Corkscrew Swamp Sanctuary
Western Everglades Research Laboratory

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EXECUTIVE SUMMARY

The past two years have been years of tremendous growth as we have begun re-establishing a formal research program at Corkscrew Swamp Sanctuary (CSS). Spurred by a need for sound ecological research focused on Western Everglades' conservation issues, we began with a focus on restoration of short-hydroperiod wetlands which provide critical early-season prey production and foraging grounds for Wood Storks and other wading birds, yet have been disproportionately lost throughout the Southwest Florida landscape.

A short-hydroperiod wetland restoration experiment at Lee County's Wild Turkey Strand Preserve (WTSP), coupled with a wetland mitigation comparison site at Panther Island Mitigation Bank (PIMB) and an in-tact short-hydroperiod reference site at CSS, was initiated in 2013. In the first two years of this project, we established a long-term monitoring program to characterize the sites pre-restoration and provide a way to quantify ecological change and compare restoration alternatives post-restoration. Short-hydroperiod wetland monitoring components were developed and added gradually and included hydrology (water levels and rainfall), vegetation (herbaceous, shrubs and trees), aquatic fauna (throw and minnow traps), birds (quarterly point counts for all birds and seasonal monthly call-back surveys for wading and marsh birds), and mammals (trail cameras). All data collected to date represent the pre-restoration baseline. While comparative analyses would be premature at this point, we provide descriptive data and discussion of trends in species presence among sites and through the hydrologic year.

With the re-establishment of a research presence at Corkscrew in the last several years, long-term monitoring conducted by resource management has been gradually transferred over to research staff. Hydrological monitoring along the boardwalk and at the Blair Center has continued. This past year we added several new hydrologic monitoring sites and our volunteers helped begin filling in holes in our historic hydrologic record using stored logbooks and datasheets. Qualitative examination of historic hydropatterns (1969-1999) to those of recent years (2000-present) suggested marked differences, with recent years drying markedly faster and longer than was seen historically. This past year was the first year our research staff was involved in Wood Stork nest monitoring and no nesting was observed at the Corkscrew colony (nesting was observed at two other small colonies in our region, but nest counts have not been completed).

Several other noteworthy projects, partnerships and accomplishments from this program in the past two years are detailed in this report:

- We established an ecological monitoring program (and began collecting pre-restoration data) at the Rigsby Tract, a 28-acre abandoned tree farm on Corkscrew that we plan to restore to pinelands and wetlands in the coming years.
- We completed the first year of a study examining the role of inundated Brazilian pepper as habitat for aquatic fauna. We found aquatic fauna standing stock in Brazilian pepper

was similar to that seen in native woody vegetation and herbaceous vegetation, but an additional year of study is needed to strengthen this study.

- We recruited and engaged a number of volunteers to allow us to expand our efforts by helping carry out field, lab, and data entry tasks associated with monitoring projects.
- We worked to organize and improve the process of collecting and utilizing citizen science data collected at Corkscrew and enlisted volunteers to help secure historic citizen science data by scanning and entering data into new databases.
- We held the first annual Corkscrew Watershed Science Forum, a one-day scientific meeting held at Corkscrew and attended by 80+ people, including regional scientists, land managers, educators, volunteers and the public.
- We began a series of monthly, informal mid-day seminars to assist with continuing science education of staff, volunteers and the public, and to promote the presence of our research program.
- We worked to build and strengthen collaborative partnerships with professionals from several South Florida organizations, including Florida Gulf Coast University (FGCU), the Southwest Florida Cooperative Invasive Species Management Area (SWFL CISMA), University of Florida Institute of Food and Agricultural Sciences (UF-IFAS), and the US Department of Agriculture's Agricultural Research Service (USDA-ARS).
- We attended and participated in numerous professional meetings throughout the state and produced several peer-reviewed publications.
- We frequently hosted visiting scientists from state, federal, and university research labs conducting research that included wetland greenhouse gas emissions and carbon storage, genetics and life history requirements of non-native plants and animals, factors impacting vulnerability of anuran species to global climate change, and population and life history studies on native plants and animals.

In the coming year we will work to maintain the momentum our growing research program built in its first two years. Our plans for WY16 include continuation and expansion of our long-term monitoring projects (habitat restoration, hydrology and Wood Stork nesting), continued focus on securing and utilizing historic data sets, improving our capacity for and utilization of citizen science at Corkscrew, and further developing relationships with colleagues and partners throughout the state in an effort to produce and support scientific products that will be of the greatest benefit to the Sanctuary and our Western Everglades ecosystem.

CONTENTS

CORKSCREW SWAMP SANCTUARY HYDROLOGIC MONITORING

Summary of effort

Hydrology was monitored throughout the Sanctuary using a combination of staff gauges, groundwater wells, and rain gauges (Figure 1). Surface water level was recorded daily by volunteers at two staff gauges (A- and B-gauges) located along the boardwalk. Groundwater levels were monitored using data loggers in wells along the boardwalk at the north Lettuce Lake and at five backcountry sites. A Stevens gauge also recorded water levels at the north Lettuce Lake. Rainfall was recorded daily at the Blair Center and monthly at two backcountry sites.

History of hydrology data collection

Staff Gauges – Water level data have been collected by Audubon staff since shortly after the Sanctuary was established using a combination of hardbound log books (1965-2004) and datasheets (1996-present). An effort began in 2012 (and remains underway) to scan these data and enter them into a database. Currently, available data begin at the B-gauge late-1959 and are sparse until 1969, after which several sizable data gaps exist. Data from the A-gauge begin in 1969 with numerous data gaps. Many of these data gaps will be filled as we continue to work through the hardcopy data.

Corkscrew's A-gauge

Wells – Groundwater data have been collected at the north Lettuce Lake since 2008 with several data gaps. In 2014, data loggers were installed and data collection re-commenced at four backcountry wells that collected data in the early 2000s: Mud Lake, NW, T1 and T2. An additional well in a new location (Prairie-Pine) was established and data collection commenced June 2015. All wells are currently fitted with Rugged TROLL 100 data loggers recording 2X daily. A BaroTROLL is centrally-located adjacent to the lab to record background barometric pressure. All data are downloaded monthly. The *Infinities, USA* data logger that had been in place at the Lettuce Lake well for many years failed in late 2014 and was replaced June 2015 with a Rugged TROLL 100.

Rain Gauges – Daily rainfall data were recorded beginning January 1969 and data are inconsistent through 1971. Daily rainfall data are more consistent from 1972 forward. Data gaps and earlier data may be filled as we continue to QA/QC data from log books and datasheets. Rainfall is recorded daily by Blair Center opening staff and logged as the previous day's rainfall (we assume most rainfall accumulated the previous day). Due to concerns about the possible effects of canopy overgrowth at the rain gauge location, a second rain gauge was installed January 2015 in an open area in the parking lot. Both rain gauges will continue to be maintained through 2015 in order to evaluate the accuracy of the original gauge and to provide a mechanism for adjusting prior rainfall data, if necessary. To date, data from the two gauges are highly correlated (R^2=0.998, N=146).

WY14 & WY15 hydrologic events and trends

Wet season rainfall was generally higher than average in WY14 (6/1/13-5/31/14) and WY15 (6/1/14-5/31/15; Figure 2), particularly early in WY14. Dry season rainfall was more typical each year, with the exception of January WY14 and April WY15, which were particularly high.

Water levels at Corkscrew in WY14 and WY15 began within the typical range (interquartile range=1st to 3rd quartile) of water levels on record (1969-present). Water levels were particularly high July 2014, setting record water levels 7/21-24 (Figure 3). Dry season recession rates were nearly always higher than the median for WY70-present. Recession rates were particularly high in the late dry season in both WY14 and WY15 (Figure 4). Notable dry-season reversals occurred in January 2014 (13.7 cm 1/29-2/2), February 2015 (8.5 cm 2/4-7) and March 2015 (11.0 cm 3/27-28). Hydroperiod at the Lettuce Lakes in WY14 and WY15 was 336 and 287 days, respectively.

Decadal hydrologic trends

Examination of hydrologic data in recent years compared with those of earlier decades (1970-present) indicates marked changes in Corkscrew's hydropattern since WY00. Median wet season rainfall (June-September) since WY00 was consistently as high or higher than that of previous decades and median dry season rainfall (January-May) since WY00 was often as low or lower than that of previous decades (Figure 5).

We compared the interquartile range (IQR) of daily water depths at the B-gauge WY00-15 with those of the 1970s (WY70-79), 1980s (WY1980-89), and 1990s (1990-99). The hydropattern in the recent decade is strikingly different from those of earlier decades (Figure 6), with a sharper peak in wet season water levels, a steeper dry season decline, and a longer dry period in April and May. Recession rates were 1.4-2X higher than the highest seen in previous decades in all dry season months except December, when they were similar to those seen in the 1980s and 1990s (Table 1). Recession rates were not compared for May as surface water was rarely above ground through May in recent years. Between WY70 and WY99, surface water was below ground at the B-gauge in April one year and in May six years (3% and 20% of years, respectively). Since 2000, surface water was below ground at the B-gauge in April eight years and in May thirteen years (50% and 81% of years, respectively). These findings and trends are somewhat preliminary as we continue to fill-in data gaps using paper records and to QA/QC historic hydrologic data.

This initial examination of decadal shifts in hydrology suggests significant changes that may help explain recent changes in marsh vegetation and annual Wood Stork colony failure, among other responses. We will continue to work with these data to better quantify and understand these trends and we will work to compare these patterns with those at other long-term sites in the region.

SHORT-HYDROPERIOD WETLAND RESTORATION MONITORING

Background


Restoration site at Wild Turkey Strand Preserve.

Audubon Florida has partnered with Lee County Conservation 20/20 with the goal of restoring habitat at Wild Turkey Strand Preserve (WTSP) in a manner that increases the early nesting season foraging habitat for Wood Storks and other wading birds by (1) increasing the prey base in both existing and restored wetlands, (2) establishing adequate connections between existing and created dry-season aquatic fauna refuges and the restored shallow wetland habitats, and (3) establishing hydroperiods and topographic contours in the restored wetland units that will concentrate aquatic fauna in November and December. Secondary goals include increasing native wildlife diversity and abundance within the restoration footprint and the adjacent natural areas and altering the hydrology within the project area to more closely resemble natural wetlands in Southwest Florida.

Ecological monitoring is being conducted at wetland restoration sites within WTSP and the Panther Island Mitigation Bank expansion site (PIMBe) (Figure 7) to document and evaluate key ecological changes under three restoration scenarios: *mitigation* (hydrologic restoration + contouring + planting + exotics control) (PIMBe); *simple restoration* (hydrologic restoration + contouring) (WTSP); and *re-wetting* (hydrologic restoration only) (WTSP).

Monitoring efforts will provide a pre-restoration characterization of each site, followed by monitoring throughout (if/when possible) and following restoration activities in order to track successional changes. The primary focus of monitoring will be the ability of the wetland to provide forage opportunity for wading birds (esp. Wood Storks during the early months of the historic nesting window (November-December)). Also of great importance is documenting the habitat value for large- and medium-sized mammals and resident and migratory birds. Tangential research questions that we also hope to address include:

1. How does the forage opportunity (aquatic prey abundance and wading bird use) provided by habitats infested with non-native trees compare to that of un-vegetated and/or similarly-structured native-habitats?
2. What is the impact of cattle grazing on wading bird forage opportunity?
3. What is the impact of the eventual spread of Burmese pythons and other predatory non-native reptiles on medium-sized mammals?

Summary of effort

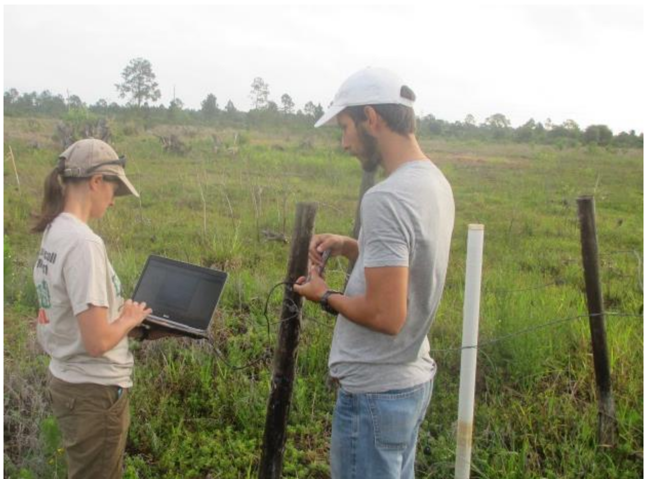
The restoration area targeted at WTSP consists of 6 fields (formerly row crops) with peripheral and/or bisecting ditches that hold water seasonally (total ≈250 acres). Peripheral ditches are bermed and latitudinal furrows span most fields (furrows are longitudinal on the NW field). An existing cattle lease is in place at the targeted restoration site. Restoration at this site is still in the planning/permitting phase, but the first phase of restoration has been identified as the ≈45-acre NE field (Figure 8).

The restoration area at PIMBe consists of three connected fields with some peripheral and bisecting ditches (with berms): phase 10 (≈110 acres), phase 9 (≈185 acres), and phase 8 (≈78 acres)(north to south). Active restoration (earth moving) began on phase 8 in May 2015 (Figure 9), at which point most monitoring was suspended due to the disturbance and interference caused by having research staff on-site. Camera traps remained on-site on phases 9 and 10 for another month but were later removed due to the large amount of traffic on-site and the increased potential for damage or theft. Cameras removed from PIMBe were moved to previously-restored phases of PIMB and will remain there throughout restoration in order to begin collecting data on restored wetlands later in succession. Monitoring components will resume as soon as is feasible, post-restoration.

Pre-restoration monitoring focuses on capturing baseline ecological data on each property (PIMBe and WTSP), particularly in existing ditches and deeper natural wetland features in the case of aquatic-dependent wildlife. Due to the relatively short window of time available pre-restoration, our focus was on getting projects off the ground as quickly as possible and monitoring components were added as protocols, equipment, and manpower were in place. Hydrologic monitoring began in late-dry season WY13 and most other components began in wet season WY14. Short-hydroperiod wetlands near Corkscrew's Blair Center were added in wet season WY14 to serve as a reference site. Details on methodology and the specific timelines for each monitoring component are included below.

Hydrology

Methods – Hydrologic monitoring began May 2013 at WTSP. A network of 11 wells were installed by KECE (Kevin Erwin Consulting Ecologist, Inc.) and checked/maintained by KCEC until we assumed responsibility in October 2013 (Figure 10). Wells were fitted with Rugged TROLL 100 data loggers (In-Situ Inc.) that reach ≈1.5-2 m below ground surface and a reference BaroTROLL was co-located with one centrally-located well (NAS5) ≈1.5 m above ground. Data loggers recorded data 2X daily. A standard rain gauge was co-located with one well (NAS1) and all hydrology data were collected monthly.



Interns, Emily Uhlmann and Jacob Zetzer, downloading hydrology data from a well at WTSP.

While we have one well (NW) in close proximity to PIMBe, on-site hydrologic monitoring has been conducted by the mitigation bank as part of the restoration process. Data will be obtained in the future but are currently unavailable.

Results – The annual patterns in water levels recorded at many wells on WTSP were similar to those seen at Corkscrew in WY14 and WY15. Wells on the eastern edge of WTSP, however, indicated abrupt, unnatural changes in water levels concurrent with periods of high water levels (primarily wet season) (Figure 11). These variations in water levels are likely a result of manipulations by the neighboring agriculture operation (pumping to keep ground water levels at or below the surface during growing season high water events). Efforts are being made by restoration project managers to better understand these water level fluctuations and to work with neighboring property owners to determine how we can concurrently meet the water needs of our wetland restoration and their farming operation.

Vegetation

Methods – Surveys to quantify vegetation were conducted semi-annually (October and April) at 18 sites on WTSP and 11 sites on PIMBe beginning April 2014 (Figures 13 & 13). Sites were selected by randomly selecting plots in accessible areas of each property from a 10 m x 10 m grid, while ensuring representative spatial coverage of restoration sites (a reference short-hydroperiod area was also included at WTSP).

A nested quadrat survey protocol was adapted from Ohio EPA and the North Carolina Vegetation Survey[1]. Each site consisted of a 10 m x 10 m primary plot. Within each primary plot, trees were surveyed within the entire 100-m^2 quadrat (identity, DBH), shrubs were surveyed within two 16-m^2 quadrats (identity, count by diameter class (0-1, 1-2, 2-2.5, 2.5-5, 5-10, 10-15, 20-25, 25-30, 30-35, 35-40, >40 cm)), and herbaceous vegetation was surveyed within three 1-m^2 quadrats (identity, cover class (0-1, 1-2, 2-5, 5-10, 10-25, 25-50, 50-75, 75-95, >95%))(Figure 14). Total cover was also estimated for each herbaceous quadrat. Plots were aligned with cardinal directions, with shrub quadrats always selected as the NW and SE regions of the primary plot. For the herbaceous plots, a 1-m^2 PVC quadrat was haphazardly tossed from the center of the primary plot (quadrats were different each sampling event). Percent cover calibration templates were used to minimize observer bias and increase estimate accuracy. Herbaceous plots were always sampled first to minimize disturbance associated with foot traffic within the plot.

Resource Manager, Allyson Webb, conducting a vegetation survey at PIMBe.

Results – Vegetation monitoring was conducted on WTSP and PIMBe once in WY14 and twice in WY15. Data are only available from 90% of sites in April and November 2014 and 34% of sites in April 2015 (no WTSP data are available from April 2015). We will work to fill existing data gaps. Non-native, invasive herbaceous species were common on both properties (Table 2), and were often dominant within plots. Monitoring plots will be added at CSS in WY16.

Aquatic fauna

Methods – Aquatic fauna standing stock was measured three times throughout each hydrologic year coinciding with important months for Wood Stork foraging in SWFL: October, December and February. Sampling began at WTSP in October 2013, at PIMBe in December 2013, and at CSS in October 2014. We initially planned to use 1-m^2 throw traps consistently, but a variety of habitat structure issues, including thick vegetation, deep water, and very narrow ditches with steep banks, prohibited effective throw trap sampling in some locations. Rather, we used a combination of throw traps and wire mesh minnow

[1] water.epa.gov/type/wetlands/assessment/oh1plant.cfm

traps, using both methods when possible to aid in efforts to make data comparable (Table 3; Figure 15, 16 & 17).

At throw trap sites, throw traps (3/site at ditch sites and 5/site at marsh sites) were deployed haphazardly and cleared using a combination of a bar seine (1.5-mm mesh) and dip nets (1-mm and 3-mm) and standard methods.[2] Water depth and vegetation characteristics (density of emergent stems, %cover of floating species) were recorded for each trap. At minnow trap sites, six minnow traps (three 6-mm and three 3-mm mesh) were set in a non-linear cluster (≈10 m apart) and remained in place for ≈24 h (minnow trap arrays were linear in ditches). Water depth was recorded for each trap. All collected fauna were kept on ice in the field and frozen for preservation upon return to the lab. (tadpoles were collected but most other amphibians and reptiles were identified and measured in the field and released). In the lab, each individual was identified (fishes and crustaceans to species, other invertebrates to lowest feasible taxonomic level) and sex (some fishes, crayfish), length (all fishes, crayfish and tadpoles), and mass (all specimens) were recorded.

Intern, Jennifer Breen, retrieving a minnow trap during aquatic fauna sampling.

Results – Data from February 2015 are not represented in this summary, as sample processing is not yet complete (15 throw trap samples and 42 minnow traps samples). During the 5 throw trap sampling events in WY14 and WY15, we deployed 135 throw traps and collected 4,794 fish, 1,278 invertebrates, and 124 herpetofauna (Table 4). Throughout the hydrologic year, brown hoplo, Eastern mosquitofish, flagfish, and crayfish contributed the greatest proportion of aquatic fauna biomass (Everglades crayfish dominated in October and December, and Everglades and slough crayfish contributed equally in February). Notable contributions to biomass were also made by least killifish in October and tadpoles in December.

Habitat structure proved challenging for throw trapping at many sampling sites (primarily those with dense non-native grasses) so minnow traps became the most common sampling

[2] Jordan, CF, S Coyne and JC Trexler (1997) Sampling fishes in heavily vegetated habitats: the effects of habitat structure on sampling characteristics of the 1-m^2 throw trap. Transactions of the American Fisheries Society 126: 1012-1020.

method. When possible, minnow traps were also deployed at throw trap sites to allow for catch comparisons (comparative analyses have not yet been performed). Because minnow trap sampling was not added until October 2013 and February 2015 data are unavailable, available minnow trap data are unevenly distributed across months and examination of fauna trends throughout the hydrologic year are not yet possible. During the 4 minnow trap sampling events in WY14 and WY15, we deployed 245 minnow traps and collected 5,874 fish, 375 invertebrates, and 171 herpetofauna (Table 5). Eastern mosquitofish, flagfish, African jewelfish, and Everglades crayfish were most abundant and most common in minnow traps.

Birds

ALL BIRDS

Methods – Single observer bird surveys were conducted quarterly (January, April, July, October), roughly timed to include spring and fall migration periods. Protocols were initially established in 2009 as an intern project (following standard variable-radius survey methods) and 7 routes were established at PIMB (existing PIMB and PIMBe), in addition to a route along the CSS boardwalk.[3] With the start of the short-hydroperiod restoration monitoring project (2013-14), the ongoing point count effort was re-evaluated and routes were condensed to 3 routes on PIMB (a subsample of existing points were selected to continue and others were eliminated) (Figure 18). Two new routes were established on WTSP in January 2014 (Figure 19). Points for all surveys were chosen by randomly selecting points from a 200-m grid superimposed on the study site. Beginning in 2015, surveys were changed to fixed-radius and point duration was changed from 5 to 6 minutes. Routes will be added through the CSS reference sites in the coming year.

Field Technician, Mica Rumbach, training for point count bird surveys along Corkscrew's boardwalk.

Surveys began within 30 minutes of sunrise and were completed within 3 hours of sunrise. Each survey route was comprised of six points. At each point, a 3-minute wait period allowed birds to settle after the surveyor's arrival, after which all birds seen or heard within a 50-m radius of the observer were recorded for each of 6 minutes. Species and detection type (visual/aural) were recorded for each individual (or group), along with any breeding or

[3] Kate Halstead, independent project for Corkscrew Swamp Sanctuary Internship

behavioral observations. No attracting devices or noises were used. Weather observations were made at each point (precipitation, temperature, cloud cover, wind speed, background noise). Travel time between sites was limited to 20 minutes. In addition to the timed point surveys, a checklist of bird species seen or heard within the entire study area was completed for each route.

Results – A total of 61 point count surveys were conducted on PIMB and WTSP through May 2015 (including training surveys, original routes, and consolidated routes). We observed 101 species during the course of the surveys, although 18 were observed along routes between points and were never recorded during the timed portion of the survey (Table 6).

