



Supplementary Materials for Report on Amphibian Monitoring at Barataria Preserve January 2018-March 2020

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Overview

While summarizing data for the two-year report, the ecologist for the Gulf Coast Inventory and Monitoring (I&M) Network often undertakes exploratory projects or considers ancillary data. The progress made on these projects is described in this supplementary materials document. All analyses and inferences made here should be considered preliminary and informal. Formal presentation of these or related results will be in the future trend reports, which are written after three two-year reports, or six years of data collection (i.e., trend report 1 will summarize data for January 2018 – March 2024).

The current Supplementary Materials document for amphibian monitoring at Barataria Preserve of Jean Lafitte National Historical Park and Preserve (NHP&P) contains (1) maps of study site location within the park and site layouts; (2) weather and environmental data summaries; (3) amphibian life history in relation to cover object occupancy; (4) list of reptiles detected during monitoring; (5) useful references for amphibians and amphibian monitoring at Barataria Preserve; and (6) select images of field setting and species ID during the reporting period.

1. Maps of study site and layout

Figure SM-1 shows the locations of the two amphibian monitoring study sites at the Barataria Preserve of Jean Lafitte NHP&P, located south of New Orleans, Louisiana. The deployment of new boards and pipes for the final design occurred in November 27, 2017, by protocol lead Jane Carlson and crew leader Billy Finney, both of the Gulf Coast Network. The same design of coverboards and PVC pipes was deployed in both the Education Center (ED) and V-Levee (LV) sites, which consisted of eight clusters of 4 coverboards and 3 pairs of PVC pipes and one additional cluster of PVC pipes only over water (Figure SM-2). Installation went as planned, resulting in 128 PVC pipes and 64 coverboards deployed between the two sites.

