CENTER FOR CONSERVATION INITIATIVES
4TH ANNUAL RESEARCH & MONITORING REPORT

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

2023

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.

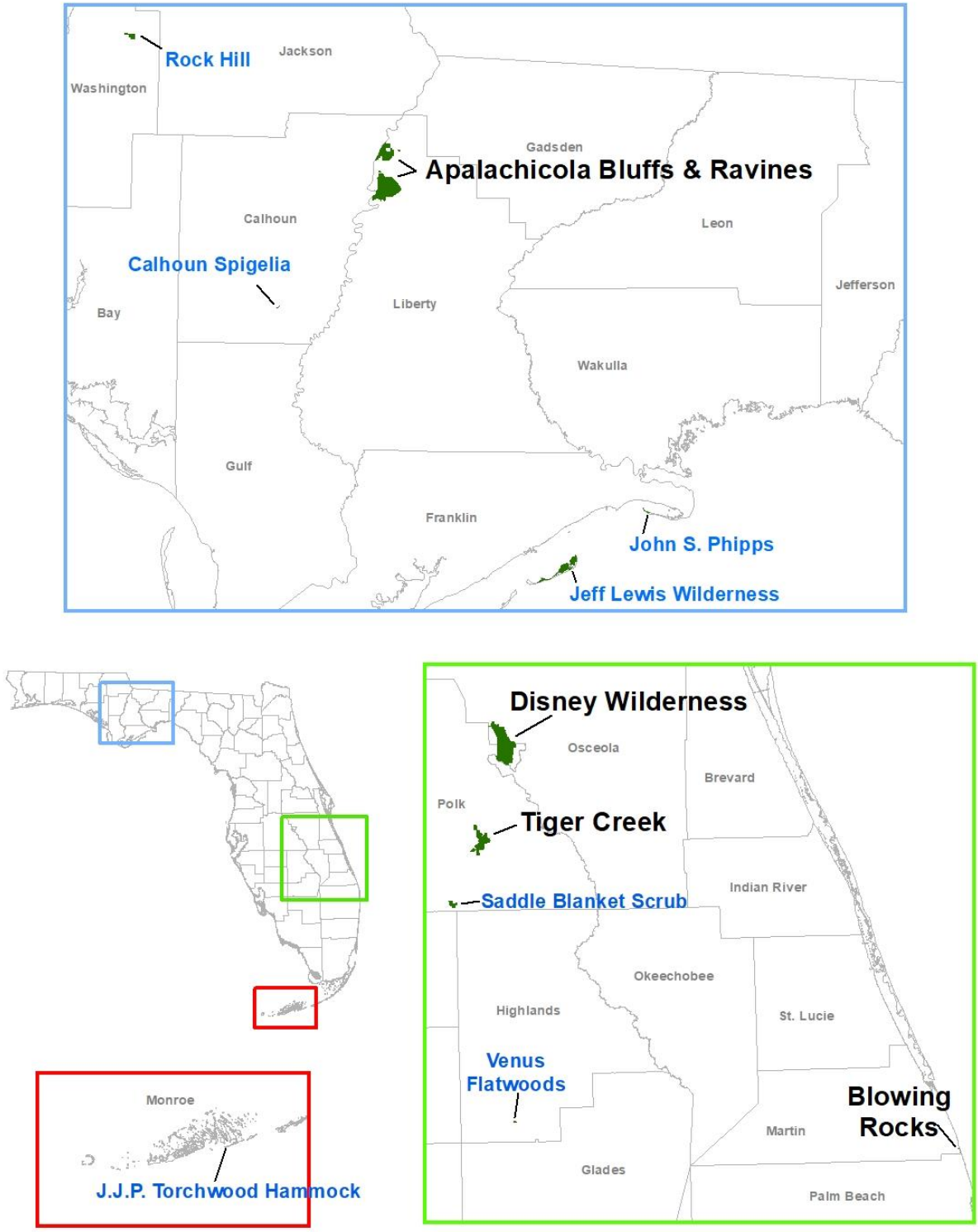
Four of the Chapter's preserves serve as CCI campuses, where most of the Center's on the ground programs, events, and strategies occur. Based on site location, history, and conservation strengths, each campus preserve has a unique conservation focal theme that is emphasized through the four CCI initiatives.

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 2020 we began compiling information and updates on the research and monitoring conducted by our conservation and science partners in annual research and monitoring reports. This fourth annual report documents the projects that were initiated, continuing, or completed during January through December 2023.

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 21 total projects, of which 11 are ongoing and 10 have been completed. The researchers are from 8 universities and colleges; 2 federal, state, and local agencies; and 3 other science or conservation organizations.

The second section has descriptions of seven active monitoring projects by local, county, state, and federal agencies. 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 1971. The list of 561 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 Research Reports and Published Works Web Map.

RESEARCH PROJECTS INITIATED, CONTINUING, OR COMPLETED IN 2023

Apalachicola Bluffs and Ravines Preserve

Community level effects of longleaf pine savannah restoration

Dr. Carolina Baruzzi. University of Florida/IFAS North Florida Research and Education Center, Quincy, FL

Duration: 2023-2025

Objectives: The goal of this study is to understand the contribution of wildlife and the soil biota to the maintanance of the longleaf pine savannah habitat. The study has the following objectives:

1) Identifying patterns of wildlife site use (abundance and occupancy) depending on time since restoration
2) Understanding the effects of wildlife on longleaf pine savanna restoration outcomes through microbial dispersal
3) Deciphering the shift of soil microbial community structure and their biogeochemical function in associated with restoration time and wildlife site use.

Methods: Staff from the UF North Florida Research and Education Center will sample large and small mammal communities, along with the soil biota across the longleaf pine savanna restored sites and four control sites (two degraded and two old growth longleaf pine savannas). They will select sites with similar time since fire to not confound time since restoration with time since fire.

To determine presence and abundance of large mammals, the researchers will place 8 cameras per site, 200 or more meters apart, in September to November. From each camera trap photo, the following data will be collected: date, time, individual species, and number of individuals.

Small mammals will be trapped in September and October using Sherman live traps placed in 7x7 grids with 20-m spacing between each trap (49 traps per grid). The traps will be baited (e.g., a peanut butter/whole oats mixture, sunflower seeds) set at dusk, checked at dawn, and closed during the day. This procedure will be repeated for a total of four nights each month. When a small mammal is found in a trap, it will be marked with an ear-tag, swabbed, and have individual data collected (i.e., species, sex, age, and weight). Any fecal samples left in the traps will be collected.

Trapped small mammals and any feces left in the traps will be swabbed for microbial samples. Using DNA amplicon approach, samples will be tested for both fungi and bacteria to understand patterns of microbial dispersal by small mammals.

To determine whether microbial dispersal by small mammals affects longleaf pine savanna restoration trajectories, the researchers will pair field sampling with a greenhouse experiment. The greenhouse experiment will be conducted at the North Florida Research and Education Center, Quincy, FL. In this experiment, they will grow plants from seed mixes used in longleaf pine savanna restoration and expose them to two soil treatments: sterile soil and soil inoculated with biota identified in the small mammal samples. Plants will be left growing in the greenhouse for approximately four months. Afterwards, they will measure plant biomass production for initial information to determine whether small mammals could influence plant community dynamics through microbial dispersal.

To determine the shift of soil microbial community structure and biogeochemical function in associated with restoration time and wildlife site use, DNA amplicon sequencing and microbial enzyme analysis will be performed to identify diversity, abundances and (C/N/P) enzyme activity of soil microbiomes. Statistical analysis (e.g., three-way anova) and Network analysis will be performed to depict the association among restoration time, wildlife pattern and the community structures of whole and animal dispersed microbes, and the consequence on changing biogeochemistry of forest soil.

Progress/Results: ONGOING. In 2023, data was collected for the following: 1) small mammal community responses to longleaf pine savanna restoration, 2) fire ant bait testing, which originated from issues during the small mammal trapping, and 3) vertebrate community responses to longleaf pine savannah restoration.

A fourth project on monitoring of soil community changes throughout restoration has been postponed because the restoration plans for the Sweetwater RZ-3 tract were delayed.

Small mammals and longleaf pine restoration: Researchers trapped and marked five small mammals across four sites in the fall of 2023. This low abundance may be caused by fire ants but there is insufficient data to determine the cause. Each individual was swabbed and fecal samples were collectd for microbial dispersal. Small mammals will be trapped again in the fall of 2024. Microbial DNA extraction and analyses will conducted in summer 2024 and spring 2025.

Fire ant bait testing: The researchers recorded the occurrences of fire ants and small mammals at traps with different baits with and without insecticide. Insecticide significantly reduced the occurrence of fire ants with peanut butter, peanut butter/oat mixture, or sunflower seed baits. There was no significant difference in fire ant abundance in traps baited with vanilla spray. This test is completed and a paper is being developed for submission to a peer-reviewed journal.

Vertebrate communities and longleaf pine savanna restoration: Camera traps were deployed at four sites in the fall of 2023 and will be repeated in fall 2024. The results for 2023 have not yet been finalized. Data from this project will be used to supplement the Snapshot USA project. Dr. Baruzzi is currently using ABRP and other SnapShot USA data to estimate wild turkey abundance across different habitats.

Distribution and ecology of soft ticks (Argasidae) in Florida

Dr. Sebastian Botero-Cañola, Department of Wildlife Ecology and Conservation, University of Florida, Gainesville, FL

Duration: 2023

Objectives: The goal of this project was to fill some knowledge gaps in the ecology of soft ticks in the United States. The project had the following objectives.

1. Validate and improve proposed *Ornithodoros turicata* collection methods.
2. Assess the distribution of *O. turicata* through the major ecosystems of Florida.
3. Conduct bloodmeal analysis to determine host-tick associations.

Methods: This study was conducted at the Apalachicola Bluffs and Ravines Preserve and throughout the Florida mainland and the keys. The researchers selected sampling sites covering the latitudinal and environmental gradient of Florida. At each sampling site, the presence of *O.turicata* ticks was determined by collecting and examining samples of the content of gopher tortoise burrows, the only known microhabitat of the species in the region. The samples were extracted using a modified leaf vacuum that removed debris, loose soil and ticks from the burrow without causing any damage to the burrow. Before any collection was performed, the burrows were inspected using a borescope camera to assess the presence of any vertebrate species. If a vertebrate was detected, sampling was not performed.

Progress/Results: FIELDWORK COMPLETED. Overall data analysis is still ongoing, but analysis of the samples from ABRP has been completed. Ten gopher tortoise burrows were sampled at ABRP in May 2023. Approximately 2 kg of soil was collected from the interior of the burrows. The tick *Ornithodoros turicata* was found in only one of the burrows sampled. One additional borrow was scoped but not sampled because of the presence of a vertebrate. A final report will be completed in September 2024. The occurrence data collected throughout Florida will be used to create a distribution model for the species.

Papers submitted: Development of an effective standardized method to survey and collect soft ticks (*Ornithodoros sp.*) in gopher tortoise (*Gopherus polyphemus*) burrows.

Papers in progress: Integrating multiple data sources to model the distribution of Ornithodoros turicata americana, a vector of epidemiological concern in North America.

Posters presented: Sebastian Botero-Cañola, Carson Torhorst, Nicholas Canino, Kathleen O'Hara, Angela James, and Samantha Wisely. The geographic distribution and environmental drivers of Ornithodoros turicata through the Southeastern United States. The 2024 Emerging Pathogens Institute Research day, Gainesville FL.