While analyses have not been performed on the full dataset, preliminary analyses were presented at the 2015 Corkscrew Watershed Science Forum and focused on spatial and temporal variation in bird communities on PIMB. Survey points were categorized as ag/disturbed (13 points), forested (5 points), transition (9 points) or marsh (15 points) and communities were examined based on habitat and season (fall, winter, spring, summer). Analysis of similarities (ANOSIM) based on a standardized Bray-Curtis dissimilarity matrix revealed bird communities on PIMB varied by habitat (Global R=0.230, P=0.001) but not by season (Global R=0.334, P=0.999). Non-metric multidimensional scaling (nMDS) indicated similar communities in forested and ag/disturbed habitats which overlapped little with marsh communities (transition communities overlapped all habitats). Univariate analyses (ANOVA) indicated relative abundance varied among habitats in 11 of the 12 most common species, with Common Gallinule, Sandhill Crane, Boat-tailed Grackle, Common Yellowthroat, Red-shouldered Hawk, and Red-winged Blackbird more common in the marsh, Eastern Meadowlark and Gray Catbird more common at ag/disturbed sites, and Red-bellied Woodpecker and Mourning Dove more common at forested sites. Season varied in 5 of the 12 common species, with Northern Cardinal and Mourning Dove more common in spring and summer than in fall and winter, and Gray Catbird and Common Yellowthroat more common in fall and winter than in spring and summer. At PIMB we detected 29 of the 88 SWFL bird species identified by Audubon as climate endangered or threatened.[4] While preliminary, these analyses demonstrated our ability to see spatial and temporal trends and detect important indicator species in our point count data.

WADING BIRDS

Methods – Wading bird surveys began December 2013 at WTSP, January 2014 at PIMBe, and October 2014 at CSS (1 route per location; Figures 20, 21 & 22) and were conducted monthly when standing water was present (September-March/April). Survey methods were adapted from those of the Standardized North American Marsh Bird Monitoring Protocol[5] and focus on wading and marsh birds and a few wetland-associated passerine species.

[4] climate.audubon.org/

[5] Conway, CJ (2011) Standardized North American Marsh Bird Monitoring Protocol. Waterbirds 34(3): 319-346.

In this double-observer survey, the primary observer relayed sightings to the secondary observer who recorded these and any observations missed by the primary observer. Primary/secondary roles alternated for each point. Surveys began within 30 minutes of sunrise and were completed within 3 hours of sunrise. Each survey route was comprised of 7 points, although a shorter route (5 points: 3 in short-hydroperiod marshes, 2 on the Rigsby Tract) was used at CSS due to the small spatial extent of the focal habitat. At each point, a 3-minute wait period allowed birds to settle after the surveyors' arrival, after which all birds seen or heard within a 200-m radius semicircular plot were recorded for each of 5 minutes. The 5-minute observation period was immediately followed by a 4-minute call-back period during which an MP3 recording played calls from Least Bittern, King Rail, American Bittern and Pied-billed Grebe (Table 7). For each individual or group, species, detection type (visual/aural), and distance class (<10 m, 10-25 m, 26-50 m, 51-100 m, 101-150 m, 151-200 m) were recorded, along with any breeding or behavioral observations. Weather observations were also made at each point (temperature, sky, wind speed, background noise). Travel time between sites was limited to 20 minutes.

Field Technician, Mica Rumbach, and intern, Mitch Petoskey, conducting a wading bird survey at WTSP.

Results – Overall, 15 target species were observed at WTSP, 10 target species were seen at PIMBe, and 6 target species were seen at CSS (Table 8). Recorded call-backs prompted calls from 2 King Rails and 1 Clapper Rail that would likely have remained undetected in a traditional point count survey (they were not detected in the visual survey). In WY14, a total of 4 surveys were conducted at WTSP with an average of 12.8 birds/route observed (Mottled Duck and Killdeer were most common). A total of 3 surveys were conducted at PIMBe but no target species were observed.

In WY15 a total of 8 surveys were conducted at WTSP and PIMBe and 7 surveys were conducted at CSS/Rigsby. More target species were observed September-December, than January-April. Early in the season, an average of 3.8 birds/route was seen at WTSP (White Ibis was most common), 7.3 birds/route was seen at PIMB (White Ibis and Great Egret were most common), and 1.3 birds/route was seen at CSS (Black-bellied Whistling-Duck, Belted Kingfisher, Great Egret and Marsh Wren). Later in the season, 5.5 birds/route was seen at WTSP (White Ibis and Cattle Egret were most common), 1.8 birds/route was seen at PIMBe (Cattle Egret was most common), and 1 bird/route was seen at CSS (all were Swamp Sparrow).

Mammals

Methods – Trail cameras were deployed at CSS beginning October 2013 and at WTSP and PIMB beginning November 2013. Due to the relatively small geographic extent of short-hydroperiod wetlands at the Corkscrew reference sites, cameras were placed in the general vicinity of short-hydroperiod wetlands but not directly within or adjacent to them. Camera locations targeted areas mammals would be likely to travel or be seen (game trails, roads, etc.) while minimizing proximity to one another. Camera locations were rotated every 3 months to increase spatial coverage and site replication and to reduce theft/vandalism. Data were downloaded and cameras were maintained bi-weekly to monthly.

All photographs were examined and each animal was identified and counted. Images were processed by two independent observers and line-by-line comparisons of each observation were made using the database. Every image for which the two observers disagreed on species identifications and/or counts was examined by a third observer who served as a tie-breaker.

Trail camera image of a bobcat with prey on PIMB.

Results – Trail cameras were deployed at a total of 13 sites on CSS (11 in WY14 and 6 in WY15; Figures 23 & 24, respectively), 48 sites on PIMB (20 in WY14 and 36 in WY15; Figures 25 & 26, respectively), and 32 sites on WTSP (13 in WY14 and 28 in WY15; Figures 27 & 28, respectively). CSS mammal monitoring represented a minimal effort due to a limited number of cameras available and a greater need in other locations (CSS cameras were not rotated). Efforts were hampered by camera theft, vandalism, and an unusually high failure rate in our primary brand/model of cameras.

Cameras collected a total of 682,060 images representing 17,128 camera trap days (through April 2015). Image processing remains underway and images have currently been processed through December 2014; no analyses have yet been performed. Cameras consistently captured all 4 species of large mammals expected in this region: Florida panther, Florida black bear, white-tailed deer, and cattle (WTSP only). We observed 6-10 species of medium-sized mammals at each site, with more species usually observed during the dry season

(Table 9). Rabbits and rodents were most difficult to identify to species. Arboreal mammals and rodents appear to be underrepresented in our data. Big Cypress fox squirrel was the only expected non-rodent mammal species not documented.

Amphibians and reptiles

Plans have been made with Frank Mazzotti (UF/IFAS) to cooperatively organize a herp blitz at Corkscrew in the coming months and to begin incorporating EIRAMP (Everglades Invasive Reptile and Amphibian Monitoring Program) surveys to monitor native and invasive herpetofauna in the vicinity of restoration monitoring sites. Mazzotti's team has made one visit to scout field sites and preliminary route ideas were discussed but surveys have not yet begun.

Discussion

The first two years of this project were highly successful, given the growing pains of our young program and our need to work out kinks in a complex, from-scratch monitoring program. Many of the site locations and sampling protocols developed prior to beginning field work required re-evaluation and modification due to field conditions. Some of these tweaks included addition of minnow trap sampling for aquatic fauna when it became evident throw traps would not be feasible and/or effective at many sites, increasing maximum time allowed between point count (and wading bird) surveys due to arduous terrain and the need for different forms of on-site transportation, and re-evaluation of criteria for trail camera placement with considerations of equipment security due to public access (permitted and trespassing), land management activities, and vehicular traffic associated with contractors and other on-site staff. On-site transportation has been one of the biggest challenges on WTSP and PIMBe (particularly during the wet season) and remains one of the biggest limitations for our efforts.

Staffing also changed throughout the first two years of this project and had a significant impact on monitoring progress. Beginning with only the Research Manager, land management interns became available to assist with field activities in fall 2013. With this arrangement (in addition to contributions made by a few field volunteers) we were able to keep up with field activities and collect data on schedule, but sample processing and data entry became back-logged and the project struggled due to a shortfall in the amount of organization and oversight that a project of this nature requires. A full-time, temporary field technician was added summer 2014 which provided a new level of project organization and stability. In early 2015 we were able to bring our field technician on as permanent staff which provided critical continuity for this project and allowed us to increase our productivity and our effectiveness in other project areas. In the latter part of WY15 we were able to make tremendous strides in catching up on sample processing, recruiting and training volunteers to assist with various aspects of this project, building complex MS Access databases for each project component, entering all field and laboratory data into databases, and ensuring the security of our digital and hardcopy data. Completion of a monitoring handbook with protocols and datasheets for all project components was instrumental in improving project continuity and training staff, interns, and volunteers.

Volunteers have been integral to this project, assisting with all aspects including field surveys and sampling, laboratory processing of aquatic fauna samples, processing of trail camera images, and data entry. While we've learned to better judge which tasks are best suited to volunteers based on their availability, background, and expertise, training and coordinating volunteers still requires significant effort. Trail camera photo processing, in particular, is extremely well-suited for volunteers (who process a large proportion of photos) and most issues with quality control are overcome by the double-observer data comparison system that we devised. In the first two years of this project we have also relied on Corkscrew resource management staff as research program volunteers. As we move forward we will work to recruit additional volunteers to help reduce the workload on these staff.

We have begun shifting our monitoring effort as active restoration activities have made sites unavailable (or impractical) for monitoring. As more restoration comes on-line at PIMBe, we will begin shifting our effort to previously-restored phases of PIMB, specifically those with shorter hydroperiods or habitats that may provide aquatic refuges for newly restored sites. We anticipate phase I of WTSP restoration will begin this year, at which time we will probably suspend monitoring on that phase of WTSP (depending on traffic and other disturbance) and continue our efforts elsewhere on WTSP.

In the coming year we will continue to expand our monitoring program to ensure we are collecting the data that will be needed to quantitatively evaluate restoration alternatives. This year, with the assistance of colleagues at UF, we will integrate EIRAMP-type surveys to document and compare native herpetofauna at study sites and serve as early-detection for large invasive reptiles. We will also begin characterizing vegetation at minnow trap sampling sites (as is done with throw traps) and add a point count survey route in the vicinity of our reference sites at Corkscrew's short-hydroperiod wetlands. This addition will further stress our need to train staff and recruit volunteers to assist with point count surveys. We will also need to work to supplement our network of trail cameras this coming year. We've experienced an unusually high failure rate with the Moultrie trail cameras that we initially purchased for our mammal monitoring. While we've worked closely with Moultrie to replace all cameras covered under warranty, replacement options that have included two newer models have failed to eliminate our problems. Furthermore, donated cameras that have allowed us to establish monitoring sites at CSS have begun to age and fail. In the coming year we will explore the use of a fundraising campaign that capitalizes on the popularity of our trail camera images. Once we find a make/model of camera that is more reliable than what we currently have, we will also work to see what sponsorship or other support opportunities may be available from the manufacturer.

RIGSBY TRACT RESTORATION MONITORING


The Rigsby Tract.

Background

This proposed restoration project will restore a 28-acre abandoned tree farm to its original natural pinelands habitat and associated short-hydroperiod wetlands, including mesic, hydric and scrubby flatwoods and upland pine forests (Figure 29). Florida's natural pinelands are one of the most highly threatened habitats in the state. In southwest FL, agriculture, residential communities, roads and canals have isolated the Greater Corkscrew Marsh from the small pockets of upland habitat that remain in the region. Severe habitat loss and fragmentation combined with poor fire management on remaining uplands have put many upland-dependent species at risk. Corkscrew Swamp Sanctuary also proposes to establish a "Restoration Classroom" at this site to serve as a replicable model for restoration of threatened upland habitat while simultaneously providing an outdoor experimental classroom to engage diverse audiences in on-the-ground conservation. In addition to benefits for our education program, this restoration classroom will provide added benefit for visiting researchers, and will increase our ability to accommodate undergraduate and graduate research students.

Ecological monitoring will accompany Rigsby Tract restoration (pre- and post-) to document species response to restoration efforts. Species of Greatest Conservation Need associated with this habitat include 22 mammals, 17 birds, 6 amphibians, 19 reptiles, and 16 invertebrates, and include Northern Bobwhite Quail, Red-cockaded Woodpecker, gopher tortoise, Eastern indigo snake, and gopher frogs. Monitoring components will be similar to (and use methodology of) those of our short-hydroperiod wetland restoration project. Additional components will likely be added at this site as the project develops and progresses due to its close proximity and additional upland habitat, and the educational benefit for visitors and students, and convenience for volunteer engagement.

Summary of effort

While restoration plans are still in development, we began collecting pre-restoration data in December 2014. Wading bird, aquatic fauna and mammal monitoring have begun and point count surveys will begin fall 2015. Vegetation monitoring will be added when our resources permit. Some vegetation monitoring was conducted at this site in January 2009, but methodology was different from our current methodology and it is uncertain how comparable data will be. We plan to eventually add a well on this property in the vicinity of the research station, but data will be somewhat redundant and its utility will be primarily educational since water levels at this site have been shown to closely correlate with those of other active stations (M. Duever, personal communication).

Aquatic fauna

Methods – This property is primarily upland with standing water primarily restricted to a peripheral ditch. Dense creeping signal grass prohibited the use of throw traps in the ditches so minnow traps were used exclusively. Five ditch sites were chosen for aquatic fauna monitoring, with site selection made in the field based on accessibility, openness of aquatic vegetation, and hydroperiod (longer hydroperiod was selected for) (Figure 30). In WY15 sampling was conducted in December and February, setting 6 traps/site (three 6-mm and three 3-mm mesh) with a 24-h soak time, as described previously.

Results – Average water depth at trap locations was 26.2 (±1.2) cm in December and 21.8 (±1.3) cm in February. One site was not sampled in February due to a combination of very shallow water and dense vegetation. Aquatic fauna samples have only been processed through December 2014, so February 2015 data are not yet available. In December 2014, 1 amphiuma, 2 Everglades crayfish, and 171 fish (7 species) were collected from a total of 30 minnow traps (Table 10). While African jewelfish were found in less than half of the samples, they represented 64% of the total fish catch and contributed 86% of the total fauna biomass.

Wading birds

Methods – Two sites on the Rigsby Tract were added to the wading bird survey route established for nearby short-hydroperiod wetlands (Figure 22) and surveys of this new route were conducted monthly December through April of WY15. Point locations were chosen to maximize the number of points possible on the property while minimizing overlap of the 200-m semicircle plots. Call-back survey methods were the same as those described previously.

Results – In the five surveys that were conducted December 2014 to April 2015 no target species (wading birds, ducks, and other wetland-dependent species) were seen on-site.

Four target species were observed as fly-overs: Double-crested Cormorant, Great Blue Heron, Great Egret, and Tricolored Heron.

Mammals

Methods – Three trail cameras were deployed on the Rigsby Tract in December 2014 (Figure 31). Site selection was challenging due to the heavy vegetation on this property and selections were based on habitat openness (clear view through vegetation, with plowed or game trails selected preferentially) and an attempt to minimize proximity to one another. Cameras remained in place and were not rotated on the Rigsby Tract as was done elsewhere due to the small property size and limited habitat openness. Data were downloaded and cameras were maintained bi-weekly to monthly.

Results – Between December 2014 and July 2015 trail cameras sampled a total of 343 camera trap days and provided 7,868 images. Digital photographs have not yet been processed for this time period.

Discussion

We have successfully begun the pre-restoration monitoring effort on the Rigsby Tract, but to date only a small amount of data have been collected and a lag in sample processing times has made even fewer data available at this time. Interpretation of available data would be premature at this point in time.

In WY16 we plan to continue the wading bird, aquatic fauna, and mammal monitoring initiated this past year. We hope to begin vegetation monitoring this coming fall and point count points will be included on this property before the end of the calendar year. With the restoration timeline uncertain, our goal is to collect as much baseline data as possible prior to restoration or significant land management activities.

WOOD STORK NEST MONITORING

Wood Storks nesting at the Lenore Island colony in WY15.

Summary of project transition

The 2015 Wood Stork nesting season represented a transition from project oversight from the resource management team (M. Knight) to our research team. A meeting was held 1/22/2015 to begin the transition process. M. Rumbach accompanied M. Knight on a monitoring flight 3/10/2015 and S. Clem accompanied M. Knight on a monitoring flight 4/9/2015. M. Knight committed to training research staff on photo processing and completing processing for the 2015 nesting season.

In absence of any protocol for flights or photo analyses, the training portion of the transition consisted of verbal explanations of how data are collected. At each of 5 known colonies (Corkscrew (CS), Baron Collier/SR29 (BC29), Collier/Hendry Line (CH), Lenore Island (LI), Caloosahatchee East (CE); Figure 32), reference photos are taken from ~800 ft. and overlapping photographs are taken on passes of each colony from 500 ft., from which nest counts can be made. Some guidance was given on how to piece photos together during analysis to ensure complete colony coverage and avoid missing or double-counting nests. Determinations of chick age are used to back-calculate nest initiation dates and counts are made of the numbers of nests and numbers of chicks per nest. Data are recorded on paper and running totals are kept for the season. Total counts for each season are retained in Corkscrew's entries in the South Florida Wading Bird Report. No paper data records or individual flight records (nest counts/flight or numbers or dates of flights/season) were available. M. Knight transferred all remaining files containing digital photos from flights to S. Clem. Transferred data include photos from flights 3/27/09, 4/13/09, 5/8/09, 2/11/10, 5/10/10, 3/16/11, 4/20/11, 3/13/12, 4/24/12, 3/27/13, 5/9/13, and 1/29/15 and a spreadsheet of nest counts from 2014. Data from previous years (prior to M. Knight's project oversight) have not yet been transferred over to research staff.

2015 nesting summary

No Wood Stork nesting was observed at the CS, CH or CE colonies in 2015. Wood Stork nesting activity was first observed at the LI and BC29 colonies 1/29/15 and 3/10/15, respectively (Table 11). Photographs from the 4/9/15 flight have not yet been processed so annual totals have not yet been calculated for active colonies.

FIELD STUDY: BRAZILIAN PEPPER AS AQUATIC HABITAT

Florida Gulf Coast University Environmental Studies senior Joshua Erickson completed a field study on the aquatic fauna community utilizing Brazilian pepper for his senior research project in October 2013 (project advisors: Shawn Clem, David Green). Due to the marked devaluation of aquatic habitats infested with Brazilian pepper and other non-native woody vegetation, we sought to evaluate its role as an aquatic refuge by comparing aquatic fauna communities with those of adjacent native woody vegetation and open marsh habitat.

FGCU senior, Josh Erickson, with fish retrieved from a minnow trap set in inundated Brazilian pepper at WTSP.

Methods

This study was primarily conducted within inundated latitudinal furrows on degraded agriculture fields at WTSP (Figure 33). One site was located nearby in a Brazilian pepper hedge adjacent to an intact marsh. While Brazilian pepper dominated this short-hydroperiod habitat (inundated <6 mo./yr.), some areas retained a mix of native trees and some areas were open with only herbaceous vegetation.

At each of 10 study sites, we deployed 5 minnow traps (3 ⅛" mesh and 2 ¼" mesh; 24-h soak). Site selection was based on accessibility and water depth (water had to be deep enough to submerge trap mouths). Vegetation at sites was categorized as Brazilian pepper (80-100% coverage) (5 sites), mixed (60% Brazilian pepper, 40% live oak or wax myrtle (2 sites), or open marsh (small coastal plain willow or grass) (3 sites).

Data collected from the 5 traps from each site (identity, count, and mass of each specimen) were pooled and analyses focused on community structure (analysis of similarities (ANOSIM) based on a standardized Bray-Curtis dissimilarity matrix) and catch per unit effort (CPUE; abundance and biomass). CPUE data were ln(y+1) transformed prior to analyses to fulfil assumptions of normality.

Results

Average water depth was 19.0±1.3 cm and average water temperature was 23.3±0.6 °C. Non-native fishes comprised <1% of the total fish catch. While community structure did not vary between habitats (Global R=-0.06, P=0.559), overall, more fish species were found in the marsh habitat (Table 12). Total fish CPUE did not vary among habitats (abundance: $F_{2,7}$=1.26, P=0.341; biomass: $F_{2,7}$=0.90, P=0.449), nor did that of any common fish species (all P>0.05) or CPUE of Everglades crayfish (abundance: $F_{2,7}$=1.47, P=0.292; biomass: $F_{2,7}$=1.26, P=0.342).

Conclusion

This study represented a preliminary effort to characterize the aquatic fauna community within short-hydroperiod wetlands dominated by Brazilian pepper and to compare the community with those of un- or lesser-infested wetlands. While the sample size was limited, these data demonstrated that Brazilian pepper heads do support an aquatic fauna community comparable to that of adjacent habitats. Increased repetition (spatially and temporally) is needed to strengthen this preliminary finding.

The primary challenge in conducting this experiment was the timing. Water levels drop very quickly on this part of WTSP (refer to hydrology section of short-hydroperiod wetland restoration monitoring), leaving only a small window of time between peak water levels (when furrows are inundated and aquatic fauna communities are re-established) and drying of this area. In this study, data were collected the first two weeks of October and we intended to sample a third week (to increase sample size) but the furrows had dried. Lee County Conservation 20/20 land management has agreed not to remove any Brazilian pepper from this area to allow us to complete another study year. We plan to run another round of this study in late September 2015.

CITIZEN SCIENCE

Daily sightings

Daily observations (presence/absence) of bird, butterfly, mammal, amphibian and reptile species along the boardwalk have been consistently recorded by boardwalk naturalists since 1998. In April 2013, sightings sheets were changed to allow for observations of bird species in 8 habitat categories (cypress, pinelands, marsh, hammock, wet prairie, lettuce lake, birdfeeders, campus), as well as those "everywhere," in flight, and where habitat was unknown. Data sheets were stored in large binders in the volunteers' boardwalk outpost (the Bunting House). A volunteer entered bird data into eBird and QA/QC'd data by removing or changing entries deemed improbable. Additional data recorded on daily sightings sheets (number of observers and presence/absence of non-bird taxa) and bird presence in different habitats (2013-present) was not entered into spreadsheets.

The research team began working with volunteers to better utilize this valuable dataset in October 2014. We currently have volunteers scanning hardcopy datasheets to secure the hardcopy data. We have also created an MS Access database to house these data and our volunteers have begun the process of entering and QA/QC-ing prior years' data to make them accessible. Going forward, data will easily be exported from our database in a format that will be easily uploaded to eBird (ebird.org) by our volunteers and daily data will be readily available to examine patterns in species presence.

