



Supplementary Materials for Amphibian Monitoring at San Antonio Missions National Historical Park: Two-Year Summary through February 2024

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Overview

As part of each Amphibian Monitoring two-year report –currently written as a web article– the ecologist for the Gulf Coast Inventory and Monitoring (I&M) Network also prepares a Supplementary Materials document of background information and ancillary data. The summaries, figures, and data explorations included here should be considered preliminary and informal. Final 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 April 2018 – February 2024).

The current Supplementary Materials document for amphibian monitoring at San Antonio Missions National Historical Park (NHP) contains (1) a project timeline that reviews major events during each 2-year reporting period since 2018; (2) an overview of ancillary weather and environmental data; (3) a list of all amphibian species detected on the park during monitoring; (4) a list of reptiles detected during the 2-year monitoring period as well as during previous monitoring years; (5) literature cited and other useful references for amphibians and amphibian monitoring at the park. The first Supplementary Materials document, covering April 2018 to February 2020 (see [Supplemental Materials to Carlson et al. 2020](#)) included a section on amphibian life history in relation to cover object occupancy, which is relevant to future trend reports but not necessary to duplicate here. Specific details on study site layout, design, cover object materials, field methods, and the pilot study can be found in the Amphibian Monitoring Protocol Narrative, Standard Operating Procedures (SOP) and associated documents (Carlson et al. 2018a, Carlson et al. 2018b, Carlson 2018).

1. Project Timeline

Since installation of the current monitoring design, the Gulf Coast Network has collected data for six monitoring years (MY), with the first spanning April 2018 through February 2019 (MY2018; see full list of MY in Table SM-1). Findings from the first two monitoring years were summarized individually in the network’s first two-year amphibian monitoring report for the park (Carlson et al. 2020), and MY 3 and 4 were covered in Carlson and Toussel (2022). Table SM-1 breaks down the full project timeline by monitoring year, focusing primarily on notable observations, missed sampling events, major changes in personnel, major weather events, and changes to methods. More details on key findings are provided in the main report, past reports, or further below in this document.

Table SM-1. Amphibian Monitoring project timeline at San Antonio Missions NHP, by monitoring year.

Monitoring Year	Relevant Events or Changes
Prior to current study: pilot study November 2011- Dec 2017	During a pilot study that lasted over 6 monitoring years, crews checked up to 50 coverboards and 40 PVC pipes in four study sites, including West side (WS), San Juan (SJ) and Hospital (HP). Sampling was once per month through April 2017, and then continued as alternate month events through to December. The pilot array was disassembled at the end of the pilot study, and PVC pipes were entirely removed from the study because of their extremely low capture rates at the park.
Installation of current design in January 2018	A crew of Gulf Coast Network staff and cooperators installed 60 coverboards total, divided evenly between WS, SJ and HP. Coverboards were arranged in clusters of four within each site. In April 2018, another crew installed one continuous data logger per site for air temperature and relative humidity. Data were, and continue to be, downloaded from loggers during each sampling event and stored on the network server.
(1) MY2018: April 2018- February 2019	Six sampling events were completed successfully, led by Billy Finney (4 events), Jane Carlson (1 event), or network cooperator Marvin Lutnesky, from Texas A&M University-San Antonio (final event). There were some issues with the continuous data loggers in Fall 2018 such that 2 months of temperature and relative humidity data were lost. There were three instances of dead Rio Grande Chirping Frogs under coverboards that appeared to be linked to freezing temperatures in the days before sampling. Just prior to the February 2019 event, four coverboards were found out of place at the HP site, but they were replaced in time for sampling.
(2) MY2019: April 2019- February 2020	Six sampling events were completed successfully, led by Marvin Lutnesky. Radiation shields were installed over continuous loggers for temperature and relative humidity in July 2019. During events in August 2019 and February 2020, there was evidence that the HP site was being used as a campsite for a local unsheltered population. This resulted in 2 boards of lost data. The reporting interval for the first 2-year report ended after the February 2020 event (Carlson et al. 2020).
(3) MY2020: April 2020- February 2021	Five sampling events were completed successfully, led by Marvin Lutnesky. The April 2020 event was missed due to COVID-19 travel restrictions. The HP site was compromised by unauthorized camping for many months during MY2020; three sampling events were significantly impacted. In June 2020, 7 of 20 boards were rendered unsamplable; in August 2020 it was 10 of 20; in October 2020, it was 12 of 20. In November 2020, Jeff Bracewell from the network and Greg Mitchell from the park installed 'do not disturb' signs on coverboards at the HP site to discourage future use as camping structures. Greg Mitchell brought park volunteers to clean up the site. Across both subsequent events, December 2020 and February 2021, only one board was disturbed at HP.
(4) MY2021: April 2021 to February 2022	Six sampling events were completed successfully, led by Marvin Lutnesky. Human disturbance to HP site continued in MY2021, though to a lesser extent than in MY2020. Four boards were unsamplable in each of April 2021 and December 2021. On 12/5/2021, crews discovered a missing continuous logger for temperature and relative humidity at HP. It was apparently stolen from its radiation shield, and a replacement was made on 12/19/2021. In July 2021, Jeff Bracewell visited the site to replace 8 boards, since some of the boards had warped excessively from dry conditions, and several other boards were rotten. In April 2021, two Texas Coralsnakes were seen at a WS coverboard, which were the first observations of this species during the current study.
(5) MY2022: April 2022 to February 2023	Six sampling events were completed successfully, led by Marvin Lutnesky. Human disturbance to HP site returned to MY2020 levels, with >4 boards unsamplable in each of August 2022, December 2022, and February 2023. Park rangers placed a motion-sensor camera at the site in October and November 2022 to capture vandalism in action, but all they recorded was a dog and two bobcats. Human visitors were nonetheless at the site while the camera was in place, including someone who rearranged the boards in late October/early November 2022, which were found in that condition on November 5 by two GULN staff members. At the time of those activities, the camera was present but apparently not working. The network decided the best course of action was to drop the site, since all efforts to curb the vandalism had failed. After sampling coverboards in February 2023, a crew led by Billy Finney moved all boards from the HP site and placed them at the WS-extension site. This new site, directly adjacent to the original WS boards, was populated with 5 clusters of 4 boards each,