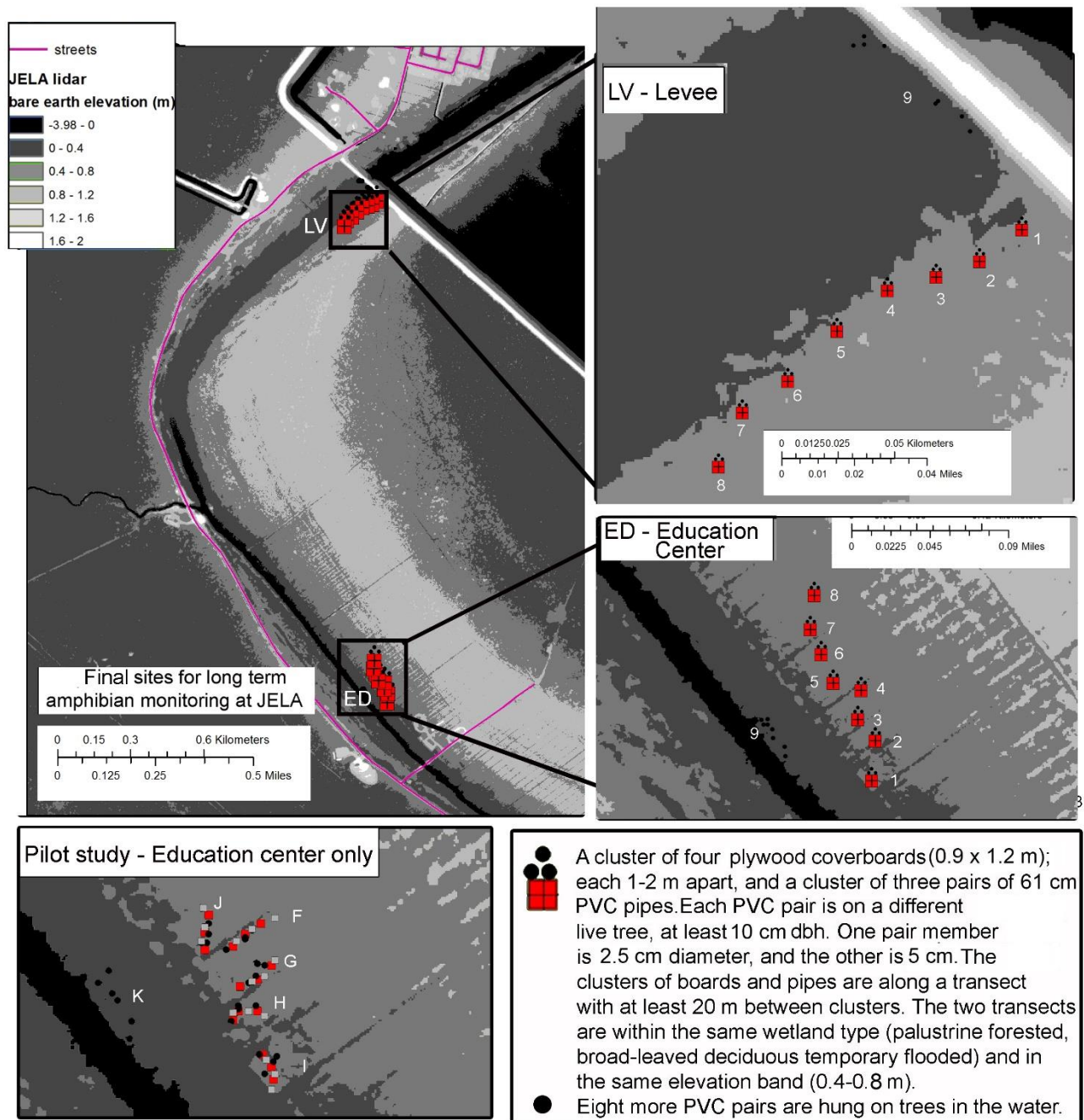


Figure SM-1. Locations and site sampling layouts for amphibian monitoring in the Barataria Preserve, which is located south of New Orleans, Louisiana. The pilot study at Education Center (ED) only was conducted from 2011–2017, and the final sampling protocol at ED and Levee (LV) was implemented in November 2017. This figure was taken from the protocol narrative, Appendix A (Carlson et al. 2018a).

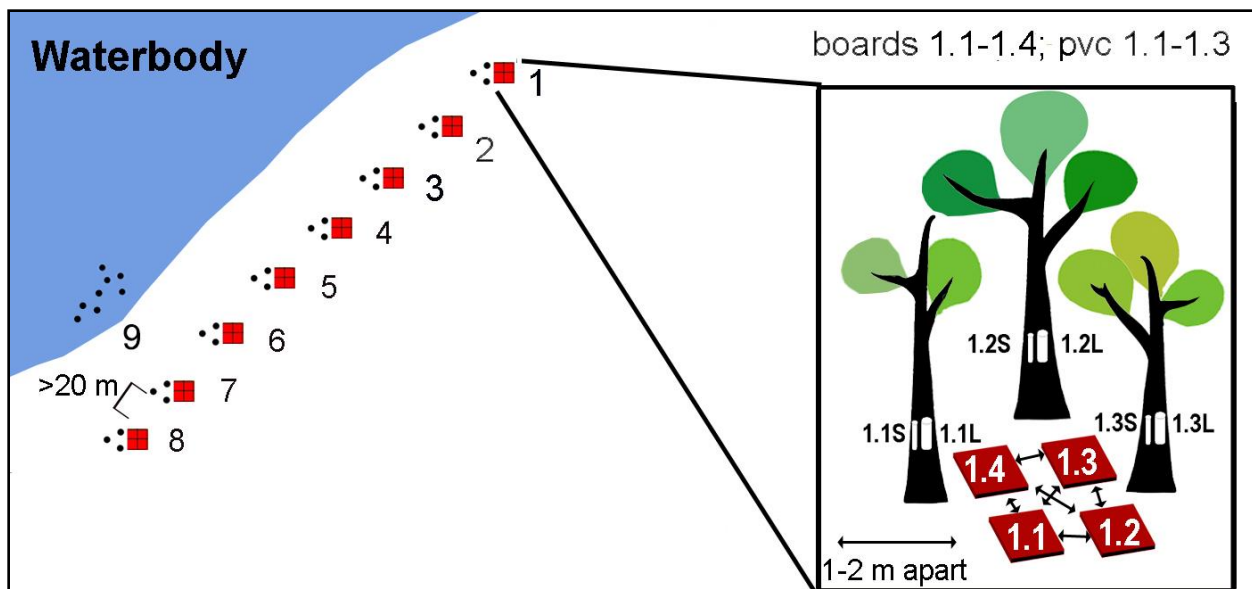


Figure SM-2. Approximate arrangement of PVC pipes and coverboards in clusters along a transect. The coverboards are shown as red squares, and the PVC pipes are black dots in the full image or white cylinders in the inset. In the inset, the pipes labeled with S are the smaller, 2.5 cm (1 inch) pipes, and the pipes labeled with L are the larger, 5 cm (2 inch) pipes.

