DWP FAWN station

CENTER FOR CONSERVATION INITIATIVES ANNUAL RESEARCH & MONITORING REPORT

2023

A COMPILATION OF RESEARCH AND MONITORING CONDUCTED BY AGENCY, ACADEMIC, AND OTHER INVESTIGATORS IN COORDINATION WITH THE NATURE CONSERVANCY'S CENTER FOR CONSERVATION INITIATIVES IN 2022

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 has established 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

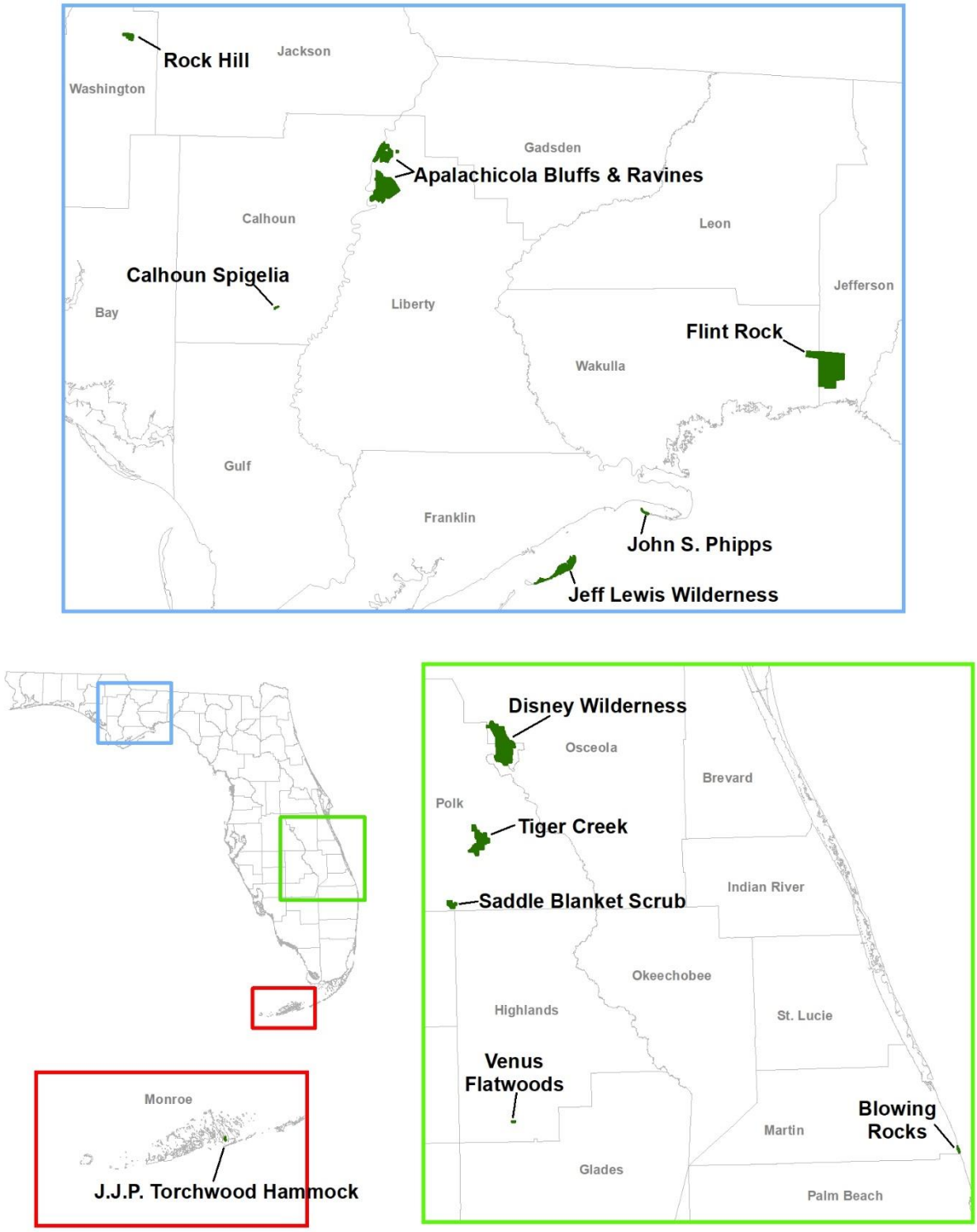
Vision: The Center for Conservation Initiatives' vision is for the conservation of nature to be a fundamental and integral value of our community that is informed and underpinned by science and research.
Mission: The Center for Conservation Initiatives' mission is to advance conservation knowledge and 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, in 2021 we began compiling information and updates on the research and monitoring conducted by our conservation and science partners. The first report documented all active or completed projects on our preserve in 2018-2020. The second annual report documented the research and monitoring initiated, continuing, or completed during January through December 2021. This third annual report documents the projects that were initiated, continuing, or completed during January through December 2022.

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 24 total projects, of which 22 are ongoing and 2 have been completed. The researchers are from 5 universities and colleges; 6 federal, state, and local agencies; and 5 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 and then by project title. Online links to data are provided where available.

The third section contains a list of all 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 483 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 INITIATED, CONTINUING, OR COMPLETED IN 2022

Apalachicola Bluffs and Ravines Preserve

Conservation of *Magnolia ashei*

USDA Agricultural Research Service, Beltsville, MD.

Duration: 2022

Objectives: To include *Magnolia ashei* from Apalachicola Bluffs and Ravines (ABRP) in the Woody Landscape Plant Germplasm Repository (WLPGR) at the US National Arboretum in Washington, DC. The WLPGR is the USDA National Plant Germplasm System repository for the conservation of temperate woody plants. These efforts at ABRP were part of a larger effort to visit other known *M. ashei* populations in Florida to inventory, map, and collect seed for ex situ conservation efforts.

Methods: The researchers planned to collect a small sample of seeds (<200 total) from ABRP. These seeds would then be propagated at the Beltsville USDA Agricultural Research Service and the resulting seedlings maintained as living plants in perpetuity as part of the US National Arboretum living collections.

Progress/Results: COMPLETED. USDA staff visited ABRP on July 30, 2022 to assess *M. ashei* at the preserve. They found traversing the preserve extremely difficult because of downed trees, vines, and thick undergrowth resulting from Hurricane Michael. There was minimal seed set among these individuals, and most of the seeds had been shed prior to the site visit. Therefore, no seeds were collected. The researchers mapped a total of 12 individuals; their GPS locations are listed in Table 1.

From Rounsaville 2023: "These 12 points represent every plant we were able to locate, but the density of undergrowth made some areas impenetrable, so it is possible there are more trees at this site. On a more positive note, we did see stems that were ~1m tall that appeared to be seedlings which have recruited post-Hurricane. Across other *M. ashei* sites in Florida, those damaged by Hurricane Michael or had otherwise experienced disturbance from fire or canopy openings displayed a positive correlation with overall fecundity, growth, and recruitment. Undisturbed forests had little-to-no seed production or seedling recruitment. In summary, light gaps in the canopy appear to be extremely important for this species. Similarly, mature trees that are destroyed by fire or toppled in storms are adept at re-sprouting and growing vigorously. This was the case at the nearby Torreya State Park, where resprouted *M. ashei* were abundant in fully exposed conditions. [At Torrey] stems that suckered from ground level had produced huge quantities of fruit/seeds on 1-2m sprouts. At ABRP there were a few large *M.*

ashei that had been pushed over by fallen hardwoods and those trees have begun to sprout from the base or horizontal sections of the living trunk."

The researchers plan to submit a request to visit the site again in 5-10 years to collect updated demographic data on the *M. ashei* population.

Table 1. Locations of *Magnolia ashei* individuals at Apalachicola Bluffs and Ravines found by USDA staff on July 30, 2022.

Site	Latitude DD	Longitude DD	Altitude (m)
TNC-ABRP	30.54151597	-84.95426937	52.548
TNC-ABRP	30.54132486	-84.95429171	52.987
TNC-ABRP	30.54095633	-84.95464477	53.447
TNC-ABRP	30.54144779	-84.95422779	53.678
TNC-ABRP	30.54092295	-84.95464612	54.148
TNC-ABRP	30.54138893	-84.95422531	55.665
TNC-ABRP	30.54143638	-84.95415019	55.912
TNC-ABRP	30.54139691	-84.95414529	56.976
TNC-ABRP	30.54183449	-84.953945	57.531
TNC-ABRP	30.54172051	-84.95399573	57.906
TNC-ABRP	30.54124701	-84.95414675	58.12
TNC-ABRP	30.54199908	-84.95361217	59.641

Crooked Creek Dam Removal Macroinvertebrate Monitoring

Florida Department of Environmental Protection, Tallahassee, FL.

Duration: 2022-2027

Objectives: Project Objective(s): To monitor changes in macroinvertebrate fauna and water chemistry before and after a dam removal from Crooked Creek in Gadsen County, FL. Comparisons will be made among nearby streams and downstream sites with historical data. In 2012-2013, proposed study sites were sampled as part of a FAMU Master's Thesis that studied effects of the dam removal of Kelley Branch in 2007. Additionally, Crooked Creek at CR270 has been routinely sampled as a reference site since 2014.

The five study areas are (1) Crooked Creek at CR270 (existing Stream Condition Index reference site, approximately 2.5 miles below dam), (2) Crooked Creek just below the dam, (3) Kelley Branch at ABRP, (4) Little Sweetwater Creek at ABRP, and (5) Crooked Creek in a restored stream channel in Gadsden and Liberty Counties, FL. Little Sweetwater Creek will serve as a control stream. Kelley Branch, which had a dam removed in 2007, will be sampled to compare steep head streams after dam removal in the long term.