Monthly bird counts

Volunteers, Keith Johnson, Art Blatt, and Phil Nye, during a monthly bird count (photo: Dick Brewer).

Bird surveys have been completed monthly by a group of volunteers since 1993. Surveys follow four routes (boardwalk, washout, central marsh, and south dike) and each route is captained by a route leader who recruits their monthly survey team and tallies data. Survey teams travel together and the number of observers varies based on the route and the time of year. Routes are generally fixed, although there is no formal protocol and adherence to routes throughout the 20+ years of the surveys is unknown. Surveys begin early in the day and duration can range from 2 to 8+ hours. Each route has a different set of 4-5 habitats within which observations are tallied. Data were entered and compiled by volunteers. Volunteers also pulled data from these surveys and submitted them to eBird.

Due to concerns with data management and a request from volunteers, the research team took over data management for the monthly bird counts in early 2015. Around the 25th of each month a route-specific spreadsheet for the upcoming month is emailed to route leaders. When counts are complete, data are sent back to the research team and imported into the database. Data are then exported in eBird format and sent to a volunteer who submits them. This arrangement has reduced numerous potential sources of error in these data and has simplified the process for volunteers. Once in the database, data are analysis-ready and can be readily filtered or exported for other purposes. We continue to work to import previous years' data into the database.

The potential utility of data from this dataset for examining decadal changes in the bird population is great. Potential challenges or limitations include variation in study areas (e.g., adherence to routes), effort (e.g., number of observers, time spent in different habitats, duration of counts), expertise, and detection (e.g., visual and aural limitations of observers, varying interference caused by different modes of transportation). As we continue to examine prior years' data we will work to identify and describe data biases in preparation for analyses.

Beginning this fall we plan to establish point count routes concurrent with monthly bird count routes and begin working with volunteers to train them in standardized point count protocols. Conducting standardized point counts concurrent with existing monthly counts will help us better understand the utility of existing data and make decisions on how to proceed long-term with this project.

Other projects

Other citizen science projects currently underway at Corkscrew include a semi-annual North American Butterfly Association butterfly survey and Audubon's Christmas Bird Count, both of which are organized and managed outside of the research program by Sally Stein, Director of Public Programs. Digital data from these projects are stored on our server and discussions have taken place about scanning the hard-copy datasheets to better secure the historical record of these projects.

VISITING RESEARCHERS

The following research projects were conducted at Corkscrew Swamp Sanctuary by visiting researchers between June 2013 and May 2015:

- **[February 2014]** Rebecca Schneider (Ph.D. student in ecology with Dr. Linda Whittingham and Dr. Peter Dunn at University of Wisconsin) visited to do visual surveys on Common Yellowthroat population ecology. She submitted a formal proposal to conduct research (including mist netting and banding) at CSS, but this project was suspended due to a change in her graduate project direction.
- **[May 2014]** Emily Schultz (M.S. student in geology with Dr. Anne Raymond at Texas A&M University) collected soil cores in the old-growth cypress to measure leaf litter accumulation.
- **[Summer 2014, 2015]** Jeremy Cohen (Ph.D. student with Dr. Jason Rohr at University of South Florida) collected southern toad metamorphs to use in a laboratory experiment examining the disease resistance of toads from different regional populations. This experiment has implications for species survival with global climate change.
- **[December 2014]** 30 African jewelfish were collected and fin clips were sent to Dr. Natalia Belfiore (University of Tampa) for a study examining African jewelfish genetics.
- **[February 2015]** SFWMD staff installed a new telemetered rain and stage recorder near the fish farm. The site name is CRKSWPS and began recording data 2/12/2015. Data are reported in DBHydro.
- **[April 2015]** One sample of water lettuce was collected from the Lettuce Lake and mailed to Paul Madeira, Molecular Biologist at the Invasive Plant Research Laboratory, USDA-ARS (Ft. Lauderdale, FL) to be used as part of a genetics study that seeks to verify the native/non-native status of *Pistia stratiotes* in Florida.
- **[May 2015]** Approximately 44,000 *Megamelus scutellaris* (adults and eggs), a biocontrol insect for water hyacinth, were released 5/28/2015 at three locations on the north end of Washout Road by Dr. Carey Minteer, Research Entomologist with USDA-ARS. Post-release monitoring will be conducted by USDA-ARS staff.
- **[ongoing]** Dr. William Mitsch (Florida Gulf Coast University) conducts and supports numerous experiments on greenhouse gasses (carbon sequestration, methane emission) using Corkscrew as a primary research site. Studies include those of Jorge Villa (Ph.D. student), Andrea Pereyra (M.S. student), Xiaoyu Li (visiting scholar), Mingzhi Lu (visiting scholar) and a team of researchers from University of Tartu, Estonia (Jaan Pärn, Kristina Sohar, and Kaido Soosaar), among others.
- **[ongoing]** David Fox (Ph.D. student in forestry with Dr. Michael Andreu at University of Florida) takes measurements of sabal palmetto to examine population dynamics.

- **[ongoing]** Jason Downing (Ph.D. student with Dr. Hong Liu at Florida International University) monitors a wild coco orchid population to study mycorrhizal associations with native and non-native species.
- **[ongoing]** FWC and partners (Roy McBride) periodically access the Sanctuary to track Florida panther. Visits are coordinated by Sanctuary administration and no data or other information are provided to the research team.
- **[future]** Dr. George Wilder (Naples Botanical Garden) has committed to completing a vascular plant inventory for the Sanctuary beginning in Winter/Spring 2016. The effort will take several years and assistance will be needed from volunteers and/or interns.

We are aware of two papers recently published using data collected at Corkscrew Swamp Sanctuary by visiting researchers:

Ohio State University doctoral student, Jorge Villa, setting up experimental chambers used to measure methane emissions at a cypress site at Corkscrew Swamp Sanctuary.

Villa, Jorge A. and William J. Mitsch. 2014. Methane emissions from five wetland plant communities with different hydroperiods in the Big Cypress Swamp region of Florida Everglades. Ecohydrology & Hydrobiology 14(2014): 253-266.

Villa, Jorge A. and William J. Mitsch. 2014. Carbon sequestration in different wetland plant communities in the Big Cypress Swamp region of southwest Florida. International Journal of Biodiversity Science, Ecosystem Services & Management, DOI: 10.1080/21513732.2014.973909

EDUCATION & OUTREACH

Mike Duever speaking at the first annual Corkscrew Watershed Science Forum.

Corkscrew Watershed Science Forum

We organized and held the first annual Corkscrew Watershed Science Forum 2/27/2015 at Corkscrew Swamp Sanctuary. The Forum was co-organized by Shawn Clem (CSS) and Kathleen Smith (FWC). This one-day symposium featured thirteen 20-minute presentations from staff at Corkscrew, CREW Trust, Collier County- Conservation Collier, Florida Fish and Wildlife Conservation Commission-CREW WEA, Florida Gulf Coast University, and Florida International University, among others. Over 80 participants attended throughout the day (Figure 34).

Lunch & Learn Seminar Series

This year we initiated/piloted a lunchtime (12-1 PM) seminar series (season only) for staff, volunteers and the public in the Blair Center classroom. Presentations averaged ≈20 attendees and the question/answer period following each presentation (along with private comments from volunteers and staff) demonstrated attendee enthusiasm and interest.

- *Florida Scrub-Jay ecology and Jay Watch citizen science*, Dr. Marianne Korosy, Audubon Florida, 12/18/2014
- *Red-Cockaded Woodpeckers in Big Cypress National Preserve*, Hana Nardi, Florida Fish & Wildlife Conservation Commission, 1/15/2015
- *Effects of the landscape on aquatic communities and animal movement*, Mike Bush, Florida International University, 2/20/2015
- *The Tamiami and other projects of profound and unintended consequences: The archaeology of how humans have shaped the Southwest Florida landscape*, Melissa Timo, Florida Public Archaeology Network, 3/5/2015

We plan to continue this as a monthly series in WY16 (November-March/April).

Professional Meetings and Presentations

- *Table Display*: S. Clem constructed and staffed a table display and looped slideshow to educate Audubon Assembly attendees about identifying and reporting non-native species (October 17-18, 2014, Hutchinson Island, FL). Table display was also used at the October 2014 *Corkscrew After Hours* event.
- Oral Presentation: "*Restoration of critical short-hydroperiod wetlands in the Corkscrew watershed"*, Shawn Clem, Mica Rumbach, and Jason Lauritsen, Big Cypress Research Symposium, 11/6/2014 (M. Rumbach, A. Webb and 2 interns also attended)
- Attended (S. Clem): Fish Chat (organized by Jeff Kline, ENP), Miami, 11/19/2014
- Attended (M. Rumbach): 19th Annual Southwest Florida Invasive Species Workshop, Florida Gulf Coast University, 1/22/2015
- Attended (S. Clem): Wood Stork working group meeting (organized by Billy Brooks, USFWS), Vero Beach, 1/28-29/2015
- Oral Presentation: "Variation in bird communities across habitats at Panther Island Mitigation Bank", Mica Rumbach, Corkscrew Watershed Science Forum, 2/27/2015
- Oral Presentation: "Restoration of critical short-hydroperiod wetlands in the Corkscrew watershed", Shawn Clem and Mica Rumbach, FGCU Wildlife Club, 4/7/2015
- Attended (S. Clem & M. Rumbach): Greater Everglades Ecosystem Restoration Conference, Coral Springs, 4/21-23/2015
- M. Rumbach joined SWFL CISMA as the Corkscrew Swamp Sanctuary representative

Other

- Planned and hosted an Audubon Florida citizen science retreat at Corkscrew Swamp Sanctuary 6/10/2014. This retreat was attended by Sally Stein (Director of Public Programs, Corkscrew Swamp Sanctuary), Marianne Korosy (IBA and JayWatch Coordinator), Matt Smith (Eagle Watch Coordinator) and Shawn Clem.
- Contributed two captioned trail camera photos each Tuesday (beginning fall 2014) for the CSS Facebook page as part of 'Trailcam Tuesday'
- Created and presented a lesson on Wood Storks and wetland ecology (presentation and class activity by S. Clem) for 5th grade students attending an afterschool program at the Golisano Children's Museum of Naples 10/7/2015, 10/9/2015, 2/12/2015
- Contributed article entitled, *Restoring Wetlands – Why and How?* (S. Clem) for Southwest Florida Spotlight Magazine (print run: March 16-31, 2015)

PUBLICATIONS

Fins and Feathers: Why Little Fish Are a Big Deal To Florida's Coastal Waterbirds (2013) A report from The Pew Charitable Trusts and Audubon Florida [http://bit.ly/FinsandFeathers]

Inland fish fauna of the Big Cypress National Preserve, Florida. Marcus Zokan, Greg Ellis, Shawn E. Clem, Jerome Lorenz and William F. Loftus. In press, Southeastern Naturalist.

Using local fishers' knowledge to characterize historical trends in the Florida Bay bonefish population and fishery. Peter E. Frezza and Shawn E. Clem. Accepted, Environmental Biology of Fishes.

Hydrologically-induced seasonal variation in freshwater forested wetland aquatic fauna communities. Shawn E. Clem, Jason A. Lauritsen and Jerome J. Lorenz. Draft nearly ready for submission, target journal: Freshwater Biology.

OTHER PROJECTS

Research staff has participated in several smaller projects the past two years that are noteworthy and/or have taken considerable resources.

Monitoring Handbook:

In an effort to ensure project continuity and increase adherence to protocols by staff and volunteers assisting with monitoring projects, we wrote a 'Wetland Monitoring Handbook' 2014-5. This 126-page handbook has become the primary reference for new interns and volunteers assisting with monitoring projects, and will be a critical tool in understanding any protocol-based biases in the long-term data set we are building through the monitoring projects. The monitoring handbook contains information on project goals, protocols and checklists for field work, maps and coordinates of sampling sites, and protocols for data entry and sample processing. It also contains copies of all datasheets and instructions on how datasheets are to be completed.

Data Storage

We sought to create a secure cache for our digital data (including citizen science data, photographs from Wood Stork flights, and scanned images of datasheets) that would provide peace of mind, prevent catastrophic data loss, and allow networked access by research staff and volunteers. A volunteer built and donated a 1 TB virtualized file storage server with redundant (mirrored) hard drives. This allows staff to access different partitioned drives for different projects and provides a way to limit accessibility to ensure security. The server is also continuously backed-up offsite using a cloud-based backup service. Prior to data being saved to the server, data redundancy is met by requiring volunteers to email completed spreadsheets (so a copy is saved on Audubon's email server) and requiring the use of Dropbox by project personnel working remotely.

Intern Projects

Land management interns at Corkscrew complete an independent project in the subject area of their choice. Projects allow interns to focus on an academic interest that may be outside or underserved in their internship while helping them build their resumes/portfolios and benefitting the Sanctuary. Recent research-related intern projects mentored by research staff include:

> <u>Hana Nardi (Fall 2013)</u>: Hana took a particular interest in the trail camera monitoring project and was instrumental in helping get this project off the ground in its early stages. While her goal was to collect and analyze data, the slow start to this project prevented her from engaging with the project on that level. Hana spent considerable extra time in the field testing, maintaining, and checking trail cameras.

Jennifer Breen (Fall 2015): Jennifer worked closely with Ralph Arwood (volunteer) and Kathleen Smith (FWC Wildlife Biologist) to develop a protocol for bat monitoring at Corkscrew. The purpose of the monitoring would be to determine species presence/absence, identify what habitat types are utilized by bats, and to examine bat presence with proximity or abundance of different wetland habitats. This monitoring effort could be applied at the Sanctuary and/or restoration sites. While no bat monitoring was conducted as part of this project, the final product will be a solid starting point if/when a need for bat monitoring arises or if a future intern wants to work with volunteers to get a volunteer-led project off the ground.

Emily McCall (Spring/Summer 2015): Emily utilized her artistic talent to create a series of 58 technical illustrations (plus supplemental pieces) of aquatic fauna (fishes, invertebrates and amphibians) frequently encountered in throw trap and minnow trap samples. These illustrations will be compiled into an illustrated guide that can be used for field and laboratory identification of specimens. The illustrations will also be used to create identification guides for use in education programs and by boardwalk volunteers.

Female and male flagfish (*Jordanella floridae*) illustrations by Land Management Intern, Emily McCall.

Volunteer Coordination

Volunteers have become a critical resource for our monitoring projects and in helping secure our historic and contemporary data. Each week, considerable time is spent by staff recruiting, training, and coordinating volunteers. Projects that have incorporated volunteer assistance include aquatic fauna monitoring (field: Nick Roach, Aric Christensen; lab: Aric Christensen, Christine Cook), mammal monitoring (field: Nick Roach, Aric Christensen; lab: Aric Christensen, Margie Pitcher, Steve Pitcher, Lisa Schroder, Jennifer Breen), bird monitoring (Art Blatt, Orlando Hidalgo, Sharon Stilwell), and datasheet scanning and data entry (Rose Garcia, Catherine Johnson, Eric Schoen).

Invasive Species

We have had a specific focus on invasive animals for several years through our involvement with Audubon Florida's Invasive Species Task Force and a grant from the J.M. Kaplan Fund. Southwest Florida's location on the spreading edge of invasive, non-native reptiles has put Corkscrew in a prime position for community education and EDRR (early detection and rapid response). For the last few years we have participated as part of the SWFL CISMA (Cooperative Invasive Species Management Area) Animal Working Group and we have encouraged staff and interns to complete the python handling (Python Patrol) training. In the past year we have begun working closely with Dr. Frank Mazzotti (UF-IFAS, Ft. Lauderdale) and his lab (The Croc Docs). Our initial goal was to help establish herpetofauna monitoring surveys similar to their EIRAMP surveys. In April 2015, two separate Argentine black-and-white tegu sightings in close proximity to Corkscrew have temporarily suspended our plans for systematic monitoring and prompted an aggressive focus on early detection and rapid response to tegus in the Corkscrew Island neighborhood and the CREW watershed. We continue to work closely with Dr. Mazzotti, FWC, and SWFL CISMA to understand and address the potential threats tegus pose to Corkscrew, and to assist with trapping and responding to tegu sightings in our neighborhood.

PLANS FOR WY16

This past year we have made tremendous progress getting caught-up with sample processing and data entry, and general organization of our monitoring projects and we have had great success in getting our effort to back-up and archive data (including historic data) off the ground. Uncertainties in staffing put tremendous stress on the infrastructure of our research program, but with the hiring of a full-time field technician in April 2015 we were able to re-allocate effort and stretch the capability of our small staff. In the coming year, we will continue to move forward with our wetland restoration monitoring projects, re-examine and seek to improve our Wood Stork monitoring program, further explore how citizen science can complement our staff-led research projects, and we will continue to nurture relationships with partner organizations throughout South Florida in order to contribute to our understanding of our region's ecology and help establish Audubon Florida as a leader in science-based conservation in Southwest Florida.

Long-term Monitoring Projects

Our short-hydroperiod wetland monitoring project will continue to collect pre-restoration data on WTSP through the WY16 wet season, as we anticipate phase I of restoration beginning the WY16 dry season. Depending on the amount of vehicular traffic and disturbance caused by restoration activities, we plan to suspend monitoring during active restoration on phase I of WTSP. While PIMBe is undergoing active restoration this coming year, our effort will be focused on previously-restored phases of PIMB, with preference for short-hydroperiod wetlands or in-tact habitats that may provide aquatic refuges for newly-restored sites. Site scouting in advance of our October aquatic fauna sampling event will be necessary. Planned additions to our current monitoring program in WY16 include:

- integration of EIRAMP or another herpetofauna monitoring component;
- addition of a point count survey route in the vicinity of the Corkscrew short-hydroperiod reference sites;
- training and addition of staff and/or volunteers to assist with point counts and vegetation surveys to reduce workload on resource management staff; and
- addition of more trail cameras at Corkscrew in order to better characterize mammals using short-hydroperiod wetlands and to replace the aging/failing cameras lost this past year. We are exploring the use of a social media fundraising campaign and/or a request for sponsorship from a manufacturer to achieve this. We will also seek to find a more reliable camera as we've had an unusually high failure rate with the Moultrie models we've primarily been using to date.

This coming year we will also re-evaluate our choice of reference site for the short-hydroperiod monitoring. The current site was selected because of its easily-accessible location and hydroperiod, but the high density of emergent vegetation appears to limit the availability of aquatic prey for wading birds. A second year of wading bird monitoring at this site will help better evaluate the current use of this site by foraging waders. Discussions with restoration planners will also help us better understand restoration targets on each property and will help us determine whether the current site is an appropriate reference or if an additional reference should be added. Additional or alternate reference sites may be selected at Corkscrew or off-site, depending on availability of the desired habitat.

WY16 will provide our first full year of pre-restoration monitoring at the Rigsby Tract. We plan to incorporate point count surveys on this site (likely splitting a route with short-hydroperiod reference sites as was done with wading bird surveys) and begin vegetation surveys, in addition to continuing the monitoring initiated in WY15.

Next year will bring significant improvement to our Wood Stork monitoring effort as we will work to develop datasheets and protocols and to ensure data are being collected using systematic, repeatable methodology. In addition to monitoring the Corkscrew colony, we have begun discussions within the Wood Stork working group to help determine what data are missing from our region that we could help provide to better characterize the status of Wood Storks in SWFL. In advance of the WY16 nesting season, we contacted and were accepted as a partner by LightHawk, a non-profit organization providing no-cost flights (pilot, plane and fuel) for conservation organizations. This partnership has the potential to provide a means for more flight time for research flights and opportunity to engage donors, politicians, or the media in order to highlight issues associated with Wood Storks or other conservation issues in SWFL.

Citizen Science

We recognize citizen science as a valuable data collection tool that may be a particularly good fit for Corkscrew due to the Sanctuary's accessibility, loyal volunteer corps, large annual visitation, and environmental education focus. In the coming year we plan to continue to improve the quality of our current citizen science projects by fine-tuning protocols and communications, improving training, and continuing to emphasize the need for accurate data collection. In order to better understand biases associated with the dataset created by volunteer-led monthly bird counts we will establish point count routes along the monthly count routes and begin conducting point counts concurrent with existing monthly counts. We are hopeful that some current monthly counters will embrace the point count methodology to increase data continuity and help improve the scientific merit of the project.

This past year we have begun the significant task of cataloguing and securing the legacy of natural history data collected at Corkscrew by staff and volunteers. With all of the historic annual logbooks now scanned and secured on our server, a volunteer will begin the task of entering the data into a database so that notes on species observations, water levels, and weather events (among other things) will be available and searchable. We will continue to scan and organize volunteers' daily observation sheets and will eventually move on towards the Christmas Bird Count and other stored data. Our goal is to get data off the shelves and into a format that it can be used to tell the story of the ecological history of the Sanctuary. We are also considering working with our IT staff to make some of these historic data available online for research and/or educational purposes.

We also plan to explore the use of smartphone technology to simplify current citizen science data collection efforts and expand our capability to catalog georeferenced natural history observations and other ecological data at the Sanctuary. Replacing the boardwalk volunteers' daily sightings sheets with a digital data reporting method has the potential to increase volunteer participation and accuracy, provide more detailed data on species' habitat use, and reduce or eliminate staff and volunteer time spent on data entry and QA/QC. We'd also like to explore the use of packaged citizen science smartphone apps for staff and backcountry volunteer sightings and natural history observations. This would provide a clearing house of georeferenced data (including photographs) that can also be used to supplement PR and education efforts. Finally, if/when we find a citizen science app that is easy to use for boardwalk observations, we'd like to encourage visitor sightings (encouraging photographs for verification purposes), perhaps debuting the app at a 'Boardwalk Blitz' natural history inventory event.

Other Projects, Partnerships, and Outreach

Other projects, partnerships, and outreach opportunities that we anticipate in the coming year include:

- completing a second year of the aquatic fauna in Brazilian pepper experiment at WTSP in September/October2015;
- supporting our partnership with Dr. Frank Mazzotti (UF-IFAS) and SWFL CISMA to respond to the threat of Argentine black-and-white tegus and other invasive reptiles within the CREW watershed, including assisting with community outreach, responding to reports of sightings, assisting with trapping efforts, and conducting monitoring;
- holding the second annual Corkscrew Watershed Science Forum at Corkscrew, January 29, 2016;
- facilitating USDA-ARS staff (Dr. Phil Tipping, Dr. Carey Minteer) in conducting a field experiment at Corkscrew examining the cumulative impact of the biocontrol insect *Megamelus scutellaris* and herbicide for controlling water hyacinth;
- helping coordinate and participating in an Audubon Florida citizen science workshop;
- continuing our series of monthly Lunch & Learn lectures scheduled to be held the 3rd Thursday of each month, November 2015-April 2016; and
- assisting Dr. George Wilder (Naples Botanical Garden) in beginning a multi-year inventory of vascular plants within Corkscrew Swamp Sanctuary.