Presentations: Carson Torhorst, Nicholas Canino, Sebastian Botero-Cañola, Kathleen O'Hara, Angela James, and Samantha Wisely. A standardized survey method for soft ticks in gopher tortoise burrows: Implications for African swine fever virus introduction to the United States. Authors: The 2024 Wildlife Society Meeting, Cape Coral FL.

Fighting extinction of *Torreya taxifolia* through collaborative partnerships

Atlanta Botanical Garden, Atlanta, GA

Duration: 2021-2024

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 2024. 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 2024.

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.

Revision and survey of jumping spiders, genera *Maevia* and *Tutelina*

FDACS FL State Collection of Arthropods, Gainesville, FL

Duration: 2023

Objectives: The objective of this study was to delimit the ranges of the *Maevia* and *Tutelina* species of jumping spiders in the panhandle of Florida.

Methods: The primary sampling technique was the use of a beating sheet, a 3-inch square cloth onto which arthropods were dislodged from leaves and limbs using a stick (which in this case was a sweep net handle). Other methods included soil sweeping and sifting and hand collecting. Target plants were saw palmettoes and understory plants with large leaves such as oak saplings and grape vines.

Progress/Results: COMPLETED. The survey at Apalachicola Bluffs and Ravines Preserve, conducted in May 2023, successfully found target species from both genera. At the beginning of Garden of Eden trail, in a xeric area dominated by saw palmetto, the researcher found two subadults of the undescribed *Tutelina* sp. C. He was able to rear one of those to an adult male. Farther down the trail, he found 3 males of *Maevia expansa* on a clump of needle palm.

At another site that had been recently burned, the researcher found 2 males of *M. expansa* on *Yucca filamentosa*. He judged that possibly these had originally been on the saw palmetto that had been burned but had moved to the more hospitable yucca which was not burned. Yucca is a plant that also has radial symmetry. However, it is possible that this is a natural substrate, as related species in the western states do live on larger yucca species. He was surprised to find a jumping spider on the burned saw palmetto. It was a female *Habronattus georgiensis*, which is normally a ground dwelling species.

The results of this research will be published as two separate refereed generic revisions, plus several smaller papers resulting from the bycatch of other poorly known or undescribed jumping spiders in the state.

Tricolored bat winter movement and roost

Florida Fish and Wildlife Conservation Commission, Fish and Wildlife Research Institute, Gainesville, FL

Duration: 2023

Objective: To capture and track tri-colored bats (*Perimyotis subflavus)* at the Apalachicola Bluffs and Ravines Preserve (ABRP) as part of a state-wide study funded by the US Fish & Wildlife Service (USFWS). The tri-colored bat has been proposed as endangered by the USFWS. The primary objective of the study is to determine where and how many tri-colored bats hibernate in Florida so that baseline population trends can be determined and better surveillance and impact assessments for white-nose syndrome can be conducted. The number of wintering bats is of conservation interest because of the emergence of white-nose syndrome (WNS), a disease caused by the fungus *Pseudogymnoascus destructans.* WNS has killed millions of bats in eastern North America over the past decade and has spread south into northern Georgia and Alabama, but not yet into Florida. WNS impacts bats most seriously during winter hibernation and tri-

colored bats, which hibernate longer than Florida's other cave bats, are the most susceptible to WNS.

Methods: Bats were captured using mist nets set over Kelly Branch at ABRP by FWC staff. When bats were captured, they recorded sex, body mass, forearm length, and wing score for all captured bats. Any captured tri-colored bats with a body mass >5g were to have transmitters attached with Perma-type Surgical Cement. Bats would then be tracked daily with a portable telemetry receiver to their roost until the transmitter died or fell off. Decontamination protocols, such as disinfecting mist nets, poles, boots, and other gear, were followed to minimize the risk of the biologists transferring *P. destructans* fungal spores between bats. In addition to decontamination protocols, biologists wore masks and gloves during surveys to prevent the spread of Covid-19.

Progress/Results: COMPLETED. FWC staff conducted mist netting at Apalachicola Bluffs and Ravines on 3 nights from 13 February 2023 to 15 February 2023. Mist nets were placed over Kelly Branch (30.458998 -84.9812). During this time, they captured 8 bats, including 3 southeastern myotis (*Myotis austroriparius*), 3 Seminole bats (*Lasiurus seminolus*) and 2 red bats (*Lasiurus borealis*). All bats appeared healthy and showed no signs of WNS. No other bats were captured, including the target species (tri-colored bat); therefore, no radio tracking occurred.

No further surveys are planned to be conducted at Apalachicola Bluffs and Ravines at this time. Capture data of nontarget species will be contributed to a master FWC database and the North American Bat Monitoring Program and will be detailed in the final grant report for the USFWS. No further analysis is planned for nontarget species at this time. However, it is important to note that because red bats and Seminole bats cannot be distinguished using acoustic methods, this capture data is important to confirm these species presence on the property (Smith and Borkholder 2024).

Reports: Smith and Borkholder 2024.

Blowing Rocks Preserve

Leatherback sea turtle tagging

Florida Leatherbacks Inc., Palm Beach Gardens, FL

Duration: 2014-Present

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 2023, Florida Leatherbacks Inc. (FLI) conducted nighttime surveys April 25-June 20, 2023. A total of 104 encounters were recorded along the Martin County Study Area. Fifty of the encounters were along the beach at Blowing Rocks Preserve (Table 1). Tracked individuals can be followed on at TrackTurtles - Live sea turtle tracking

Table 1. Results of the 2023 FL leatherback turtle surveys by Florida Leatherbacks Inc. (Table from Florida Leatherbacks Inc. 2023).

Beach:	# Encounters	# Encounters with new (untagged) turtles	# Encounters with recaptured turtles
Hutchinson Island	5	0	5
St. Lucie Inlet State Park	26	0	26
HSNWR	19	3	16
Jupiter Island/Blowing Rocks	50	10	40

Reports: Martin 2024.

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 (FNAI), Tallahassee, FL

Duration: 2020-2025

Objectives: The project objective is to measure change in the density of gentian pinkroot stems over time along with habitat structure and composition at four sites: Calhoun Spigelia, Rock Hill, Three Rivers, and Apalachee. FNAI plans 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.

Methods: 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.

Progress/Results: ONGOING. At Calhoun Spigelia Preserve, the number of gentian pinkroot individuals declined from 5 to 0 in the one monitoring plot between 2021 and 2023 (Table 2). At Rock Hill Preserve, the number of gentian pinkroots increased from a total of 792 to 1869 across the three monitoring plots between 2021 and 2023. Of the four study sites, the Rock Hill plots were the only ones to have an increase in plants in 2023 (Table 2). At both sites, the monitoring plots were burned during prescribed fires within six months prior to monitoring.

Across the four study sites in 2021, 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). FNAI plans to monitor the plots again in 2025. While the conclusions that can be drawn from this initial monitoring events 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 and FNAI 2023a).

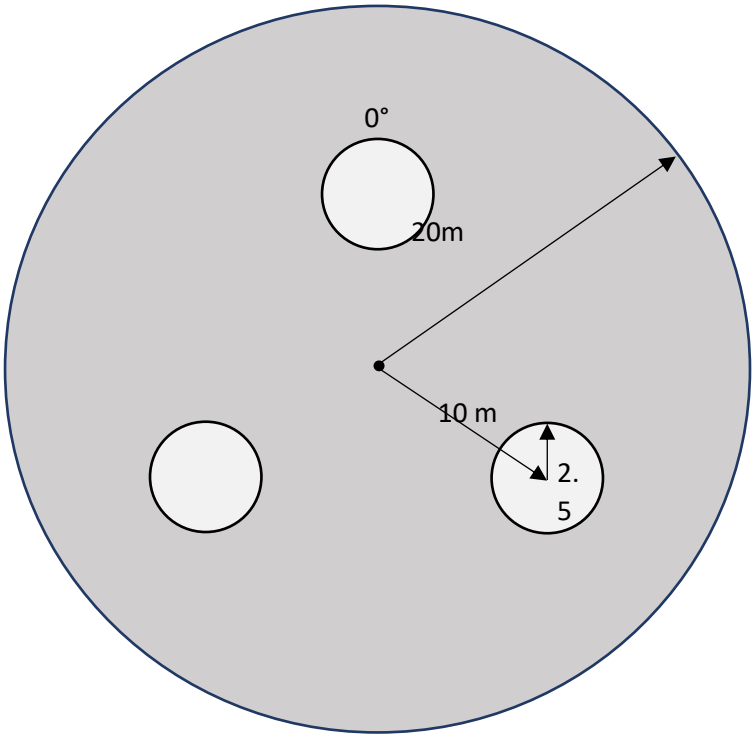
Reports: FNAI 2023a, FNAI 2021b, and FNAI 2021c.

Table 2. Gentian pink monitoring results at Calhoun Spigelia and Rock Hill Preserves, 2021 and 2023 (from FNAI 2023a).

Location	Number of Plots	Total Plant Count 2021	Total Plant Count 2023	Flower Count 2021	Flower Count 2023	Net Plant Change from 2021 to 2023	Percent of Plots where Failed to Find species	Percent of Plots that Declined	Percent of Plots that Remained Stable	Percent of plots that Increased
Calhoun	1	5	0	2	0	-5	100%	100%	0%	0%
Rock Hill	3	792	1869	226	277	1077	0%	0%	0%	100%
Three Rivers	12	611	454	468	259	-157	42%	42%	8%	8%
Apalachee	8	2875	2094	1646	1223	-781	0%	50%	25%	25%

Figure 2. Map of gentian pinkroot plots at Calhoun Spigelia (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 traps 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 rain 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 DWP and other MASTIF data from across the US, Dr. Clark led an analysis to determine how climate indirectly effects tree fecundity that comes through 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).

Published papers: 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), the Jones Center at Ichauway, 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.

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 ground-truthed [using NEON vegetation plot data and data collected by Tall Timbers at each site. "

Progress/Results: COMPLETED. Data collection was conducted at DWP in early 2022. A paper on the project was published in 2023 in the Journal of Geophysical Research (Robertson et al. 2023). Results summary from the paper: "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."

Published papers: Robertson et al. 2023.

Enhancing the drought-resilience of crops

Dr. Vidya Suseela, Department of Plant and Environmental Sciences, Clemson University, Clemson, SC

Duration: 2023-2026

Methods: This study focuses on identifying the microbiome that imparts drought tolerance in ruderal plants and devising strategies to transfer the microbiome-mediated drought tolerance

trait to crop plants. Researchers will target *Andropogon virginicus* (broomsedge bluestem), a grass native to the 32 states across the southeastern US. This species active growth period (mid-June to early September) coincides with the most drought-prone periods of the year across its ranges. In addition, *A. virginicus* is a C4 plant in the same subfamily (Andropogoneae or sorghum tribe) as many important crops such as maize (corn), sugarcane, and sorghum. Based on a grass genomics analysis by the researcher, *A. virginicus* is phylogenetically related to these main crops, making it a potential candidate for relatively easier transfer of its rhizobiome to corn, sugarcane, sorghum and other Andropogoneae crops.

Methods: Rhizosphere soils of *Andropogon virginicus* will be collected from the Disney Wilderness and 29 other field sites across the southern US to develop a rhizobiome inoculum. The effectiveness of the inoculum to impart drought tolerance in corn will be tested using a series of greenhouse and field experiments.

Progress/Results: Ongoing. In 2023, soil collection was completed from 20 field sites, including DWP. Soil collections will be completed in 2024. Sites may be revisited based on initial findings. Soil. Lab and data analyses of soils is in progress.

