



ARTICLE

Texas Tortoise Monitoring at Palo Alto Battlefield National Historical Park: Results for 2024

[Palo Alto Battlefield National Historical Park](#)



An adult Texas tortoise (*Gopherus berlandieri*) at Palo Alto Battlefield National Historical Park.
NPS photo/ GULN staff

Project Background and Methods

The Texas tortoise (*Gopherus berlandieri*) is a small, cryptic tortoise of south Texas and three states in Mexico that is [threatened](#) by widespread habitat loss and illegal collection. There is only one U.S. National Park unit where this species is commonly found, [Palo Alto Battlefield National Historical Park](#) (NHP) in Brownsville, Texas. The tortoises that live on the park do not face the same immediate threats as those occurring on unprotected lands, but even so, their abundance, health, and local movements require monitoring to support future management decisions.

The Texas tortoise monitoring project was established in 2008 by the [Gulf Coast Network](#), part of the National Park Service's [Inventory and Monitoring \(I&M\) Program](#). The goals of the Texas tortoise monitoring project are to: (1) track the tortoise's status in seven permanent, 4-hectare sampling units, in terms of catch per unit effort, movements, body condition, and the distribution of sizes and sexes captured, and (2) analyze cross-year trends in abundance and survivorship from mark-recapture data. The Texas tortoise monitoring project is a long-term mark-recapture study, where field crews conduct standardized tortoise surveys once each year, always for the same amount of time and within the same seven survey units. The survey units are located on lomas, which are low ridges covered in thorny shrubs and mesquite trees, the tortoises' preferred habitat in coastal Texas (see Figure 1 for a schematic of a park loma and its adjacent habitats).

Sampling events occur over a three-day period each fall. All seven units are surveyed twice over this period, each time by a different team that dedicates eight person-hours of effort to each unit, or about two hours for a four-person team. As team members encounter tortoises, they weigh them, measure their carapace dimensions, photograph them, record their sex, and record a GPS location. For newly encountered individuals, they mark them by drilling holes in scutes according to a unique numeric code, to allow for identification upon recapture (see cover photo). The park's Texas tortoises have been surveyed, marked, and measured like this at least once per year for 15 years; however, the total effort, survey areas, and written protocols have changed over time. The current protocol, [Version 3.0](#), was published in 2018. Previous annual reports for this project as well as other information can be found in the [Gulf Coast Network Texas Tortoise Monitoring Project](#) on the NPS DataStore or the [network's website for the Texas tortoise project](#).