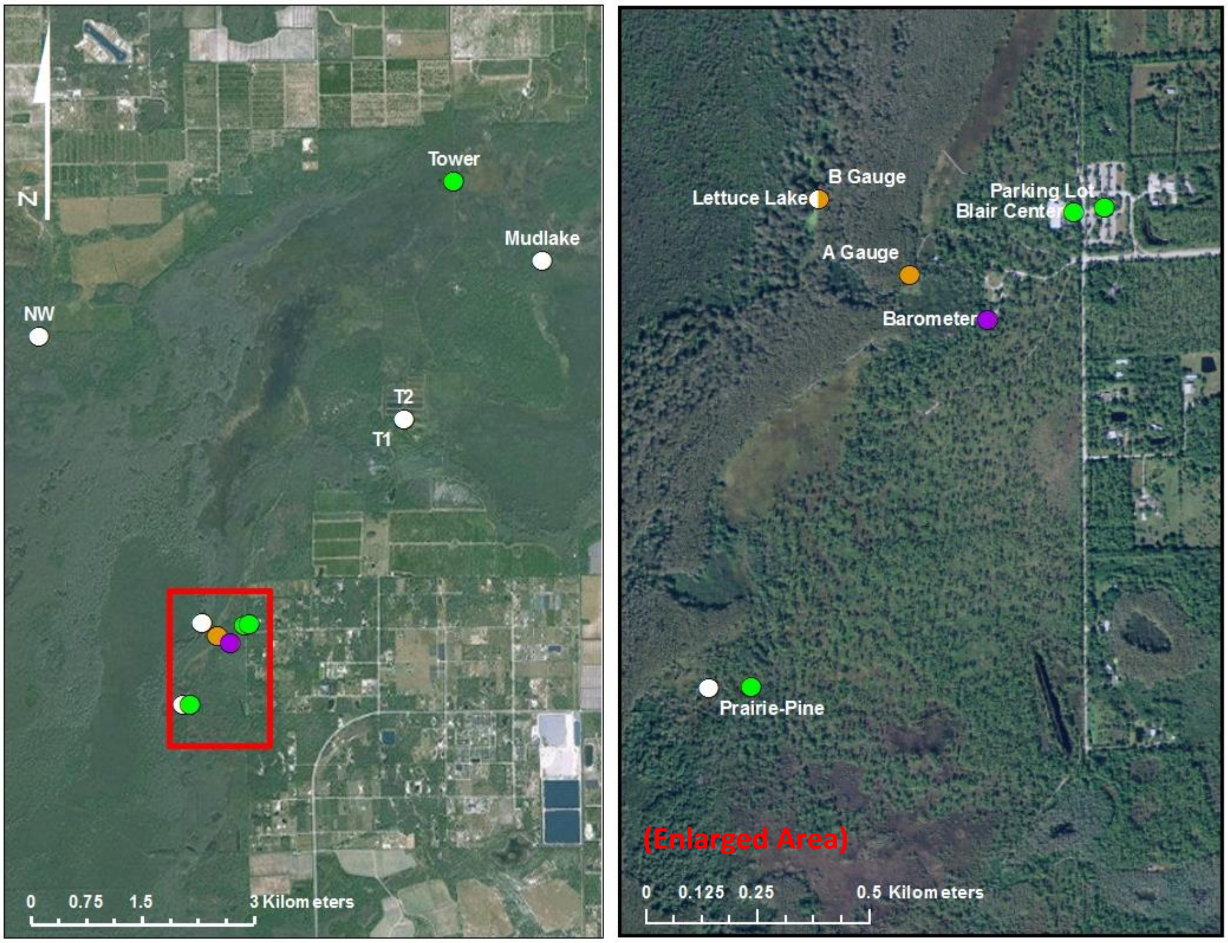


Figure 1. Location of hydrologic monitoring stations at Corkscrew Swamp Sanctuary. Station colors indicate presence of groundwater wells (white), staff gauges (orange), rain gauges (green), and barometer (purple). Area within red rectangle (left) is enlarged in the image on right.

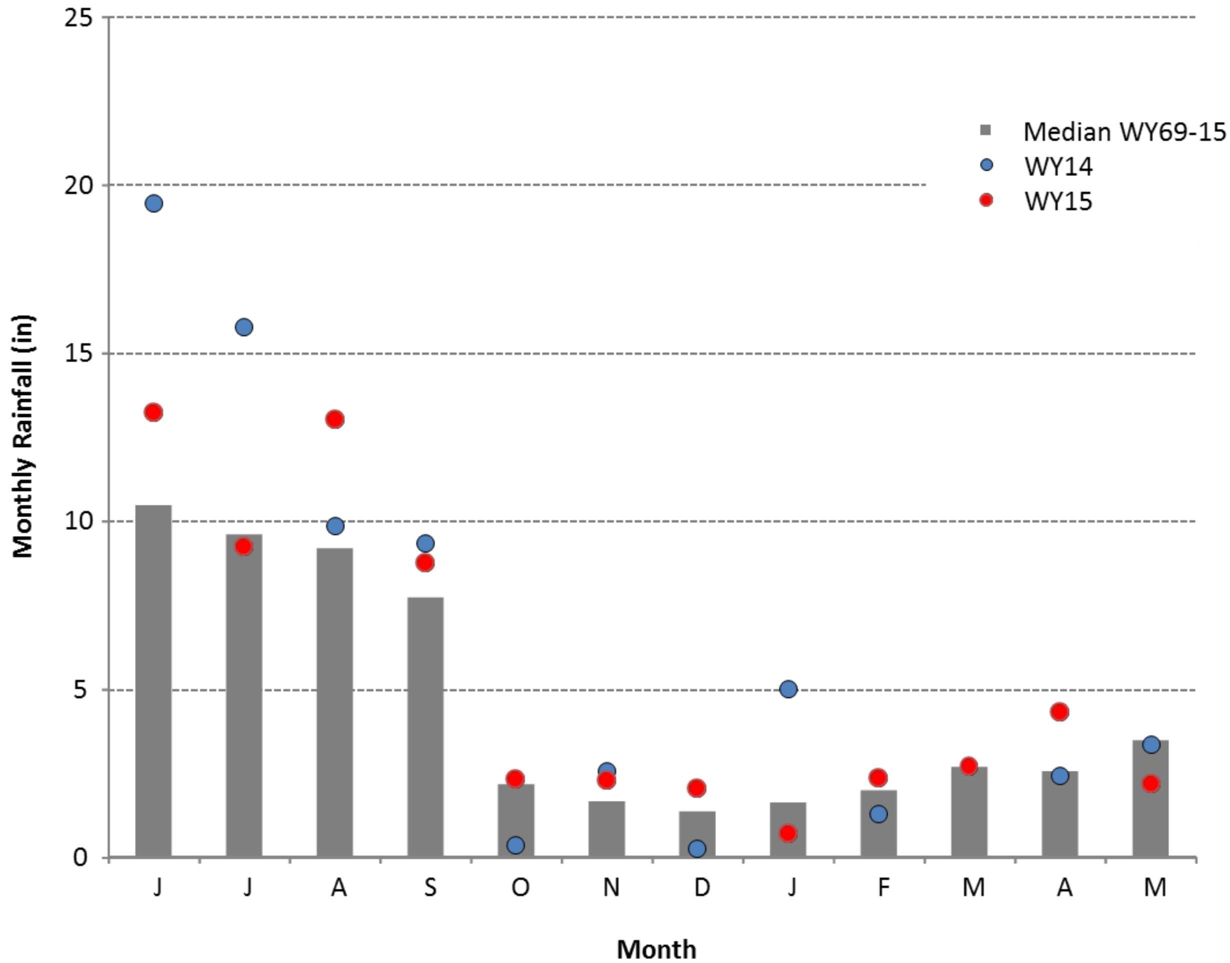


Figure 2. Monthly rainfall (inches) at the Corkscrew's visitor center throughout the hydrologic year (June-May) in WY14 (blue), WY15 (red) and the median of the period of record (gray bars; 1969-present).

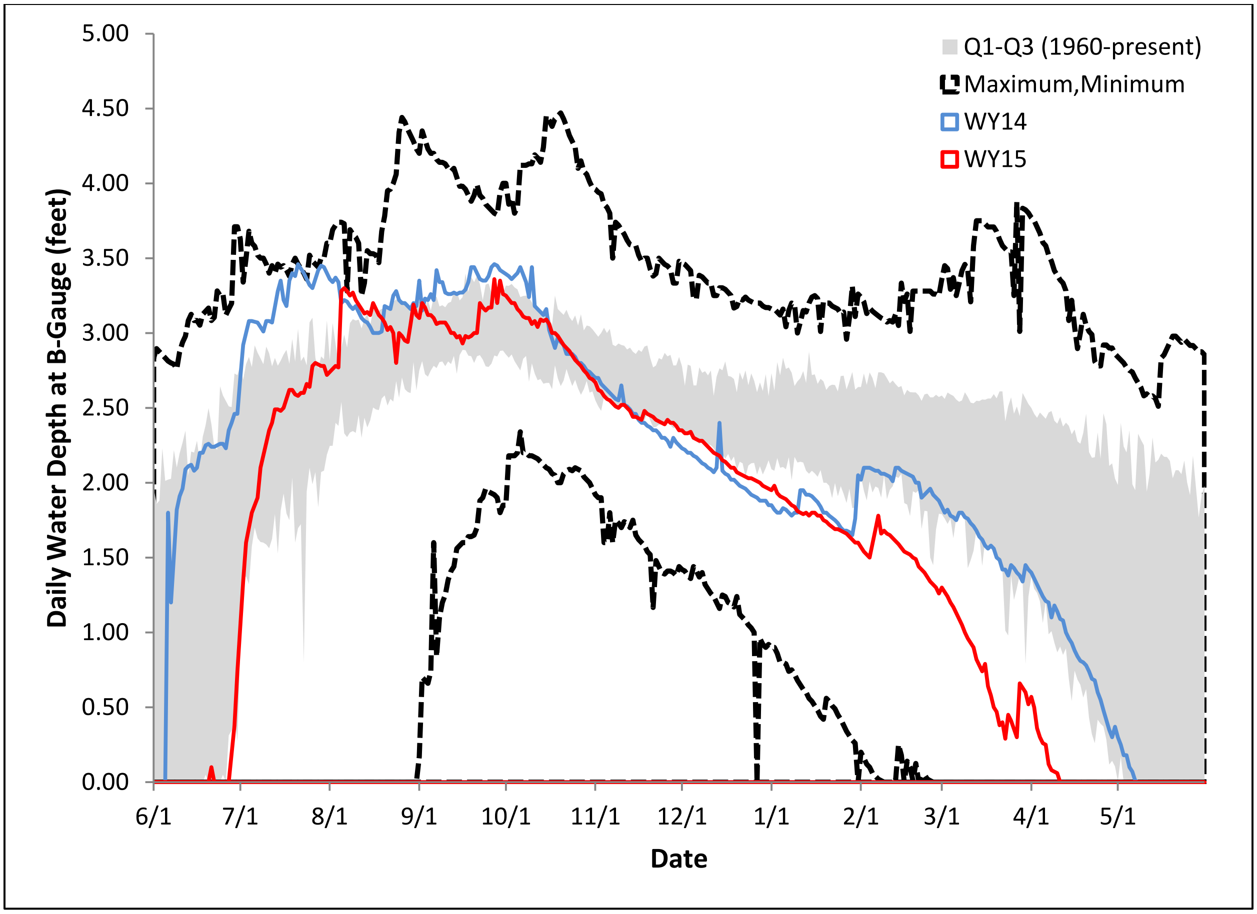


Figure 3. Daily water depth at the Corkscrew B-gauge (ft.). Shaded area represents the interquartile range of daily data and dashed lines represent the daily maximum and minimum on record (1960-present). Colored lines represent daily depths throughout the two focal years (blue=WY14, red=WY15).

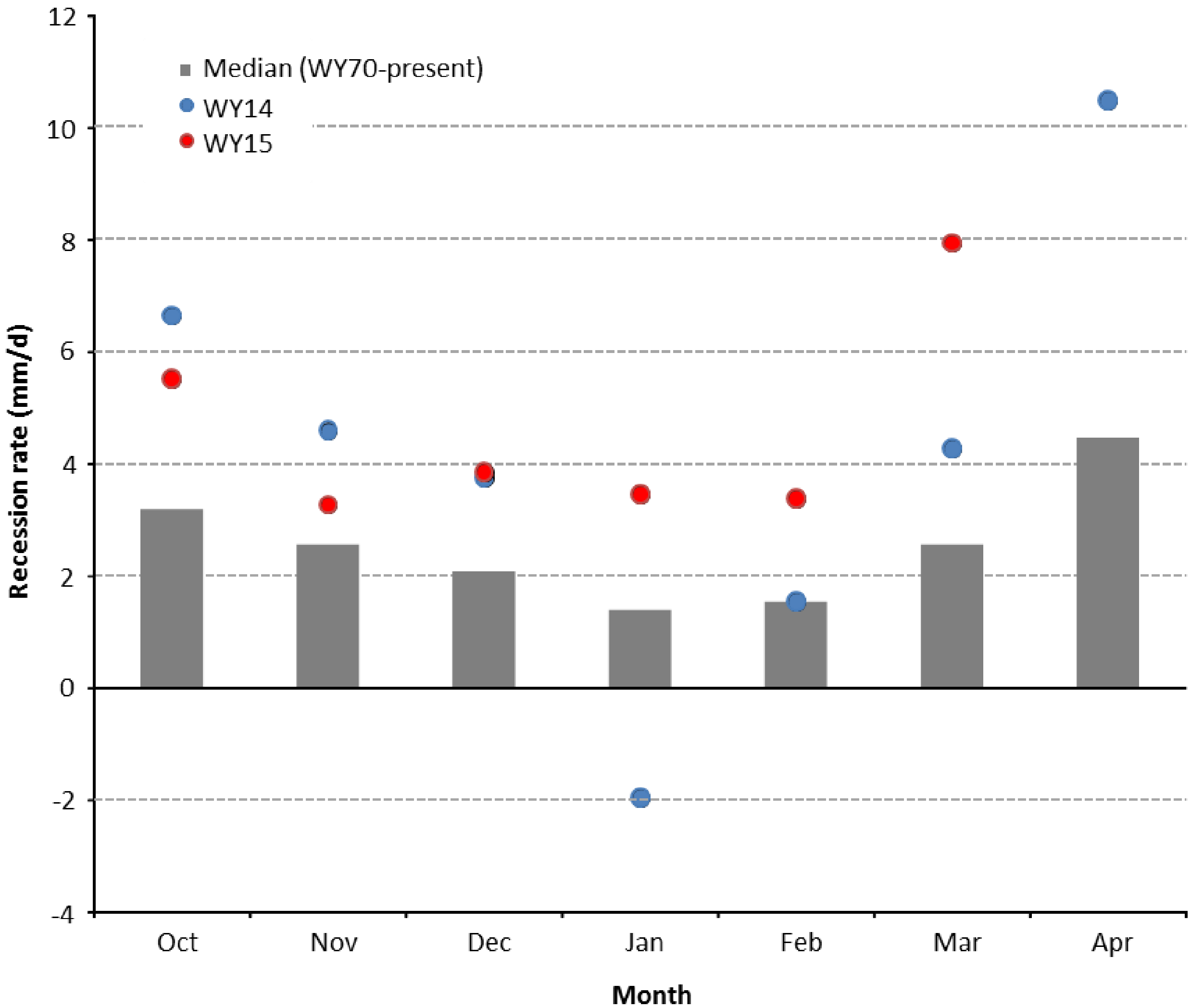


Figure 4. Median monthly water level recession rate (mm/d) at the B-gauge for the Corkscrew Swamp Sanctuary period of record (WY70-present; gray bars), WY14 (blue), and WY15 (red). No recession rate is reported for April WY15 as water levels fell below ground at the B-gauge and rate could not be calculated.

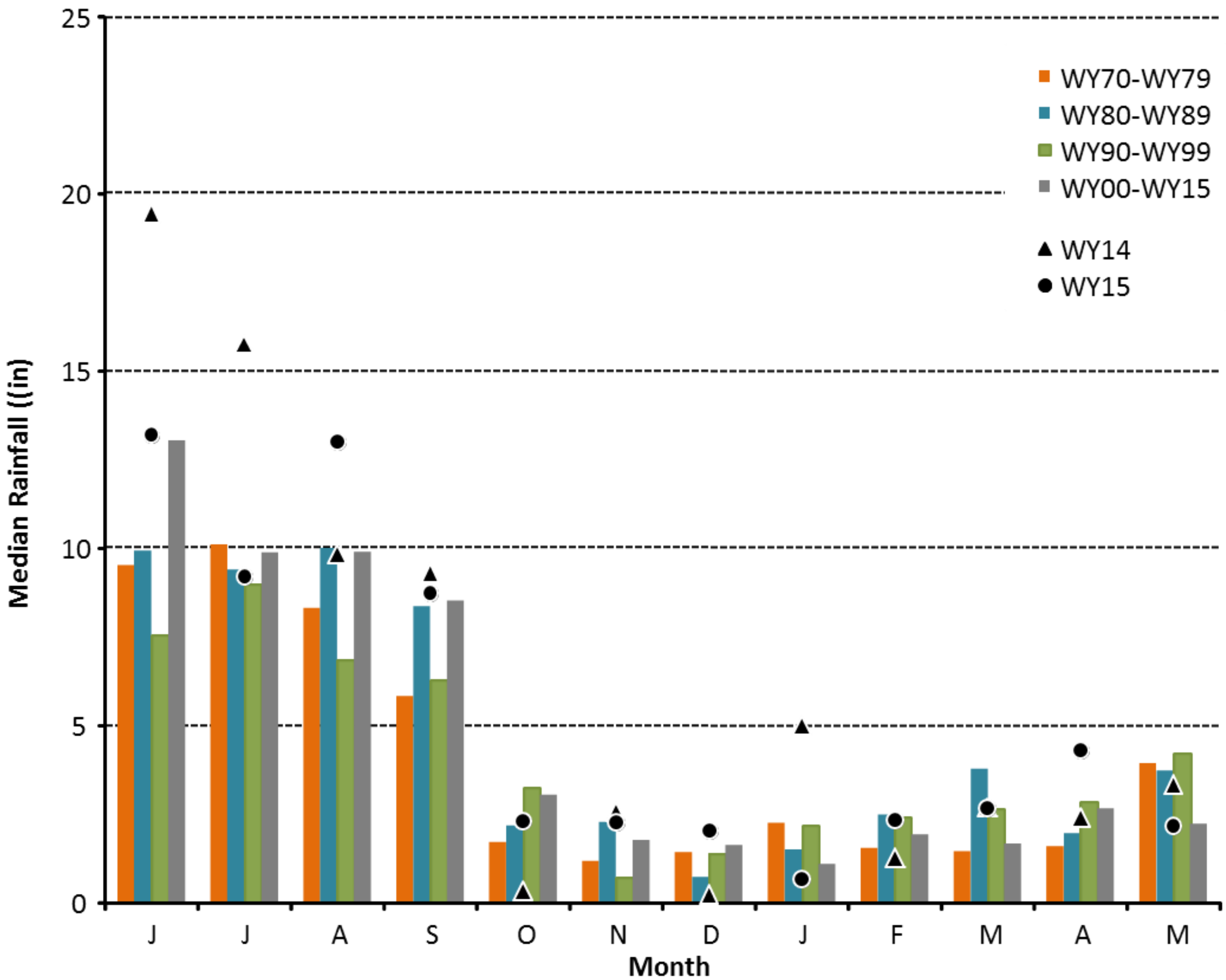


Figure 5. Median monthly rainfall (in.) throughout the hydrologic year (June-May) at the Corkscrew visitor center for each decade on record (1970s, 1980s, 1990s, 2000-present). Rainfall for WY14 (triangle) and WY15 (circle) are included for reference.

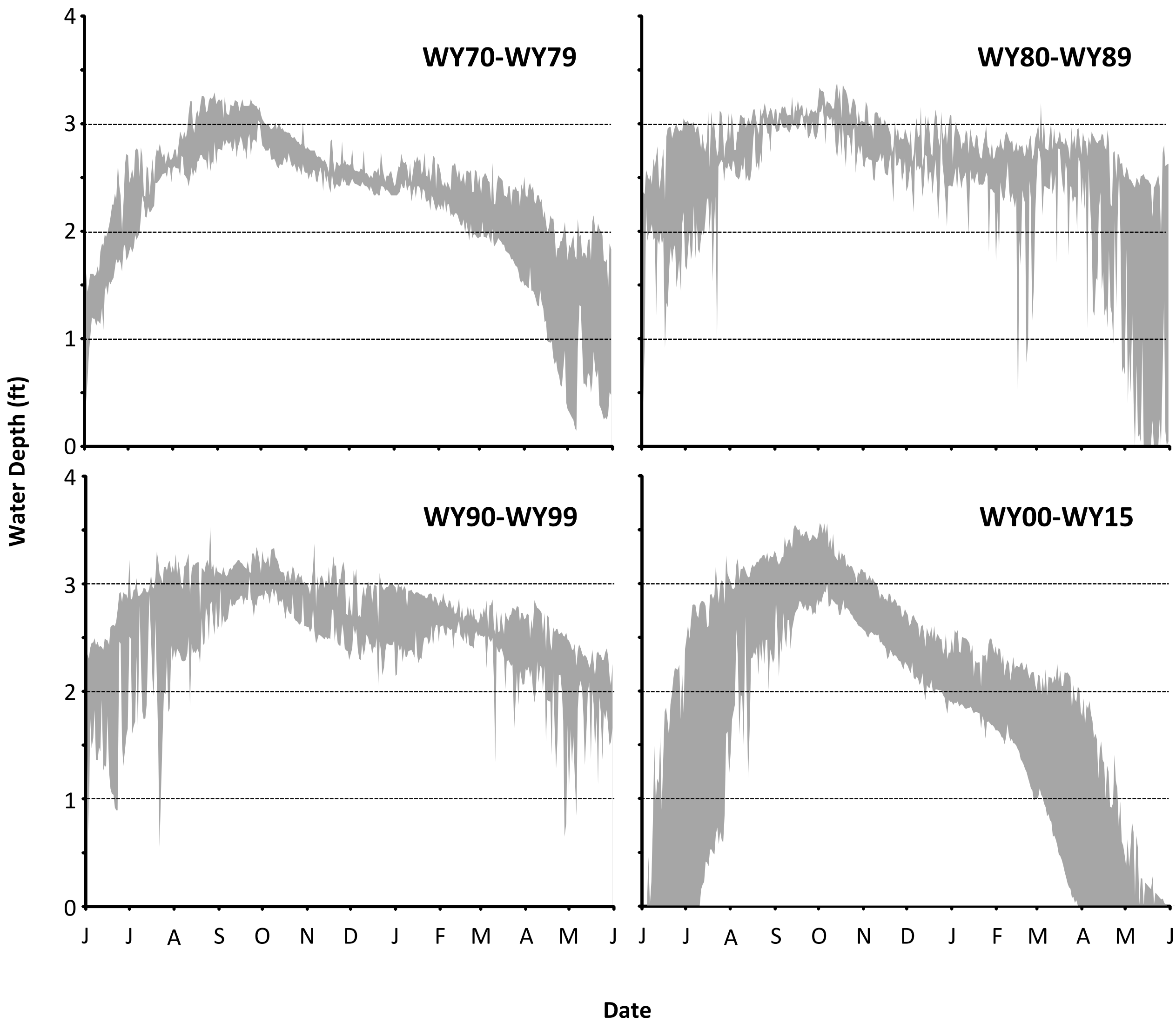


Figure 6. Daily water depth (ft.) at the B-gauge throughout the hydrologic year (June-May), WY70-present. Shaded areas represent the interquartile range of daily water depths for each time period.