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

Ian Biazzo. PhD student, Department of Biology, University of Central Florida, Orlando, FL

Duration: 2020-2023

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 focused 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 2020-2022. 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 were checked weekly for frogs. All frogs were identified to species, measured from snout to urostyle, sexed if possible, and given unique Visible Implant Elastomer (VIE) tags. The PVC pipes were 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 the study sites.

Progress/Results: COMPLETED. Mr. Biazzo collected 3,000 data points from his mark-recapture study on treefrogs in pine flatwoods, 99% of which were for pinewoods treefrogs *Dryophytes femoralis*. He 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. The species showed high site fidelity, with individuals often returning to the same tree for several consecutive months. Local survival for populations in this study were between 70-85%.

Dissertation: Biazzo 2023.

Papers published: Biazzo and Quintana-Ascencio 2022a.

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

Reports: Biazzo and Quintana-Ascencio 2022b.

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 – 2023

Objectives: This project had three objectives:

1. To identify threats Florida sandhill 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 (FSCs) were captured, fitted with a USFWS band and GSM cellular transmitter, and then released at the capture site throughout central Florida. 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 FSCs and to 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: COMPLETED**.** The project was completed in 2023, with a final report submitted at the end of the year to the Florida's State Wildlife Grants Program, which funded the project. During 2017-2021, FWC radio-tagged 41 FSC and color-banded 77 throughout central Florida. FWC collected survival, productivity, and movement data from the radio-tagged and banded FSCs. Most radio-tagged FSCs used both natural and suburban areas. Birds using mostly suburban habitat had an average home range of 415 ha; birds mostly on conservation lands had an average home range of 2435 ha. Survival in both habitats was roughly equal, with 77% in suburban areas and 79% in conservation areas. Breeding results showed a higher hatching success rate in suburban areas (90%) versus conservation areas (67%). However, fledgling and independence success rates were very similar: 43% and 20%, respectively, for suburban FSCs; 43% and 24%, respectively, for FSCs on conservation lands.

At DWP, an adult FSC was captured and fitted with a backpack transmitter on 12 December 2019 on the east side of the preserve 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 FSC and its mate regularly roosted and foraged on DWP, using depression marshes, dry prairie, and mowed areas around the office and shop. The FSC 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.). The FSC successfully nested in a Poinciana residential area in spring of 2020, and FWC radio-tagged one of the chicks The adult FSC has not been observed since September 2021. The radio-tagged chick of the DWP adult dispersed from the natal area and explored the pastureland around Lake Tohopekaliga and areas to the west and south of the natal area (Figure 5). FWC will continue to collect movement data for as long as transmitters remain operational.

Reports: Dellinger 2023.

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.

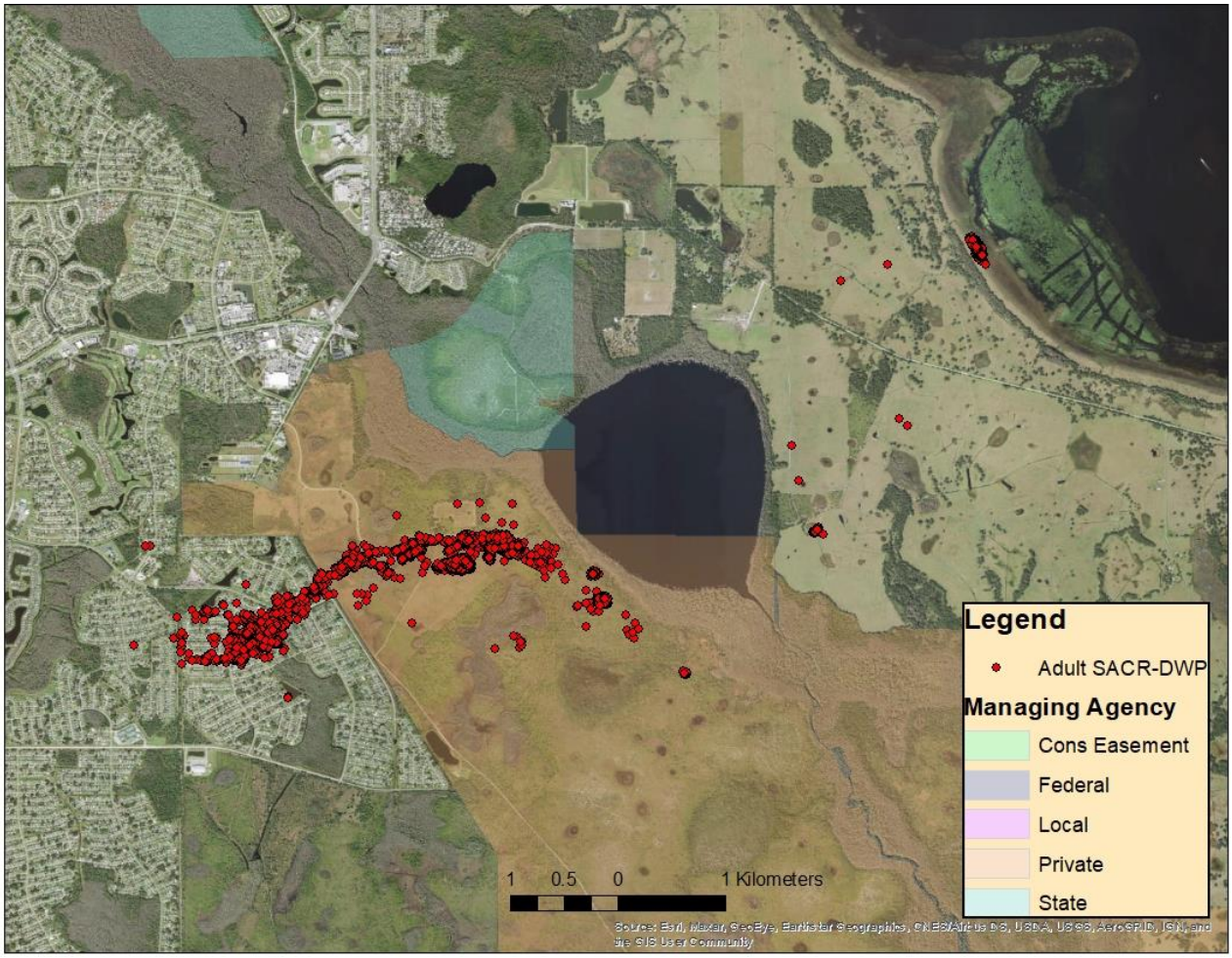
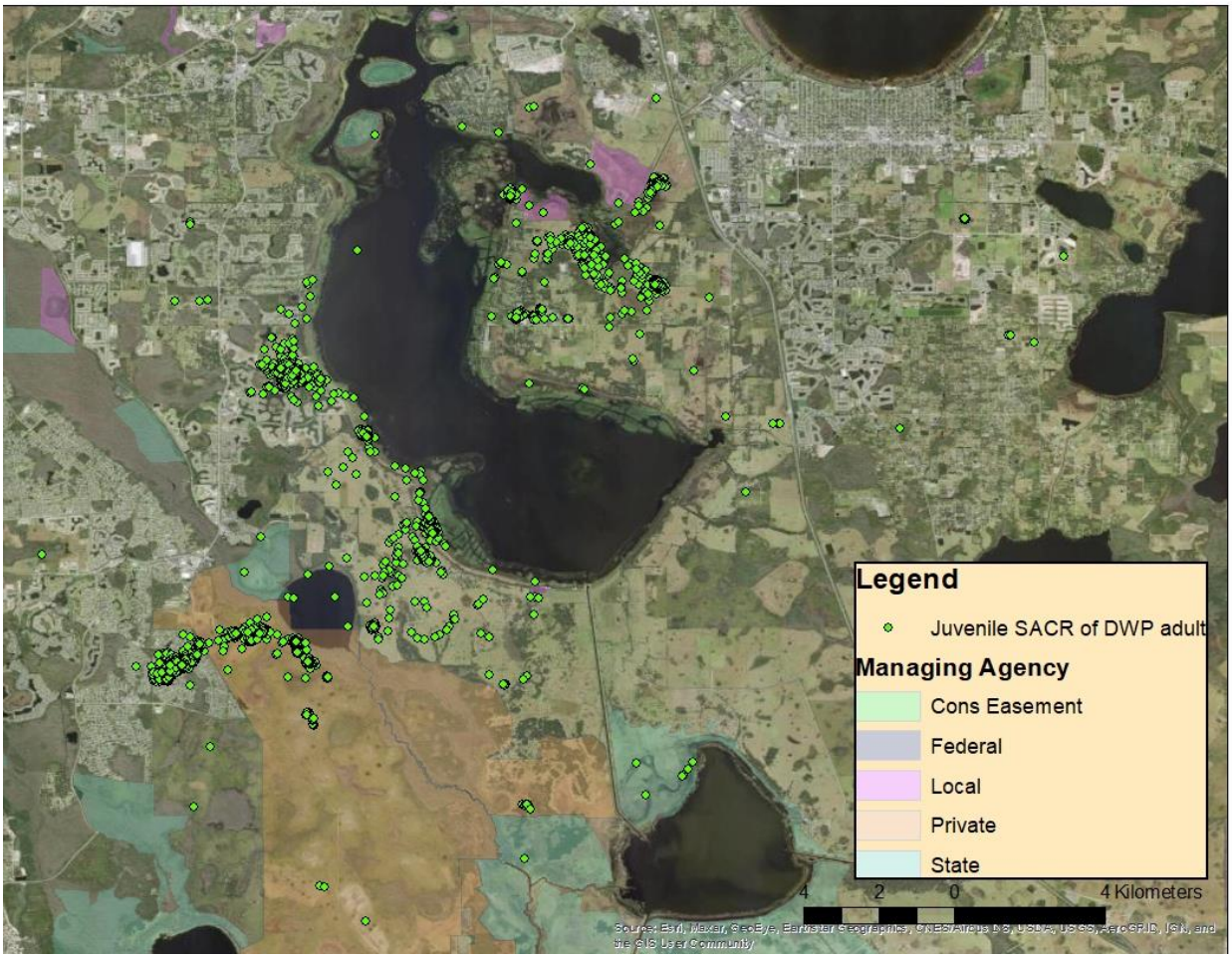


Figure 5. Movements from 2020-2021 of a juvenile Florida sandhill crane that hatched from a nest on Disney Wilderness Preserved but was captured and radio-tagged while with its parents in a Poinciana, Florida suburban area in November 2020. Map courtesy of Tim Dellinger, FWC.



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 – 2023

Objectives: To assess the prevalence, intensity, and consequences of *Dermomycoides* infections in Florida amphibian populations. *Dermomycoides* is a worldwide anuran pathogen associated with mortality events, yet little is known about its overall impact on amphibian populations and species. For this study, it was predicted that disease dynamics would vary across wetland type and wetland community composition. The 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 *Dermomycoides* 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 *Dermomycoides* in metamorphosed individuals.

Progress/Results: COMPLETED. Mr. Atkinson completed his dissertaton in the spring of 2023 (Atkinson 2023). The presence of *Dermomycoides* at DWP was confirmed from samples taken from the first field visit. The following research results are from the abstract of the dissertation: "[The researcher] collected a total of 1973 anurans across the five field sites with 32% of individuals infected with *Dermomycoide*s in the more "natural" habitats while 8.8% of individuals were infected in the [more urban areas]. [He] identified that co-variates including co-infection status, host species, host life stage, sampling month, and sampling site explained

much of the variability of infection status within individuals and sites. In the experimental infection studies, he identified that host susceptibility to *Dermomycoides* varied significantly by species, but sub-lethal impacts may still occur in tolerant species. This study is the first to establish epidemiological patterns of *Dermomycoides* across space, time, and host species and fills knowledge gaps in our understanding of how invasive species alter pathogen dynamics. Ultimately, this work highlights the need for ongoing monitoring, experimental studies, and mitigation efforts to address the challenges pathogens pose to amphibian biodiversity."