Monitoring Year	Relevant Events or Changes
	using HP boards plus additional boards to replace those missing from HP. The first sampling event at WS-extension was in April 2023. During this MY, central Texas was under severe drought conditions, from roughly May 2022 to March 2023.
(6) MY2023: April 2023 to February 2024	Six sampling events were completed successfully, led by Marvin Lutnesky. There were some issues with data loggers having nonsensical dates and times during offloads, but these were corrected by setting the end date and time to the time of download and adjusting dates and times throughout to match. After this issue was detected, a new download shuttle was provided and the inconsistencies stopped. April and May of this MY were notably wetter than in the past several years, but mild drought returned later in the summer. For this MY as for previous MY, boards regularly needed replacement, and in MY2023, crews started using 5-ply plywood to increase longevity. Network cooperator Marvin Lutnesky proposed a pilot study using recycled plastic lumber as an alternative. Throughout the first six monitoring years of the current study, the Gulf Coast Network's field methods remained unchanged, although minor changes were made to datasheets to improve data recording practices (SOP03, Carlson et al. 2022). The reporting interval for the current 2-year report ended in February 2024. The data collected over these six years is being prepared for the network's first status and trends report for amphibian monitoring at the park.

2. Ancillary Weather and Environmental Data

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 may be influenced 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
- Ground surface temperature 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 at a central location in each study site
- Daily rainfall and daily barometric pressure from a weather station at the San Antonio Stinson Municipal Airport (<3 km away from each site).
- Documentation of major weather events, including storms or prolonged droughts

These data are assembled and organized into several datasets on the network server. Several derived variables are calculated from the raw environmental data, to create covariates that should more directly relate to patterns of amphibian activity and reproduction. For example, relevant variables could include total rainfall in the 3 months before an event (Figure SM-1A), number of days in the three months before an event