2. Weather and Environmental Summaries

The Gulf Coast Network collects a wide range of environmental measurements in association with each amphibian monitoring event. These ancillary data are necessary because amphibian occupancy of monitored cover objects is highly variable and influenced, to an unknown degree, by current and past weather conditions. This variability creates a statistical challenge for the network, because weather-driven fluctuations in cover occupancy may mask declines or increases in amphibian abundance caused by anthropogenic stressors, which is of primary interest to the network and park. By using ancillary data in models predicting amphibian occupancy and abundance, the network has a better chance of detecting problematic changes in amphibian abundance during the 6-year trend analyses for focal amphibian species.

The environmental variables currently measured or assembled by the network are as follows:

- Air temperature and relative humidity at the start and end of each sampling event in each site
- Surface temperature inside each PVC pipe and under each coverboard at the time of sampling
- Continuous air temperature and relative humidity measured at half-hour or hourly intervals for all days of the year, recorded by a datalogger located a central location in each study site
- Continuous air pressure measured at hourly intervals for all days of the year, recorded by a data logger located at the ED site. A single pressure logger for both sites is acceptable because cross-site variability is low

- Continuous sensor depth of an underwater logger, to approximate water depth of the waterbody nearest each of the two study sites (different sections of the Bayou des Famille). Measurements are hourly, every day of the year
- Daily rainfall from a weather station in Audubon Park, New Orleans, LA (20 km away)
- Documentation of major weather events, particularly hurricanes and tropical storms that pass through the area

These data are assembled and organized into a single dataset on the network server, where they are used for preliminary comparisons with amphibian abundance. Although 2-year reports are not used for dissection and interpretation of temporal patterns, several plots of weather data are shown here, including a plot of air temperature over time (averaged between the two sites) and amphibian frequency (Figure SM-3).

Over the reporting interval, the continuous weather datasets are mostly complete with only a few data gaps. The network lost some data due to malfunctions in the data loggers themselves or malfunctions in the devices used to download the loggers. For air temperature, relative humidity, barometric pressure and water level loggers at ED and LV, the period of interest runs from 1/1/2018 to 3/19/2020. At ED, relative humidity data were missing from 1/31/2020 to 3/19/2020; these dates would have been missing for temperature at ED as well, but they could be copied from the barometric pressure gauge on the same tree, which also records air temperature. At LV, temperature and relative humidity data were missing from 1/1/2018 to 1/29/2018 (sensor was not yet installed there) and from 1/31/2020 to 3/19/2020. For sensor water depth at ED, data were missing from 1/1/2018 to 3/14/2018 (sensor was not yet installed there), and from 11/27/2019 to 12/12/2019. For sensor water depth at LV, data were missing from 1/1/2018 to 3/29/2018 (sensor was not yet installed there), and from 11/27/2019 to 12/12/2019. Barometric pressure has the same missing data as for ED sensor water depth. The rainfall data sourced from nearby was also complete for the reporting interval. In Figure SM-3, the temperature and relative humidity data are average over both sites when no data are missing and represent only one site when the other site's data are missing.

Between January 2018 and March 2020, there were four major storm events in the region that could have affected sampling or amphibian behavior during the current reporting interval. The first was tropical storm Alberto, which made landfall on May 29, 2018, near Laguna Beach, FL, and was not associated with any heavy rainfall at the Barataria Preserve. The second and third were tropical storm Gordon, which made landfall near Pascagoula, MS, on Sept. 4, 2018, and hurricane Michael, which made landfall on October 10, 2018, near Mexico Beach, FL. Neither was associated with any significant rainfall near the study sites. The fourth was hurricane Barry, which made landfall on July 13, 2019, at Intracoastal City, Louisiana, south of Lafayette, Louisiana. This final hurricane was associated a small spike in rainfall near the study sites, and the water sensor depths in the Bayou des Famille showed an increase in water level after the storm.

