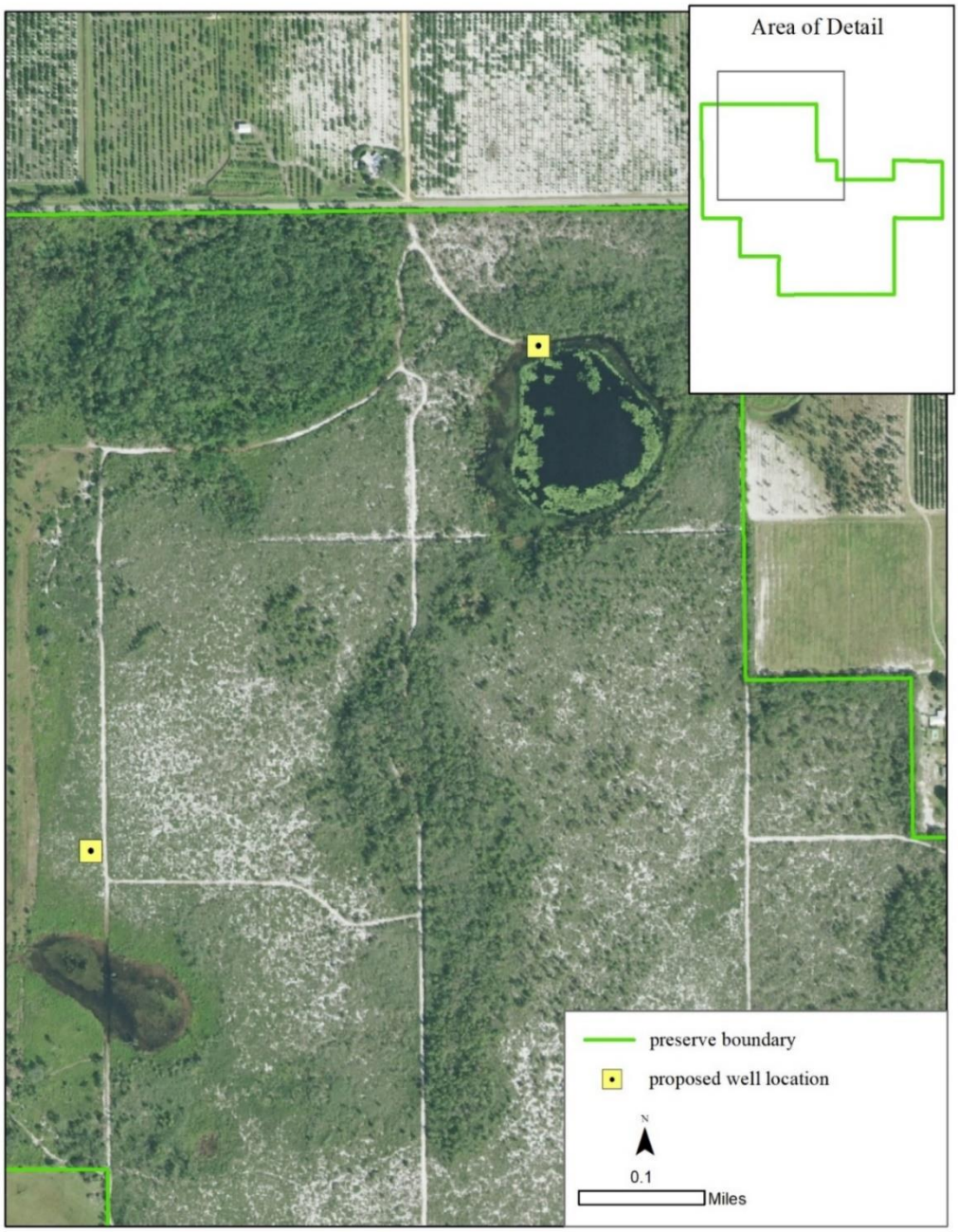
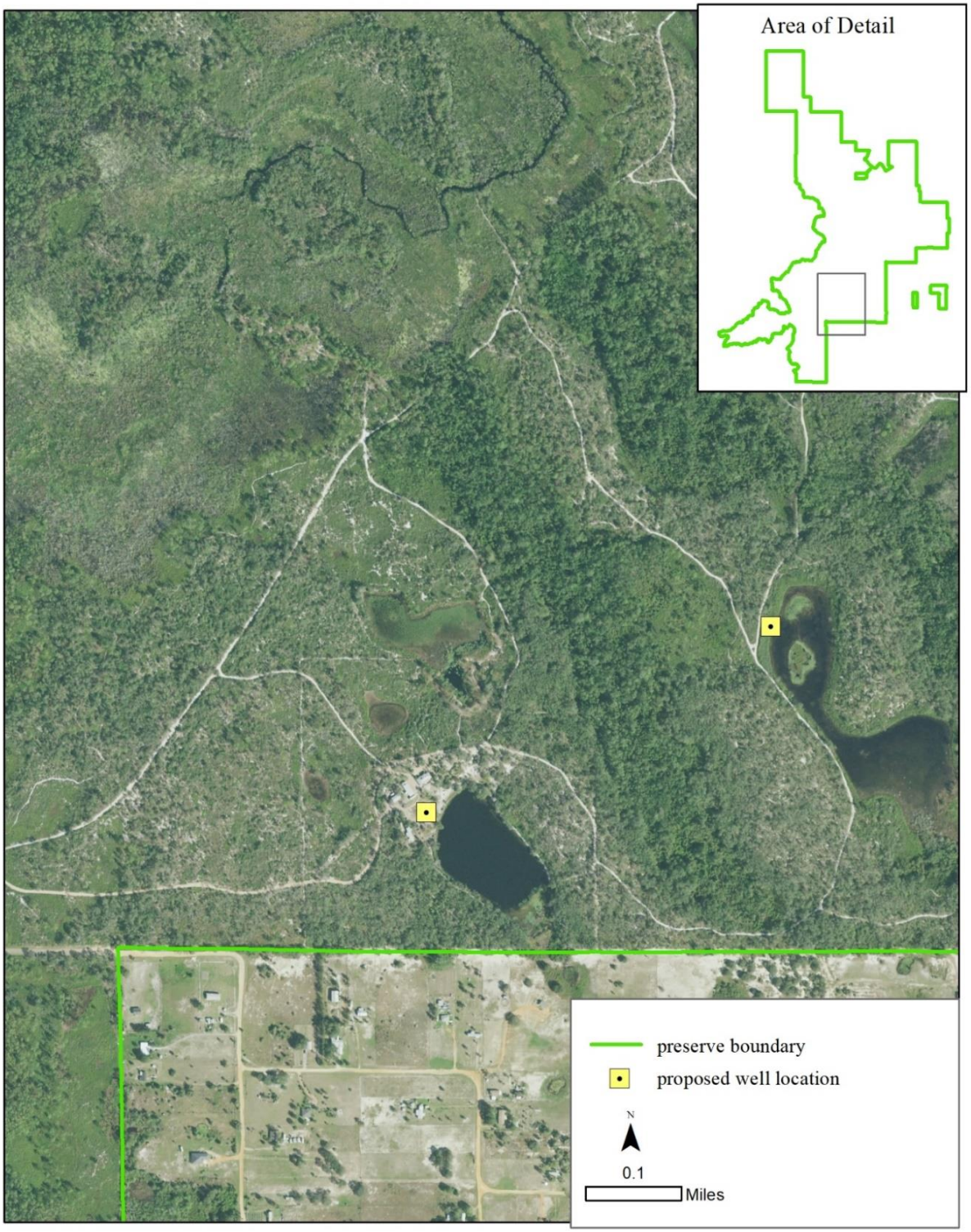


Figure 11. Location of CFWI monitoring wells and vegetation transects at Tiger Creek Preserve.



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