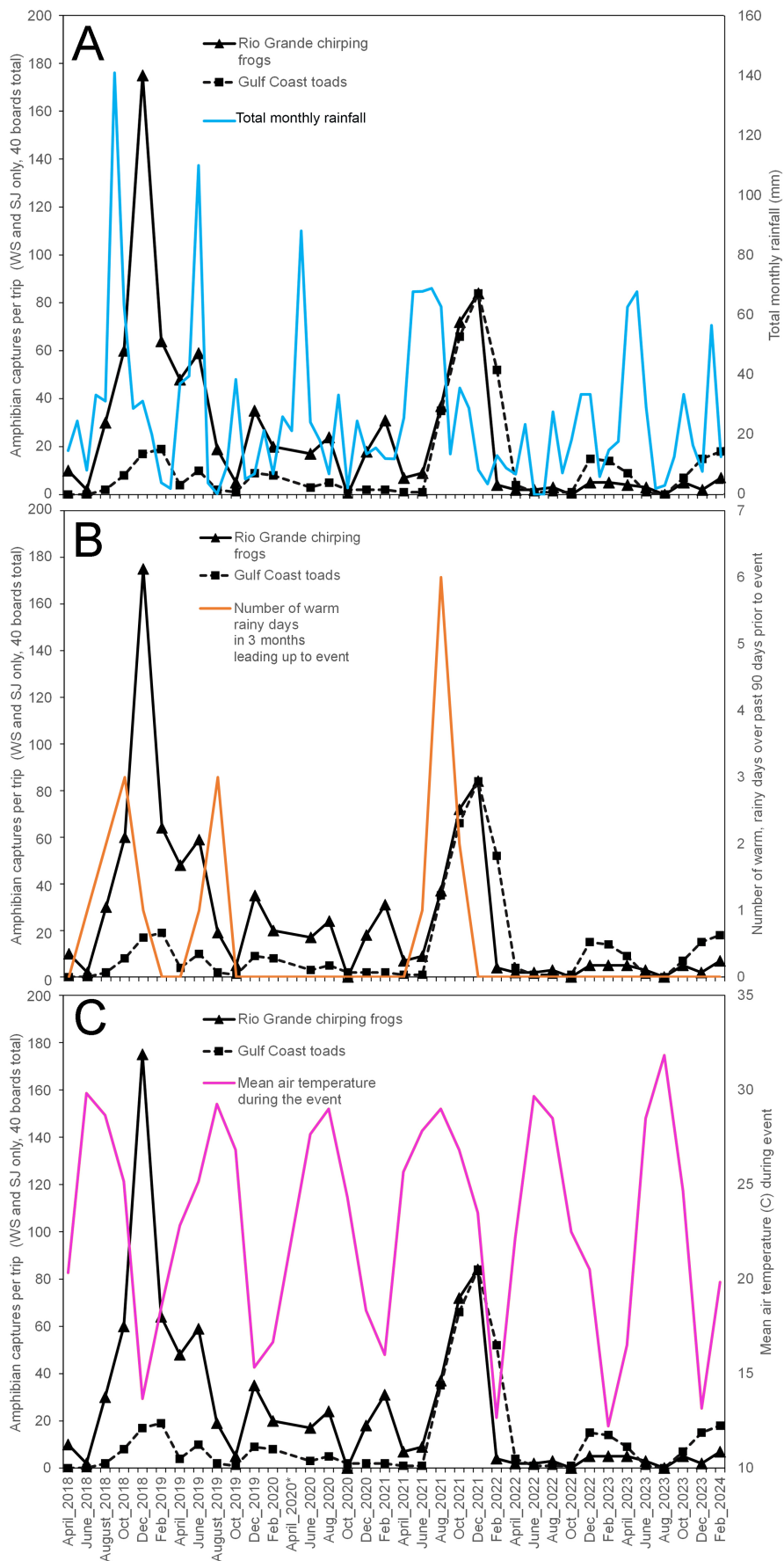


Figure SM-1. Derived environmental variables in relation to amphibian sampling events and amphibian captures for San Antonio Missions NHP from April 2018-February 2024. (A) Total rainfall per month (mm); (B) the number of warm (>20°C) rainy (>3cm rainfall) days in the 3 months prior to a sampling event; and (C) the average air temperature during a sampling event.

when toad breeding activity is likely (i.e., warm days [$>20^{\circ}\text{C}$] that also had significant rainfall [$>3\text{cm}$]; Figure SM-1B; temperatures for breeding from Blair 1960), or the mean air temperature during an event, which would likely influence an amphibian's need for thermal refuges like coverboards (SM-1C). Because 2-year reports are focused on the status of amphibians, rather than trends over time, there are no statistical comparisons between weather data and amphibian relative abundance in the current report. Even so, visual comparisons suggest meaningful associations will likely be found.

3. List of Amphibian Species Detected During Monitoring

Only three amphibian species were detected by I&M crews during the current 2-year reporting period, but four additional species have been recorded in monitoring sites within the city limits in previous years (Table SM-2). These additional records include observations from the project's six-year pilot phase (2011-2017), which also employed PVC pipes as artificial refuges for arboreal species. The only non-native species on this list is the Rio Grande Chirping Frog. In the table below and throughout this document, scientific and common names follow Crother (2017), with the exception that the network has updated *Hyla* to *Dryophytes*.

Table SM-2. Amphibian species recorded by I&M crews under coverboards or out in the open during monitoring events at San Antonio Missions NHP since the I&M project began at the park (2011-2024). * species with an encounter rate high enough for long term monitoring by I&M. **species seen during I&M monitoring that were not recorded in the original inventory by Duran (2004).

