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# Summary of Amphibian Community Monitoring at Fort Frederica National Monument, 2009

Natural Resource Data Series NPS/SECN/NRDS—2010/097

**ON THE COVER**
Clockwise from top left, *Hyla chrysoscelis* (Cope's grey treefrog), *Hyla gratiosa* (barking treefrog), *Scaphiopus holbrookii* (Eastern spadefoot), and *Hyla cinerea* (Green treefrog).
Photographs by J.D. Willson.

# Summary of Amphibian Community Monitoring at Fort Frederica National Monument, 2009

Natural Resource Data Series NPS/SECN/NRDS—2010/097

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# Executive Summary

This report summarizes data collected with the SECN Amphibian Monitoring Protocol (Byrne et al. *in preparation*) at Fort Frederica National Monument in 2009.

- Data were collected at eight spatially-balanced random locations at the monument with two techniques: automated recording devices and visual-encounter surveys.
- Sampling activities occurred at the monument from 5/18/2009 to 5/28/2009 and gain from 09/09/2009 to 10/02/2009.
- We detected 93 amphibians in six species or order, and 100 reptiles in 13 species, genera, or families.
- One non-native amphibian, greenhouse frog, was detected. No non-native reptiles were detected.
- Two of the amphibian species detected were the first recorded occurrences at the monument and additions to the species list; Southern cricket frog and Southern leopard frog.
- Two of the reptile species detected were the first recorded occurrences at the monument and additions to the species list; five-lined skink and Eastern box turtle.
- Observed native species richness is six, the sample adequately characterized species richness, and the sample was dominated by one species, Southern leopard frog.
- No single amphibian species was distributed across the monument. In general, different species occurred at each sampling location.
- Green anole and ground skink were the most widely distributed reptile species at the monument.
- This monitoring protocol will be implemented again at the monument in 2012.

# Introduction

## Overview

Amphibian populations have exhibited declines in North America and many other areas around the world. Several factors are attributable to population declines and localized extinctions. Among these factors are disease and anthropogenic stressors such as habitat loss and degradation, non-native predators, acid precipitation, altered hydrology and hydroperiod, ultraviolet radiation, and chemical contaminants (Collins and Storfer 2003). Although diseases and parasites naturally occur in amphibian populations, the effects of these influences can be exacerbated when combined with other anthropogenic stressors.

Amphibians have complex life cycles, where the immature phase often consists of an aquatic larval stage, followed by a post-metamorphic adult terrestrial stage. Slight alterations in the aquatic or terrestrial communities upon which amphibians are dependent upon can have substantial impacts on the survival, reproduction, and persistence of a species. Given their habitat requirements, anatomy, and physiology, amphibians are considered good indicators of ecological condition.

The southeastern U.S. is host to one of the most diverse amphibian communities in the world. With an estimated 140 amphibian species, more than half of which are salamanders, the Southeast accounts for about half of the total number of amphibians in the U.S (Echternacht & Harris 1993, Petranka 1998). The Southeast Coast Network (SECN) has 61 known amphibian species; 26 in Caudata (salamanders, newts, amphiumas, sirens), and 35 in Anura (frogs and toads) (NPSpecies 2010).

Given their known population declines, sensitivity to anthropogenic stressors, and the diversity of amphibians in the southeastern U.S., amphibian communities are a priority for SECN monitoring efforts.

The National Park Service Omnibus Management Act of 1998, and other reinforcing policies and regulations, require park managers "to establish baseline information and to provide information on the long-term trends in the condition of National Park System resources" (Title II, Sec. 204). The amphibian-community monitoring data summarized herein is a tool to assist park managers in fulfilling this mandate.

This report summarizes data collected under the draft SECN Amphibian Community Monitoring Protocol (Byrne et al. *in preparation*).

## Objective

- Determine trends in amphibian-species occupancy, distribution, diversity, and community composition in SECN parks.

# Methods

## Study Area

Fort Frederica National Monument (FOFR), located on St. Simon's Island in southeast Georgia (Figure 1). The monument is divided by the Frederica River, one of the primary salt marsh rivers in the Brunswick area, with 99 acres of marsh lands at the Frederica site on the west side of the river and approximately 137 acres of uplands adjoining the east side of the river. The separate Bloody Marsh site consists of 8 acres of which approximately five acres are tidal marsh. The salt marsh is dominated by cordgrass (*Spartina* spp.), and the uplands are a mix of coastal maritime hammock dominated by Virginia live oak (*Quercus virginiana*) and a small component of slash pine (*Pinus elliottii*).