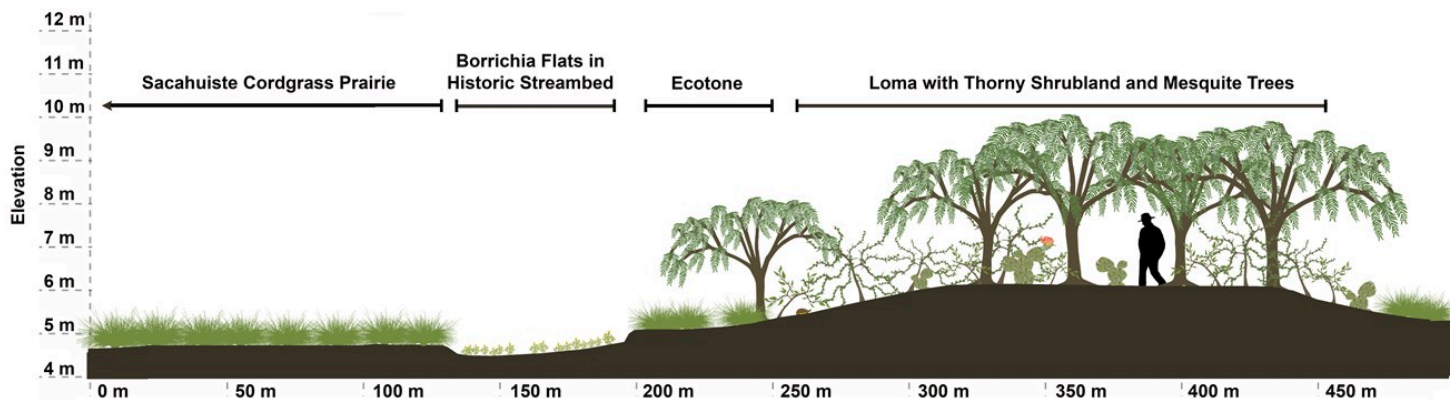


Figure 1. A schematic of a loma and other major habitats at Palo Alto Battlefield NHP. The park has wide expanses of sacahuiste prairie (*Spartina spartinae*) with intermittent old streambeds containing sea ox-eye daisy (*Borrichia frutescens*). Near these old streambeds, the ground elevation gently rises into a ridge, or loma, typically covered in woody shrubs, prickly pear (*Opuntia engelmannii*) and mesquite trees (*Prosopis glandulosa*). Lomas are the main habitat of Texas tortoises in the park.

2024 Trip Summary

The Gulf Coast Network completed its Fall 2024 Texas tortoise monitoring trip from November 12 to November 15. Thirteen participants were split into two teams, each surveying all seven units for the required eight person-hours of effort, for a total of 16 person-hours, with the two surveys conducted one to two days apart. The 2024 trip also included one survey that was not part of routine fieldwork. This non-focal survey, called a bonus survey, received a total effort of eight person-hours. The bonus survey unit was located in a previously identified area of the park that, like the seven focal units, had relatively high elevations and suitable vegetation. The intent was to check for previously marked tortoises that may have moved to areas not normally surveyed.

Tortoise Encounters

The Fall 2024 trip yielded 42 unique live tortoises, although 10 were found during bonus surveys or were outside unit boundaries or survey times (Table 1). This amounted to 32 individuals found over 112 person-hours within time-and-area constrained surveys, or a catch-per-person-hour effort of 0.29. This yield was considerably lower than last year’s encounter rate of 0.38 (Figure 2).

Table 1. Live, unique tortoises found both in and out of surveys. Each individual tortoise was counted only once, even if it was seen during both surveys. Total counts of individuals were then summed for all seven units, resulting in a combined number of tortoises across both teams. The total includes a separate tally of newly marked individuals for 2024 ("new"), in addition to the combined total that also counts tortoises recaptured from previous years. The table does not include two dead tortoises found during surveys, both unmarked.

Areas	Female	Male	Juvenile	Total
During surveys in the seven focal units	13	18	1	32 (4 new)
Bonus surveys or outside survey boundaries	6	4	-	10 (6 new)
Total live individuals	19	22	1	42 (10 new)