Common Name	Scientific Name
Blanchard's Cricket Frog	<i>Acris blanchardi</i>
American Bullfrog	<i>Lithobates catesbeianus</i>
Gulf Coast Toad*	<i>Incilius nebulifer</i>
Great Plains Narrowmouth Toad	<i>Gastrophryne olivacea</i>
Green Treefrog	<i>Dryophytes cinereus</i>
Rio Grande Chirping Frog*	<i>Eleutherodactylus cystignathoides</i>
Rio Grande Leopard Frog**	<i>Lithobates berlandieri</i>

4. List of Reptile Species Detected During Two-Year Reporting Period and Since Monitoring Began

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 project. Table SM-3 lists all reptile species encountered in each monitoring site during the current reporting interval (MY2022-2023), including the most recent encounter date.

Table SM-3. Reptiles detected under coverboards or by visual observation during sampling events in the 2022 and 2023 monitoring years (April 2022 - February 2024). HP is for Hospital site, SJ is for San Juan, and WS is for West Side.

Group	Common name	Scientific name	Most recent sighting per site	Site	Count
Lizards	Green Anole	<i>Anolis carolinensis</i>	12/11/2022	WS	1
Lizards	Green Anole	<i>Anolis carolinensis</i>	2/12/2023	HP	3
Lizards	Green Anole	<i>Anolis carolinensis</i>	2/11/2024	SJ	3
Lizards	Little Brown Skink	<i>Scincella lateralis</i>	4/10/2022	WS	2
Lizards	Little Brown Skink	<i>Scincella lateralis</i>	6/12/2022	SJ	3
Lizards	Little Brown Skink	<i>Scincella lateralis</i>	8/14/2022	HP	13
Snakes	Texas Threadsnake	<i>Rena dulcis</i>	6/11/2023	SJ	1
Snakes	Texas Coralsnake	<i>Micrurus tener</i>	8/14/2022	HP	1
Snakes	Checkered Gartersnake	<i>Thamnophis marcianus</i>	2/11/2024	SJ	1
Snakes	Checkered Gartersnake	<i>Thamnophis marcianus</i>	2/11/2024	WS	5

Since I&M began collecting amphibian monitoring data in 2011, 17 reptile species have been detected by I&M crews in San Antonio Missions NHP, not counting the satellite property Rancho de las Cabras (Table SM-4). In the inventory by Duran (2004), a total of 42 reptile species were documented through direct observation or museum records; 25 of these are not on the I&M list, but the inventory covered a larger area and used additional methods not implemented by I&M, such as turtle traps, minnow traps and drift fences. The only non-native species on Table SM-4 is the Mediterranean Gecko, which was last seen under coverboards at San Juan in 2019. More recently, another non-native gecko, the Moorish Gecko (*Tarentola mauritanica*), has been recorded in many sites in San Antonio (Davis et al. 2024). Although it is potentially within the park as well, it has not yet been documented in I&M study sites.

Table SM-4. Reptile species recorded by I&M crews since the amphibian monitoring project began at San Antonio Missions NHP (2011-2024). Individuals were either under coverboards or seen out in the open during monitoring events. The original inventory by Duran (2004) documented 42 reptile species at the park, but some records were from the park's rural Rancho property, roughly 30 miles to the south.

Group	Common Name	Scientific Name
Lizards	Green Anole	<i>Anolis carolinensis</i>
Lizards	Six-lined Racerunner	<i>Aspidoscelis sexlineatus</i>
Lizards	Mediterranean Gecko	<i>Hemidactylus turcicus</i>
Lizards	Prairie Lizard	<i>Sceloporus consobrinus</i>
Lizards	Texas Spiny Lizard	<i>Sceloporus olivaceus</i>
Lizards	Little Brown Skink	<i>Scincella lateralis</i>
Snakes	Western Diamondback Rattlesnake	<i>Crotalus atrox</i>
Snakes	Texas Threadsnake	<i>Rena dulcis</i>
Snakes	Ruthven's/Schott's Whipsnake	<i>Masticophis (schotti) schotti</i>
Snakes	Texas Coralsnake	<i>Micrurus tener</i>
Snakes	Plain-bellied Watersnake	<i>Nerodia erythrogaster</i>
Snakes	Great Plains Ratsnake	<i>Pantherophis emoryi</i>
Snakes	Western Ratsnake	<i>Pantherophis obsoleta</i>
Snakes	Flat-headed Snake	<i>Tantilla gracilis</i>
Snakes	Checkered Gartersnake	<i>Thamnophis marcianus</i>
Snakes	Western Ribbonsnake	<i>Thamnophis proximus</i>
Turtles	River Cooter	<i>Pseudemys concinna</i>

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