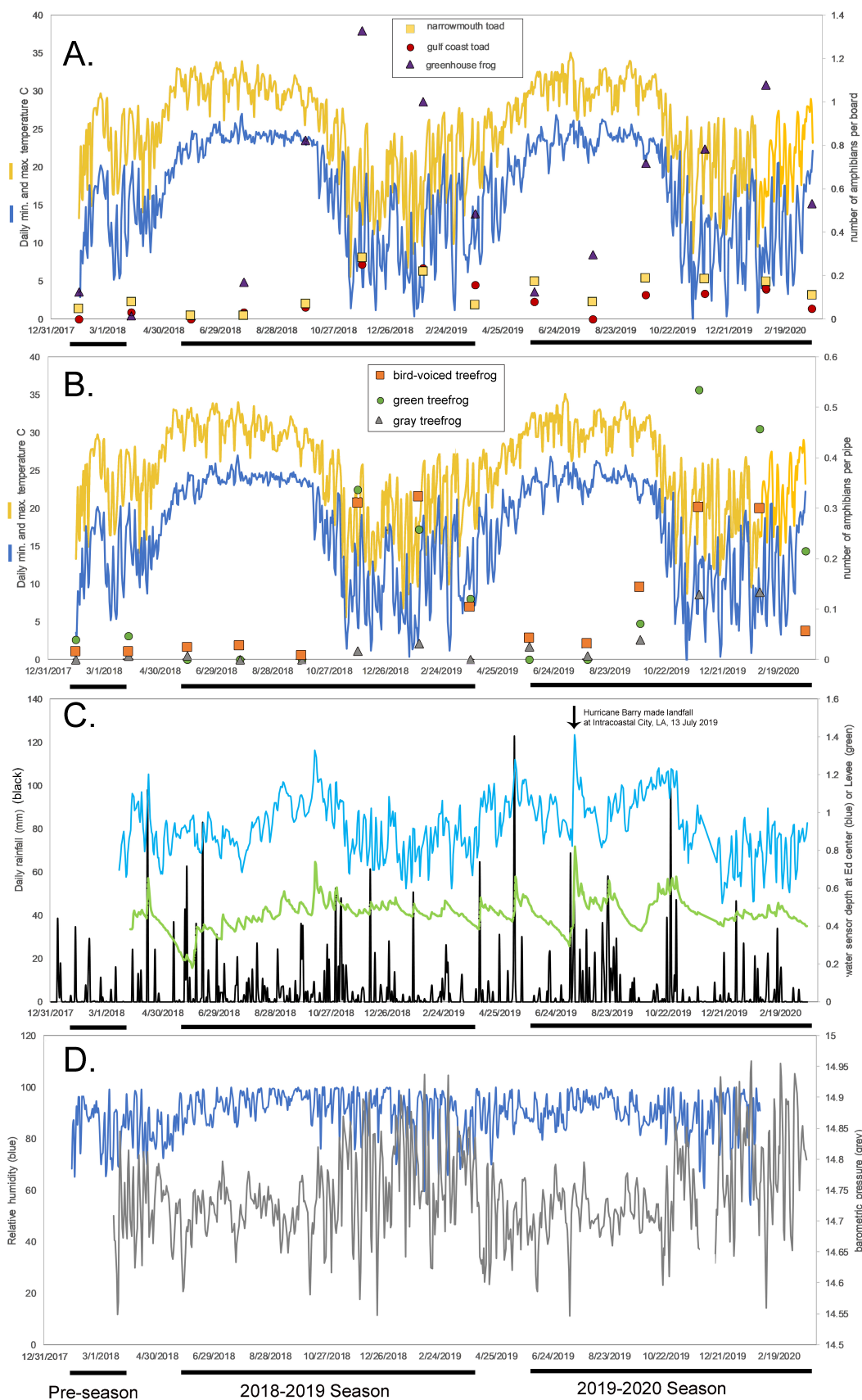


Figure SM-3. Continuous weather data for Barataria Preserve from Jan. 2018-March 2020. (A) mean daily minimum and maximum temperatures (two sites averaged) compared to frequency of three amphibian species under monitored coverboards for both sites combined; (B) the same daily temperature data, compared to frequency of three species of treefrogs in monitored PVC pipes for both sites combined; (C) daily rainfall data from Audubon Park, 20 km away (black line), as well as sensor water depth in the bayou at both study sites (blue for ED and green for LV); (D) daily mean barometric pressure from the continuous sensor at ED site (grey) and daily mean relative humidity averaged over the two sites (blue).