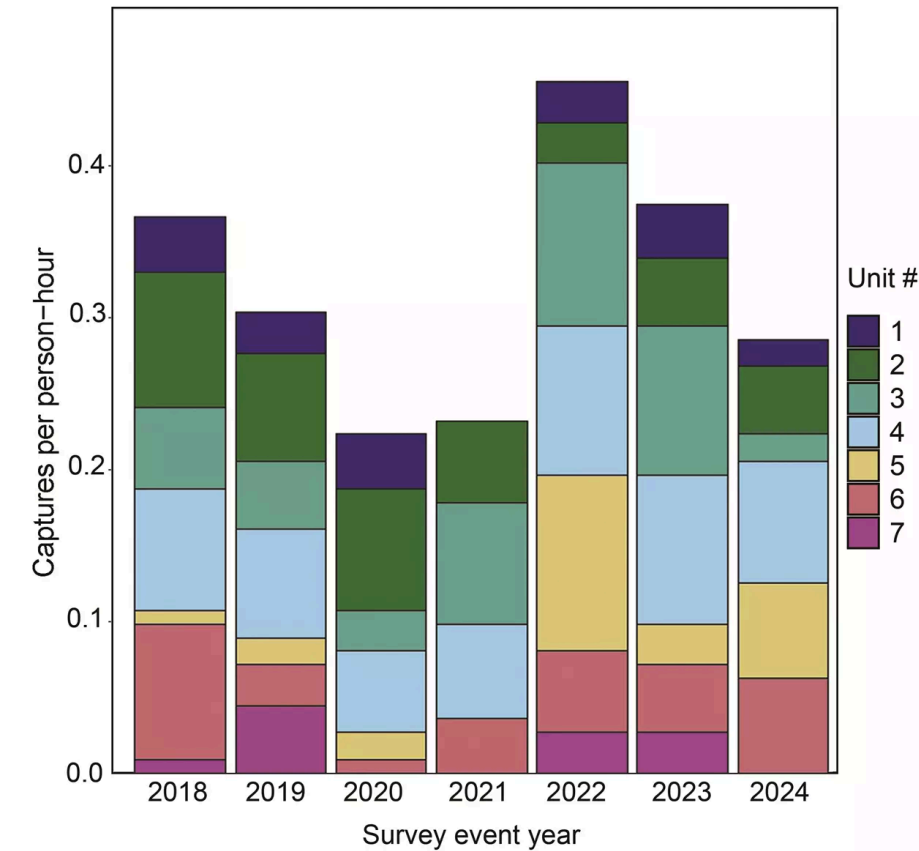


Figure 2. Tortoise encounters per person-hour of effort within each unit (colored portions within each bar) for each survey trip since Fall 2018. Locations of the units are shown in Figure 3.

Ten tortoises were newly marked during the trip, with the trip’s final new ID being 360. Four newly-marked tortoises were found during focal (non-bonus) surveys, one was found just outside a unit boundary, and five were found during the bonus survey. The number of newly-marked tortoises in 2024 comprised 13% of all individuals found during focal surveys. This is a relatively low rate of new tortoise encounters compared with an average of 37% for the period between 2018 and 2023.

Regarding recapture rates and detectability, only three of the 32 unique live tortoises, or about 9%, were captured by both survey teams, excluding bonus units or out-of-time/bounds encounters. The rate of 9% shared captures was lower than in the 2023 survey. The Fall 2023 trip yielded 42 unique live tortoises, with nine individuals in common, which is 18% shared captures.

The 32 tortoises found during survey events were distributed unevenly among units (Figure 3). The greatest yield was in unit 4 with nine unique individuals. Units 2, 5, and 6 had five or seven encounters, while units 1, 3, and 7 had two or fewer encounters. The four highest-yielding units each had one tortoise that was newly marked in 2024, whereas the three lower-yielding units had none. High yields in unit 4 and low yields in units 1 and 7 are not unexpected, as was reported in the [last trip report](#). These persistent cross-unit differences are thought to be related to each loma's unique set of plant communities, past agricultural impacts, and the degree of invasion by the non-native Guinea grass (*Megathyrsus maximus*). The low yield in unit 3 (two tortoises) does come as a surprise though, as the previous survey trip yielded 11 unique individuals there.

A tortoise's location is recorded each time it is encountered. The straight-line distance between two consecutive encounter locations is defined here as a movement. Since 2008, the Gulf Coast I&M Network has recorded 709 movements. Most were relatively short, with a median of 48 m. A small subset of movements were much longer, however, defined here as this project's top 95th percentile of movement distances (> 212 m). Two tortoises that moved over 212 m were detected in the Fall 2024 sampling event, including T276, which moved 352 m from unit 6 to unit 5, and T296, which moved 1,409 m from the park Visitor Center area to unit B9 (Figure 3). The latter distance was the third longest recorded over the 17-year long project, following distances of 1,999 m and 2,468 m. These records bumped the total number of study-long 212+ m movements from 35 to 37.

Notable Observations from Fieldwork

Pairs: When multiple tortoises are found in close proximity, it is often an indication of mating behavior. Five pairs of tortoises were encountered in units 1, 2, 4, and 5.

Dead: Two dead tortoises were found in 2024, including one hatchling (44 mm total length) that was found in unit 6. The other dead tortoise was an unmarked adult found near the bike path on the south end of the park.

Time Between Encounters: Of the 28 previously-marked tortoises found during focal survey events, 22 or 79% had been encountered at least once within the past three trips (beginning in fall 2021). Four tortoises had last been recorded during survey events in 2018, and the remaining two were last recorded in 2014 (T79) or 2015 (T84). The lowest numbered (longest in project) tortoise that was found in 2024 was T31, originally marked in 2009 and last encountered in 2022.