Methods: FDEP staff will collect and analyze water chemistry and macroinvertebrates at each site over a 5-year period. In addition, field bioassessment methods (Habitat Assessment, Linear Vegetation Survey, and Rapid Periphyton Survey) will be conducted for each sampling event. The resulting data from this project may be used to improve the Stream Condition Index Stressor ID process as well as inform management decisions.

Progress/Results: ONGOING. Data collection began in late 2022/early 2023.

Fighting extinction of *Torreya taxifolia* through collaborative partnerships

Atlanta Botanical Garden, Atlanta, GA.

Duration: 2021-2023

Objectives: To conduct a post-Hurricane Michael survey, collect cuttings for propagation, and conduct a genetic analysis of the *Torreya taxifolia* population at Apalachicola Bluffs and Ravines Preserve (ABRP). The Atlanta Botanical Garden (ABG) has funding to address several Priority #1 Recovery Actions in the US Fish & Wildlife Service's Implementation Progress Report for the endangered *T. taxifolia.* The work at ABRP is part of a larger ABG project that includes the only two other protected *T. taxifolia* sites: Angus Gholson Nature Park and Torreya State Park.

Methods:

Post-Hurricane Michael survey: To assess the biological damage to the Apalachicola Bluffs and Ravines Preserve resulting from Hurricane Michael in 2018, Garden staff and partners will survey and assess the condition of known trees. This updated information will allow ABG to provide federal and state partners a post-Hurricane Michael population assessment to be used in the management of all biological preserves.

Collection of cuttings: ABG will collect cuttings from healthy individuals not currently represented in the ABG Safeguarding Collection. Individuals selected for cutting collection will be rated a 4 or higher (on scale from 1-5), determined by the overall size of the individual, presence of leaf spot, and number and size of Fusarium cankers. A maximum of three cuttings, approximately 6-inches in length each, will be collected from each healthy individual. Cuttings will then be sent to the Safeguarding Nursery in Atlanta, Georgia for propagation. Given the extensive damage from Hurricane Michael, it is imperative to collect cuttings from all remaining trees to secure the invaluable genetic diversity found in the wild population.

Population genetics: ABG scientists will use DNA analysis techniques to assess whether conservation safeguarding efforts are properly representing the diversity within the wild population and identify any locations within the population range with unique genetic diversity. A single DNA sample (~2-inch cutting) will be collected from every individual located within the Apalachicola Bluffs and Ravines Preserve. Tangible outcomes from the genetic assessment will include: 1) determine if there is genetic differentiation among ravines; 2) locate any areas

within the *T. taxifolia* range with unique genetic diversity; 3) test for isolation by distance across ravines; and 4) upload all sequences to the Short Read Archive on the National Center for Biotechnology Information database, ensuring that the data is publicly available.

Progress/Results: ONGOING.
Post-Hurricane Michael survey: In May of 2021, 16 known locations of *Torreya taxifolia* were visited across ABRP to relocate the trees, assess their health, and collect DNA samples for genetic analysis. Of the 16 *Torreya taxifolia* visited at ABRP, 12 were located while the remaining 4 trees were searched for but not found (25%). It is likely these trees are either dead from debris caused by Hurricane Michael, were not found due to being covered by vines or other surrounding vegetation, or they are no longer in an above-ground state. The trees could still be alive via their underground root system. It is possible, future surveys may reveal that the trees have re-sprouted, but thorough efforts in 2021 to relocate these individuals were not successful.

Post-hurricane assessments at ABRP will be scheduled for 2023. Results of post-hurricane survey efforts will be reported to TNC no later than fall/winter 2024 (the final overall project completion date).

Collection of cuttings: No vegetative cuttings were collected during the May surveys because vegetative cuttings of *T. taxifolia* have shown lower rooting success during late spring and early summer months. Cuttings will be collected during the post-hurricane surveys planned for 2023.

Torreya taxifolia population genetics: Individuals targeted for post-hurricane assessments in May 2021 were selected for inclusion in the genetic analysis because ABG did not have genetic representation of these individuals. The 12 *Torreya taxifolia* trees that were located during the search efforts, as well as additional trees from past field work at ABRP, were included in the genetic analysis. To-date, DNA has been extracted from over 200 *T. taxifolia* individuals and the extractions have been sent for processing to an external laboratory. Results will be analyzed by ABG to determine the genetic diversity between and within ravine systems.

Fungi in a warmer world

Jennifer O'Keefe, Morehead State University, Morehead, KY.

Duration: 2021-2022

Objectives: To build better models of past environmental changes and to predict how fungi will respond to changing conditions today. The project aimed to identify and analyze small fungal remains (fungal microfossils) preserved in the sediments from before, during, and after the Middle Miocene Climatic Optimum (MMCO), a gradual warming event that began more than 17 million years ago. Sediments were sampled and studied for palynology, with a focus on

microfungal remains. Samples were collected from 11 localities worldwide, including Alum Bluff at Apalachicola Bluffs and Ravines Preserve (ABRP).

Methods: Sediments were collected at a 40 cm spacing along the 7.9 m thick Fort Preston Sand exposure of Alum Bluff. The researchers conducted the sampling very carefully to minimize damage to the exposure. Minor trenching (20 cm wide x approx. 30 cm deep into the exposure face) was necessary to reach relatively unweathered sedimentary material. The trench was excavated such that removed material was placed temporarily next to the trench and then replaced in the trench, returning it to the original contours. Samples were taken in 2.5-cm diameter, 15-cm long PVC tubes that were pounded into the trench and then removed with the short cores of sediment intact. Once obtained, the sample tubes were wrapped in aluminum foil and stored on ice until returned to the lab at Morehead S.U. The ice minimized growth of modern microorganisms in the sediments.

The samples were minimally processed for palynology. Slides of the resultant residues were examined using light and laser confocal microscopy, and fungal remains were used to characterize mid-Miocene fungal assemblages present at the time of deposition. Results were added to a newly developed global database of mid-Miocene fungal assemblage distributions. Prepared residues and slides were archived at the University of Florida's Florida Museum of Natural History in Gainesville.

Progress/Results: COMPLETED. The researchers collected 20 samples from Alum Bluff in June 2021. Lab work and analyses were completed in 2022. Processed samples were examined for fungal spore/conidia/etc. content. Fungal remains were photo documented and identified. A paper is expected by the end of 2023.

A poster was presented at the 2022 Geological Society of America meeting: Tarton L., Jones S., Caldwell A., Romero I.C., Nuñez Otaño N.B., Fairchild J., Lennex Stone L., Horsfall T., Warny S., Pound M.J., and O'Keefe J.M.K. Fungi in a Warmer World: Middle Miocene Fungal Assemblages from Alum Bluff. Poster 9-52. Joint Meeting of the NC-SE Sections of the Geological Society of America. 7-8 April 2022. The poster provided the following project results:

> "The diversity of spores varies among samples, with half being barren. This suggests that recovery from the stratigraphically-controlled samples will be highly variable. From the samples with material, the mycobiota of Alum Bluff are characterized by diverse amerospores and didymospores, with phragmospores and bulbilspores found throughout. From the museum slides, the appearance of germlings, bulbils, and didymos suggests a humid environment. Preliminary identification data shows the presence of cf. Savoryella, cf. Humicola, and cf. Xylariaceae/Hypoxylaceae. As the project continues, we will complete correlation of fossil fungal spores with their extant relatives to make better paleoecological inferences of past environments and possible future predictions. During summer 2022, the 2021 stratigraphically-controlled samples will be analyzed so

that assemblage changes in Alum Bluff can be correlated with existing paleoecological and paleoclimatological proxies."

Blowing Rocks Preserve

Leatherback sea turtle tagging

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. Awaiting project updates for 2021 and 2022. 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.

Calhoun Spigelia Preserve

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

Florida Natural Areas Inventory, Tallahassee, FL.

Duration: 2020-2025

Objectives: The original 2020 project objective was 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) plan to 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.

Because the population estimates had large confidence intervals, likely resulting from the low percentage (0.3%) of habitat surveyed, the project objective was modified in 2021 to measure change in the density of gentian pinkroot stems over time along with habitat structure and composition.

Methods: In May and June 2020, FNAI conducted population counts within 2.5 m radius plots randomly 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.

In 2021, FNAI established three permanent monitoring plots at Rock Hill and one at Callhoun Spigelia (Figure 2). The plots are 20-m radius circular plots (Figure 3) placed within known current or historic populations of gentian pinkroot. The center point of each plot was permanently marked and mapped with a submeter GPS unit. The plots were censused and habitat metrics for canopy (cover, height, DBH of trees rooted in the plot) and overall shrub structure (cover and height) were recorded at the 20-m plot level. Three smaller subplots (2.5m radius) within the 20-m plot were established, where additional shrub and herbaceous cover and structure data were recorded. The three subplots were placed 10 m from the center of the plot at 0, 120, and 240° (Figure 3). All shrub and herbaceous species within these subplots were identified; if it was not possible to identify a plant to species, FNAI recorded genus or family. Photos were taken at each plot.

Establishing permanent larger plots allowed for better density estimations within the known habitat and as well as change assessments in both gentian pinkroot density and habitat characteristics. These larger plots incorporated the edge of the known gentian pinkroot populations and would therefore provide better insights into expansion and contraction of population distribution through time (FNAI 2021b).

Progress/Results: ONGOING. In 2020, 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 0.64 stems/plot with a 95% CI of -0.58-1.85 and a population estimate of 1536 (± 2926).

In 2021, within the permanent plots, FNAI found a mean of 264 plants (SD=160.730) within the 3 plots at Rock Hill and at total of 5 plants within the one plot at Calhoun Spigelia.