3. Amphibian Life History in Relation to Cover Object Occupancy

The artificial cover objects used in this study are meant to serve as shelter for amphibians, such as would a hollow branch or bark crevice on a standing tree (for a PVC pipe) or a dead log on the ground (for a plywood coverboard). The network uses a fixed number of PVC pipes and coverboards that remain in the same locations over time, and they assume that on average, amphibians are occupying them proportionately to their population abundance. As such, when the number of amphibians found in PVC pipes or under coverboards increases over time, it is inferred that there are more amphibians of that species present at the site overall. Even so, the need for shelter is not constant throughout the year, so occupancy may fluctuate across seasons, independent of population sizes. There may also be differences in environmental conditions among years that cause increased use of cover objects, such as an unusually cold winter. Finally, each species may have its own thresholds and preferences for using cover objects, such that any abundance proxy based on cover object data is not comparable across species. To begin to parse out these effects, the network tests for associations with weather variables, as described above, but also considers life history descriptions from the literature to better understand what drives the various patterns in cover object occupancy. These life history descriptions focus on the seven species that are abundant enough under cover objects to potentially be included in trend analyses after six years of data collection: *Hyla avivoca* (bird-voiced treefrog), *Hyla cinerea* (green treefrog), *Hyla squirella* (squirrel treefrog), *Hyla chrysoscelis* (Cope's grey treefrog), *Eleutherodactylus planirostris* (greenhouse frog), Gulf Coast toad (*Incilius nebulifer*) and narrow-mouthed toad (*Gastrophryne carolinensis*).

Four *Hyla* species

The four *Hyla* species at Barataria Preserve are, like other treefrog species, primarily active from dusk until dawn. They forage and feed at night from perches on exposed branches or leaves, either in the tree canopy, in shrubs, or in other vegetation closer to ground level. During the daytime, they are in their resting stage, although some species may vocalize during the day, when weather is changing. Inactive frogs can be found under loose bark or logs, on limbs or trunks, on buildings or other vertical structures, or even resting on leaves or stalks in the open. Their use of sheltered or exposed resting places depends partially on the time of year. During winter days, including the coldest nights, treefrogs take shelter in the most protected places, like under bark or in woody crevices, which is what the PVC pipes approximate. These protective cover objects may also be attractive when conditions are particularly dry. In much of the spring, summer, and early fall, in contrast, treefrogs require less thermal or drought protection and may spend the day resting in relatively exposed locations. All four species also move closer to wetlands, ponds and other waterbodies during the spring and summer, since they use these habitats to find mates and lay eggs in submerged masses, which develop into aquatic tadpoles. Depending on the species and location, the breeding season begins in March or April and ends in August, September or November. For these reasons, PVC pipes are used less from April to October and more in the winter. There also appear to be differences in PVC pipe use among species, although this cannot be readily parsed from differences in overall abundance. Green treefrogs tend to spend more time over water and in the surrounding shrubby vegetation, whereas squirrel, bird-voiced and grey treefrog may use forested habitats more often. Bird-voiced treefrogs, in particular, are more exclusively associated with cypress-tupelo swamps or large river systems, whereas the other species are found in a wider range of forested and wetland habitats.

Eleutherodactylus planirostris

The greenhouse frog is the only exotic amphibian species monitored by the Gulf Coast Network at the Barataria Preserve. This species is native to islands in the Caribbean, and it first arrived in the United States in the late 1800's, in southern Florida. Anderson and Seigel (2003) captured one greenhouse frog during their 2001-2002 inventory for the park, although this individual was found in a residential area north of the park boundary. This species had not been detected in any preceding inventories for the park (e.g., Rossman and Demaste 1989). During network monitoring, the greenhouse frog was first detected at the Education center site in 2012. This species occurs in leaf litter and under logs on the ground, which is what the coverboards approximate. Unlike the other amphibian species monitored for this project, greenhouse frogs do not depend on standing water to breed. Eggs are laid between May and September in high humidity locations on land, and the young hatch as froglets without a tadpole stage. This species is sensitive to cold, so like the treefrog species, it uses the monitored cover objects more often during the colder months of the year.

Incilius nebulifer

The Gulf Coast toad (*Incilius nebulifer*) is the only true toad species (family Bufonidae) known to occur within the Barataria Preserve. Woodhouse's toad (*Anaxyrus woodhousii* or *Anaxyrus fowleri-woodhousii* complex) has been recorded south of Lake Pontchartrain and in the Marrero area, but not within the park boundary (Anderson and Siegel 2003; Rossman and Demastes 1989). It is reported that Gulf Coast and Woodhouse's toads can hybridize to produce viable adults, but there have been no observations of potential hybrids from the area. The Gulf Coast toad, like other toad species, is mainly nocturnal. It emerges from burrows or from under logs or leaf litter to feed during the night, especially when conditions are damp and warm. When temperatures are below 10° C (50° F), this toad species is rarely seen outside of cover (Dundee and Rossman 1989). Breeding is from April to September, when toads travel to standing water to find mates and lay eggs. Gulf Coast toads are found in a wide range of habitats throughout southern Louisiana, eastern Texas and coastal Mississippi, from suburban lawns and gardens, to agricultural areas, to forests.