Dissertation: Atkinson 2023.

Published papers: Atkinson and Savage 2023.

Jeff Lewis Wilderness Preserve

Investigating mangrove (Rhizophora mangle and Avicennia germinans) temperature response at an expanding range front in north Florida

Dr. Josh Breithaupt, Coastal and Marine Laboratory, Florida State University, St. Teresa, FL
Rachel Biton, Master's student, Coastal and Marine Laboratory, Florida State University, St. Teresa, FL

Duration: 2023-2024

Objectives: The purpose of this study is to measure site-specific changes in temperature surrounding mangroves and salt marsh vegetation at the Jeff Lewis Wilderness Preserve on Dog Island, Florida. Knowing how temperature influences mangrove survival and growth at a microclimate scale (m) will help predict future spread. Temperature is the primary determinate of mangrove latitudinal distributions and influences their physiology and structure in coastal ecosystems, especially in the northern Gulf of Mexico. As climate change continues, a decrease in extreme cold weather events that can cause mangrove mortality is expected, which may allow mangroves to expand poleward.

Methods: A total of four air temperature loggers were placed in mangroves and salt marsh vegetation to autonomously record air temperature for 12 months. One logger was attached to the inside of the mangrove canopy at the fringe edge and one in the interior section of the islands. Two additional loggers were deployed on PVC poles at the *Spartina alterniflora* fringe and *Juncus roemerianus* in the interior marsh locations. Plot-level data were collected including observations of freeze damage and mortality to red and black mangroves. Additionally, red and black mangrove leaves were collected and analyzed for nutrient content.

The occurrence of a severe freeze event on December 24, 2022 allowed for the evaluation and comparison of mangrove responses. Spatial and temporal analyses were conducted on air temperature logger data to identify the timing and magnitude of the lowest temperature during the freeze event. In the spring of 2023, an assessment of post-freeze leaf damage was conducted. Leaf collection for nutrient content analysis was conducted in May of 2023 in six replicate plots. In each plot, two leaves were clipped from five different mangroves, for a total of ten leaves per species, to be analyzed for total nitrogen, carbon, and phosphorus. In December of 2023, mortality assessments were conducted. Plot data were analyzed to quantify mean average height and stem density for red and black mangroves, as well as their respective responses (% damage and mortality) to the freeze event. Mean C:N and N:P of all leaves were compared by species and by site.

Progress/Results: FIELDWORK COMPLETED. A final report is estimated to be completed by August 2024. The research will contribute to one manuscript for a master's thesis paper.

Posters presented: Biton R., Breithaupt J., and Miller T.E. 2023. Investigating mangrove (*Rhizophora mangle* and *Avicennia germinans*) freeze response using regional and site-scale temperature differences at an expanding range front in north Florida. Coastal and Estuarine Research Federation. Portland, OR. November 2023.

Biton R., Breithaupt J., and Miller T.E. 2023. Investigating mangrove (*Rhizophora mangle* and *Avicennia germinans*) freeze response using regional and site-scale temperature differences at an expanding range front in north Florida. Apalachicola National Estuary Research Reserve Symposium. Apalachicola, FL. February 2023.

Presentations: Biton R. and Breithaupt J. 2024. Investigating regional-scale differences in mangrove structure and composition in the context of freezing air temperatures and nutrient availability at an expanding range limit in northern. Apalachicola National Estuarine Research Reserve, Apalachicola, FL. April 2024.

Biton R. and Breithaupt J. 2024. Effect of regional winter temperature gradients at an expanding mangrove range limit in Northern Florida. Florida Fish and Wildlife Conservation Commission Coastal Habitat Integrated Mapping and Monitoring Program & Mangrove Working Group. St. Petersburg, Florida. January 2024.

Rock Hill Preserve

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

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

Locations: Rock Hill Preserve and Tiger Creek Preserve

Duration: 2018-2023

Objectives: This study explored how differences in climate, fire, and species composition interact and relate to longleaf pine densities and growth rates in distinct communities.

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: COMPLETED. Densities and age ranges of longleaf pines from Rock Hill and Tiger Creek Preserves 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

The dissertation was completed in 2023. From Zampieri 2023: Stand structure varied across communities, resulting from unique interactions between climate, fire, and species composition. In general, species composition and fire were better predicters than climate of tree and grass stage densities; however, overall growth rates were best predicted by climate. Longleaf growth rates increased with temperature but declined under dry conditions. This research suggests that longleaf pine growth rates across its range will be more impacted by climate change than will longleaf pine density.

Dissertation: Zampieri 2023.

Published papers: Zampieri and Pau 2022.

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

Florida Natural Areas Inventory (FNAI), Tallahassee, FL.

Duration: 2020-2025

Objectives: The project objective is to measure change in the density of gentian pinkroot stems over time along with habitat structure and composition at four sites: Calhoun Spigelia, Rock Hill, Three Rivers, and Apalachee. FNAI plans 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.

Methods: 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.

Progress/Results: ONGOING. At Calhoun Spigelia Preserve, the number of gentian pinkroot individuals declined from 5 to 0 in the one monitoring plot between 2021 and 2023 (Table 2). At Rock Hill Preserve, the number of gentian pinkroots increased from a total of 792 to 1869 across the three monitoring plots between 2021 and 2023. Of the four study sites, the Rock Hill plots were the only ones to have an increase in plants in 2023 (Table 2). At both sites, the monitoring plots were burned during prescribed fires within six months prior to monitoring.

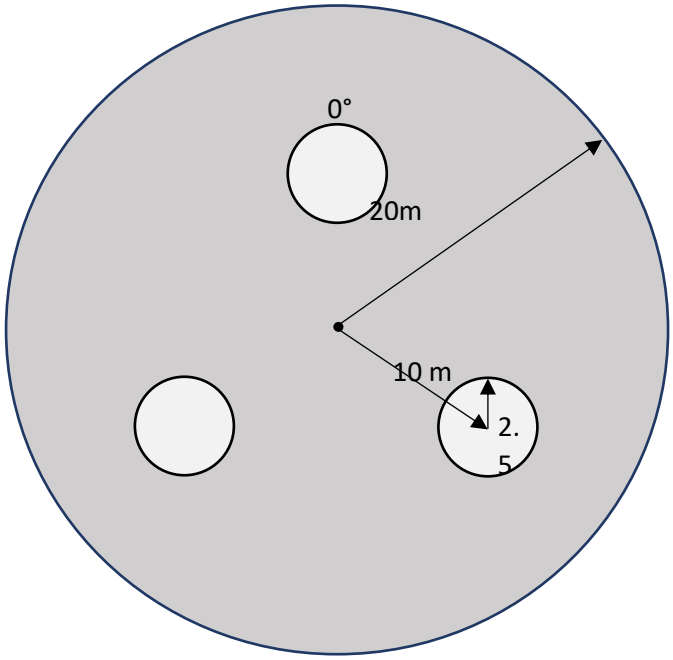
Across the four study sites in 2021, plots that received a prescribed burn in the months immediately preceding this survey had on average a higher number of gentian pinkroot individuals per plot than those that did not receive a spring prescribed fire (FNAI 2021b). While several habitat metrics that 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). FNAI plans to monitor the plots again in 2025. While the conclusions that can be drawn from this initial monitoring events 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 and FNAI 2023a).

Table 2. Gentian pink monitoring results at Calhoun Spigelia and Rock Hill Preserves, 2021 and 2023 (from FNAI 2023a).

Location	Number of Plots	Total Plant Count 2021	Total Plant Count 2023	Flower Count 2021	Flower Count 2023	Net Plant Change from 2021 to 2023	Percent of Plots where Failed to Find species	Percent of Plots that Declined	Percent of Plots that Remained Stable	Percent of plots that Increased
Calhoun	1	5	0	2	0	-5	100%	100%	0%	0%
Rock Hill	3	792	1869	226	277	1077	0%	0%	0%	100%
Three Rivers	12	611	454	468	259	-157	42%	42%	8%	8%
Apalachee	8	2875	2094	1646	1223	-781	0%	50%	25%	25%

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

Bonamia rangewide surveys for informing the SSA

Florida Natural Areas Inventory (FNAI), Tallahassee, FL

Duration: 2023

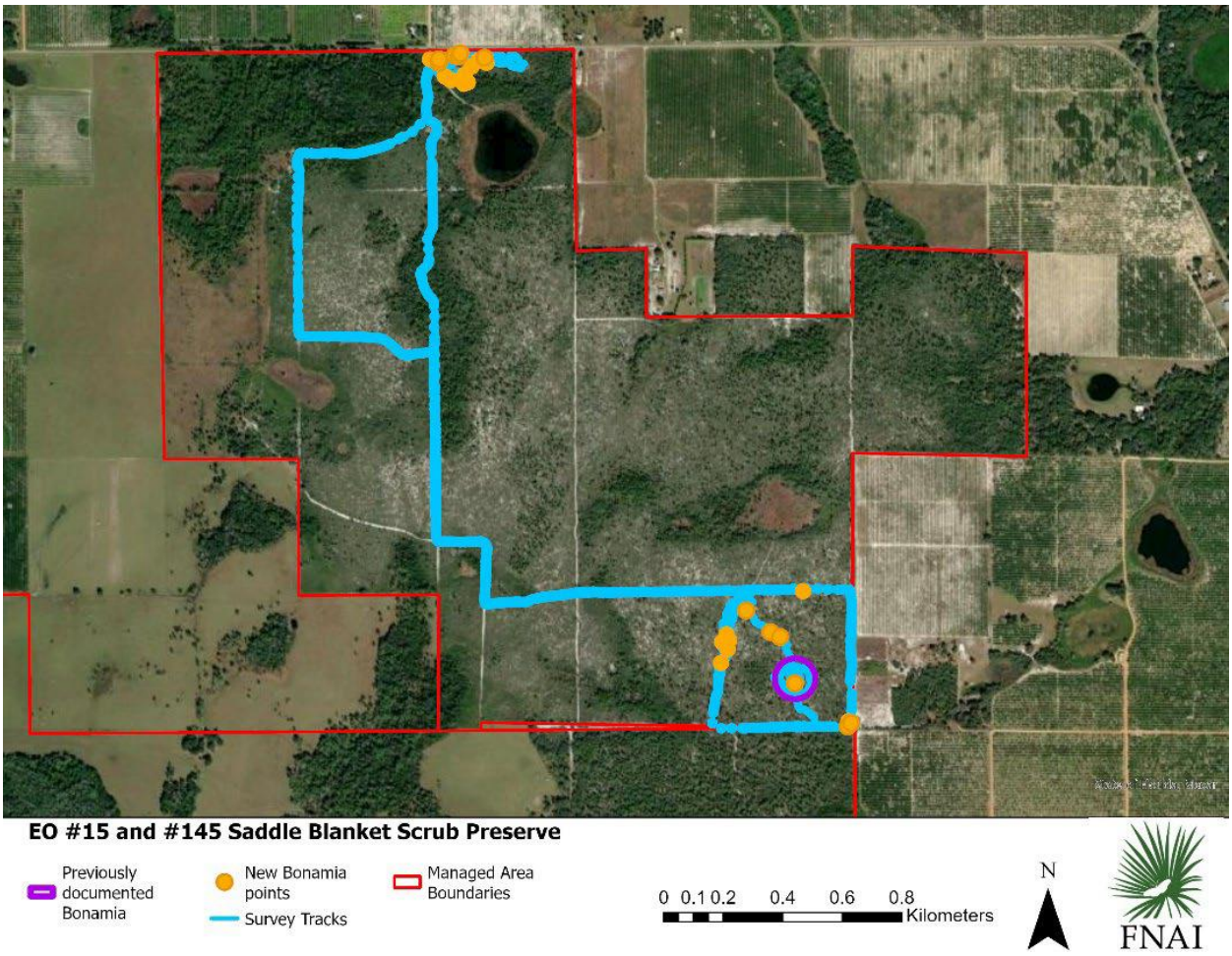
Objectives: The objective was to revisit *Bonamia grandiflora* (Florida Bonamia) element occurrences throughout the species' range to determine current population status. This project aimed to assist USFWS and partner biologists with a Species Status Assessment (SSA) for *Bonamia grandiflora* and determine the overall conservation status of the species. Sites surveyed included Tiger Creek and Saddle Blanket Scrub Preserves.