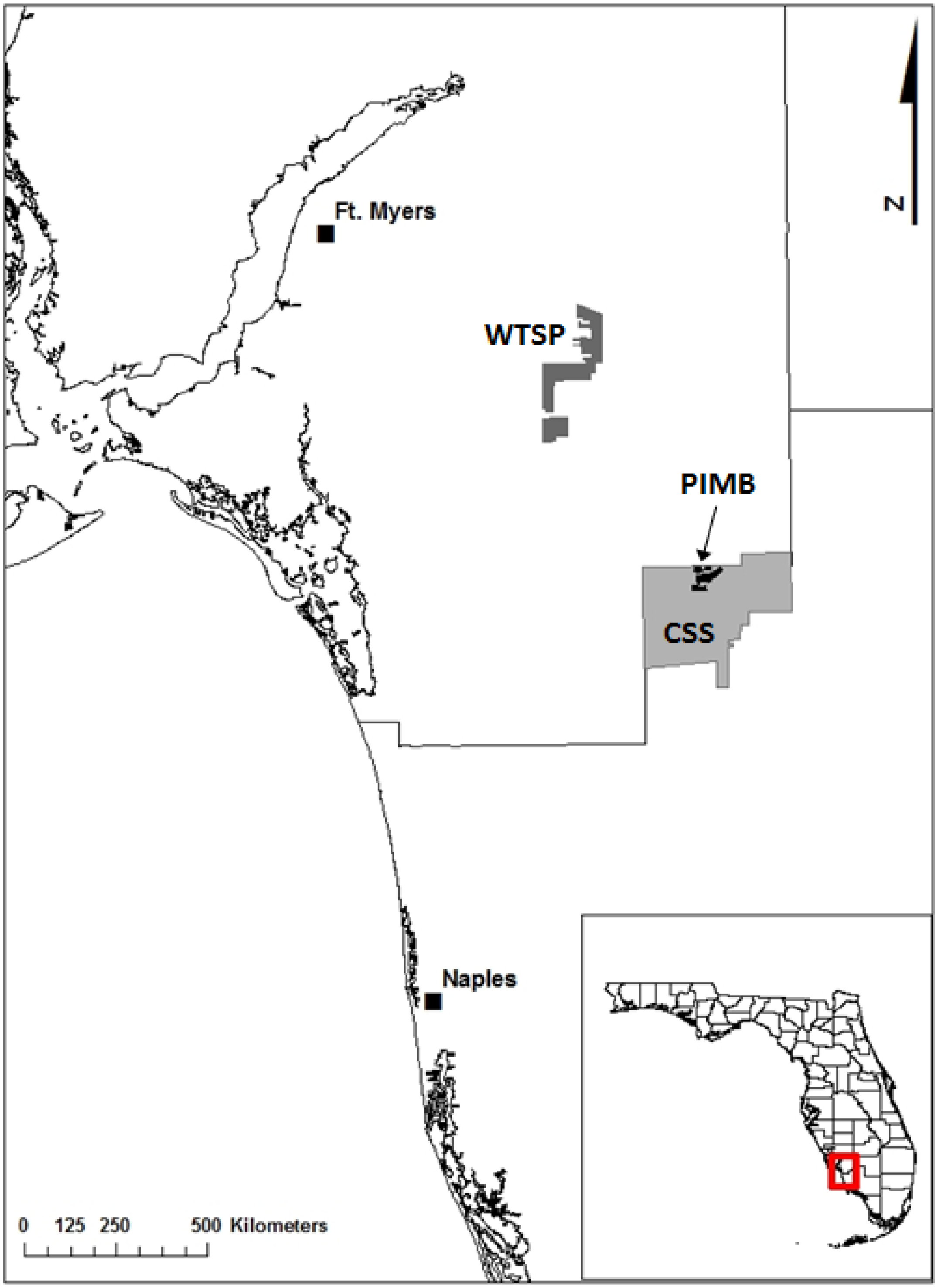


Figure 7. Location of Corkscrew Swamp Sanctuary (CSS), Panther Island Mitigation Bank (PIMB), and Wild Turkey Strand Preserve (WTSP) in Southwest Florida. The Panther Island Mitigation expansion (PIMBe) is due east of PIMB.

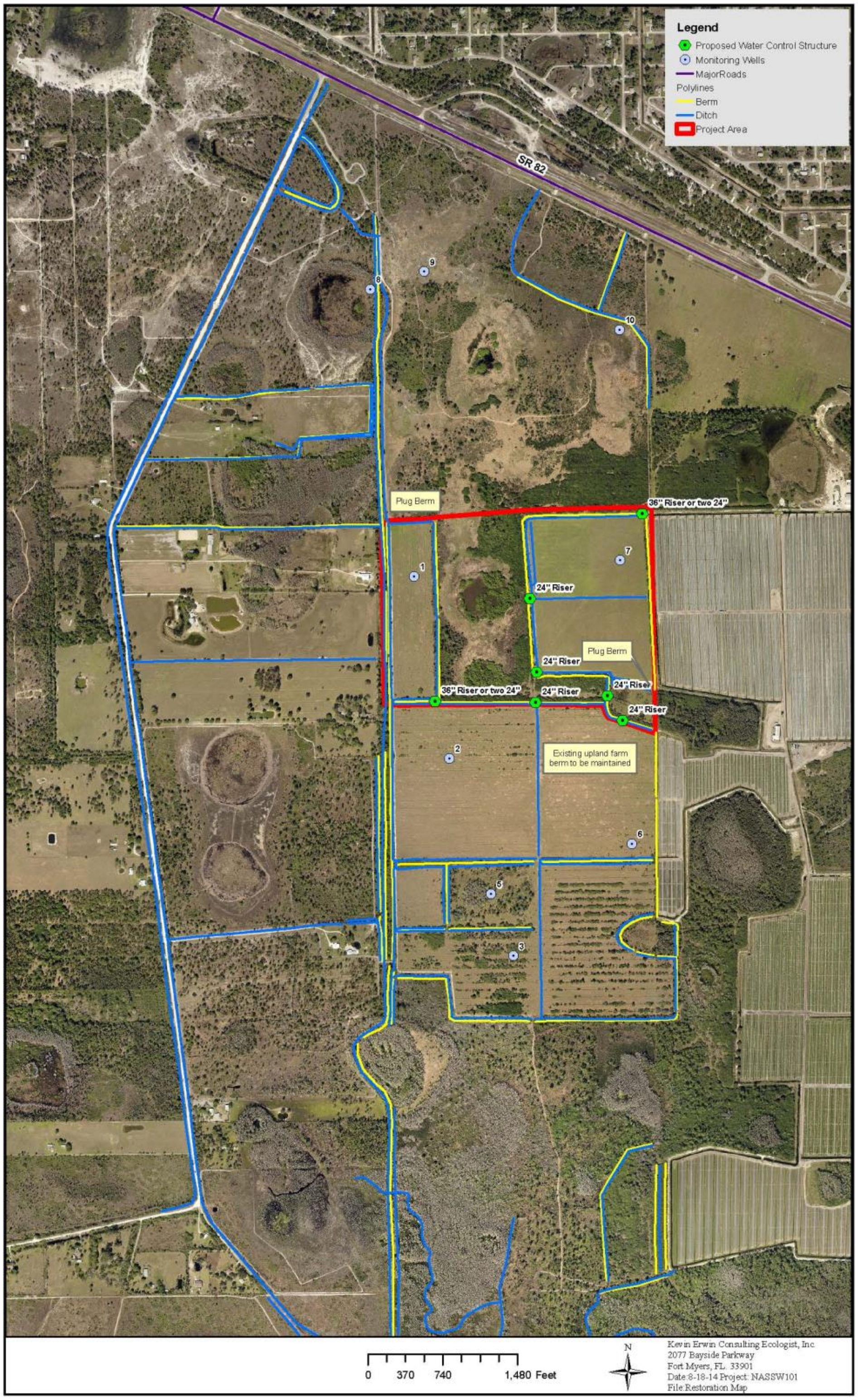


Figure 8. Current (8/2014) plan for phase I of the experimental restoration of short hydroperiod wetlands at Wild Turkey Strand Preserve (WTSP).

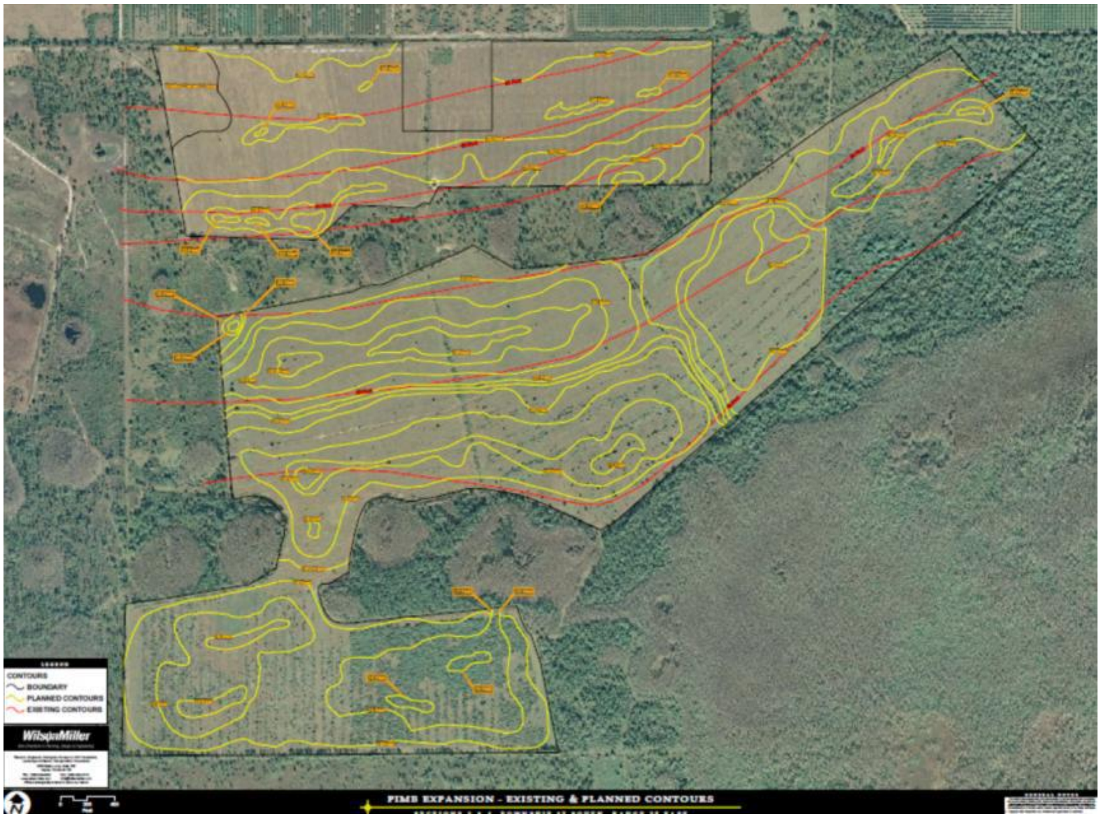


Figure 9. Existing and planned contours for wetland restoration at the Panther Island Mitigation Bank expansion (PIMBe).

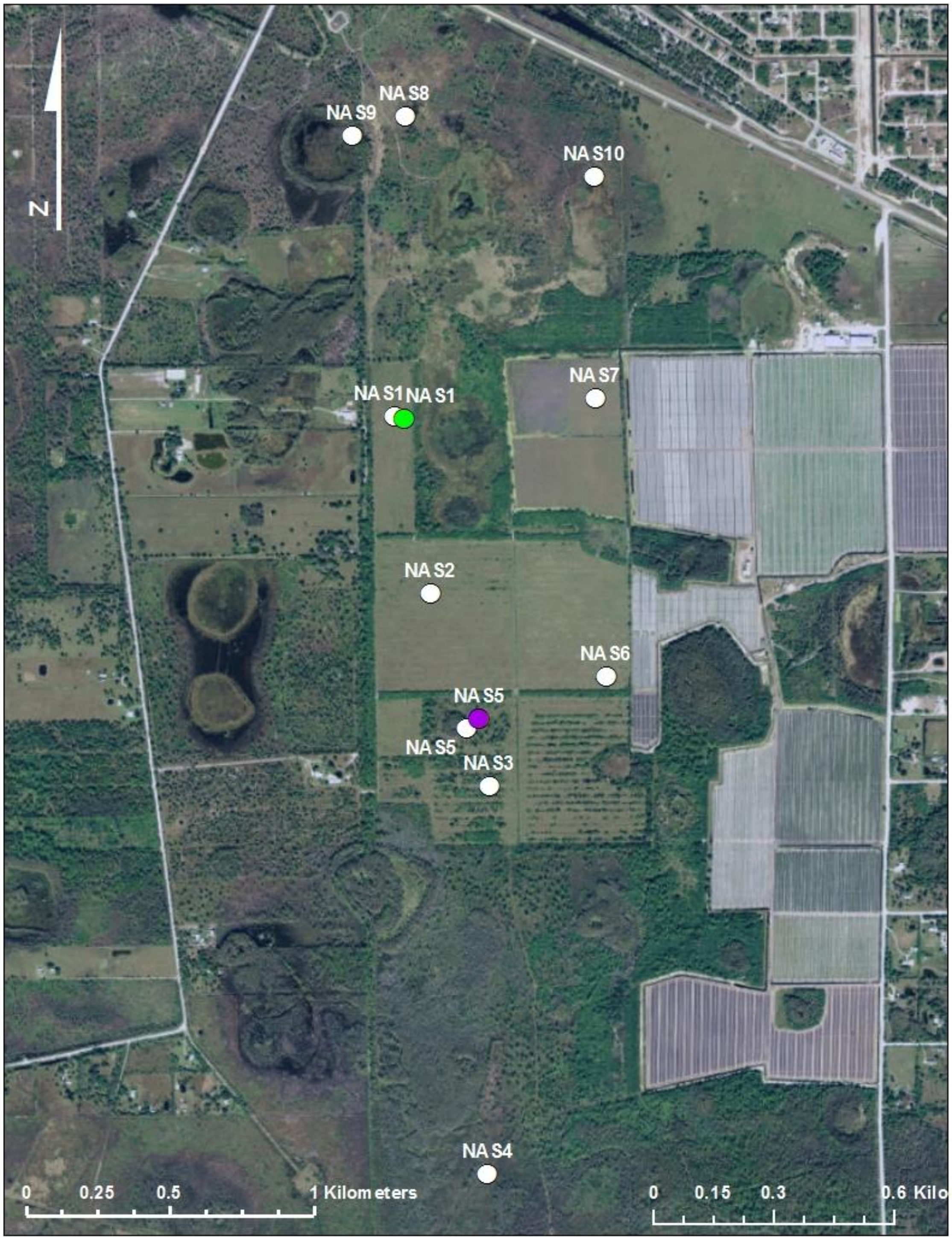


Figure 10. Locations of 10 groundwater wells (white), rain gauge (green), and barometer (purple) comprising the hydrologic monitoring stations for WTSP short-hydroperiod wetland restoration.

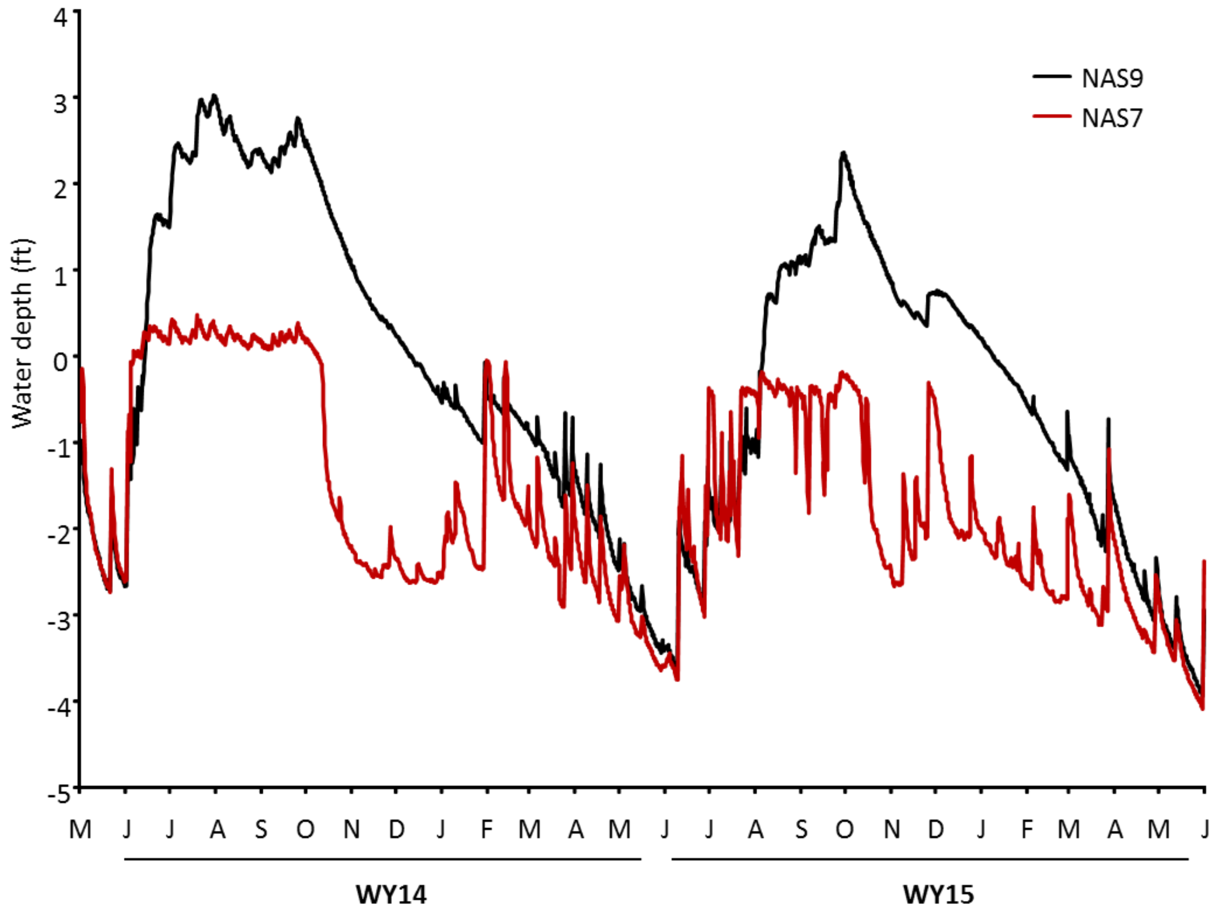


Figure 11. Daily water levels at two groundwater wells at WTSP through the first two years of short-hydroperiod wetland restoration monitoring (WY14-15). NAS9 (black) is in an intact wetland in the northwestern region and NAS7 (red) is in the center of the northeastern-most agriculture field, adjacent to an active agriculture operation.

Figure 12. Location of the 10 m x 10 m vegetation monitoring plots at WTSP.

Figure 13. Location of the 10 m x 10 m vegetation monitoring plots at PIMBe.

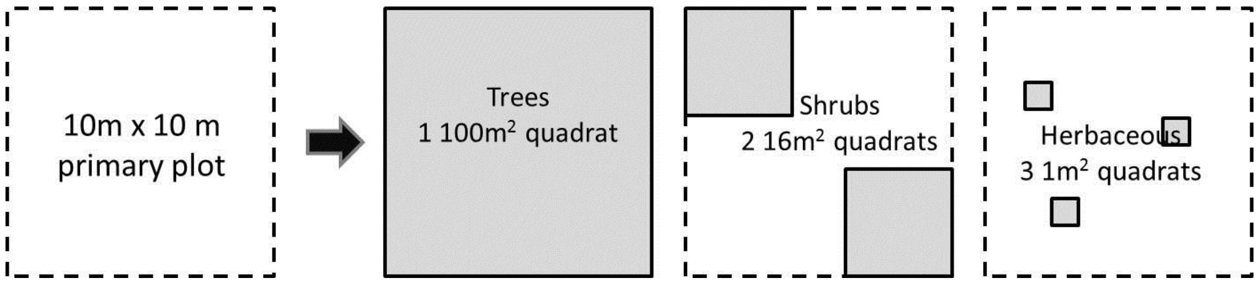


Figure 14. Schematic diagram of the nested vegetation sampling design used in short-hydroperiod wetland restoration monitoring. Monitoring plots consist of 10 m x 10 m primary plots, within which monitoring of trees (entire plot), shrubs (two 4 m x 4 m quadrats) and herbaceous vegetation (three 1m x 1 m quadrats) is conducted.