Gastrophryne carolinensis

The Eastern narrow-mouthed toad is not a member of the true toad family, but is instead a small, smooth-skinned frog in the family Microhylidae. Like the other amphibians studied here, members of this species are active at night (especially at dusk and early evening) and take refuge under cover during the day. Activity increases during and just after rain, and it decreases during cold weather. Like Gulf Coast toads, they are found in diverse natural and semi-natural habitats, including lawns, gardens, meadows, flooded swamps, marshes and bottomland forests. Unlike true toads however, they require a fairly constant moisture source. Breeding season is from April to October, at sites that can range from wetlands to streams to tire ruts, as long as there is sufficient vegetation or debris for singing males. During the breeding season, individuals travel from resting refuges to breeding waterbodies each evening at dusk.

4. List of Reptile Species from Amphibian Monitoring

When reptiles are encountered during monitoring, the species name and number of individuals are always recorded, even though reptiles are not the targeted taxonomic group for the protocol. Table SM-1 lists the species names, most recent encounter date and method of encounter. Most reptile species are photographed when encountered, and the network will provide photos upon request.

Table SM-1. Reptiles detected in or under monitored cover objects, or by casual observation between January 2018 and March 2020. An asterisks marks the only non-native reptile detected in the park on a monitoring trip, the brown anole. This is the first detection of this species on the park by network staff, and this species has not yet been detected in either amphibian monitoring transect at the park.

Date of most	Method of encounter	Latin name	Common name
3/19/2020	Coverboard	<i>Thamnophis proximus</i>	Gulf Coast Ribbonsnake
1/30/2020	Coverboard	<i>Storeria dekayii</i>	Dekay's Brownsnake
9/28/2018	Coverboard	<i>Liodytes rigida</i>	Glossy Swampsnake
7/31/2019	Coverboard	<i>Nerodia fasciata</i>	Broad-Banded Watersnake
9/24/2019	Coverboard	<i>Nerodia erythrogaster</i>	Plain-bellied Watersnake
9/28/2018	Coverboard	<i>Agkistrodon contortrix</i>	Copperhead
9/28/2018	Coverboard	<i>Coluber constrictor</i>	Black-masked Racer
9/25/2019	Casual observation	<i>Lampropeltis triangulum</i>	Western Milk Snake
9/25/2019	PVC pipe	<i>Pantherophis obsoleta</i>	Western Ratsnake
9/25/2019	Coverboard and PVC pipe	<i>Plestiodon laticeps</i> or <i>Plestiodon</i> sp. (possibly <i>Plestiodon fasciatus</i>)	Broad-headed Skink or juvenile skink of either Broad-headed or Common Five-lined skink
3/19/2020	Coverboard	<i>Scincella lateralis</i>	Little brown skink
All events	Coverboard and PVC pipe	<i>Anolis carolinensis</i>	Green anole
3/19/2020	Casual observation at Twin Canals	<i>Anolis sagrei</i>	Brown anole*
9/25/2019	Casual observation	<i>Terrapene carolina</i>	Common Box Turtle

5. References

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6. Images of field setting and species ID