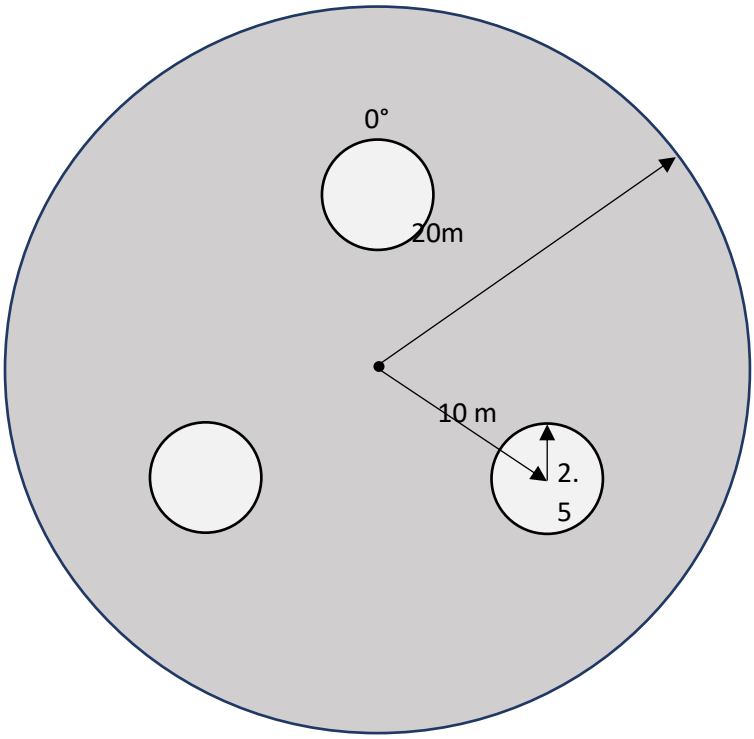
Across the four study sites, plots that received a prescribed burn in the months immediately preceding this survey had on average a higher number of gentian pinkroot individuals per plot than those that did not receive a spring prescribed fire (FNAI 2021b). While several habitat metrics that were collected such as canopy cover and herbaceous cover varied by site, their

overlapping confidence intervals indicated no significant patterns, especially in terms of explaining the variability of gentian pinkroot abundance (FNAI 2021b). Following their initial monitoring period in 2021, FNAI plans to monitor the plots again in 2023 and 2025. While the conclusions that can be drawn from this initial monitoring event are limited, over time and subsequent prescribed fire applications, meaningful conclusions about annual abundance fluctuation and habitat conditions, especially as they respond to prescribed fire, will be examined (FNAI 2021b).

Reports were submitted to the US Forest Service (FNAI 2021b) and to the Florida Forest Service (FNAI 2021d).

Figure 2. Map of gentian pinkroot plots at Calhoun (From FNAI 2021b).

Figure 3. 20-meter radius plot for gentian pinkroot, with 3 – 2.5meter subplots located at 0°, 120°, and 240° at Calhoun Spigelia (From FNAI 2021b).



Disney Wilderness Preserve

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 – 2028

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. Beginning in 2019, seed traps have been collected annually along with crop counts of longleaf found within the NEON plots.

In 2019 at DWP, 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.

Seed and cone data from the three study sites are 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).

Eight papers have been published using data from this project: Bogdziewicz et al. 2023, Parsons et al. 2023, Journe et al. 2022, Qiu et al. 2022, Sharma et al. 2022, Clark et al. 2021, Qui et al 2021a, and Qui et al.2021b.

Development of Surface Biology Ground remote sensing applications

Dr. Kevin Robertson. Fire Ecology Program, Tall Timbers, Tallahassee, FL.

Duration: 2022-2023

Objectives: To integrate ground-based and remotely sensed data to develop algorithms for identifying fire-frequented plant communities and their biodiversity in the southeastern US using hyperspectral imagery from the National Ecological Observatory Network (NEON). This will contribute to development of methods for improving remote monitoring of biodiversity in support of the anticipated NASA Surface Ground Biology (SBG) mission scheduled for 2026. The SBG will combine image spectroscopy and thermal infrared imagery to identify linkages between observable parameters and biodiversity (Robertson 2022). This study will be conducted at the three southeastern NEON sites: Disney Wilderness Preserve (DWP), Jones Ecological Research Center, and Ordway-Swisher Biological Station.

Methods: Researchers used NEON's airborne hyperspectral imagery collected for the Disney Wilderness Preserve (DWP) in 2021. At multiple locations within a 3 km x 3 km area on the DWP serving as the focal area for remote sensing analyses, they identified all vascular plant species and estimated their cover within temporary 10 m x 10 m (100 m^2) vegetation plots. On the day

of visit, plots were laid out using a measuring tape and wire flags, plant species were identified, their cover estimated, and flags removed the same day.

Progress/Results: FIELDWORK COMPLETED. Data collection was conducted at DWP in early 2022. Using species composition and cover data collected by Tall Timbers at the three study sites along with NEON vegetation plot data, the researchers tested the capacity of the BioDivMapR algorithm to map plant beta diversity from NEON's hyperspectral imagery. Beta diversity is the ratio between local and regional species diversity. BioDivMaPR is an R package for producing biodiversity indicator maps from optical imaging data. From Robertson et al. 2023: "[The researchers] sought to assess the effects of image pixel resolution, size of mapping windows composed of pixels, and number of spectral species assigned to pixels in [BioDivMapR]. BioDivMapR classifies pixels as spectral species, then calculates beta diversity as dissimilarity of spectral species among mapping windows each composed of multiple pixels. [They] used NEON airborne 1 m resolution hyperspectral images collected at three sites representing native longleaf pine ecosystems in the southeastern U.S. and aggregated pixels to sizes ranging from 1-90 m for comparative analyses. Plant community composition was groundtruthed [using NEON vegetation plot data and data collected by Tall Timbers at each site]. Results show that the capacity to detect plant beta diversity decreases with fewer pixels per mapping window, such that pixel resolution limits the size of mapping windows effective for representing beta diversity. Mapping window size in turn limits the spatial resolution of beta diversity maps composed of mapping windows. Assigning too few pixels per window, as well as assigning too many spectral species per image, results in overestimation of dissimilarity among locations that have plant species in common. This overestimation undermines the capacity to contrast mapping window dissimilarity within versus among community types and reduces the information content of beta diversity maps. These results demonstrate the advantage of maximizing spatial resolution of hyperspectral imaging instruments on the anticipated NASA SBG satellite mission and similar remote sensing projects."

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 – 2023

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.

Non-intrusive geophysical investigation of sinkholes

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

Duration: 2020-2022

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. 2020).

Methods: In 2020, 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 100 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 SFWMD borehole at DWP (Comas et al. 2020).

In 2022, the researchers revisited the depression marshes to deploy longer profiles for imaging the karstification features in the Floridan Aquifer. The methods were the same as in 2020.

Progress/Results: FIELDWORK COMPLETED. The researchers presented a poster on the results from the 2020 site visit: Comas X., Gutiérrez F., Zarroca M., Roqué C. et al. 2021. Investigating sinkholes related to a deep-seated interstratal karst in the Disney Wilderness Preserve (Florida) using an array of near-surface geophysical methods. AGU Fall Meeting, 1-17 December 2020. The poster provided the following project results:

> "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).
>
> 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
>
> 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); 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)."

Analysis of images obtained in 2022 is in progress.

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: FIELDWORK COMPLETED. Mr. Biazzo has 3,000 data points from his mark-recapture study on treefrogs in pine flatwoods, 99% of which are pinewoods treefrogs *Dryophytes femoralis*. He has concluded from these data that pinewoods treefrogs climb up larger trees to escape the direct and indirect effects of fires, and reenter the shrub layers in the following weeks as shrubs regreen. This work also suggests that this species shows high site fidelity, with individuals often returning to the same tree for several consecutive months. Local survival for populations in this study are between 70-85% (Biazzo 2022). He expects completion

of his dissertation in 2023. A paper was published in Fire Ecology in 2022 (Biazzo and Quintana-Ascencio 2022).

Presentations: International Fire Ecology and Management Congress, Dec 2021 (virtual); Southeast Partners in Amphibian and Reptile Conservation (SEPARC), Feb 2022 (virtual); and Student Scholar Symposium, University of Central Florida, April 2022

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 had 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 were captured, fitted with a USFWS band and GSM cellular transmitter, and then released at the capture site. The transmitters collected up to 47 GPS locations during a 24-hour period with previous days' data available on demand. Mr. Dellinger used 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 were calculated with the Kaplan-Meier estimator. Productivity data (e.g., laying date, hatching, brood size, fledging) were collected by examining daily movements of transmitter-marked birds and through occasional site visits during the breeding season.

Progress/Results: ONGOING. FWC radio-tagged 19 cranes in conservation areas, including one at the Disney Wilderness Preserve (DWP). They also color-banded 80 cranes and attached transmitters to 23 adults and 23 juveniles in suburban areas. One juvenile radio-tagged in Poinciana in November 2020 was the chick of the radio-tagged DWP adult.

At 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. The transmitter was deployed 370 days before detaching sometime after 17 December 2020. 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 and forayed to the conservation easement and private

ranchlands between DWP and Lake Tohopekaliga (Figure 4.). 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. The crane has not been observed since September 2021.

The radio-tagged chick of the DWP adult dispersed from the natal area and has been exploring the pastureland around Lake Tohopekaliga and areas to the west and south of the natal area (Figure 5).

FWC continues to collect survival, productivity, and movement data from the radio-tagged and banded cranes, and is currently analyzing survival, productivity, movement, and habitat use data. A final report is due to the granting agency in 2023. Research will continue beyond this date through other funding as many transmitters remain operational.

Figure 4. Movements from December 2019–December 2020 of an adult Florida sandhill crane radio-tagged on Disney Wilderness Preserve, Florida. Map courtesy of Tim Dellinger, FWC.