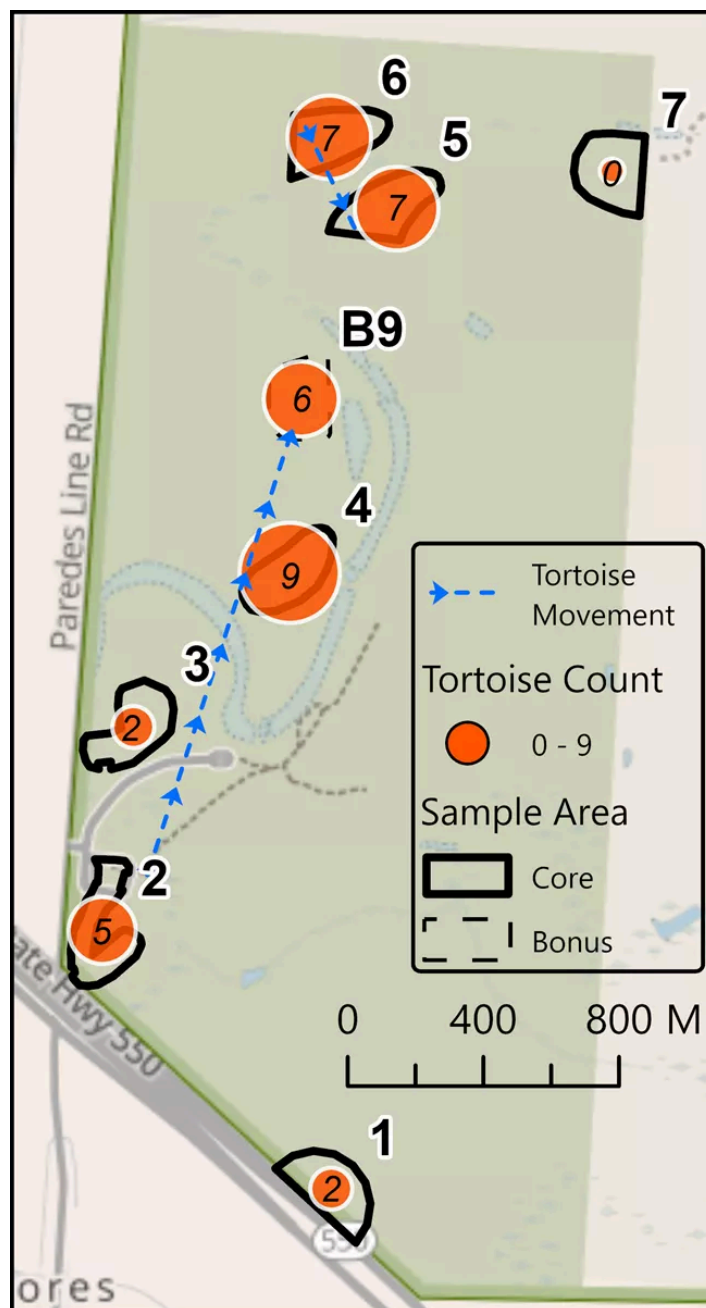


Figure 3. Encounters per survey unit (circle size) at Palo Alto Battlefield NHP in 2024. Arrowed lines show long distance movements between consecutive encounters on the current and previous trip. Solid or dotted outlines indicate the seven primary sample areas and single bonus survey area for 2024.

Environmental Conditions

Since monitoring began at Palo Alto Battlefield NHP, tortoise yields have fluctuated from one year to the next. This was true during the early years of the project, when survey areas were still being defined, and it has remained true even with fixed survey areas and repeat-surveys within trips, which began in Fall 2018 (Figure 2). Although the exact causes of fluctuating yields are not understood, two environmental variables are known to influence tortoise behavior and detectability: temperature and precipitation. Temperature has a more instantaneous impact, where animals become inactive or increasingly sheltered when too hot or cold. Meanwhile, the vegetation response to precipitation is slower, and it impacts the quality and quantity of forage and overall detectability. This year's survey was during a relatively warm week (Figure 4A) following a wet late summer/ early fall (Figure 4B).