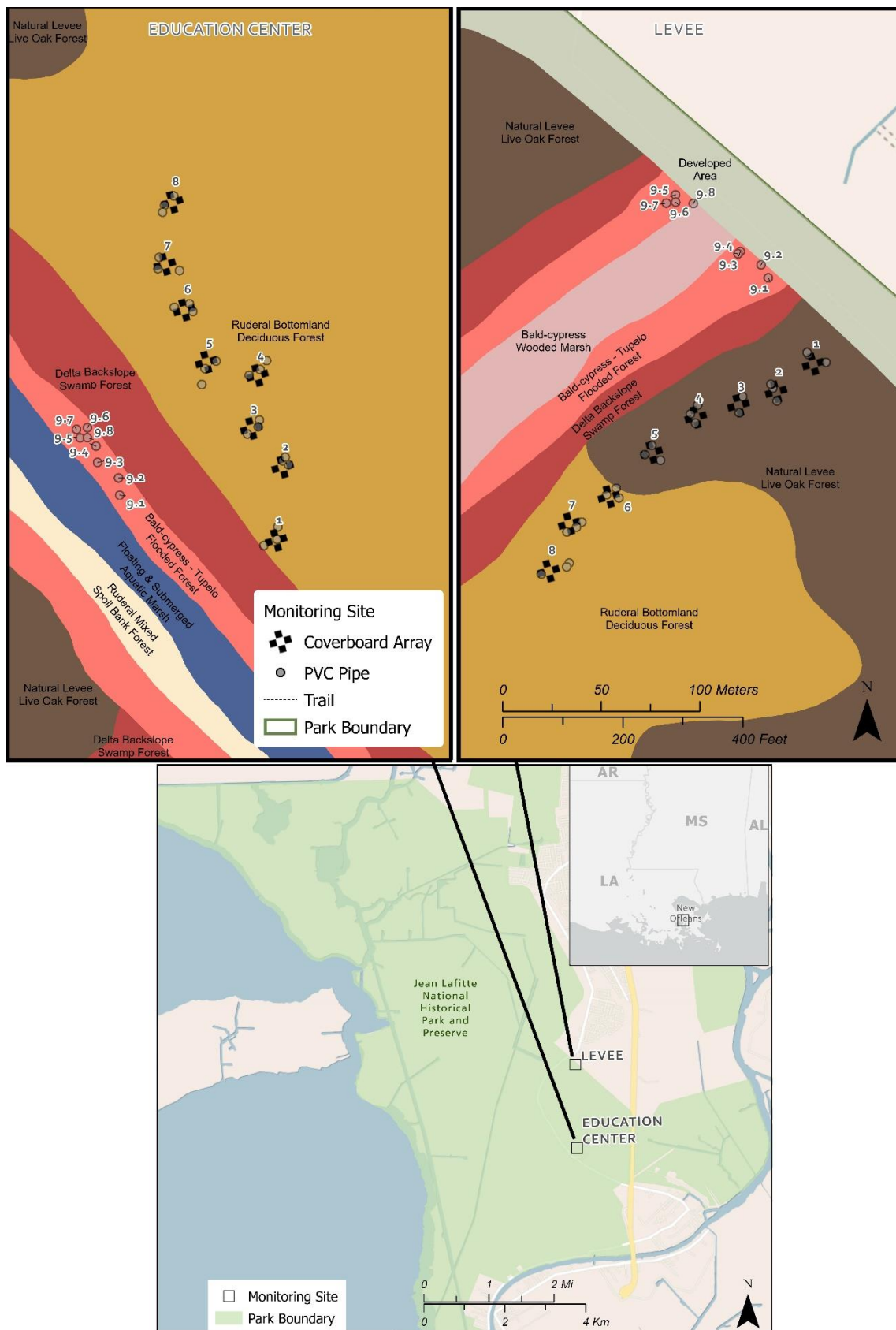


Image SM-1. Map of vegetation classification types (Hop et al. 2017) for the two amphibian monitoring study sites at Barataria Preserve, with locations of amphibian monitoring clusters overlaid. Larger map (below) shows study site locations in the park.



Photo SM-2. Coverboards at LV cluster 1. The LV study site spans the transition between the natural levee live oak forest and the ruderal (i.e., disturbed, regrown) bottomland deciduous forest. The transition between communities is gradual and not clearly detectable in the field, even though it appears abrupt in Image SM-1.



Photo SM-3. Continuous data logger at ED site, near coverboard cluster 5. This study site is classified as ruderal bottomland deciduous forest.



Photo SM-4. The section of LV site where PVC pipes are hung over water in the Bayou des Famille (cluster 9). The dark PVC pipe houses the water depth sensor for LV site. This photo was taken July 2018.



Photo SM-5. PVC pipes in cluster 9 of LV site. This photo was taken in January 2018.



Photo SM-6. The section of ED site where PVC pipes are hung over water (cluster 9), in a wetland adjacent to the Bayou des Famille This photo was taken in January 2018.



Photo SM-7. The section Bayou des Famille that is closest to the ED study site. This photo was taken in July 2018.



Photo SM-8. Greenhouse frog, *Eleutherodactylus planirostris*, a non-native frog found at both amphibian monitoring sites at the Barataria Preserve.



Photo SM-9. Spring peeper (*Pseudacris crucifer*) at LV site.