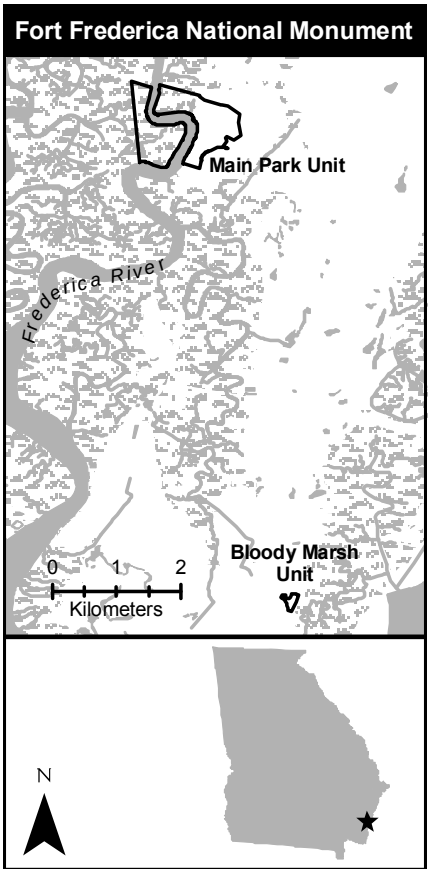


**Figure 1.** Location of Fort Frederica National Monument.

FOFR has eight known amphibian species and 17 known reptiles (Tuberville et al. 2005) (Appendix A); which includes the one amphibian and two reptiles added to the Monument's species list as a result of these 2009 monitoring efforts summarized herein. The amphibians consist of seven species in Anura (frogs and toads). The reptiles consist of one species of Crocodilia, 13 species in Squamata (e.g. lizards, snakes, geckos, and skinks), and three species in Testudines (turtles and tortoises).

## Sampling Design

A detailed explanation of the sampling design and site selection can be found in the SECN Draft Amphibian Monitoring Protocol (Byrne et al. *in preparation*) and sample site selection SOP (Byrne 2009). In summary, to allow for park-wide inference, the monument's administrative boundary was used as the sampling frame. The sampling frame was divided into a systematic 0.5-ha grid; the center point of each grid cell served as the potential sampling site. A spatially-balanced sample was drawn from this grid using the Reversed Randomized Quadrant-Recursive Raster (RRQRR) algorithm (Theobald et al. 2007). Alternate points were used when selection criteria (i.e., including safety and access issues) were not met. A sample size of eight was chosen after consideration of park size, hypothesized variability, and logistical issues regarding travel time and conducting monitoring activities in five to six park units per year. Sampling locations are presented in Figure 2.