Methods: The locations at which the species were previously observed on the two preserves were visited by FNAI botanists in the summer of 2023. Where the species was present, they determined the number of plants, mapped the areal extent of the population, and recorded phenology and habitat amount/quality. They also recorded absence when the species was not found.

Progress/Results: COMPLETED. From FNAI 2023b: "[At Saddle Blanket Preserve] there had been one small Florida bonamia population documented in 1983, shortly after the area had been mechanically chopped, which may have actually been beneficial for the Florida bonamia. The only notes made about the population were that "several specimens" were observed. Within the original EO area, 279 stems, most of which were vigorous and in fruit, were observed in 2023 (Figure 8). By searching a larger area of the property, the EO was also expanded to include occupied scrub areas outside of the original extent. An additional 129 stems, about ¼ in fruit, were found near but outside the EO in the patchy scrub and along the interior roads. Co-occurring species included scrub oak (*Quercus inopina*), coastalplain staggerbush (*Lyonia fruticosa*), saw palmetto (*Serenoa repens*), sand pine (*Pinus clausa*), sand live oak (*Quercus geminata*), myrtle oak (*Quercus myrtifolia*), and scrub palmetto (*Sabal etonia*). Additionally, another population was found in the northern part of the property about 2.3 km away (i.e., outside of the separation distance). This new occurrence is quite sizeable, with 637 stems in an approximately 300 x 100m area on the northern edge of the property near the entrance. At least half of these were reproductive, mostly in the fruiting stage. Compared to other populations visited during this survey, this was one was the most advanced phenologically, as few flowers and many more fruits were present. In general, the scrub within the property is very high quality and highly suitable for Florida bonamia. The canopy was generally open with only infrequent sand pine, shrubs were patchy with many bare sandy openings, and no invasive plant species were found."

Reports: FNAI 2023b.

Figure 8. Location of Bonamia grandiflora *at Saddle Blanket Scrub Preserve (from FNAI 2023b).*



Tiger Creek Preserve

Black bear abundance within the Highlands/Glades subpopulation of Florida

Florida Wildlife Research Institute, Florida Fish and Wildlife Conservation Commission, Gainesville, FL

Duration: 2023

Objectives: This project is the beginning of a multi-year effort to update estimates of abundance, density, and genetic diversity in the six larger black bear (*Ursus americanus*) subpopulations of Florida (Apalachicola, Big Cypress, Eglin, Highlands/Glades, Ocala/St. Johns, and Osceola) between 2023 and 2028. Because of the scope of this larger study, the researchers will conduct field work on 1-2 subpopulations each year, starting with the

Highlands/Glades bear subpopulation in the South-Central Bear Management Unit (BMU). Tiger Creek Preserve was one of several sites included in the project in 2023.

This project had three objectives:

1. Estimate bear density and abundance, by sex, in the Highlands/Glades subpopulation (HGS).
2. Estimate genetic diversity in the HGS.
3. Identify instances of immigration to the HGS from other subpopulations by genotyping hair samples to the subpopulation of origin.
4. Compare bear density, abundance, genetic diversity, and the number of identified immigrants to population assessments from 2017 and identify subpopulation trends over time.

Methods: A bear corral was installed in the Pfundstein Management Area of Tiger Creek Preserve in the summer of 2023. The corral consisted of two strands of barbed wire strung around three to five trees so that the corral contains an area 10-30 m^2. The two strands were 35-40 cm and 65-70 cm above ground. Bait (small amount of bakery products and corn) were placed on the ground, and additional bait and scent lure were hung 2.5 m above ground in the center of the corral.

All bear hair samples captured by the barbed wire were to be collected in coin envelopes labeled with date, corral number, corral side, barb number, and a rank of quality based on the amount of hair. Each barb containing hair was to be treated as a new sample. All barbs were to be burned after sample collection to remove residual DNA. The corral was checked once per week for 6 consecutive weeks (6 weekly sampling occasions) to match sampling efforts across Florida subpopulations. Hair samples were to be stored dry at room temperature for subsequent genetic analysis.

Progress/Results: COMPLETED. During the six-week collection period, no bear hair was found on the barbed wires of the Tiger Creek corral. However, the researchers stress that this does not indicate an absence of bears on the preserve. FWC found enough evidence of bear occurrences in neighboring areas, including the Lake Wales Ridge State Forest, to designate the area around the preserve as “Frequent bear occurrence” (Brian Schieck, FWC, pers. comm.).

Bonamia rangewide surveys for informing the SSA

Florida Natural Areas Inventory (FNAI), Tallahassee, FL

Locations: Saddle Blanket Scrub Preserves and Tiger Creek Preserve

Duration: 2023

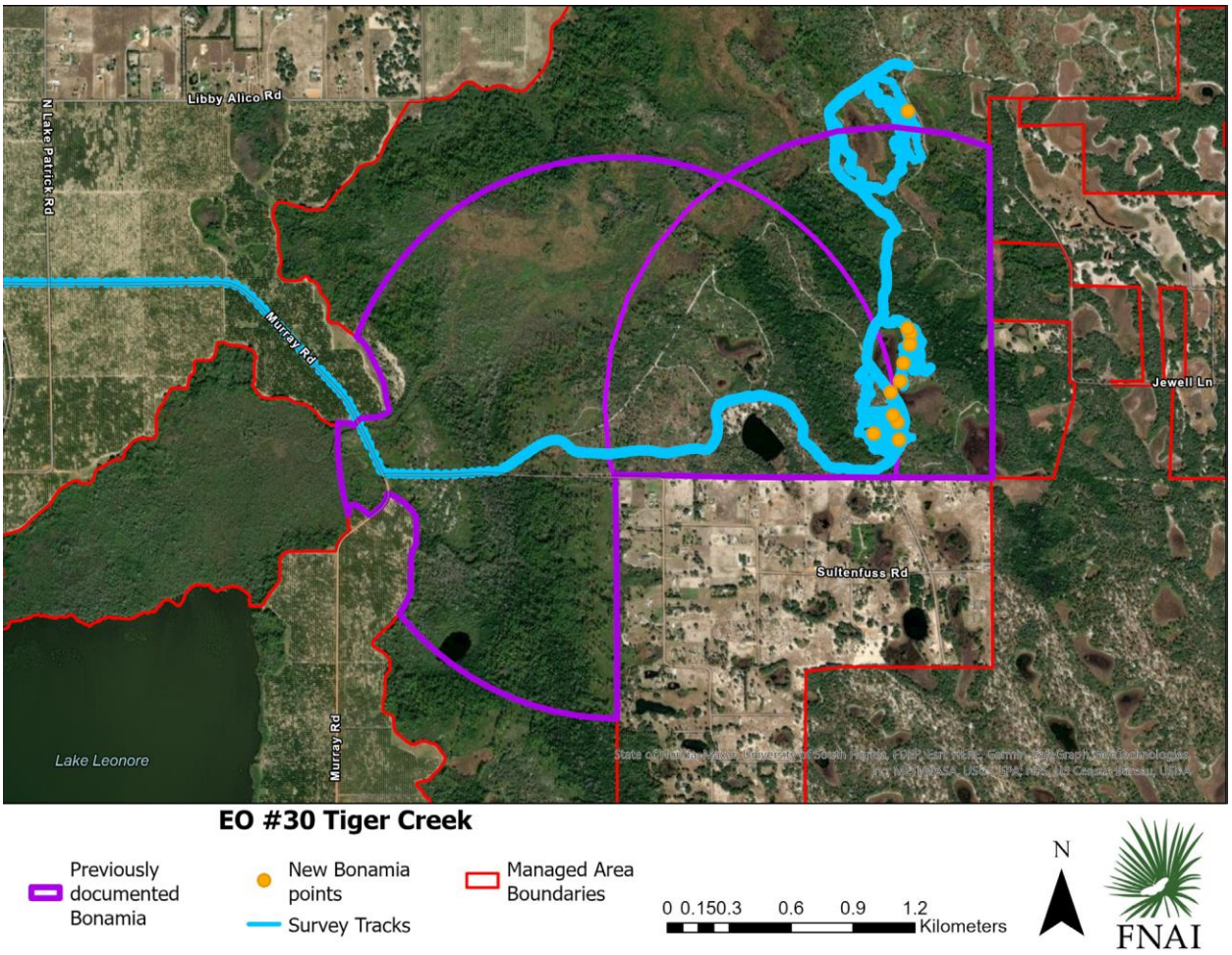
Objectives: The objective was to revisit *Bonamia grandiflora* (Florida bonamia) element occurrences throughout the species' range to determine current population status. This project aimed to assist USFWS and partner biologists with a Species Status Assessment (SSA) for *Bonamia grandiflora* and determine the overall conservation status of the species. Sites surveyed included Tiger Creek and Saddle Blanket Scrub Preserves.

Methods: The locations at which the species were previously observed on the two preserves were visited by FNAI botanists in the summer of 2023. Where the species was present, they determined the number of plants, mapped the areal extent of the population, and recorded phenology and habitat amount/quality. They also recorded absence when the species was not found.

Progress/Results: COMPLETED. From FNAI 2023b: "Florida bonamia was found growing in the southeastern part of Tiger Creek in sandhill (Figure 9). In total 45 stems were found, all vegetative expect for 3 with flower and fruits. Stems were short, only 10-25 cm long on average. The shrub layer was light to moderate in cover, about 10-30% cover, and about 1.2 m in height on average. Co-occurring species included myrtle oak (*Quercus myrtifolia*), turkey oak (*Quercus laevis*), sand live oak (*Quercus geminata*), and coastalplain honeycombhead (*Balduina angustifolia*). The habitat was generally found to be of high quality, though the leaf litter layer was thick in some areas, up to 75% of cover. It is possible that more Florida bonamia occurs outside of the previously delimited EO in the central sandhill areas of the property, but time constraints limited FNAI's ability to search much outside the EO."

Reports: FNAI 2023b.

Figure 9. Location of Bonamia grandiflora *at Tiger Creek Preserve (from FNAI 2023b).*



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

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

Locations: Rock Hill Preserve and Tiger Creek Preserve

Duration: 2018-2023

Objectives: This study explored how differences in climate, fire, and species composition interact and relate to longleaf pine densities and growth rates in distinct communities.

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: COMPLETED. Densities and age ranges of longleaf pines from Rock Hill and Tiger Creek Preserves 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

The dissertation was completed in 2023. From Zampieri 2023: Stand structure varied across communities, resulting from unique interactions between climate, fire, and species composition. In general, species composition and fire were better predicters than climate of tree and grass stage densities; however, overall growth rates were best predicted by climate. Longleaf growth rates increased with temperature but declined under dry conditions. This research suggests that longleaf pine growth rates across its range will be more impacted by climate change than will longleaf pine density.