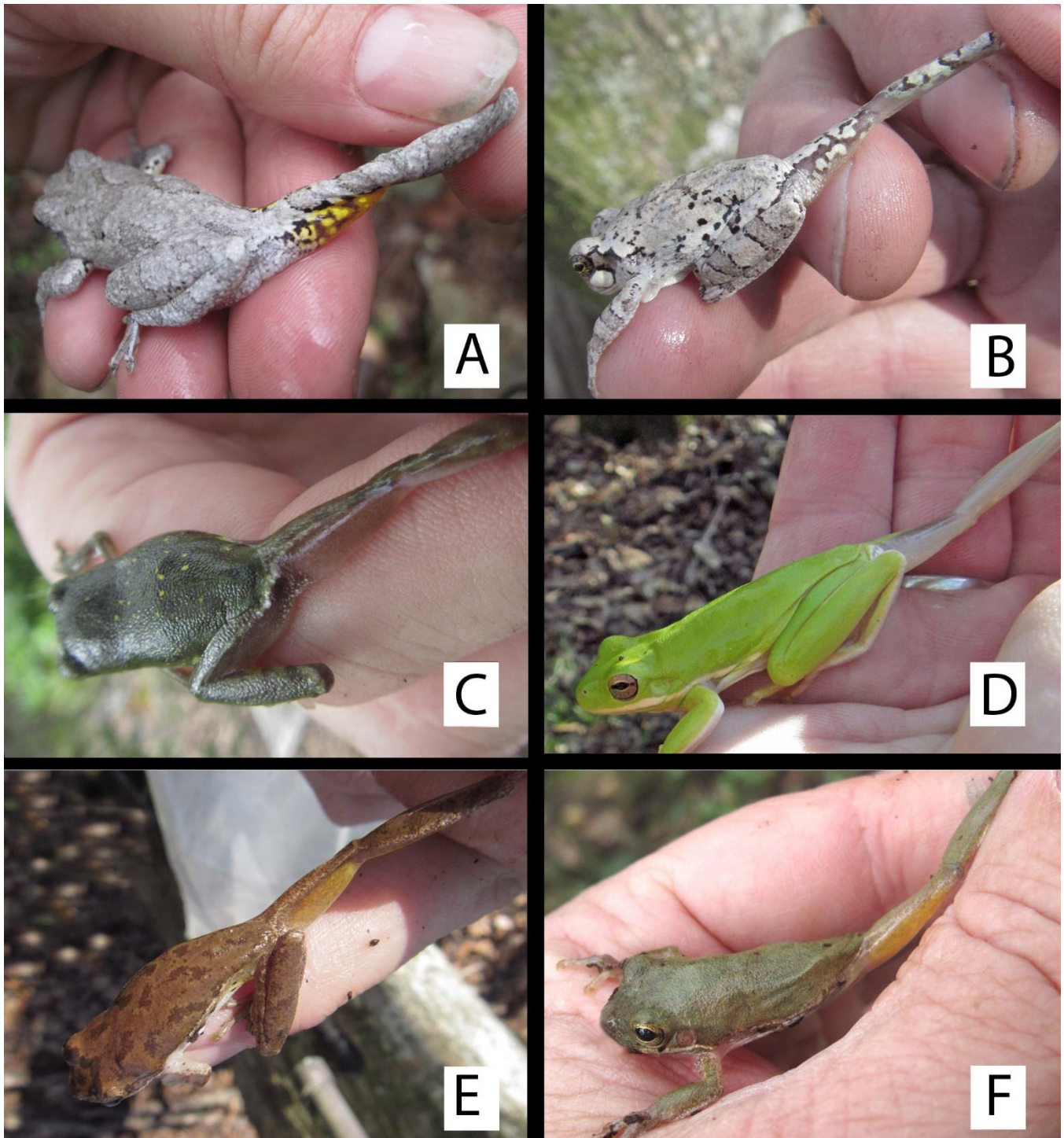


Photo SM-10. Treefrog identification photos showing hind leg exposed for four species. (A) Cope's gray treefrog (*Hyla chrysoscelis*); (B) bird-voiced treefrog (*Hyla avivoca*); (C) and (D) darker and lighter forms of green treefrog (*Hyla cinerea*); (E) and (F) browner and greener forms of squirrel treefrog (*Hyla squirella*).



Photo SM-11. Gulf Coast toad (*Incilius nebulifer*) found under a coverboard at the Barataria Preserve.



Photo SM-12. Narrow-mouthed toad (*Gastrophyrne carolinensis*) found under a coverboard at the Barataria Preserve.



Photo SM-13. Eastern newt (*Notophthalmus viridescens*) in immature eft stage, photographed at the ED center site.



Photo SM-13. Brown anole (*Anolis sagrei*), a non-native species that was seen for the first time in the park by network staff in March 2020. Because no photos of brown anoles in the park are available at this time, this photograph is of an individual seen in New Orleans in 2019, taken by Jane Carlson.