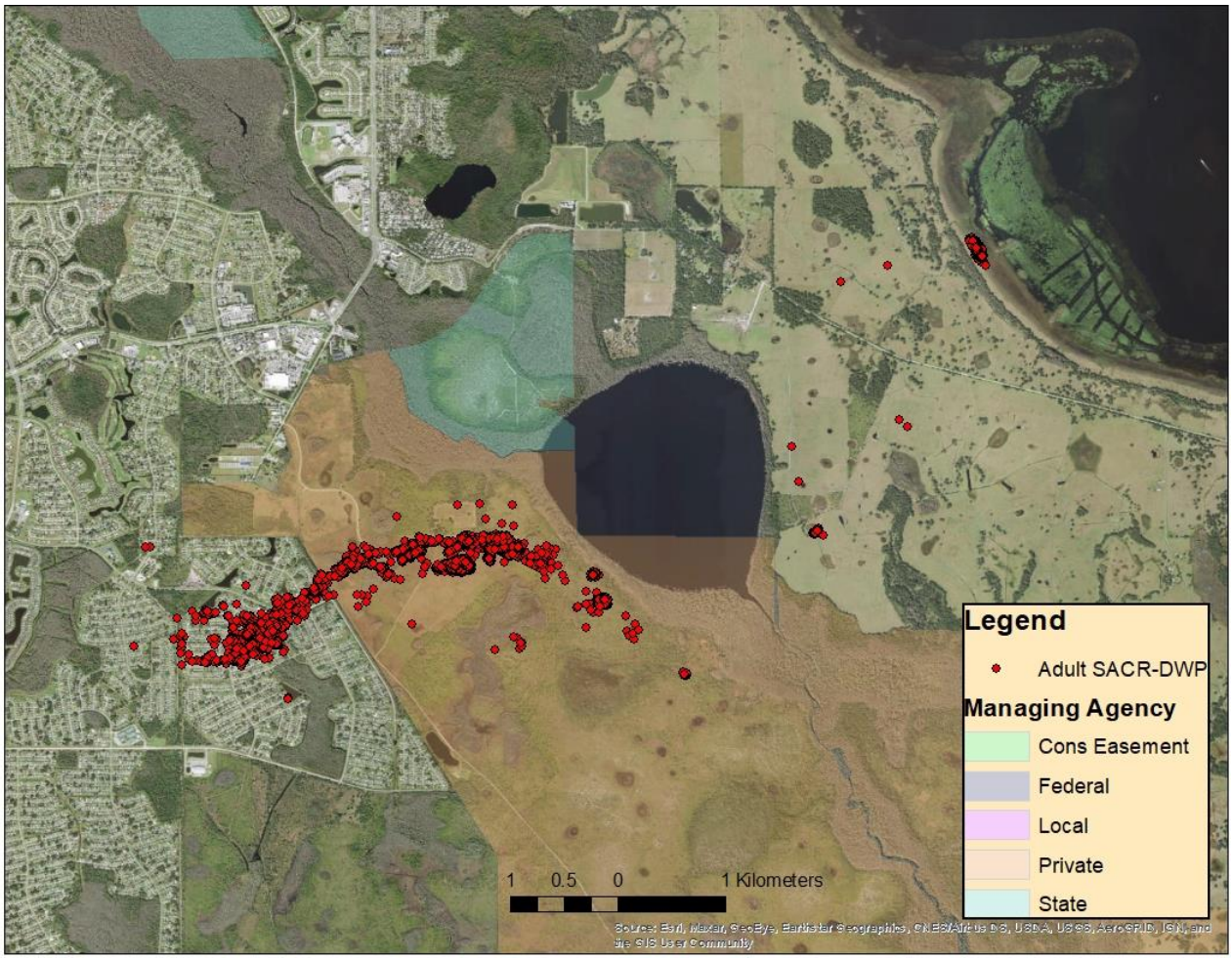
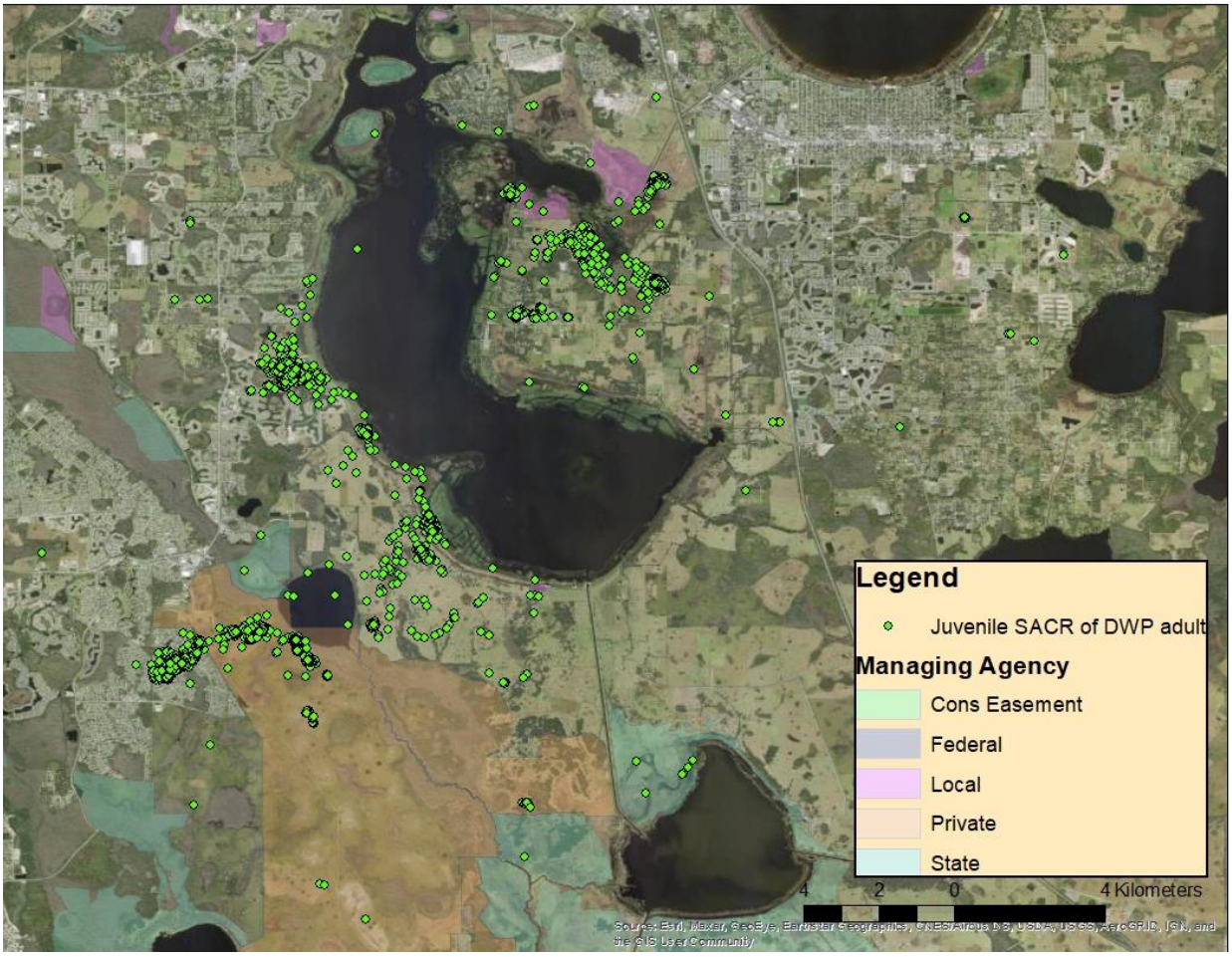


Figure 5. Movements from 2020-2021 of a juvenile Florida sandhill crane that hatched from a nest on Disney Wilderness Preserved but was captured and radio-tagged while with its parents in a Poinciana, Florida suburban area in November 2020. Map courtesy of Tim Dellinger, FWC.



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 was completed in 2022. Mr. Atkinson expects to complete his dissertation in the spring of 2023.

Rock Hill 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: 2020-2025

Objectives: The original 2020 project objective was 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) plan to 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.

Because the population estimates had large confidence intervals, likely resulting from the low percentage (0.3%) of habitat surveyed, the project objective was modified in 2021 to measure change in the density of gentian pinkroot stems over time along with habitat structure and composition.

Methods: In May and June 2020, FNAI conducted population counts within 2.5 m radius plots randomly 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.

In 2021, FNAI established three permanent monitoring plots at Rock Hill (Figure 6) and one at Callhoun Spigelia. The plots are 20-m radius circular plots (Figure 7) placed within known current or historic populations of gentian pinkroot. The center point of each plot was permanently marked and mapped with a submeter GPS unit. The plots were censused and habitat metrics for canopy (cover, height, DBH of trees rooted in the plot) and overall shrub structure (cover and height) were recorded at the 20-m plot level. Three smaller subplots (2.5m radius) within the 20-m plot were established, where additional shrub and herbaceous cover and structure data were recorded. The three subplots were placed 10 m from the center of the plot at 0, 120, and 240° (Figure 7). All shrub and herbaceous species within these subplots were identified; if it was not possible to identify a plant to species, FNAI recorded genus or family. Photos were taken at each plot.

Establishing permanent larger plots allowed for better density estimations within the known habitat and as well as change assessments in both gentian pinkroot density and habitat characteristics. These larger plots incorporated the edge of the known gentian pinkroot

populations and would therefore provide better insights into expansion and contraction of population distribution through time (FNAI 2021b).

Progress/Results: ONGOING. In 2020, 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 0.64 stems/plot with a 95% CI of -0.58-1.85 and a population estimate of 1536 (± 2926).