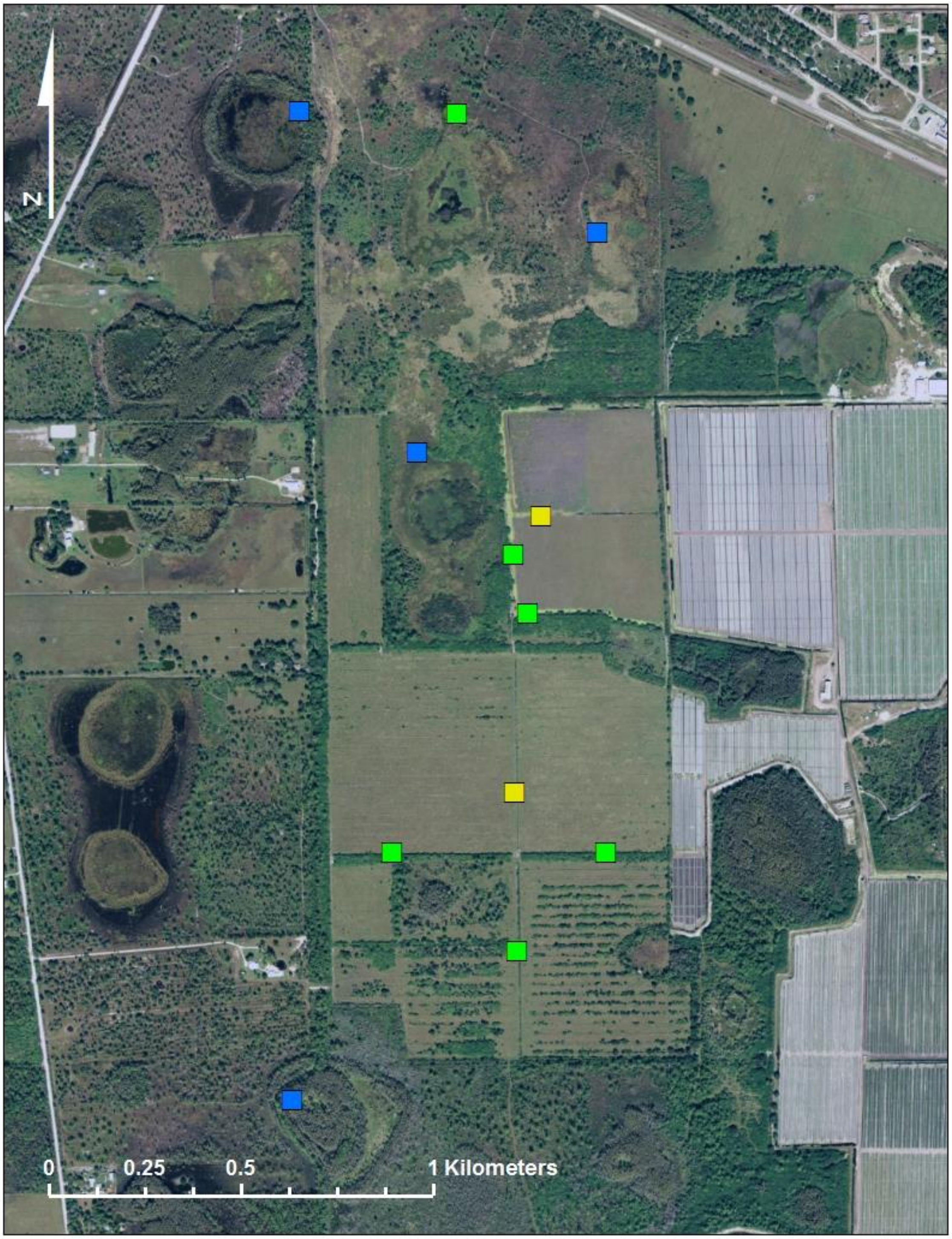


Figure 15. Location of aquatic fauna sampling sites at WTSP in WY14 & WY15 (yellow=throw trap only, blue=minnow trap only, green=throw trap + minnow trap).

Figure 16. Location of aquatic fauna sampling sites at PIMBe in WY14 & WY15 (yellow=throw trap only, blue=minnow trap only, green=throw trap + minnow trap).

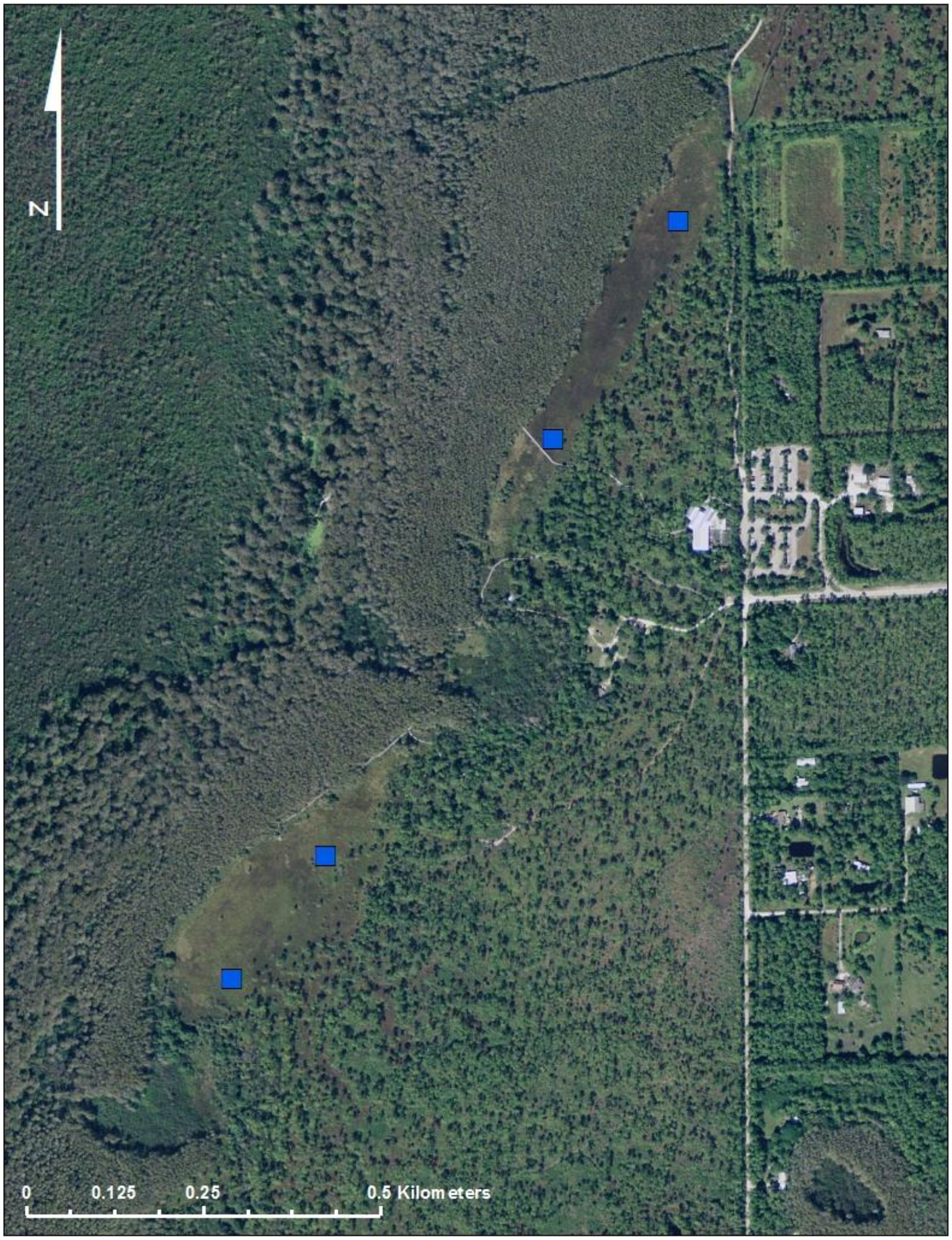


Figure 17. Location of aquatic fauna sampling sites at Corkscrew Swamp Sanctuary short-hydroperiod wetlands in WY14 & WY15 (minnow trap only).

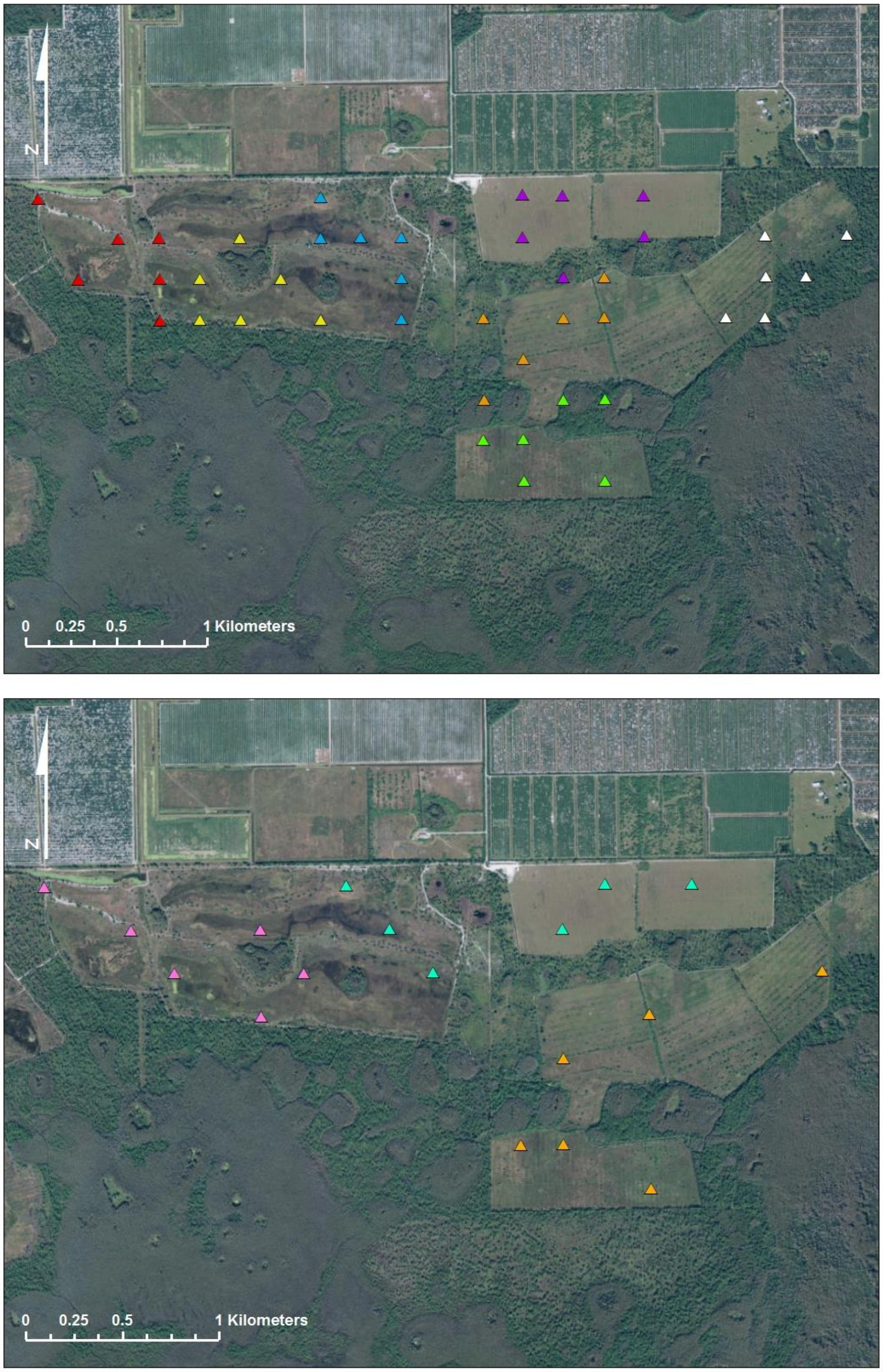


Figure 18. Point locations of the 7 point count routes (each route indicated by a separate color) established on PIMB in 2009 as an intern project (**top**) and the 3 point count routes that were retained as part of the restoration monitoring effort beginning in 2013 (**bottom**).

Figure 19. Point locations for the two point count survey routes (each route indicated by a separate color) on WTSP.

Figure 20. Point locations for the wading bird survey route on WTSP.

Figure 21. Point locations for the wading bird survey route on PIMBe.

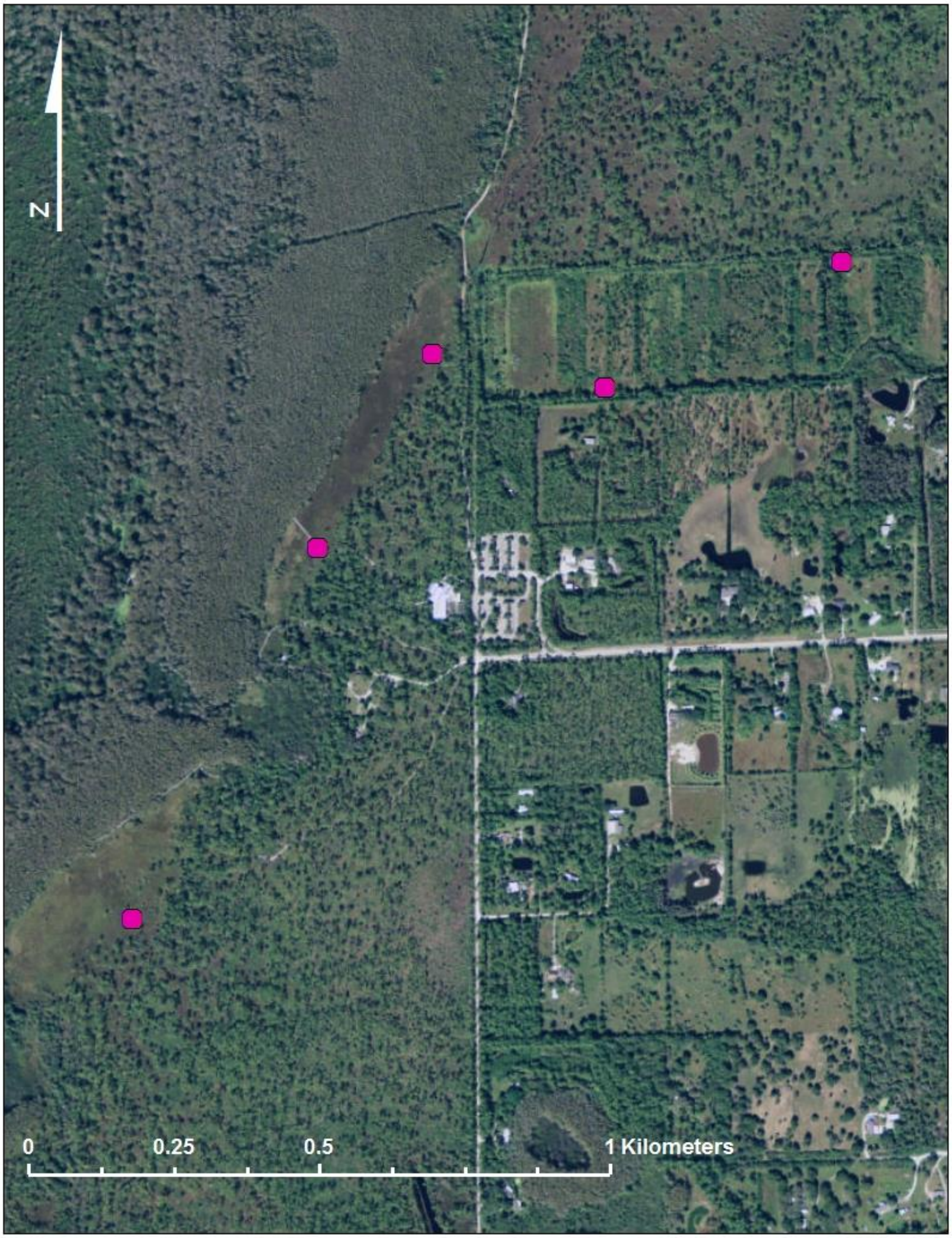


Figure 22. Point locations for the CSS wading bird survey route that includes reference short-hydroperiod wetlands and the Rigsby Tract.

Figure 23. Location of mammal monitoring sites at CSS in WY14 (by season: light green=early dry (Dec-Feb), dark green=late dry (Mar-May)).

[MAP REMOVED TO ENSURE THE SECURITY OF TRAIL CAMERA LOCATIONS]

Figure 24. Location of mammal monitoring sites at CSS in WY15 (by season: light blue=early wet (Jun-Aug), dark blue=late wet (Sep-Nov), light green=early dry (Dec-Feb), dark green=late dry (Mar-May), black=all).

[MAP REMOVED TO ENSURE THE SECURITY OF TRAIL CAMERA LOCATIONS]

Figure 25. Location of mammal monitoring sites at PIMBe in WY14 (by season: light green=early dry (Dec-Feb), dark green=late dry (Mar-May)).

[MAP REMOVED TO ENSURE THE SECURITY OF TRAIL CAMERA LOCATIONS]

Figure 26. Location of mammal monitoring sites at PIMB (including PIMBe) in WY15 (by season: light blue=early wet (Jun-Aug), dark blue=late wet (Sep-Nov), light green=early dry (Dec-Feb), dark green=late dry (Mar-May), black=all).

[MAP REMOVED TO ENSURE THE SECURITY OF TRAIL CAMERA LOCATIONS]

Figure 27. Location of mammal monitoring sites at WTSP in WY14 (by season: light green=early dry (Dec-Feb), dark green=late dry (Mar-May)).

[MAP REMOVED TO ENSURE THE SECURITY OF TRAIL CAMERA LOCATIONS]

Figure 28. Location of mammal monitoring sites at WTSP in WY15 (by season: light blue=early wet (Jun-Aug), dark blue=late wet (Sep-Nov), light green=early dry (Dec-Feb), dark green=late dry (Mar-May)).

[MAP REMOVED TO ENSURE THE SECURITY OF TRAIL CAMERA LOCATIONS]

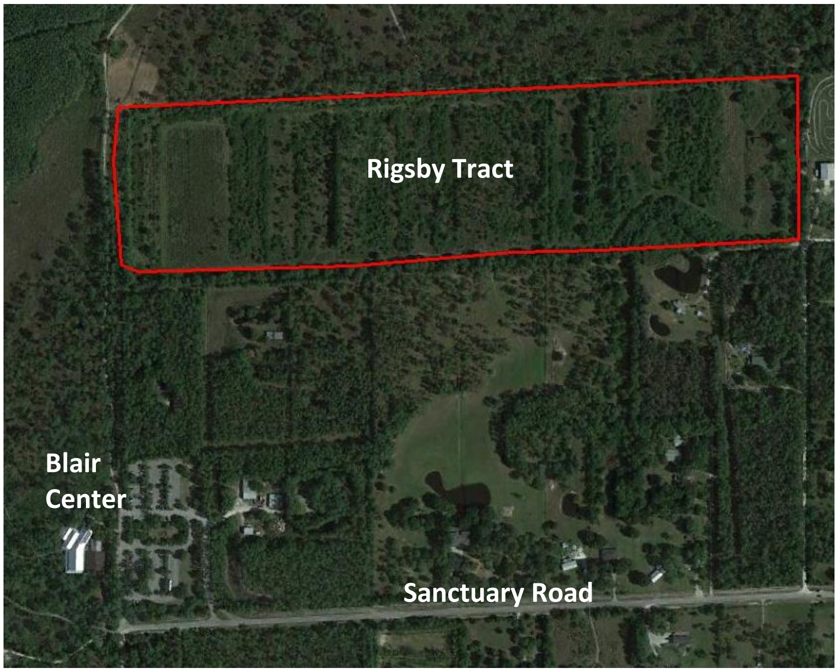
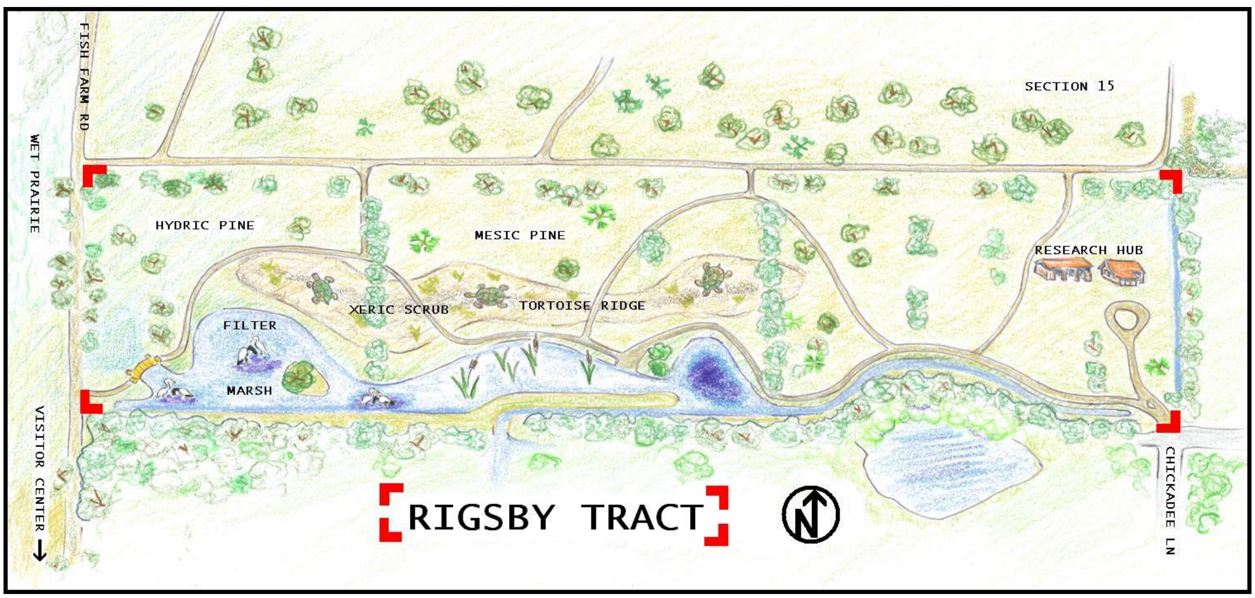


Figure 29.
Location of the Rigsby Tract relative to the Blair Center and Sanctuary Road (**left**). Schematic drawing of the Rigsby restoration plan including location of habitats, walking trails, filter marsh, and research station (**bottom**).