Dissertation: Zampieri 2023.

Papers published: Zampieri and Pau 2022.

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: 2022-2023

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 was completed in 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-present

Objectives: To obtain real-time weather from automated weather towers at Apalachicola Bluffs and 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 ABRP, DWP, and TCP were completed in 2022. The Blowing Rocks Preserve station was completed in 2023. 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), Jupiter (BRP), Poinciana (DWP), and Tiger Creek (TCP) FAWN stations. The station locations at each of the three preserves are shown in Figures 10-13.

Figure 10. Location of the FAWN weather station at Apalachicola Bluffs and Ravines Preserve.

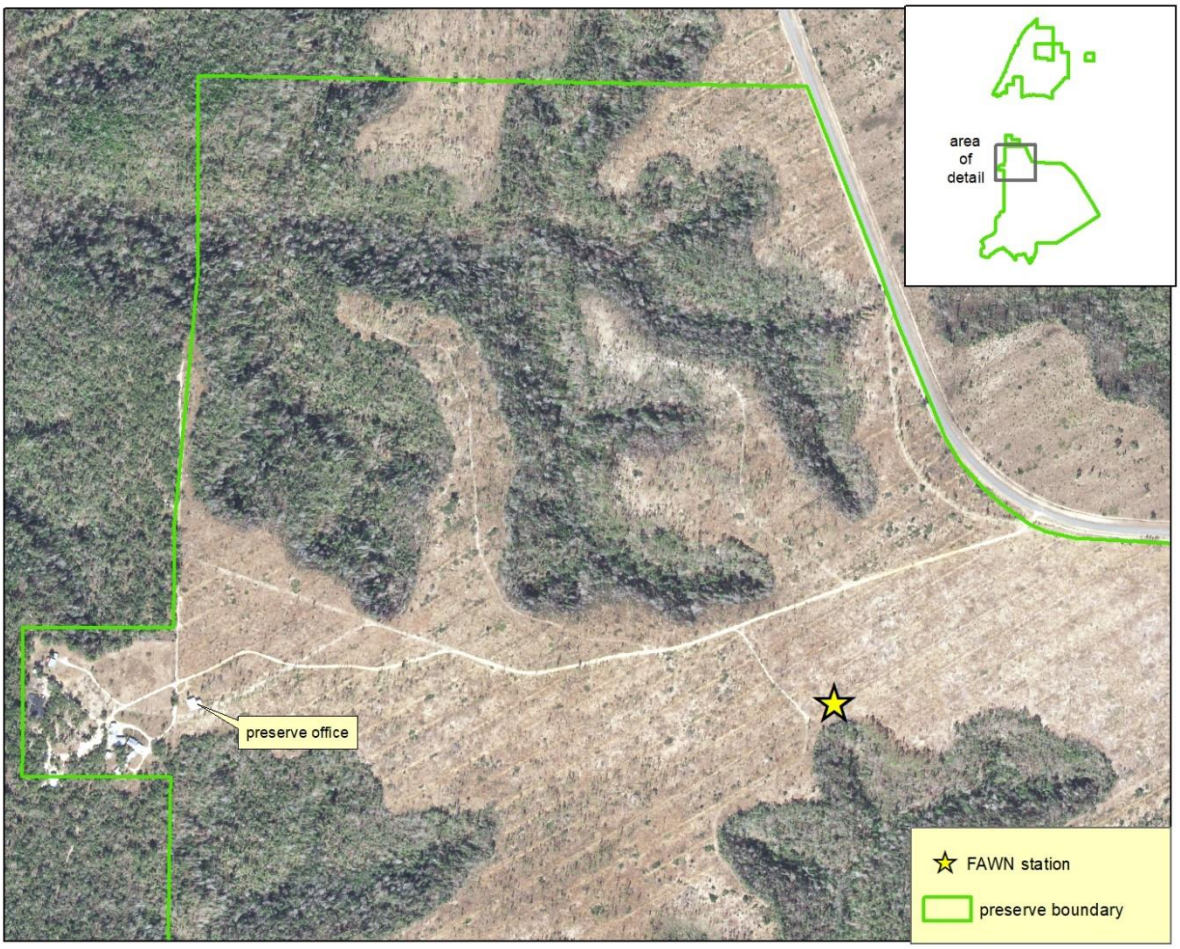


Figure 11. Location of the FAWN weather station at Disney Wilderness Preserve.

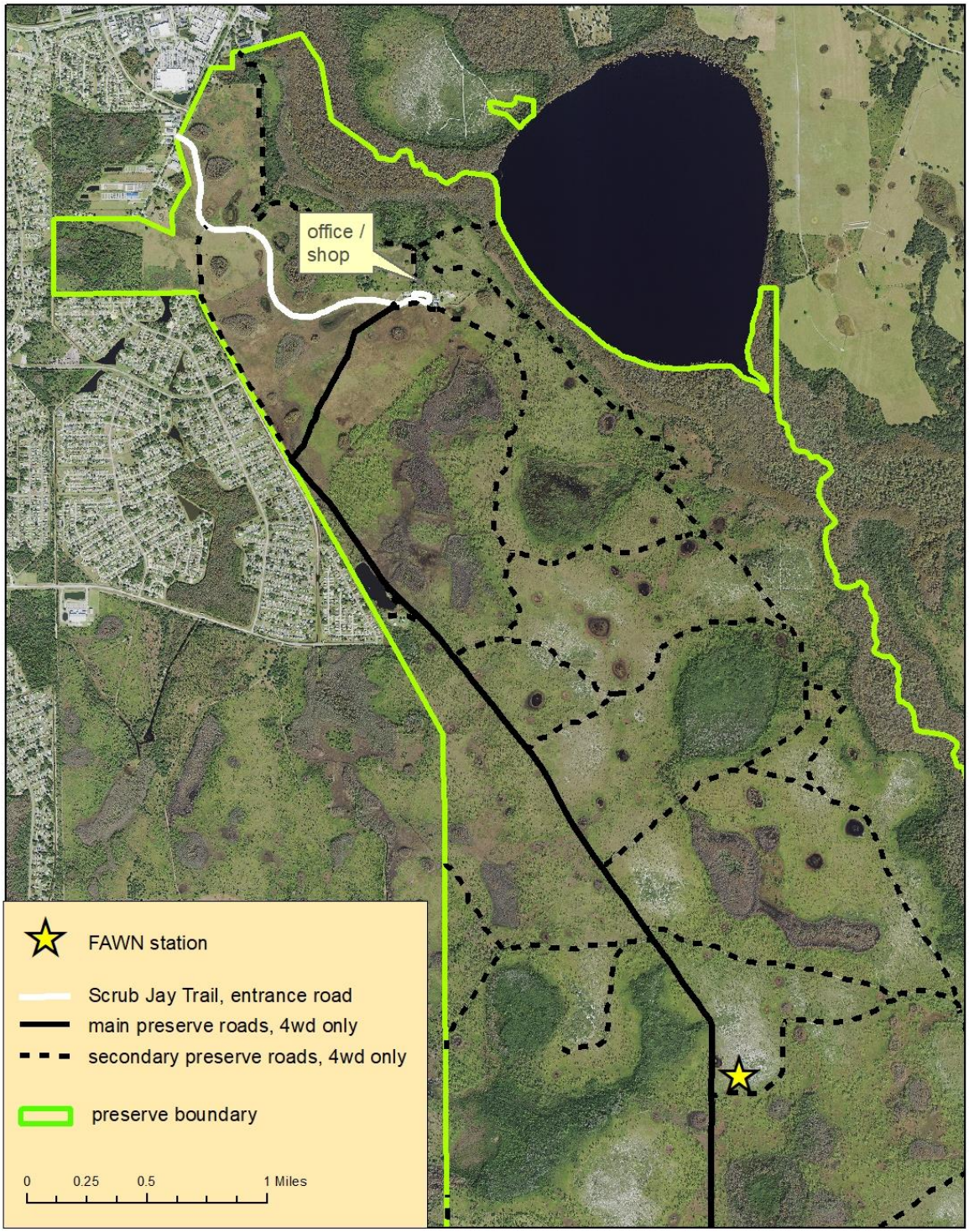


Figure 12. Location of the FAWN weather station at Tiger Creek Preserve.

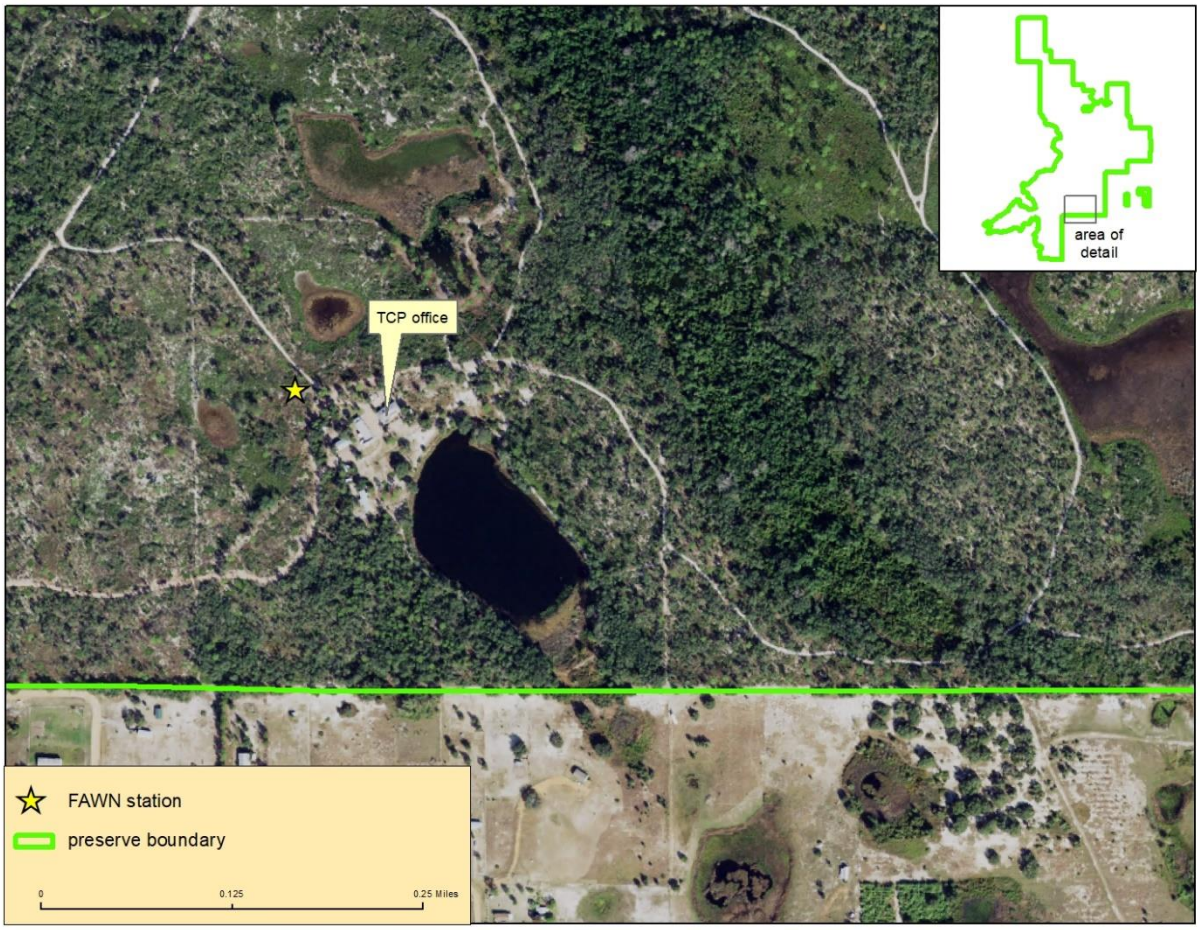


Figure 13. Location of the FAWN weather station at Blowing Rocks Preserve.