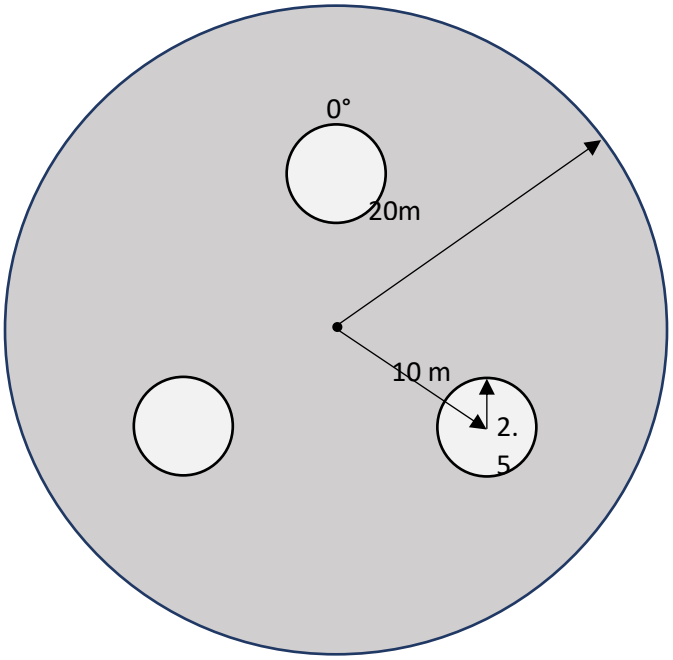
In 2021, within the permanent plots, FNAI found a mean of 264 plants (SD=160.730) within the 3 plots at Rock Hill and at total of 5 plants within the one plot at Calhoun Spigelia.

Across the four study sites, plots that received a prescribed burn in the months immediately preceding this survey had on average a higher number of gentian pinkroot individuals per plot than those that did not receive a spring prescribed fire (FNAI 2021b). While several habitat metrics that were collected such as canopy cover and herbaceous cover varied by site, their overlapping confidence intervals indicated no significant patterns, especially in terms of explaining the variability of gentian pinkroot abundance (FNAI 2021b). Following their initial monitoring period in 2021, FNAI plans to monitor the plots again in 2023 and 2025. While the conclusions that can be drawn from this initial monitoring event are limited, over time and subsequent prescribed fire applications, meaningful conclusions about annual abundance fluctuation and habitat conditions, especially as they respond to prescribed fire, will be examined (FNAI 2021b).

Reports were submitted to the US Forest Service (FNAI 2021b) and to the Florida Forest Service (FNAI 2021d).

Figure 6. Map of gentian pinkroot plots at Rock Hill (From FNAI 2021b)

Figure 7. 20-meter radius plot for pinkroot gentian, with 3 – 2.5meter subplots located at 0°, 120°, and 240° (From FNAI 2021b).



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: 2021-2022.

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, *Conradina brevifolia*, in Florida. Survey areas include Saddle Blanket Scrub Preserve.
2. Determination of the current status and distribution of the giant scrub plasterer bee. Survey areas include Tiger Creek Preserve.
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: ONGOING. *Osmia calaminthae* surveys at Saddle Blanket – the presence of the bee on the preserve has been confirmed. The researcher observed the bee on *Conradina brevifolia* blooms during one site visit in 2022. No bees were collected. *Caupolicana floridana* surveys at Tiger Creek – no surveys took place during the 2021 or 2022 field seasons. Surveys at both preserves are planned for 2023.

Tiger Creek 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: 2021-2023

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, *Conradina brevifolia*, in Florida. Survey areas include Saddle Blanket Scrub Preserve.
2. Determination of the current status and distribution of the giant scrub plasterer bee. Survey areas include Tiger Creek Preserve.
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: ONGOING. *Osmia calaminthae* surveys at Saddle Blanket – the presence of the bee on the preserve has been confirmed. The researcher observed the bee on *Conradina brevifolia* blooms during one site visit in 2022. No bees were collected. *Caupolicana floridana* surveys at Tiger Creek – no surveys took place during the 2021 or 2022 field seasons. Surveys at both preserves are planned for 2023.

Venus Flatwoods

Assessment of molecular genetic diversity and population differentiation in longleaf pine

Kelly Peterson. PhD Student, Odum School of Ecology, University of Georgia, Athens, GA.

Duration: 2022

Objectives: This study will characterize molecular genetic diversity and population differentiation in the longleaf pine species to inform restoration and conservation efforts, including seed transfer zones (STZs).

Methods: The researcher collected leaf tissue from 20-30 old-growth longleaf pines from each of approximately 30 locations across the species range. Collections were from individuals >100 years old to decrease the chances of capturing admixture between native and more-recently translocated individuals. The samples were transported on ice and then placed in ultra-cold storage at the University of Georgia.

The researcher is using restriction-site associated DNA sequencing to fragment the longleaf pine genome and identify loci containing single nucleotide polymorphisms. Then she processes the resulting genetic data using the STACKS bioinformatic pipeline to quantify genetic divergence between populations and overall levels of genetic diversity within the species and within the populations. She also uses the spatially-explicit Bayesian statistical model conStruct to assess genetic structure across the species range, look for associations between genetic and environmental variation, and qualitatively compare results to proposed STZs for the southeastern US.

Progress/Results: FIELDWORK COMPLETED. Data collection from Venus Flatwoods was completed in January 2022. Needles were collected from 21 trees on the preserve. Field collection for the range wide population genetic study will be completed in early 2023. Lab analyses are in progress.

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 (ABRP), Blowing Rocks Preserve (BRP), Disney Wilderness Preserve (DWP), and Tiger Creek Preserve (TCP). 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: ONGOING. Installations of the towers and sensors at Apalachicola Bluffs and Ravines, Disney Wilderness, and Tiger Creek Preserves were completed in 2022. The standard suite of FAWN data is available at FAWN - Florida Automated Weather Network (ufl.edu). Additional data only collected on the Conservancy's preserves (e.g., KBDI and fuel moisture) is available at https://fawn.ifas.ufl.edu/soil_moisture_dat/. The preserve weather stations have been designated as the Bristol (ABRP), Poinciana (DWP), and Tiger Creek (TCP) FAWN stations. The station locations at each of the three preserves are shown in Figures 8-10. IFAS plans to install a station at BRP in 2023 (Figure 11).

Figure 8. Location of the FAWN weather station at Apalachicola Bluffs and Ravines Preserve.

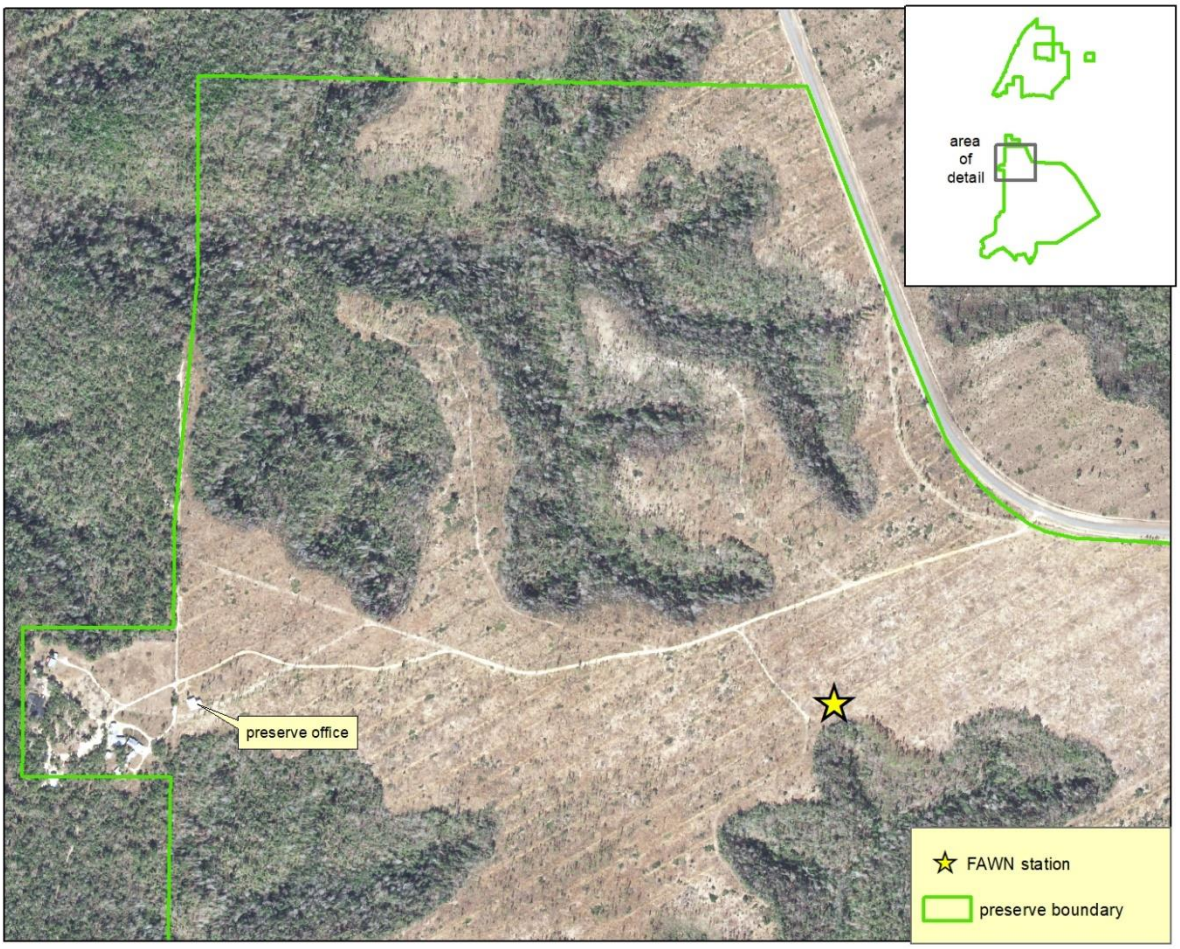


Figure 9. Location of the FAWN weather station at Disney Wilderness Preserve.