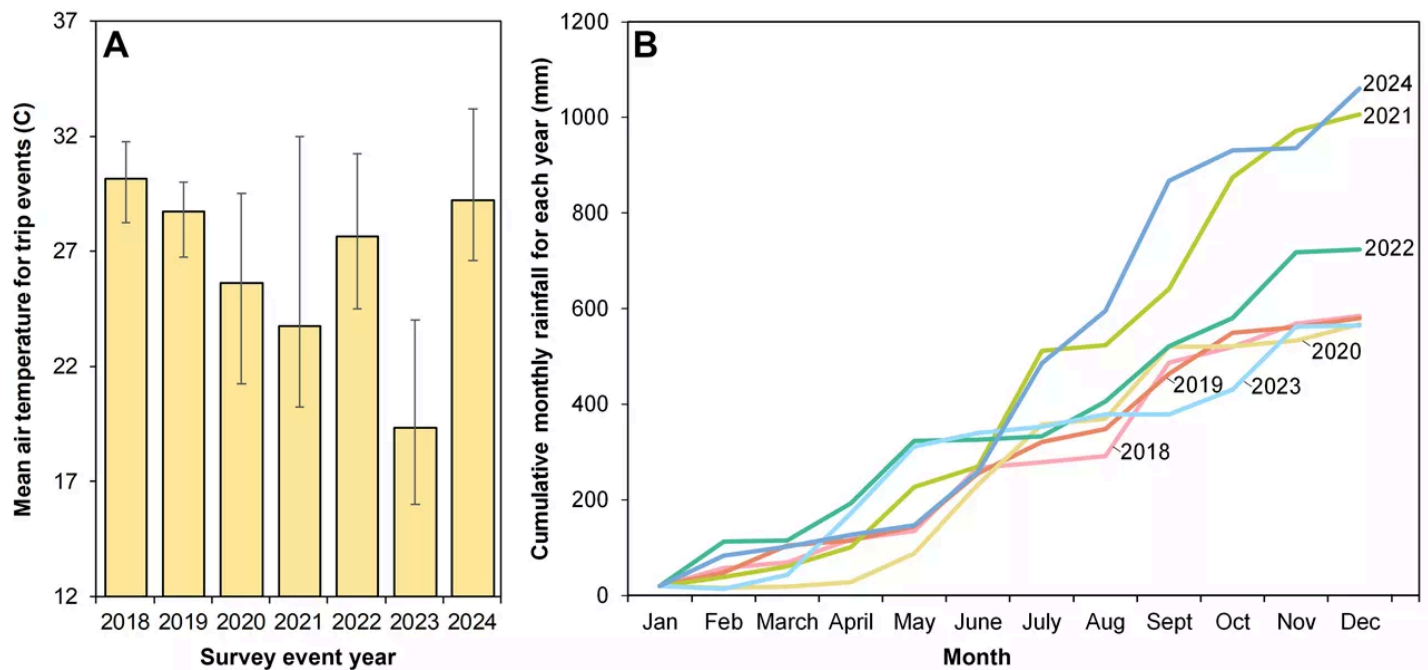


Figure 4. Temperature and rainfall related to Texas tortoise surveys from Fall 2018 to Fall 2024. (A) Mean air temperature recorded on-site during tortoise surveys. Error bars represent the maximum and minimum values recorded each year. (B) Accumulated annual precipitation for each survey year.

The mild temperatures likely resulted in increased tortoise activity levels. However, the wet seasonal conditions encouraged plant growth through the late summer. Surveyors have noticed that vegetation density, coinciding with a strong growing season, is often aligned with a low capture rate. This inference has thus far been substantiated by the strong negative relationship between the [Enhanced Vegetation Index](#), a measure of plant vigor, and capture rate, as shown in Figure 5. It is uncertain whether this relationship is an outcome of lower detectability, as animals are hidden by dense vegetation, or if the animals are simply not there, possibly dispersed across the landscape rather than more concentrated on loma peaks.