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 14). 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.

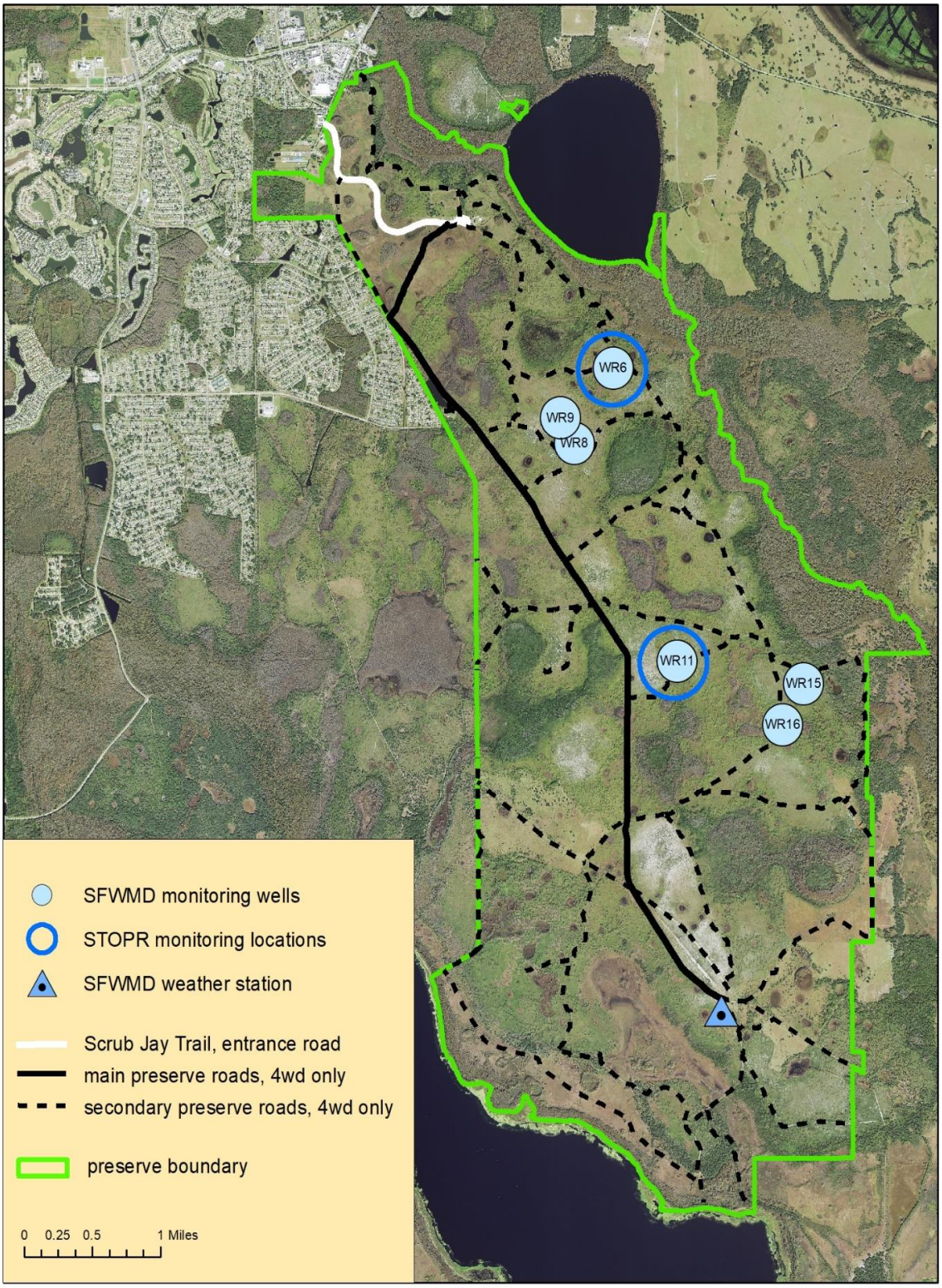
The water level data from these wells and others monitored by the South Florida Water Management District (SFWMD) are being used to develop a groundwater/surface water interaction model. This model will estimate impacts of future groundwater withdrawals occurring in metro-Orlando on the wetlands being 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 continue 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. If 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 14. 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 15. 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 15) 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:

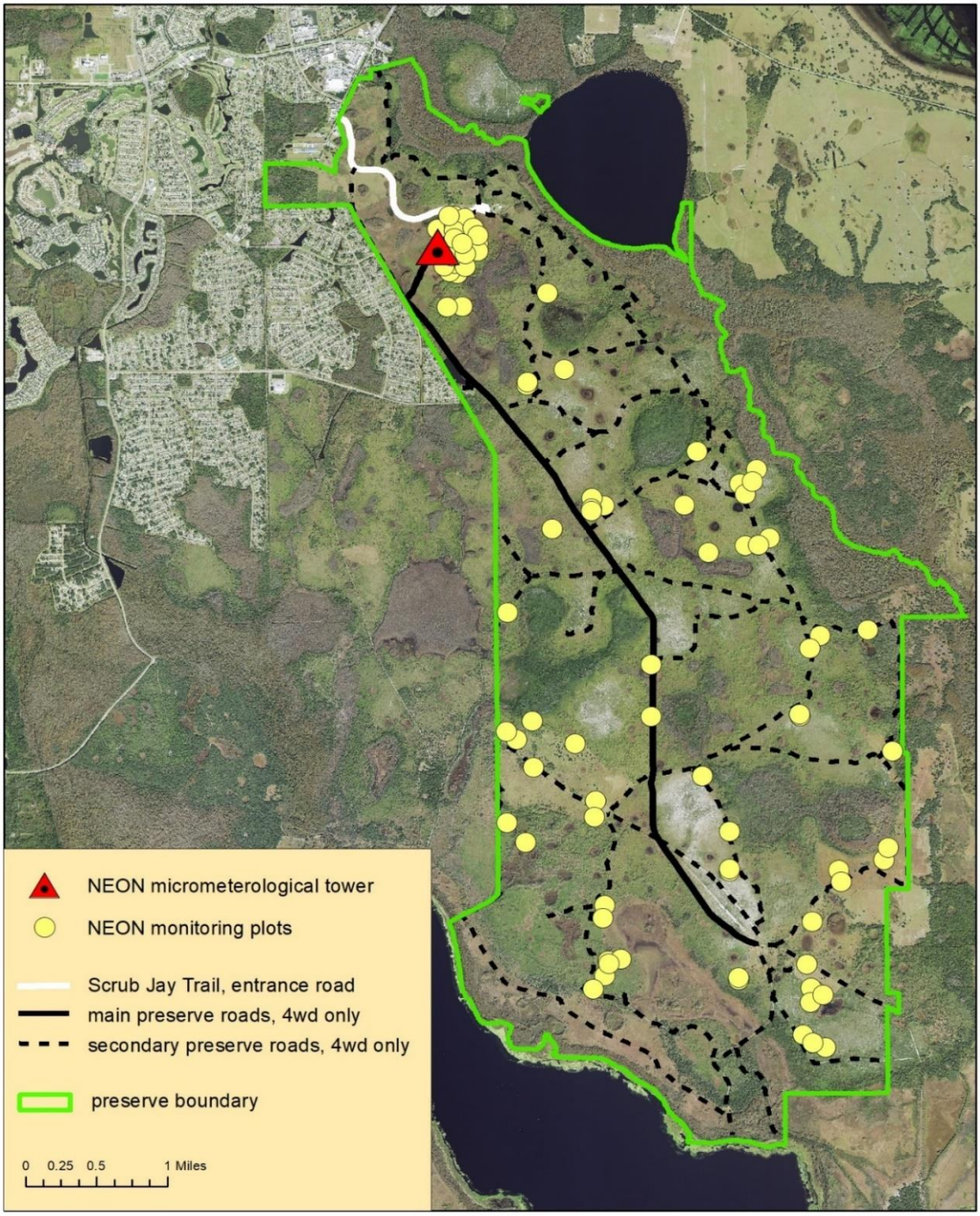
1. Breeding land birds: Bird observations are made to capture interannual variation in avian abundance, diversity, and distribution (NeonScience.org). All bird species observed are recorded using point count methods.

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.

Papers published: As of Jan 2024, at least 101 papers have been published on studies using NEON data from DWP: Biazzo 2023, Bogdziewicz et al. 2023, Brown et al 2023, Chuckran et al. 2023, Dallas et al. 2023, Dynarski et al. 2023, Hakkenberg et al. 2023, Hansen et al. 2023, Hernandez et al. 2023, Hu et al. 2023, Huang et al. 2023, Ibanez et al. 2023, Kaspari et al. 2023, Li et al. 2023, Lin et al. 2023, Lombardozzi et al. 2023, Parsons et al. 2023, Qin et al. 2023, Qui et al. 2023, Richardson 2023, Robertson et al. 2023, Sanchez-Zapero et al. 2023a., Sanchez-Zapero et al. 2023b, Santos and Herndon 2023, Sipps and Magruder 2023, Tolan et al. 2023, Wang et al. 2023a, Wang et al. 2023b, Weintraub-Leff et al. 2023, Xu et al. 2023, Yi et al. 2023, Armstrong et al. 2022, 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, Musinsky et al. 2022, Paull 2022, Possinger et al. 2022, Qiu et al. 2022, Rishmawi et al. 2022, Robertson 2022, Schweiger and Laliberte 2022, Sharma et al. 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, 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, Qiu et al. 2021b., Stachewicz et al. 2021, Weinstein et al. 2021a, Weinstein et al. 2021b, Yang 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. 2020, 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 15. 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 16). 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.

Progress/Results: ONGOING. Station data is available from the Incorporated Research Institutions for Seismology (IRIS) website: https://ds.iris.edu/ds/nodes/dmc/data/#requests.

Papers published: At least 62 publications have been produced using data from the DWPF station: Aster et al. 2023, Ping et al. 2023, Guimaraes 2022, Gualtieri et al. 2021, Ringler et al. 2021, Baer 2020, Ringler et al. 2020, Sobolev et al. 2020, Yepaneshnikov and Yepaneshnikova 2020, Ritzwoller and Feng 2019, Braunmiller et al. 2019, Kim and Lekic 2019, Frietsch et al. 2019, Heyburn et al. 2018, Tary et al. 2018, Mancinelli 2016, Sobelev et al. 2016, Ye et al. 2016, McNamara et al. 2015, Ringler et al. 2015a, Ringler et al. 2015b, van Driel et al. 2015, Lou 2013, Obrebski et al. 2013, Ottemöller and Bormann 2013, Yuan 2013, Bogue 2012, de Azevedo 2012, Groos et al. 2012, Ringler et al. 2012, Trnkoczy et al. 2012, Yano 2012, Gonzalez et al. 2011, Molodenskii 2011, Groos 2010, Ringler et al. 2010, Baba et al. 2009, French et al. 2009, Tsai 2009, Bensen et al. 2008, Dewey and Dellinger 2008, Liang and Langston 2008, Tauzin et al. 2008, Bensen 2007, Bensen et al. 2007, Gonzalez et al. 2007, Ichinose and Goldstein 2007, Ishii 2007, Tsai and Ekström 2007, Hensen et al. 2006, Wilson 2006, Liu et al. 2005, McNamara et al. 2005a, McNamara et al. 2005b, Baptiste 2004, Fnais 2004, McNamara and Buland 2004, O'Leary et al. 2004, Benetatos et al. 2002, and McLaughlin et al. 2000.