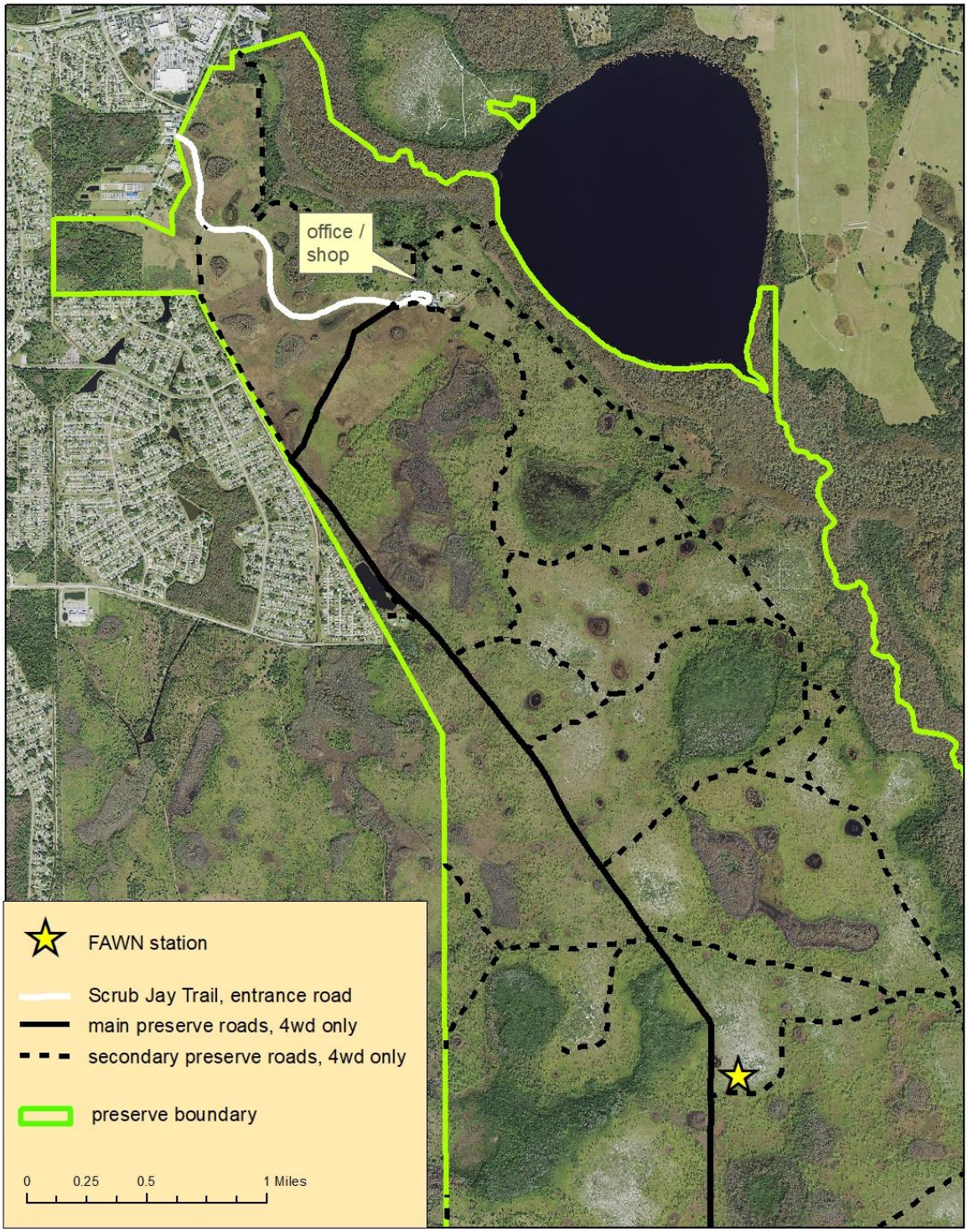


Figure 10. Location of the FAWN weather station at Tiger Creek Preserve.

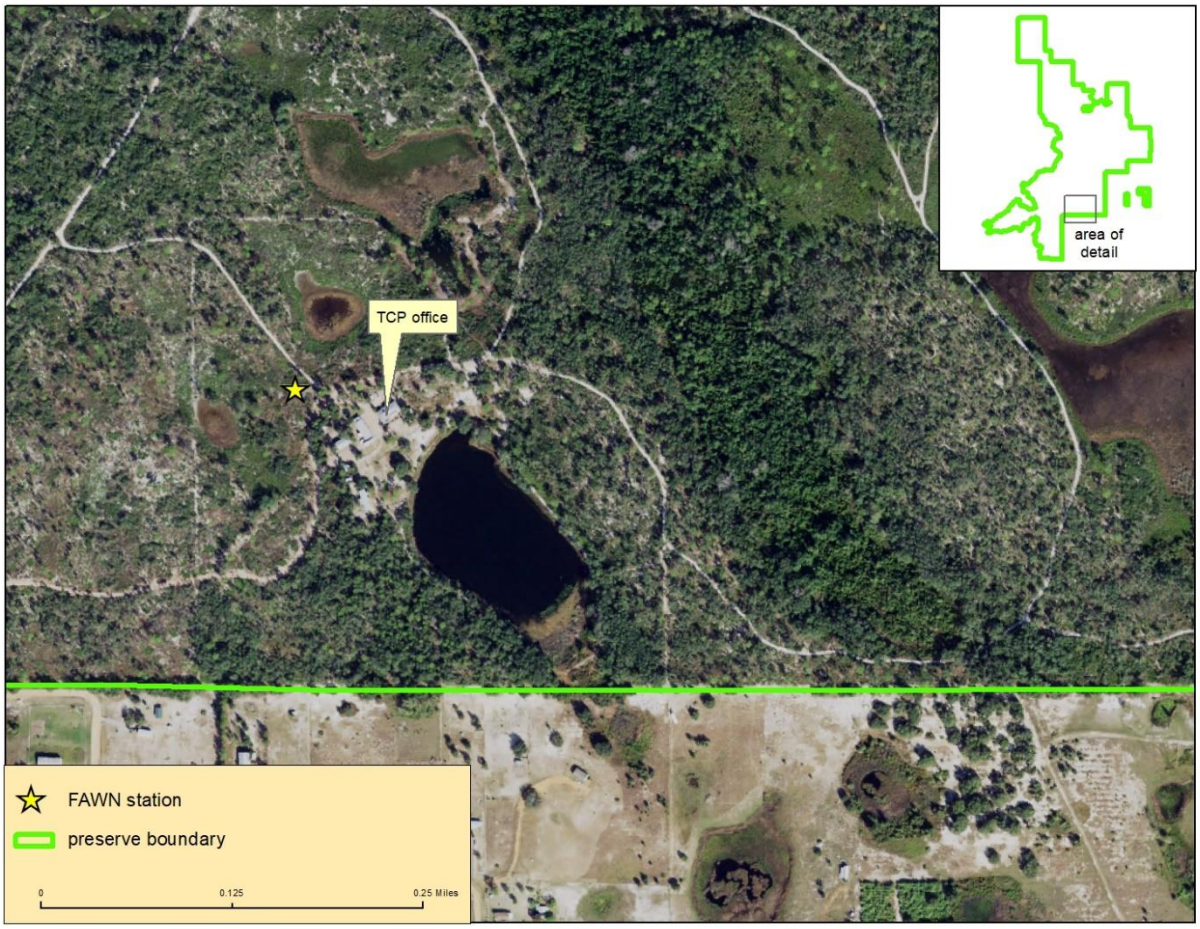


Figure 11. Proposed location of the FAWN weather station at Blowing Rocks Preserve.

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 12). 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.

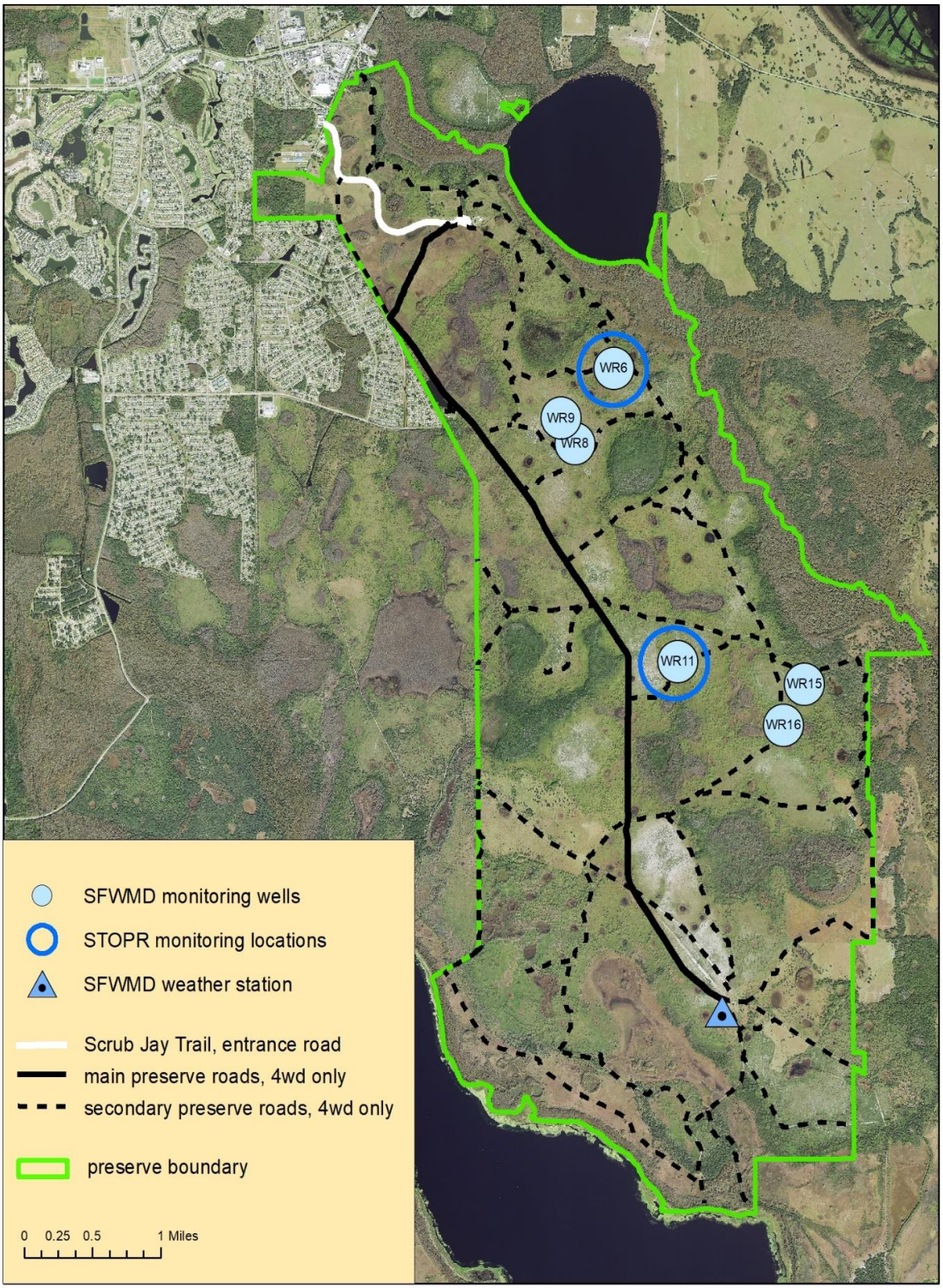
The water level data from these wells and others monitored by the South Florida Water Management District (SFWMD) are being used to develop a groundwater/surface water interaction model. This model will estimate impacts of future groundwater withdrawals occurring in metro-Orlando on the wetlands being 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 12. 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 the DWP is shown in Figure 13. 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 13) 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:

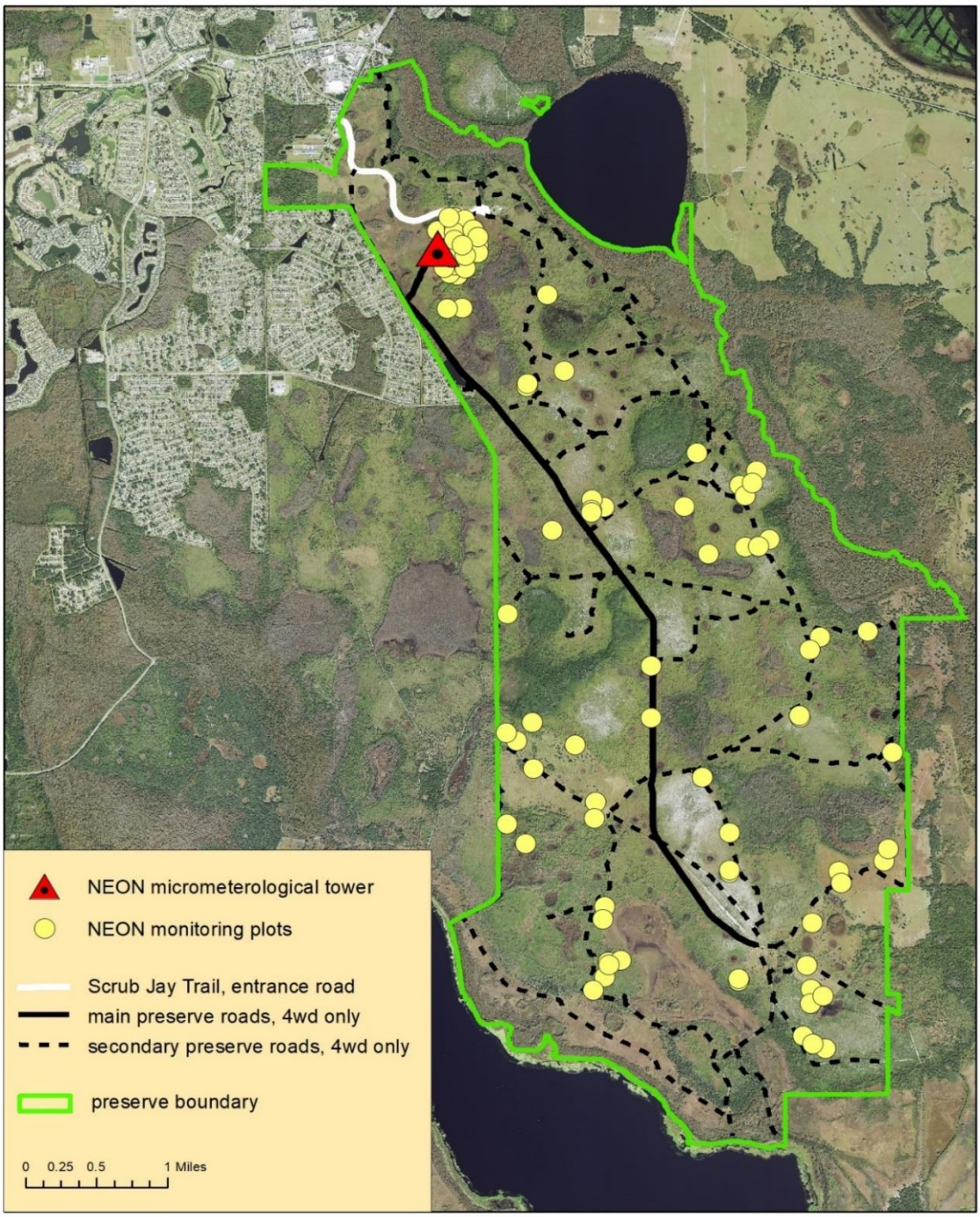
1. Breeding land birds: Bird observations are made to capture interannual variation in avian abundance, diversity, and distribution (NeonScience.org). All bird species observed are recorded using point count methods

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 March 2023, at least 78 papers have been published on studies using NEON data from DWP: Bogdziewicz et al. 2023, Chuckran et al. 2023, Ibanez et al. 2023, Lin et al. 2023, Parsons et al. 2023, Qui et al. 2023., Sanchez-Zapero et al. 2023a., Sanchez-Zapero et al. 2023b, Santos and Herndon 2023, Wang et al. 2023a, Wang et al. 2023b, Xu et al. 2023, Atkins et al. 2022a, Atkins et al. 2022b, Biazzo and Quintana-Ascencio 2022a, Biazzo and Quintana-Ascencio 2022b, Doby et al. 2022, Donnelly et al. 2022, Gallo 2022, Gobron et al. 2022, Jones 2022, Journe et al. 2022, Li et al. 2022, Marconi et al. 2022, Moon et al. 2022, Paull et al. 2022, Musinsky et al. 2022, Possinger et al. 2022, Qiu et al. 2022, Rishmawi et al. 2022, Robertson 2022, Sharma et al. 2022, Schweiger and Laliberte 2022, Tang et al. 2022, Ten Caten et al. 2022, Waterman et al. 2022, Ye et al. 2022, Yu et al. 2022, Yuan et al. 2022, Zhang et al. 2022, Ayres et al. 2021, Brown et al. 2021, Clark et al. 2021, Dynarski et al. 2021, Delwiche et al. 2021, Fiorella et al. 2021, Hantak et al. 2021, Kang et al. 2021, Liu et al. 2021, Messer and Raber 2021, Parker 2021, Parra 2021, Patel et al. 2021, Pinto and Cavender-Bares 2021, Qui et al. 2021a, Qui et al. 2021b., Stachewicz et al. 2021, Weinstein et al. 2021, Yu et al. 2021, Zhang et al. 2021, Brown et al. 2020, Egli 2020, Farella 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, Weiglein 2019, Gaynor et al. 2018, Kramer and Chadwick 2018, Hoekman et al. 2017, Ghabbour et al. 2015, and Loescher et al. 2014.

Figure 13. 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 14). 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 15 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, Gonzalez et al. 2007, and Fnais 2004.

Figure 14. Location of the USGS seismic station at Disney Wilderness Preserve.