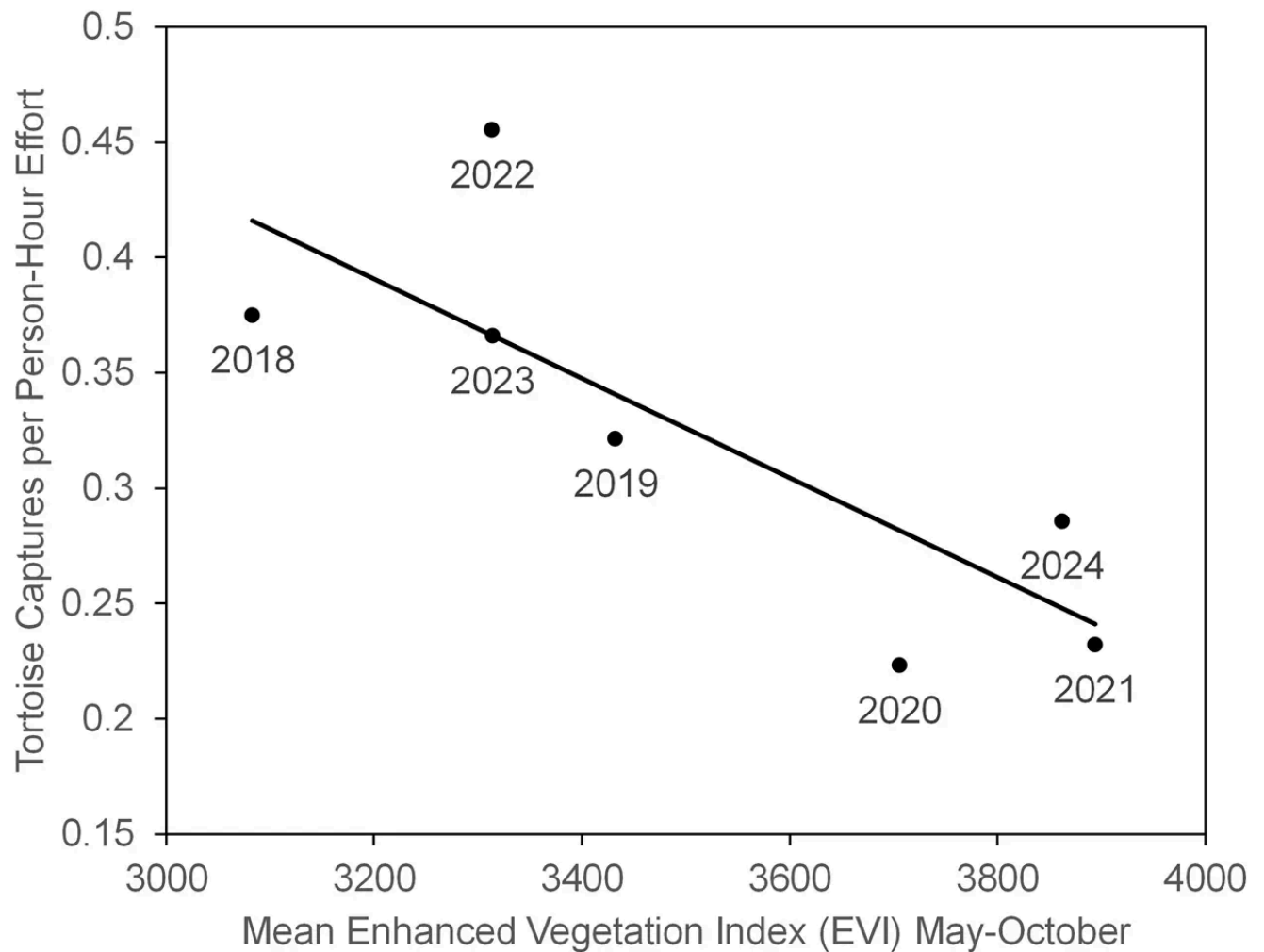


Figure 5. Tortoise capture rate compared with Enhanced Vegetation Index (EVI), averaged for the six months preceding tortoise surveys. EVI measures plant productivity through spectral signatures recorded in 16-day averages of satellite imagery (MODIS/Terra satellite; MOD13Q1.016).

Casual Observations

During a tortoise survey, participants may write down wildlife sightings or record other observations that seem interesting or unusual. These observations are informal and do not have a direct bearing on tortoise analysis, but they may provide informative or at least entertaining context to survey reports. Notable species observed by crew members in 2024 are listed below.

Native

- Eastern Cottontail Rabbit (*Sylvilagus floridanus*)
- Southern Plains Woodrat (*Neotoma micropus*)
- Rose-bellied Lizard (*Sceloporus variabilis*)
- Texas Horned Lizard (*Phrynosoma cornutum*) (Figure 6)
- Texas Spiny Lizard (*Sceloporus olivaceus*)
- Black-striped Snake (*Coniophanes imperialis*)
- Western Diamond-backed Rattlesnake (*Crotalus atrox*)
- Gulf Coast Ribbon Snake (*Thamnophis proximus orarius*)
- Texas Indigo Snake (*Drymarchon melanurus erebennus*) (Figure 6)
- Blue Metalmark Butterfly (*Lasaia sula*)

Non-Native

- Feral Hog (*Sus scrofa*)
- Nilgai (*Boselaphus tragocamelus*)
- Mediterranean Gecko (*Hemidactylus turcicus*)