Figure 16. 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

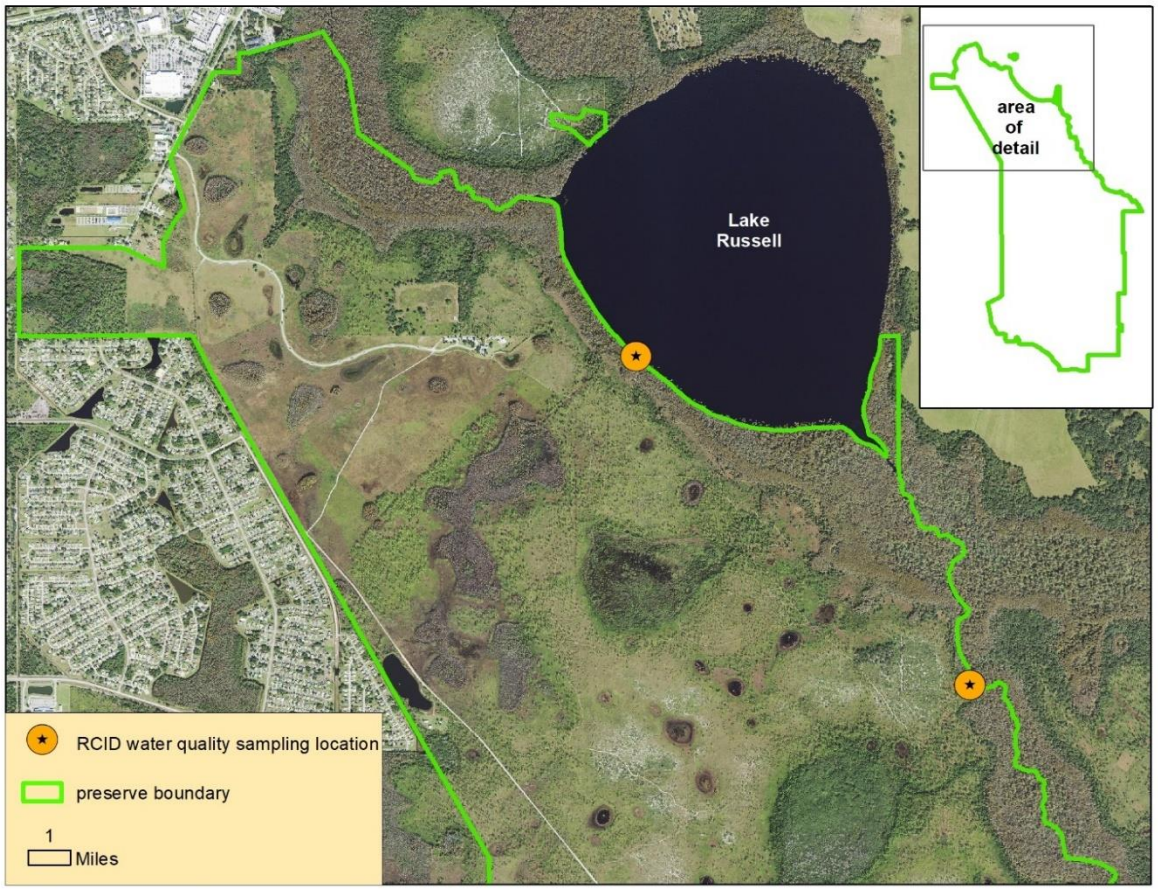
Duration: 1998-present

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 17). 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 17. 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 established in the CFWI monitoring by 2025. Two surficial aquifer wells with continuous water level and rainfall recorders will be installed at each preserve in upland habitat within 50 m of a wetland (Figures 18 and 19). 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 18. Location of CWFI monitoring wells at Saddle Blanket Scrub Preserve.

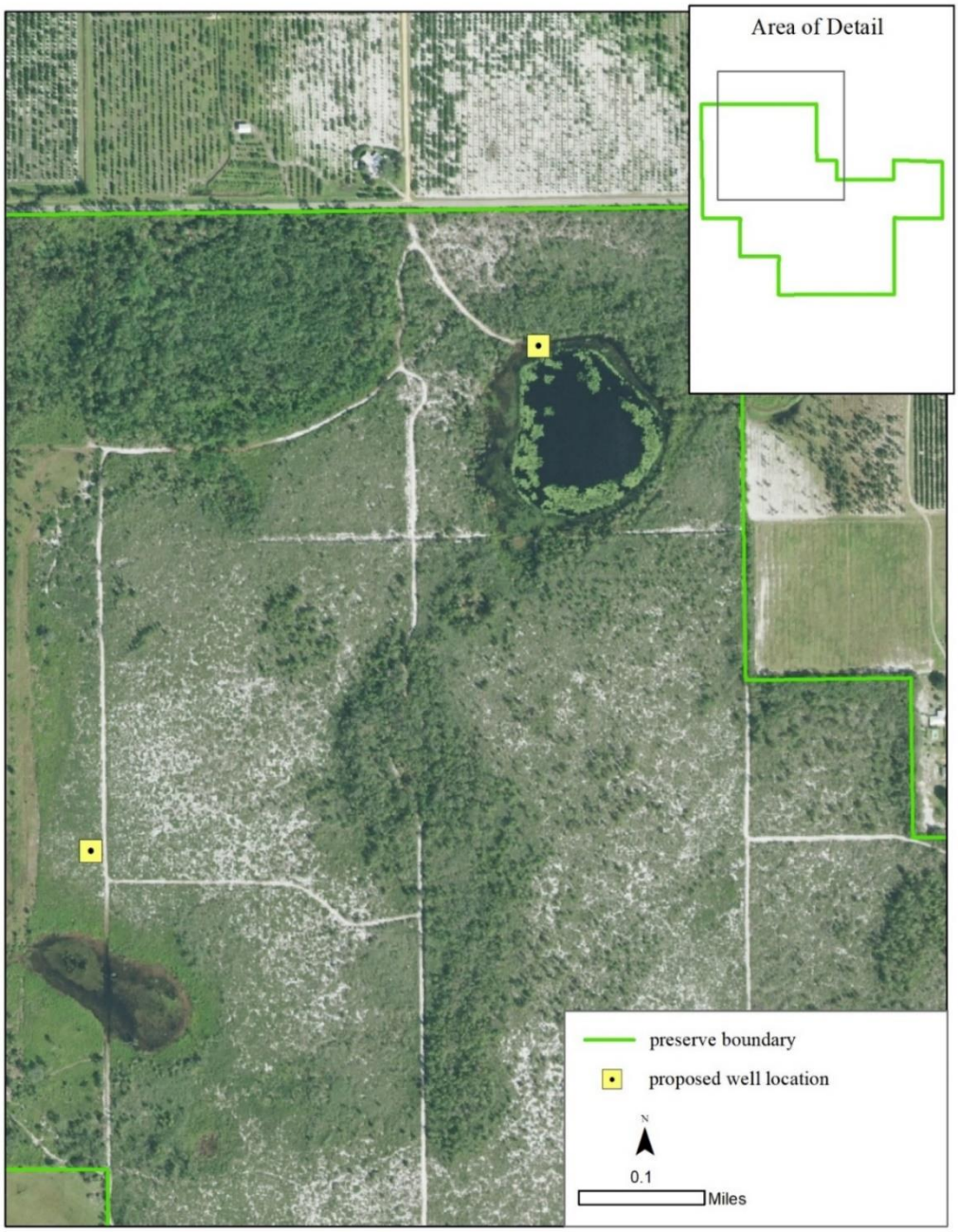
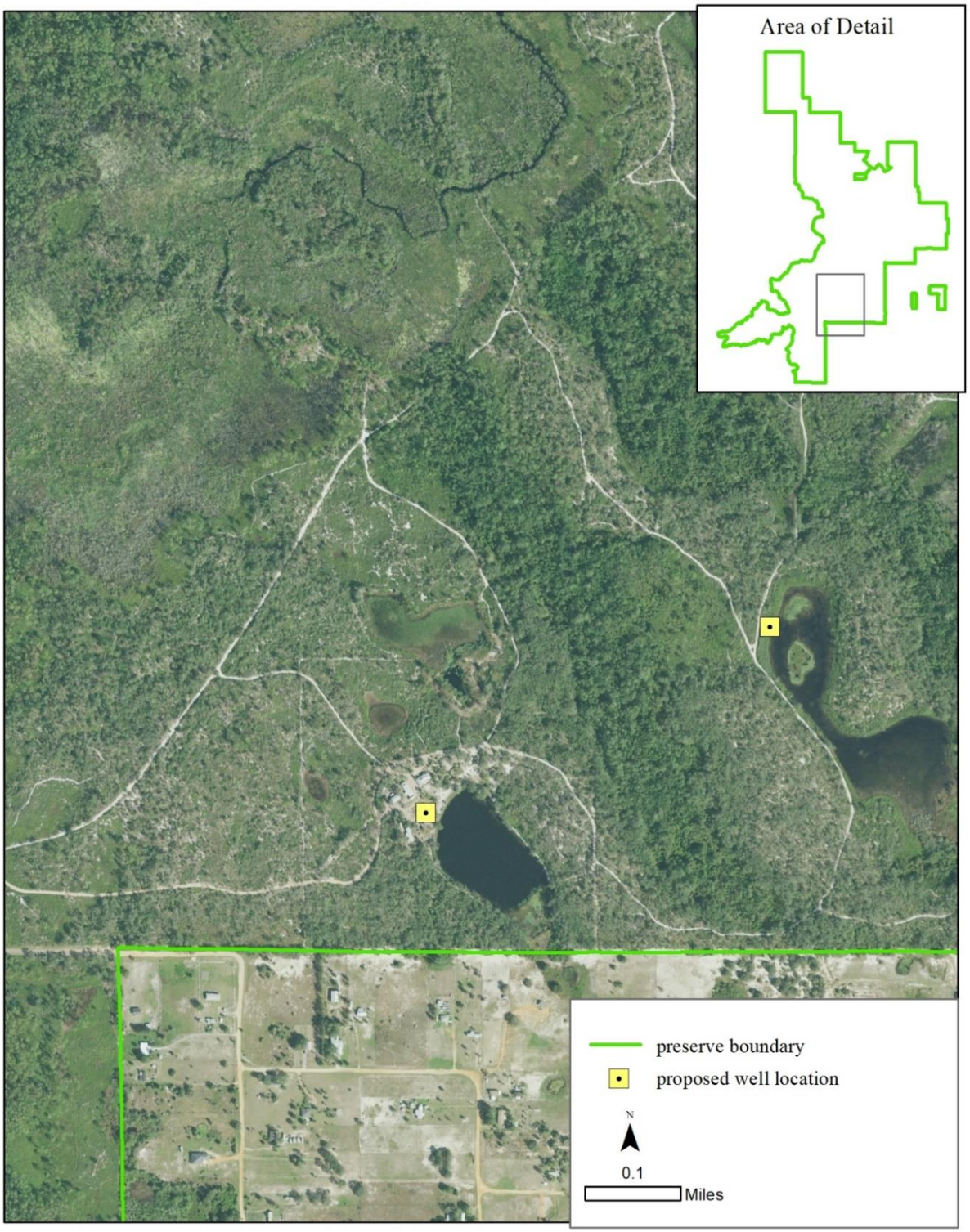


Figure 19. Location of CFWI monitoring wells and vegetation transects at Tiger Creek Preserve.



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