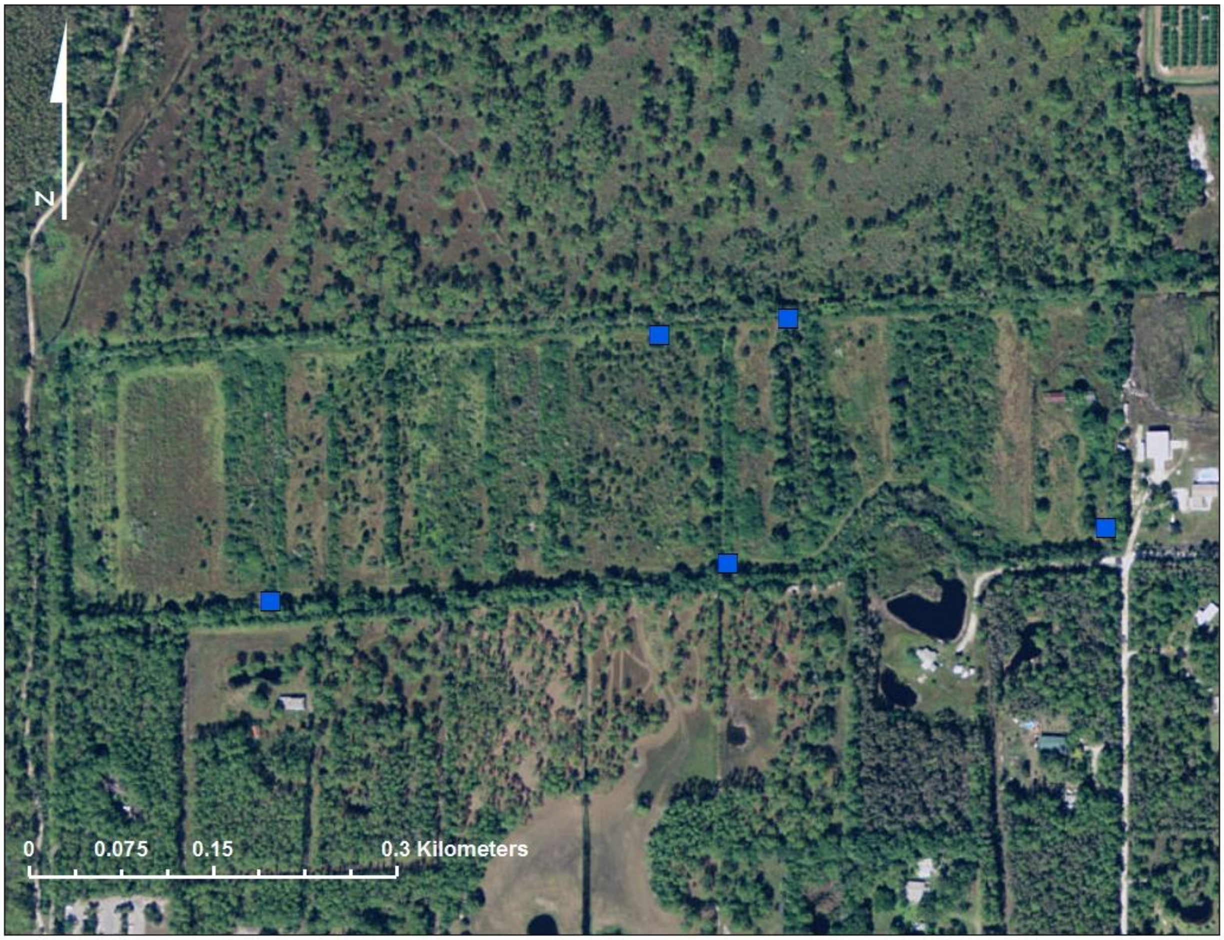


Figure 30. Location of the five aquatic fauna sampling sites on the Rigsby Tract (minnow trap only).

Figure 31. Locations of mammal monitoring sites on the Rigsby Tract. All three sites were used in both the early dry (light green=Dec-Feb) and late dry (dark green=Mar-May) seasons of WY15.

[MAP REMOVED TO ENSURE THE SECURITY OF TRAIL CAMERA LOCATIONS]

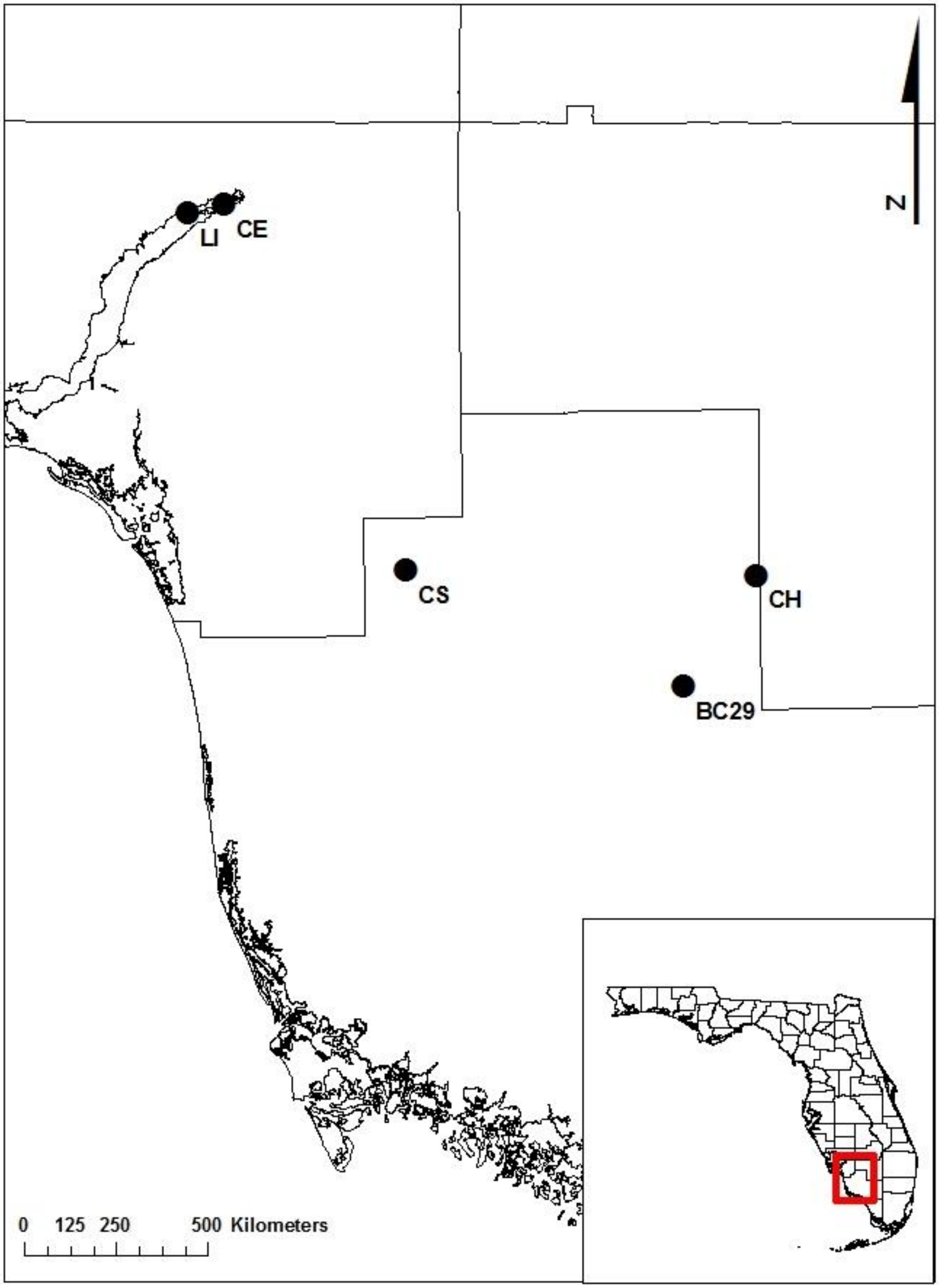
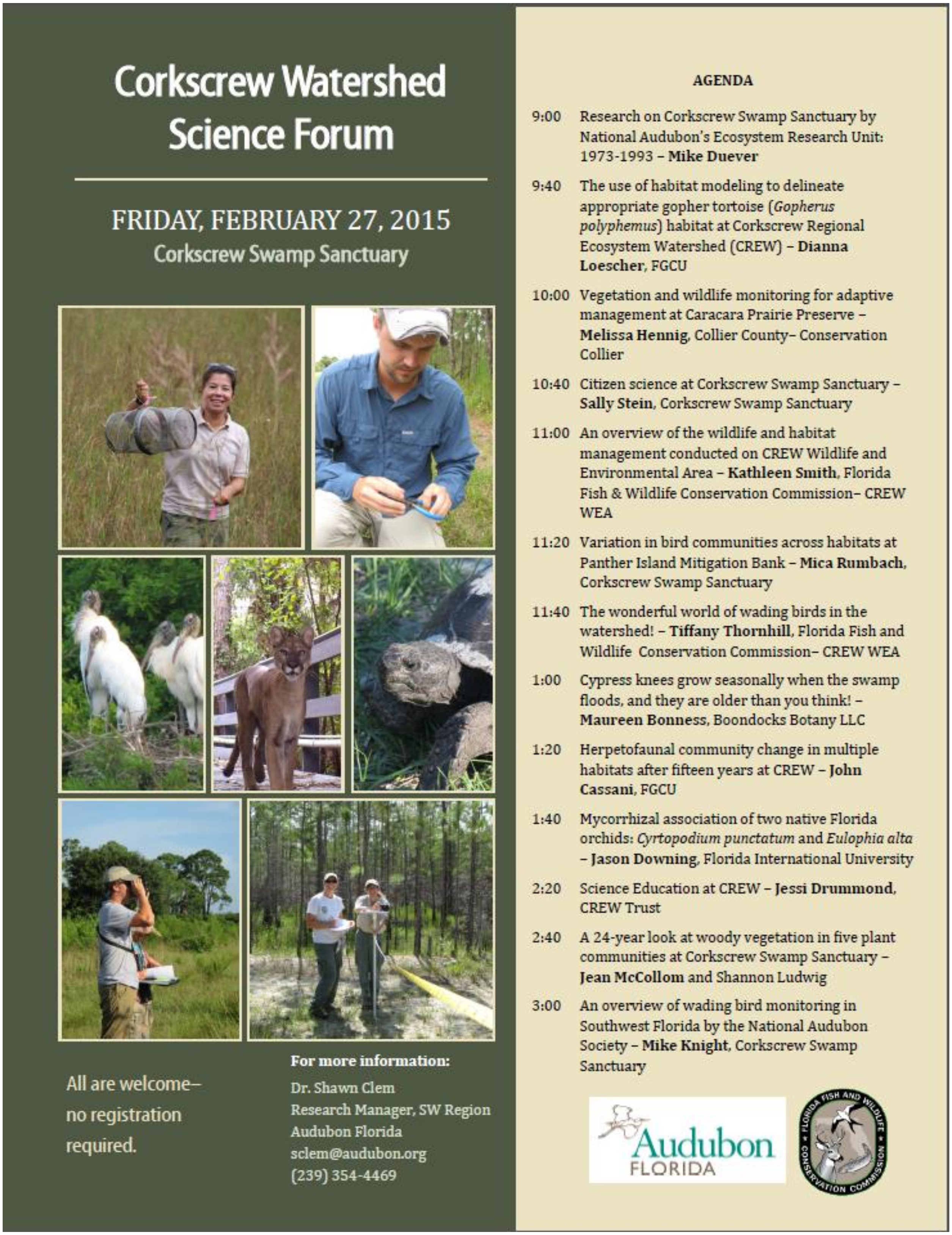


Figure 32. Locations of the five Southwest Florida Wood Stork colonies monitored in the 2015 nesting season (LI=Lenore Island, CE=Caloosahatchee East, CS=Corkscrew Swamp Sanctuary, CH=Collier/Hendry line, BC29=Barron Collier/SR-29).

Figure 33. Satellite image of the latitudinal habitat used for Brazilian pepper aquatic fauna study. Furrows were inundated throughout the study while adjacent upland habitat was generally dry. Rows are ≈22 m apart (image width spans ≈190 m).


Corkscrew Watershed Science Forum

FRIDAY, FEBRUARY 27, 2015
Corkscrew Swamp Sanctuary

All are welcome– no registration required.

For more information:
Dr. Shawn Clem
Research Manager, SW Region
Audubon Florida
sclem@audubon.org
(239) 354-4469

AGENDA

9:00 Research on Corkscrew Swamp Sanctuary by National Audubon's Ecosystem Research Unit: 1973-1993 – **Mike Duever**

9:40 The use of habitat modeling to delineate appropriate gopher tortoise (*Gopherus polyphemus*) habitat at Corkscrew Regional Ecosystem Watershed (CREW) – **Dianna Loescher**, FGCU

10:00 Vegetation and wildlife monitoring for adaptive management at Caracara Prairie Preserve – **Melissa Hennig**, Collier County– Conservation Collier

10:40 Citizen science at Corkscrew Swamp Sanctuary – **Sally Stein**, Corkscrew Swamp Sanctuary

11:00 An overview of the wildlife and habitat management conducted on CREW Wildlife and Environmental Area – **Kathleen Smith**, Florida Fish & Wildlife Conservation Commission– CREW WEA

11:20 Variation in bird communities across habitats at Panther Island Mitigation Bank – **Mica Rumbach**, Corkscrew Swamp Sanctuary

11:40 The wonderful world of wading birds in the watershed! – **Tiffany Thornhill**, Florida Fish and Wildlife Conservation Commission– CREW WEA

1:00 Cypress knees grow seasonally when the swamp floods, and they are older than you think! – **Maureen Bonness**, Boondocks Botany LLC

1:20 Herpetofaunal community change in multiple habitats after fifteen years at CREW – **John Cassani**, FGCU

1:40 Mycorrhizal association of two native Florida orchids: *Cyrtopodium punctatum* and *Eulophia alta* – **Jason Downing**, Florida International University

2:20 Science Education at CREW – **Jessi Drummond**, CREW Trust

2:40 A 24-year look at woody vegetation in five plant communities at Corkscrew Swamp Sanctuary – **Jean McCollom** and Shannon Ludwig

3:00 An overview of wading bird monitoring in Southwest Florida by the National Audubon Society – **Mike Knight**, Corkscrew Swamp Sanctuary

Audubon FLORIDA

FLORIDA FISH AND WILDLIFE CONSERVATION COMMISSION

Figure 34. Flyer from the first annual Corkscrew Watershed Science Forum held 2/27/2015.

Table 1. Median recession rate (change in water depth through the month divided by days/month) for each decade and for WY14 and WY15 (mm/d). Rates in bold are greater than the optimal 5 mm/d recession rate for Everglades wading birds (D. Gawlik, personal communication).

	WY 70-79	WY 80-89	WY 90-99	WY 00-15	WY 14	WY 15	Mag. increase from previous decades (max) to WY00-15
October	3.07	2.41	0.81	**5.70**	**6.63**	**5.51**	1.8X
November	1.53	1.64	2.74	4.57	4.57	3.25	1.7X
December	0.82	2.10	2.19	2.16	3.74	3.83	
January	-0.41	1.36	0.84	3.39	-1.97	3.44	2.5X
February	1.53	0.77	1.50	2.20	1.52	3.37	1.4X
March	2.01	1.80	2.54	**5.08**	4.27	**7.92**	2.0X
April	**5.93**	4.23	2.95	**9.60**	**10.46**		1.6X

Table 2. Presence of herbaceous and tree taxa (X=present) recorded in vegetation monitoring plots at PIMBe and WTSP (no shrubs were recorded in any plots) in three sampling events (dry season WY14 and wet and dry seasons WY15).

			Property	
Latin Name	Common Name	Status	PIMBe	WTSP
<u>Herbaceous</u>				
Aeschynomene indica	Indian jointvetch	Native	X	
Ambrosia artemisiifolia	Common ragweed	Native	X	X
Amphicarpum muhlenberg	Blue maidencane	Native	X	
Andropogon glomeratus	Bushy broom grass	Native	X	
Andropogon virginicus	Broom grass	Native	X	X
Bidens spp.	Beggarticks	*		X
Carex spp.	Sedge	*	X	X
Cirsium spp.	Thistle	Native		X
Commelina spp.	Day flower	*	X	X
Cynodon dactylon	Bermuda grass	Introduced	X	X
Cyperus spp.	Cyperus sedge	*	X	X
Desmodium spp.	Tick trefoil/beggar lice	*		X
Dichromena colorata	Star rush	Native	X	
Digitaria spp.	Crabgrass	*	X	X
Diodia virginiana	Virginia buttonweed	Native	X	X
Equisetum spp.	Horsetail	Native		X
Erigeron spp.	Fleabane	*		X
Eupatorium capillifolium	Dog fennel	Native	X	X
Eustachys spp.	Finger grass	*		X
Euthamia minor	Flat-top goldenrod	Native	X	X
Hedeoma spp.	False penny royal	Native	X	
Hydrocotyle spp.	Water pennywort	*	X	X
Hymenachne amplexicaulis	West Indian marsh grass	Native	X	
Hypericum spp.	St. John's wort	*	X	
Lachnocaulon minus	Small's bogbutton	Native		X
Lachnocaulon spp.	Bogbutton	Native		X
Lepidium virginicum	Poor man's pepper/pepper grass	Native	X	X
Lobelia spp.	Lobelia	*		X
Ludwigia peruviana	Peruvian primrose willow	Introduced	X	
Ludwigia repens	Creeping primrose willow	Native		X
Ludwigia spp.	Water primrose	Native	X	X
Mikania scandens	Climbing hempvine	Native	X	
Mimosa sp.	Unidentified mimosa	*	X	
Panicum repens	Torpedo grass	Introduced	X	X
Paspalum notatum	Bahia grass	Introduced	X	
Paspalum urvillei	Vasey's grass	Introduced	X	
Phyla nodiflora	Fogfruit	Introduced	X	X
Poaceae spp.	Unidentified Poaceae	*		X
Polygonum spp.	Knotweed	*	X	X

Latin Name	Common Name	Status	Property	
			PIMBe	WTSP
Ptilimnium capillaceum	Herbwilliam/Mock bishop-weed	Native		X
Rhynchospora spp.	Beaksedge	*	X	
Rubus trivialis	Dewberry	Native	X	
Sarcostemma clausum	White twinevine	Native	X	
Sesbania spp.	River hemp	*	X	
Setaria parviflora	Foxtail	Native		
Setaria spp.	Foxtail grass	*	X	X
Spermacoce verticillata	Shrubby false buttonweed	Introduced		X
Sporobolus indicus	Smut grass	Introduced	X	
Sporobolus spp.	Dropseed grass	*	X	X
Trifolium spp.	Clover	*		X
Urena lobate	Caesarweed	Introduced	X	
Urochloa mutica	Para grass	Introduced	X	
Vitis rotundifolia	Muscadine	Native	X	
Xyris spp.	Yellow-eyed grass	Native	X	
Tree				
Myrica cerifera	Wax myrtle	Native		X
Sabal palmetto	Cabbage palmetto	Native		X
Schinus terebinthifolius	Brazilian peppertree	Introduced	X	X
Unidentified			X	X

* may be native or introduced depending on species

Table 3. Summary of aquatic fauna sampling effort at each site throughout WY14 and WY15 (T=throw traps, M=minnow traps). Asterisk (*) indicates sampling was attempted but the site was dry or too shallow to sample.

	WY14			WY15		
Site	Oct	Dec	Feb	Oct	Dec	Feb
CSS						
CSWP1				M	*	*
CSWP2				M	*	*
CSWP3				M	*	*
CSWP4				M	*	*
PIMBe						
P9Pond				M	T,M	T, M
P10Pond		T, M	T, M	T, M	T, M	T, M
PID01		M	M	M	M	M
SW9		M	M	M	M	M
WTSP						
CW	T	*	*	M	*	*
D01	T	*	T	T	*	*
D02	T	T, M	T, M	T, M	T, M	T, M
D03					T, M	T, M
D04	T	*	T	T, M	T, M	*
D05	T	*	T	T, M	T, M	T, M
D06	T		T	T, M	T, M	*
D07				T	*	*
FV	T	M	M	M	*	*
GM	T			T, M	*	*
LS	T	M	M	M	M	*
S-Dome		M	M			

Table 4. Total number of each aquatic fauna taxon collected (N), incidence (%I) and relative contribution to total fauna biomass each sampling month, as observed in data from 120 throw trap samples collected “pre-restoration” as part of the short-hydroperiod wetland restoration monitoring project. “---“ indicates taxon was not collected in throw traps during that month. Insect life stage is indicated by superscripts (A=adult, L=larval). Asterisks (*) indicate non-native taxa.

				%Biomass		
Latin Name	Common Name	N	%I	Oct	Dec	Feb
Fishes						
*Hoplosternum littorale**	Brown hoplo	62	19.7	30.70	14.74	56.75
Fundulus chrysotus	Golden topminnow	23	13.1	1.27	0.38	0.38
Jordanella floridae	Flagfish	228	27.9	7.35	12.87	9.08
Lucania goodei	Bluefin killifish	94	19.7	---	---	---
Gambusia holbrooki	Eastern mosquitofish	2,818	75.4	22.46	33.25	15.97
Heterandria formosa	Least killifish	1,494	31.1	5.81	0.20	0.73
Lepomis gulosus	Warmouth	11	8.2	3.48	5.32	---
*Hemichromis letourneuxi**	African jewelfish	33	12.3	1.60	0.50	---
----------	Unidentified fish	31	7.4	0.04	0.01	---
Invertebrates						
Gastropoda	Snail (unidentified)	33	5.7	<0.01	---	0.53
Planorbella spp.	Planorbid snail	5	3.3	0.07	---	---
Pomacea spp.	Apple snail	2	1.6	0.02	---	---
Physella spp.	Physid snail	22	4.9	0.01	<0.01	0.26
Bivalvia	Bivalve (unidentified)	1	0.8	<0.01	---	---
Oligochaeta	Worm	7	4.1	<0.01	---	0.01
Hirudinea	Leech	1	0.8	---	---	0.03
Crustacea						
Palaemonetes paludosus	Estuarine grass shrimp	96	18.9	0.77	1.38	0.15
Procambarus spp.	Crayfish (unidentified)	54	9.0	1.04	0.35	---
Procambarus alleni	Everglades crayfish	120	25.4	15.63	12.66	5.46
Procambarus fallax	Slough crayfish	61	18.9	2.32	2.86	5.56
Insecta						
Anisoptera^{L}	Dragonfly (unidentified)	55	9.8	0.27	0.03	0.42
Aeschinidae^{L}	Darner dragonfly	13	7.4	0.59	---	---
Libellulidae^{L}	Skimmer dragonfly	203	42.6	1.54	0.82	0.81
Gomphidae^{L}	Clubtail dragonfly	6	3.3	---	0.32	---
Coenagrionaidae^{L}	Damselfly	48	20.5	0.06	0.01	0.03
Heteroptera^{A}	(Unidentified)	6	3.3	<0.01	0.05	---
Belostoma spp. ^{A}	Giant water bug	47	24.6	0.90	<0.01	0.10
Corixidae^{A}	Water boatman	1	0.8	<0.01	---	---
Lethocerus spp. ^{A}	Toe biter	1	0.8			
Pelocoris femoratus^{A}	Alligator flea	22	11.5	0.08	0.02	0.02
Ranatra spp. ^{A}	Water scorpion	10	6.6	0.07	0.17	0.04

Latin Name	Common Name	N	%I	%Biomass Oct	Dec	Feb
Coleoptera[A]	Beetle (adult)	283	29.5	0.55	0.21	0.40
Coleoptera[L]	Beetle (larval)	34	4.9	0.22	---	0.04
Cybister spp.[L]	Predaceous diving beetle	8	5.7	0.08	---	---
Dytiscidae[A]	Predaceous diving beetle	25	6.6	0.01	1.06	0.03
Gyrinus spp.[A]	Whirligig water beetle	89	9.8	0.28	0.02	0.56
----------	Unidentified Invertebrate	15	8.2	0.14	0.01	0.40
Amphibians & Reptiles						
Anura	(unidentified tadpole)	118	13.1	1.82	12.38	1.97
Rana grylio	Pig frog	1	0.8	---	---	---
Notophthalmus viridescens	Peninsula newt	2	1.6	0.02†	---	---
Siren intermedia	Lesser siren	3	1.6	---	---	---

† biomass calculation only included one individual as the other was released in the field

Table 5. Total number (N) and incidence (%I) of fish, crustacean, amphibian and reptile fauna captured in 245 minnow trap samples collected "pre-restoration" as part of the short-hydroperiod wetland restoration monitoring project. Asterisks (*) indicate non-native taxa.