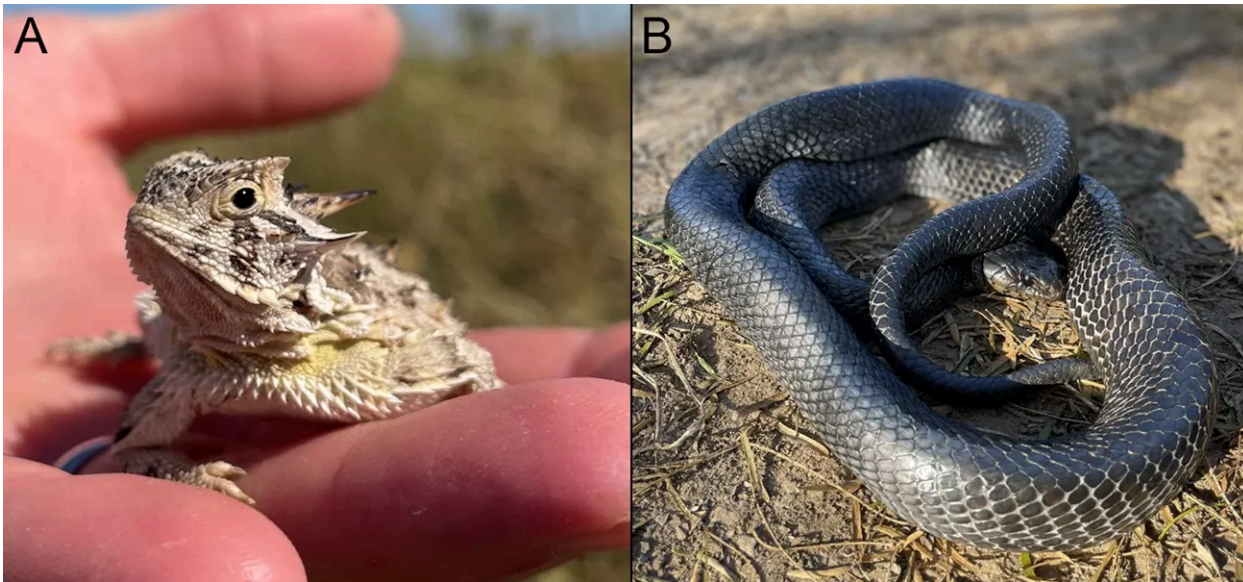


Figure 6. (A) Texas Horned Lizard and (B) Texas Indigo Snake found during the fall 2024 tortoise monitoring survey.

The Gulf Coast Network started the mark/recapture monitoring project at Palo Alto National Battlefield NHP in 2008, and the next tortoise survey trip will occur in the fall of 2025. The landscape surrounding the park continues to develop, and area-wide, Texas tortoise habitat continues to shrink. The park maintains a sizable population of tortoises, but long-term monitoring is important to understand how external pressures will impact the park's population of this iconic south Texas species.

Article written by Gulf Coast Network staff

Supplementary materials to this report are available in the NPS datastore, as are all previous project briefs. Follow [this link](#) for the 2024 Supplementary Materials (NPS internal downloads only) and links to all other project materials.

Companion Reports

Bracewell J and Carlson JE. 2024. [Texas Tortoise Monitoring at Palo Alto Battlefield National Historical Park: Results for 2023](#). Gulf Coast I&M Network, Lafayette, LA

Carlson JE. 2023. [Trip Report for Tortoise Monitoring at Palo Alto Battlefield NHP 2022](#). Gulf Coast I&M Network, Lafayette, LA.

Bracewell J and Carlson JE. 2022. [Comparison of Vegetation Structure in Texas Tortoise Habitats using LiDAR](#). Gulf Coast I&M Network, Lafayette, LA.

Carlson JE. 2022. [Resource Brief: Texas Tortoise Program Summary](#). Gulf Coast I&M Network, Lafayette, LA.

Carlson JE. 2022. [Trip Report for Tortoise Monitoring at Palo Alto Battlefield NHP 2021](#). Gulf Coast I&M Network, Lafayette, LA.

Carlson JE. 2021. [Trip Report for Tortoise Monitoring at Palo Alto Battlefield NHP 2020](#). Gulf Coast I&M Network, Lafayette, LA.