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

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

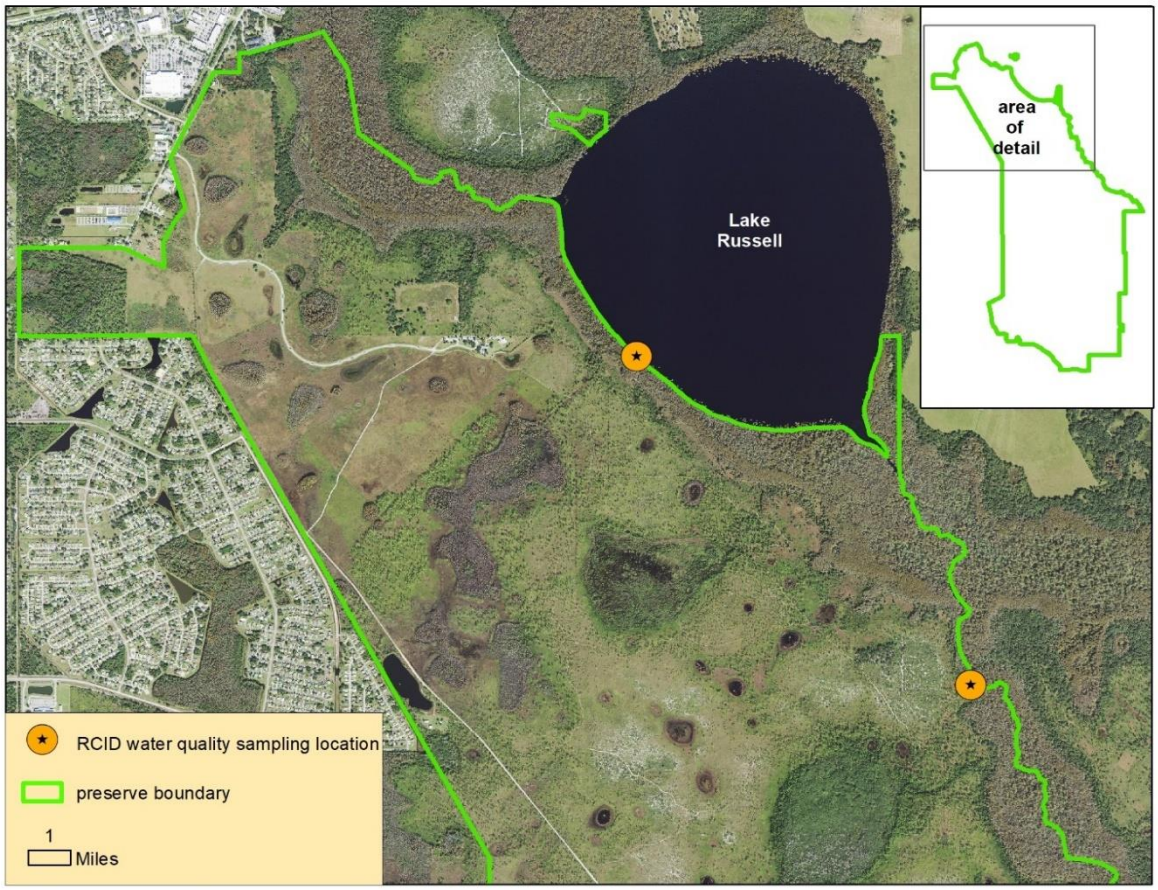
Duration: 1998-present

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 15). 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 15. 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, Tallahassee, 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 16 and 17). 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: ONGOING. SWFWMD completed installation of the wells in 2021. The vegetation monitoring transects were established in 2022. Data available by request from the Southwest Florida Water Management District.

Figure 16. Location of CWFI monitoring wells at Saddle Blanket Scrub Preserve.

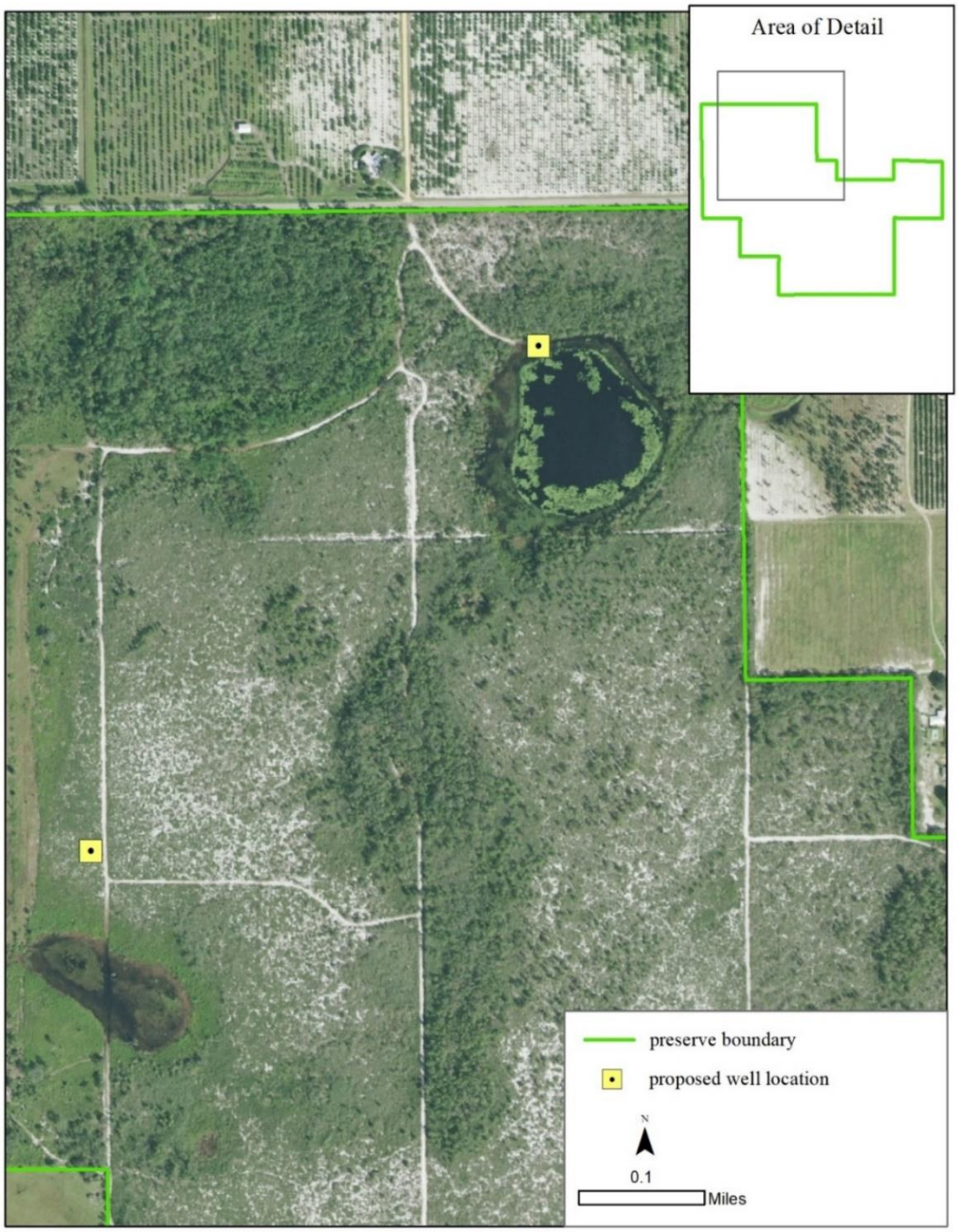
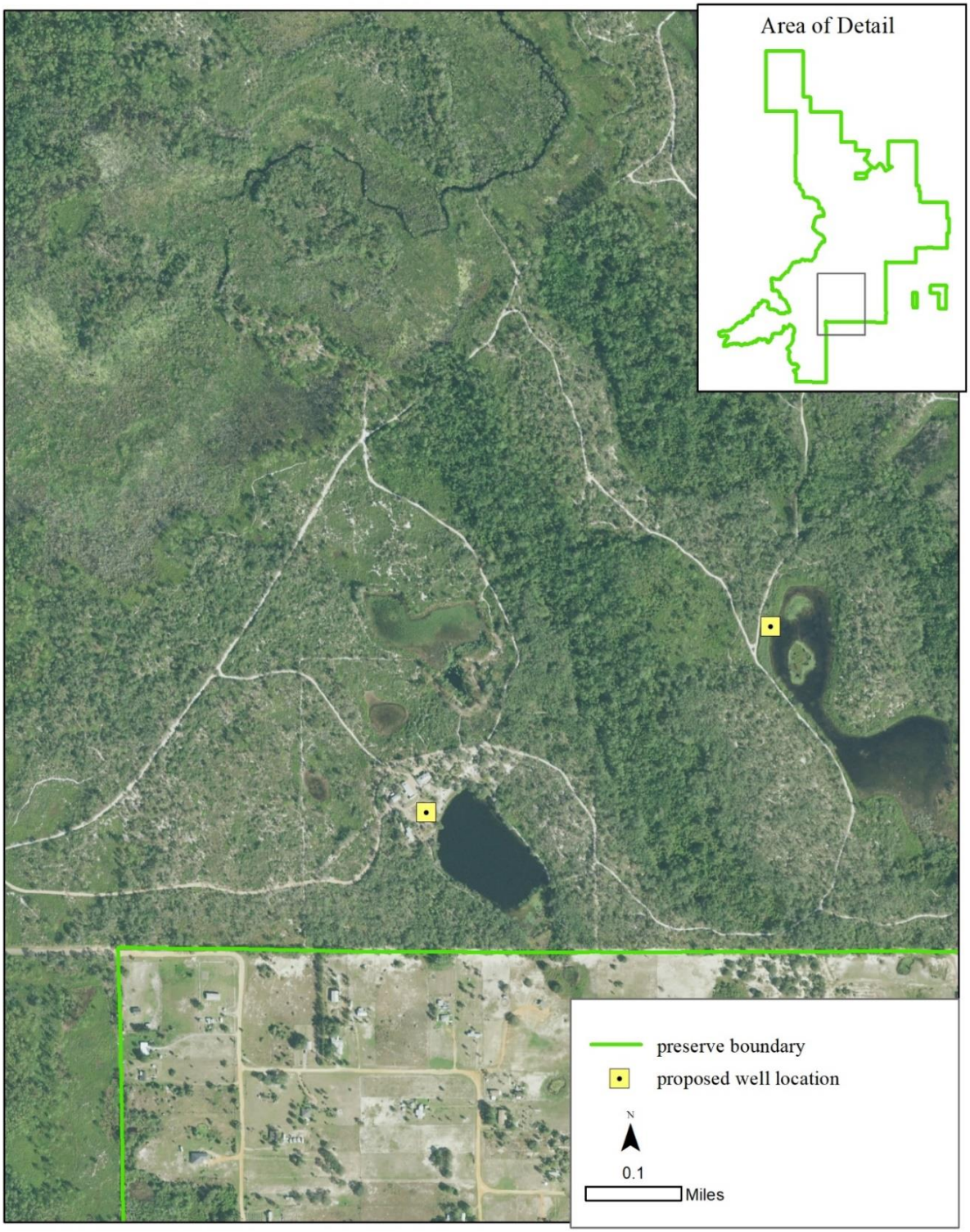


Figure 17. Location of CFWI monitoring wells and vegetation transects at Tiger Creek Preserve.



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