Latin Name	Common Name	N	%I
Fishes			
Ameiurus nebulosus	Brown bullhead	1	0.4
*Hoplosternum littorale**	Brown hoplo	31	5.7
Fundulus chrysotus	Golden topminnow	47	8.6
Jordanella floridae	Flagfish	847	37.6
Lucania goodei	Bluefin killifish	17	4.1
Gambusia holbrooki	Eastern mosquitofish	3,982	53.1
Heterandria formosa	Least killifish	76	5.7
Poecilia latipinna	Sailfin molly	99	11.8
Lepomis gulosus	Warmouth	51	12.2
Lepomis macrochirus	Bluegill sunfish	1	0.4
Lepomis marginatus	Dollar sunfish	53	5.3
Lepomis punctatus	Spotted sunfish	1	0.4
Micropterus salmoides	Largemouth bass	1	0.4
*Cichlasoma bimaculatum**	Black acara	10	3.3
*Cichlasoma urophthalmus**	Mayan cichlid	4	0.4
*Hemichromis letourneuxi**	African jewelfish	648	29.0
*Oreochromis aureus**	Blue tilapia	2	0.4
----------	Unidentified Fish	3	1.2
Crustaceans			
Palaemonetes paludosus	Estuarine grass shrimp	122	12.7
Procambarus alleni	Everglades crayfish	222	29.4
Procambarus fallax	Slough crayfish	31	7.3
Amphibians & Reptiles			
Anura	(unidentified tadpole)	48	9.8
Rana grylio	Pig frog	3	1.2
Lithobates sphenocephala	Southern leopard frog	1	0.4
Notophthalmus viridescens	Peninsula newt	99	13.9
Amphiuma means	Amphiuma	8	3.3
Siren spp.	Siren (unidentified)	4	1.6
Nerodia fasciata	Banded water snake	7	2.9
Regina alleni	Striped crayfish snake	1	0.4

Table 6. Bird species observed during point count bird surveys conducted through May 2015 at restoration sites (current and previous) on Panther Island Mitigation Bank (PIMB) and Wild Turkey Strand Preserve (WTSP). Presence of each species is indicated by the type of habitat in which it was observed (N=natural (WTSP only), D=disturbed, R=restored (PIMB only)). Species observed along a route but not during any point are indicated with an asterisk (*). Flyovers are not represented.

Common Name	Latin Name	PIMB	WTSP
Podicipedidae (Grebes)			
Pied-Billed Grebe	*Podilymbus podiceps*	R	
Pelicanidae (Pelicans)			
American White Pelican	*Pelecanus erythrorhynchos*	*	
Anhingidae (Anhingas)			
Anhinga	*Anhinga anhinga*	R	D
Phalacrocoracidae (Cormorants)			
Double-Crested Cormorant	*Phalacrocorax auritus*	*	
Ardeidae (Herons, Egrets, Bitterns)			
American Bittern	*Botaurus lentiginosus*	R, D	*
Least Bittern	*Ixobrychus exilis*	R	
Great Blue Heron	*Ardea herodias*	R, D	*
Great Egret	*Ardea alba*	R, D	N, D
Snowy Egret	*Egretta thula*	R, D	N
Little Blue Heron	*Egretta caerulea*	R, D	*
Tricolored Heron	*Egretta tricolor*	R, D	
Cattle Egret	*Bubulcus ibis*	R, D	D
Green Heron	*Butorides virescens*	R, D	D
Black-crowned Night-Heron	*Nycticorax nycticorax*	R, D	D
Threskiornithidae (Ibises, Spoonbills)			
Glossy Ibis	*Plegadis falcinellus*	R	*
White Ibis	*Eudocimus albus*	R, D	N, D
Roseate Spoonbill	*Platalea ajaja*	R	*
Ciconiidae (Storks)			
Wood Stork	*Mycteria americana*	R	*
Anatidae (Dabbling Ducks)			
Black-bellied Whistling Duck	*Dendrocygna autumnalis*	R	D
Mallard	*Anas platyrhynchos*		*
Mottled Duck	*Anas fulvigula*	R	*
Blue-Winged Teal	*Anas discors*	R, D	
Cathartidae (New World Vultures)			
Black Vulture	*Coragyps atratus*	R, D	N, D
Turkey Vulture	*Cathartus aura*	R, D	N, D

Common Name	Latin Name	PIMB	WTSP
Accipitridae (Ospreys, Kites, Hawks, Eagles)			
Osprey	*Pandion haliaetus*	R	*
Swallow-tailed Kite	*Elanoides forficatus*	R, D	*
Cooper's Hawk	*Accipiter cooperii*	*	
Northern Harrier	*Circus cyaneus*	D	*
Red-shouldered Hawk	*Buteo lineatus*	R, D	N,D
Bald Eagle	*Haliaeetus leucocephalus*	*	D
Falconidae (True Falcons, Caracaras)			
Crested Caracara	*Caracara cheriway*	*	
American Kestrel	*Falco sparverius*	R, D	N
Odontophoridae (Bobwhites, Quails)			
Northern Bobwhite	*Colinus virginianus*	R, D	D
Phasianidae (Upland Game Birds)			
Florida Wild Turkey	*Meleagris gallopavo osceola*	R, D	*
Indian Peafowl	*Pavo cristatus*	D	
Rooster (Domestic Chicken)	*Gallus domesticus*	R	D
Rallidae (Rails, Gallinules, Coots, Soras)			
King Rail	*Rallus elegans*	R	
Sora	*Porzana carolina*	R	
Common Gallinule	*Gallinula geleata*	R	
Purple Gallinule	*Porphyrio martinica*	R	
American Coot	*Fulica americana*	R	
Unknown Rail		R	
Aramidae (Limpkins)			
Limpkin	*Aramus guarauna*	R	D
Gruidae (Cranes)			
Sandhill Crane	*Grus canadensis*	R, D	D
Charadriidae (Plovers)			
Killdeer	*Charadrius vociferous*	R, D	D
Scolopacidae (Yellowlegs, Sandpipers, Snipes)			
Greater Yellowlegs	*Tringa melanoleuca*	R	*
Lesser Yellowlegs	*Tringa flavipes*	R	
Solitary Sandpiper	*Tringa solitaria*	*	
Least Sandpiper	*Calidris minutilla*	*	
Wilson's Snipe	*Gallinago delicata*	*	*
Unknown Sandpiper			*
Columbidae (Pigeons, Doves)			
Mourning Dove	*Zenaida macroura*	R, D	N, D
Common Ground-Dove	*Columbina passerina*	R, D	N
Strigidae (Owls)			
Great-Horned Owl	*Bubo virginianus*	R	

Common Name	Latin Name	PIMB	WTSP
Barred Owl	*Strix varia*	R, D	
Caprimulgidae (Goatsuckers)			
Common Nighthawk	*Chordeiles minor*	R	
Chuck-will's-widow	*Caprimulgus carolinensis*	D	
Apodidae (Swifts)			
Chimney Swift	*Chaetura pelagica*	*	*
Trochilidae (Hummingbirds)			
Ruby-Throated Hummingbird	*Archilochus colubris*	R	
Alcedinidae (Kingfishers)			
Belted Kingfisher	*Megaceryle alcyon*	R, D	
Picidae (Woodpeckers)			
Yellow-bellied Sapsucker	*Sphyrapicus varius*	*	
Red-headed Woodpecker	*Melanerpes erythrocephalus*	R	
Red-bellied Woodpecker	*Melanerpes carolinus*	R, D	N, D
Downy Woodpecker	*Picoides pubescens*	R, D	N, D
Hairy Woodpecker	*Picoides villosus*	*	
Northern Flicker	*Colaptes auratus*	R	
Pileated Woodpecker	*Dryocopus pileatus*	R, D	N, D
Unknown Woodpecker		R, D	
Tyrannidae (Flycatchers)			
Eastern Phoebe	*Sayornis phoebe*	R, D	N, D
Great Crested Flycatcher	*Myiarchus crinitus*	R, D	D
Eastern Kingbird	*Tyrannus tyrannus*	*	
Laniidae (Shrikes)			
Loggerhead Shrike	*Lanius ludovicianus*	R, D	
Vireonidae (Vireos)			
White-eyed Vireo	*Vireo griseus*	R, D	N, D
Corvidae (Jays, Crows & Allies)			
Blue Jay	*Cyanocitta cristata*	R, D	N, D
Fish Crow	*Corvus ossifragus*	R	D
Hirundinidae (Swallows)			
Barn Swallow	*Hirundo rustica*	R	
Northern Rough-Winged Swallow	*Stelgidopteryx serripennis*	*	D
Tree Swallow	*Tachycineta bicolor*	R, D	*
Purple Martin	*Progne subis*		*
Paridae (Chickadees & Titmice)			
Tufted Titmouse	*Baeolophus bicolor*	D	
Sittidae (Nuthatches)			
Brown-headed Nuthatch	Sitta pusilla	R	*

Common Name	Latin Name	PIMB	WTSP
Tryglodytidae (Wrens)			
Marsh Wren	*Cistothorus palustris*	R	
Sedge Wren	*Cistothorus platensis*	R,D	
Carolina Wren	*Thryothorus ludovicianus*	R, D	N, D
House Wren	*Troglodytes aedon*	R, D	
Unknown Wren		R, D	
Sylviidae (Gnatcatchers)			
Blue-Gray Gnatcatcher	*Polioptila caerulea*	R, D	N, D
Turdidae (Thrushes)			
Veery	*Catharus fuscescens*	D	
Wood Thrush	*Hylocichla mustelina*	*	
American Robin	*Turdus migratorius*	*	D
Mimidae (Mimids)			
Gray Catbird	*Dumetella carolinensis*	R, D	N, D
Northern Mockingbird	*Mimus polyglottos*	R, D	N, D
Brown Thrasher	*Toxostoma rufum*	R	D
Sturnidae (Starlings)			
European Starling	*Sturnus vulgaris*	R	D
Parulidae (Wood-Warblers)			
Northern Parula	*Setophaga americana*	R, D	
Black-Throated Blue Warbler	*Setphaga caerulescens*	D	
Yellow-rumped Warbler	*Setophaga coronata*	R	N, D
Palm Warbler	*Setophaga palmarum*	R, D	N, D
Pine Warbler	*Dendroica pinus*	R, D	N
American Redstart	*Setophaga ruticilla*	*	
Worm-eating Warbler	*Helmitheros vermivorum*	R	N
Common Yellowthroat	*Geothlypis trichas*	R, D	N, D
Northern Waterthrush	*Seiurus novaboracensis*	R	
Unknown Warbler		R, D	N, D
Cardinalidae (Cardinals, Buntings, Grosbeaks, Dickcissels)			
Indigo Bunting	*Passerina cyanea*	D	
Northern Cardinal	*Cardinalis cardinalis*	R, D	N, D
Emberizidae (Emberizine Sparrows & Allies)			
Eastern Towhee	*Pipilo erythrophthalmus*	R, D	*
Field Sparrow	*Spizella pusilla*	*	*
Grasshopper Sparrow	*Ammodramus savannarum*	R, D	
Song Sparrow	*Melospiza melodia*	*	
Swamp Sparrow	*Melospiza georgiana*	R	
Unknown Sparrow		R, D	D
Icteridae (Icterids)			
Eastern Meadowlark	*Sturnella magna*	R, D	N, D
Red-winged Blackbird	*Agelaius phoeniceus*	R, D	N, D

Common Name	Latin Name	PIMB	WTSP
Common Grackle	*Quiscalus quiscula*	R, D	*
Boat-tailed Grackle	*Quiscalus major*	R, D	N, D
Fringillidae (Finches)			
American Goldfinch	*Carduelis tristis*	*	
Unknown Species		R, D	N, D

Table 7. Timeline of the 9-minute recording used for wading bird surveys. The recording consists of a 5-minute observation period followed by a series of calls by Least Bittern (LEBI), King Rail (KIRA), American Bittern (AMBI), and Pied-billed Grebe (PBGR) interspersed with periods of silence to allow observers to hear call-backs.

Time		
0:00	[START]	(5 min silence)
5:00	LEBI	*coo* (x5 series)
		kak (x2 series)
		(30 seconds of silence)
6:00	KIRA	*kek* (x2 series)
		kek-burr (x2 series)
		(30 seconds of silence)
7:00	AMBI	*pump-er-lunk* (x3 series)
		(30 seconds of silence)
8:00	PBGR	*owhoop* (1 series)
		hyena (x2 series)
		(30 seconds silence)
9:00	[STOP]	

Table 8. Bird species observed during wading bird surveys conducted in WY14 and WY15 as part of the short-hydroperiod wetland restoration monitoring at Corkscrew (CSS), Panther Island Mitigation Bank expansion (PIMBe), and Wild Turkey Strand Preserve (WTSP). Presence of each species is indicated by the type of habitat in which it was observed (N=natural (CSS, WTSP only), D=disturbed (PIMBe, WTSP only)). Flyovers are not represented.

		Property		
Common Name	Latin Name	CSS	PIMBe	WTSP
Podicipedidae (Grebes)				
Pied-billed Grebe	*Podilymbus podiceps*		D	N
Anhingidae (Anhingas)				
Anhinga	*Anhinga anhinga*			N, D
Ardeidae (Herons, Egrets, Bitterns)				
Great Blue Heron	*Ardea Herodias*		D	N, D
Great Egret	*Ardea alba*	N	D	N
Snowy Egret	*Egretta thula*		D	D
Little Blue Heron	*Egretta caerulea*		D	N, D
Cattle Egret	*Bubulucus ibis*		D	D
Black-crowned Night-Heron	*Nycticorax nycticorax*			N
Threskiornithidae (Ibises, Spoonbills)				
White Ibis	*Eudocimus albus*	N	D	N, D
Ciconiidae (Storks)				
Wood Stork	*Mycteria americana*		D	D
Anatidae (Dabbling Ducks)				
Black-bellied Whistling-Duck	*Dendrocygna autumnalis*	N		
Mottled Duck	*Ana fulvigula*			N
Rallidae (Rails, Coots, Gallinules)				
Clapper Rail	*Rallus longirostris*			D
King Rail	*Rallus elegans*		D	N, D
Gruidae (Cranes)				
Sandhill Crane	*Grus Canadensis*		D	D
Alcedinidae (Kingfishers)				
Belted Kingfisher	*Megaceryle alcyon*	N		N
Tryglodiytidae (Wrens)				
Marsh Wren	*Cistothorus palustris*	N		

<u>Emberizidae (Emberizine Sparrows)</u>				
Swamp Sparrow	*Melospiza georgiana*	N		
#Species		6	10	15

Table 9. Presence of large, medium, and small mammal and bird species (X=present) observed using trail cameras on each wetland restoration property (CSS, PI, WTSP) during the wet and dry seasons of WY14 and WY15. WY15 dry season data are not represented. Mammal species counts are conservative due to the presence of unidentified rabbits, squirrels and rodents.

		Property/Season					
		CSS		PI		WTSP	
Common Name	Latin Name	Wet	Dry	Wet	Dry	Wet	Dry
Large Mammals							
Cattle	*Bos* spp.					X	X
Florida panther	*Puma concolor coryi*	X	X	X	X	X	X
Florida black bear	*Ursus americanus floridanus*	X	X	X	X		X
White-tailed deer	*Odocoileus virginianus*	X	X	X	X	X	X
#Species		3	3	3	3	3	4
Medium Mammals							
Bobcat	*Lynx rufus*	X	X	X	X	X	X
Cat (domestic)	*Felis catus*		X		X		X
Coyote	*Canis latrans*	X	X	X	X	X	X
Dog (domestic)	*Canis familiaris*	X	X		X	X	X
Eastern spotted skunk	*Spilogale putorius*				X		X
Gray fox	*Urocyon cinereoargenteus*	X	X				
Hog (feral)	*Sus scrofa*	X	X	X	X	X	X
Horse (domestic)	*Equus caballus*		X				X
Nine-banded armadillo	*Dasypus novemcinctus*	X	X	X	X	X	X
Northern raccoon	*Procyon lotor*	X	X	X	X	X	X
Northern river otter	*Lontra canadensis*				X	X	
Virginia opossum	*Didelphis virginiana*	X	X	X	X	X	X
#Species		8	10	6	10	8	9
Small Mammals							
Eastern cottontail rabbit	*Sylvilagus floridanus*	X	X			X	
Eastern gray squirrel	*Sciurus carolinensis*	X	X				
Marsh rabbit	*Sylvilagus palustris*						X
Rabbit (unidentified)		X	X	X	X	X	X
Rodent (unidentified)		X	X		X		X
Squirrel (unidentified)		X	X				
#Species		3	3	1	2	1	2
Birds							
American Crow	*Corvus brachyrhynchos*					X	
American Robin	*Turdus migratorius*		X		X		X
Anhinga	*Anhinga anhinga*					X	
Barn Owl	*Tyto alba*					X	
Barred Owl	*Strix varia*				X		
Black-bellied Whistling-Duck	*Dendrocygna autumnalis*			X		X	
Black-crowned Night-Heron	*Nycticorax nycticorax*			X			
Blue Jay	*Cyanocitta cristata*	X	X		X	X	

		Property/Season					
		CSS		PI		WTSP	
Common Name	Latin Name	Wet	Dry	Wet	Dry	Wet	Dry
Black Vulture	*Coragyps atratus*	X	X	X	X		
Cattle Egret	*Bubulcus ibis*			X	X	X	X
Common Ground-Dove	*Columbina passerine*	X	X		X		
Crested Caracara	*Caracara cheriway*				X		
Eastern Meadowlark	*Sturnella magna*					X	
Great Blue Heron	*Ardea Herodias*			X		X	
Glossy Ibis	*Plegadis falcinellus*			X		X	
Gray Catbird	*Dumetella carolinensis*			X			
Great Egret	*Ardea alba*	X		X		X	X
Little Blue Heron	*Egretta caerulea*	X		X		X	
Limpkin	*Arams guarauna*	X		X			
Mourning Dove	*Zenaida macroura*	X	X	X	X	X	
Mottled Duck	*Anas fulvigula*					X	
Northern Cardinal	*Cardinalis cardinalis*		X	X	X		
Northern Mockingbird	*Mimus polyglottos*	X	X				
Roseate Spoonbill	*Platalea ajaja*			X		X	
Red-shouldered Hawk	*Buteo lineatus*	X	X	X	X	X	
Sandhill Crane	*Grus canadensis*		X	X	X	X	
Snowy Egret	*Egretta thula*			X		X	
Tricolored Heron	*Egretta tricolor*					X	
Florida wild turkey	*Meleagris gallopavo Osceola*	X	X	X	X	X	X
Turkey Vulture	*Cathartus aura*		X	X			X
White Ibis	*Eudocimus albus*			X	X	X	
Wood Stork	*Mycteria americana*			X		X	
Yellow-crowned Night-Heron	*Nyctanassa violacea*			X	X	X	
Yellow-rumped Warbler	*Setophaga coronata*		X				

Table 10. Total number (N), incidence (%I), and relative contribution to total fauna biomass (%Biomass) of each taxon collected in 30 minnow traps in December 2014 on the Rigsby Tract. "na" indicates mass was not included in calculations because animal was released in the field.

Latin Name	Common Name	N	%I	%Biomass
Fishes				
Jordanella floridae	Flagfish	1	3.3	0.20
Gambusia holbrooki	Eastern mosquitofish	43	20.0	2.81
Heterandria formosa	Least killifish	1	3.3	0.04
Enneacanthus gloriosus	Bluespotted sunfish	1	3.3	0.20
Lepomis gulosus	Warmouth	6	20.0	3.62
Lepomis marginatus	Dollar sunfish	10	20.0	4.07
Hemichromis letourneuxi	African jewelfish	109	46.7	86.60
Crustaceans				
Procambarus alleni	Everglades crayfish	2	6.7	4.07
Amphibians & Reptiles				
Amphiuma means	Amphiuma	1	3.3	na

Table 11. Summary of Wood Stork (WOST) nesting observations made from photographs taken on the three survey flights conducted in 2015. Survey locations target known existing colonies: CSS=Corkscrew Swamp Sanctuary, BC29=Baron Collier/SR29, CH=Collier/Hendry line, CE=Callosahatchee east, LI=Lenore Island. Asterisks (*) indicate WOST were observed but flight photographs have not yet been processed and data are unavailable.

	Colony				
Date	**CSS**	**BC29**	**CH**	**CE**	**LI**
1/29/2015	No nests	No nests	No nests	No nests	18 WOST roosting; 1 BRPE nesting
3/10/2015	No nests	11 WOST nest starts	No WOST nests; 1 GREG nest start	No nests	No nests; Various wader activity
4/9/2015	No nests	*	No nests	No nests	*

Table 12. Average (±SE) CPUE (5 minnow traps, pooled) of aquatic fauna among the three habitat types sampled (N=5 Brazilian pepper sites, N=2 mixed vegetation sites, N=3 herbaceous marsh sites). Asterisks (*) indicate non-native species.

		Habitat			
Common Name	Latin Name	Pepper	Mixed	Marsh	Total
Eastern mosquitofish	*Gambusia holbrooki*	147.4±46.8	39.5±15.5	75.0±43.8	1041
Flagfish	*Jordanella floridae*	11.2±6.3	0	24.7±24.7	130
Least killifish	*Heterandria formosa*	3.4±2.1	0	10.0±5.5	47
Sailfin molly	*Poecilia latipinna*	1.0±0.8	0	0.7±0.7	7
Brown hoplo*	*Hoplosternum littorale*	0.2±0.2	0.5±0.5	1.3±0.9	6
Marsh killifish	*Fundulus confluentus*	0	0	1.3±1.3	4
African jewelfish*	*Hemichromis letourneuxi*	0.6±0.6	0	0	3
Dollar sunfish	*Lepomis marginatus*	0	0	0.3±0.3	1
Bluefin killifish	*Lucania goodei*	0	0	0.3±0.3	1
Golden topminnow	*Fundulus chrysotus*	0	0	0.3±0.3	1
Bluespotted sunfish	*Enneacanthus gloriosus*	0	0	0.3±0.3	1
Everglades crayfish	*Procambarus alleni*	1.2±0.7	2.5±0.5	12.7±7.2	49
Total		165.0±54.3	42.5±15.5	127.0±53.1	1291