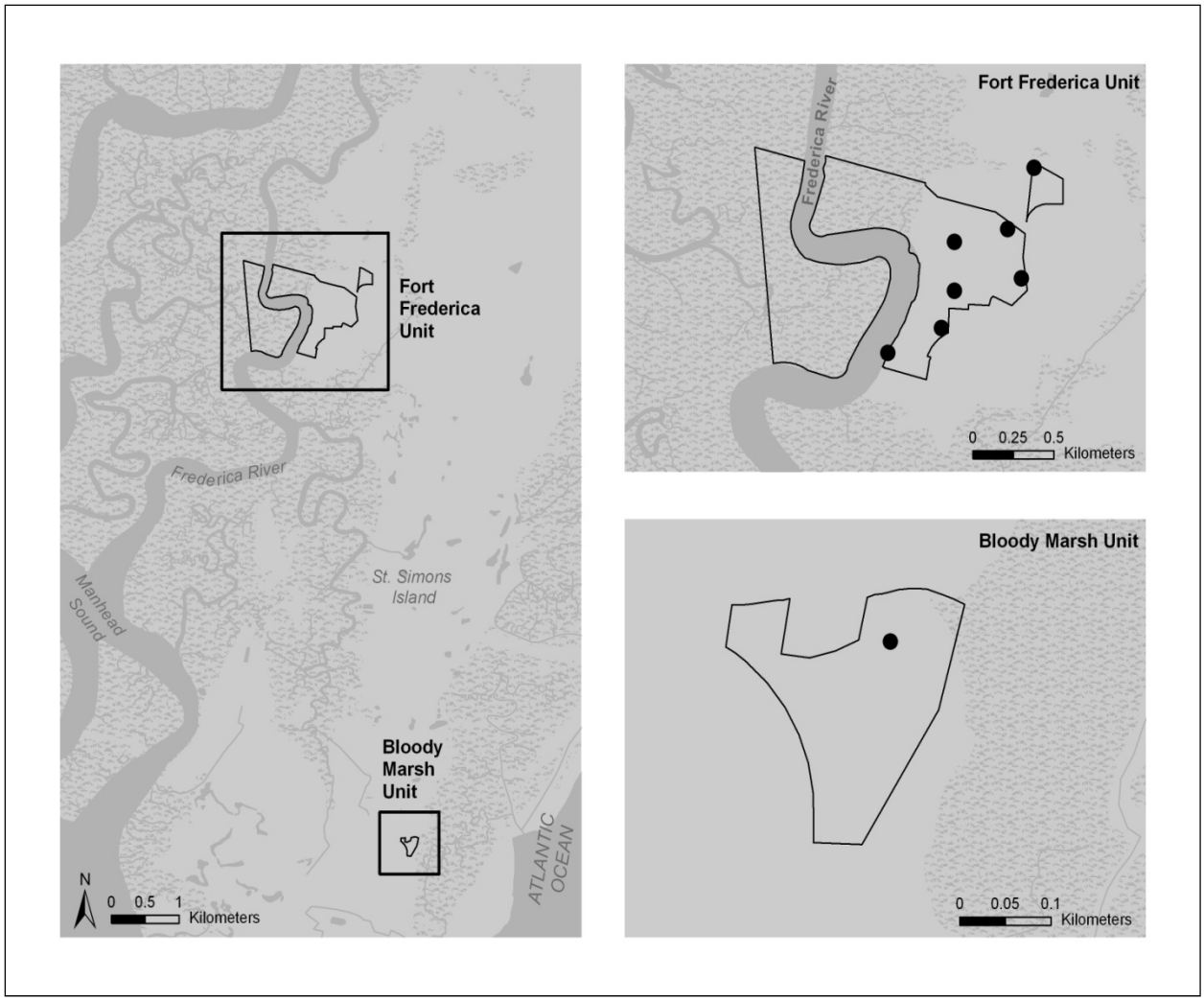


**Figure 2.** Spatially-balanced random sampling locations at FOFR, 2009.

## Sampling Methodology

Three sampling techniques are used as part of SECN amphibian monitoring; a combination of active and passive sampling techniques. The active technique is a time- and area-constrained medium-intensity visual encounter survey (VES) that incorporates dip-net techniques in sampling locations with aquatic communities. All species or species sign detected by sight or sound are recorded as part of the VESs. The passive technique is an automated-recording device (ARD) programmed to record one minute every ten minutes from dusk to dawn once every three days. Use of multiple techniques, as a "toolbox" approach (Olson et al. 1997), is generally agreed to be the most effective means to monitor amphibian communities (Hutchens and DePerno 2009). These sampling techniques are described in detail in Byrne (2007a) and Byrne (2007b).

ARD's were deployed from 5/18/2009 to 5/28/2009. A total of 2560 minutes were recorded by the eight devices deployed the monument. The ARDs detected three amphibian species at FOFR, including one non-native amphibian. VESs were conducted from 09/09/2009 to 10/02/2009. The VESs detected six amphibian species and five reptile species, including one non-native amphibian.

## Data Analysis

Because this is the first year of this protocol's implementation at the monument, only the status of the elements presented in the aforementioned monitoring objective are presented; except occupancy. The data in this report are summarized and presented in three general categories: diversity, composition, and distribution. Sampling locations are presented in Figure 2, labeled locations are presented in Appendix B, and species detected at each location are presented in Appendix C.

Despite a well-trained and dedicated field crew, complete identification of all individuals encountered was not always possible due to the quick and evasive nature of many species. Species were, however identified to most refined taxonomic level possible. For example, while the surveyors are approaching a small pool surrounded by dense vegetation they catch brief glimpses of and hear several frogs dive into the pool prior to completing a full visual inspection of the individuals necessary for identification. Although the majority of these species could most likely be indentified to the genus or family level (i.e., Unknown Rana or Ranidae in this instance) based upon knowledge of the site and the local fauna, a conservative estimation is used and these species are identified to Order as "Unknown Anuran".

Although the primary purpose for implementing the aforementioned monitoring techniques as part of SECN monitoring efforts was to detect amphibians, reptiles were also encountered. It is important to note that neither VESs nor ARDs are not effective tools to survey for many reptile species, nor was the intent of VES implementation to target reptiles, but all reptile, and reptile sign detections are presented.

### *Diversity*

Diversity is defined as "the variety and abundance of species in a defined unit of study" (Magurran 2004, p. 8). Diversity is a community property that is related to trophic structure, productivity, stability, (McIntosh 1967, McNaughton 1977), immigration / emigration (Colwell and Lees 2000), and ecological condition (i.e., ecological integrity as defined by Karr and Chu 1995). Species diversity consists of two components, the number of species (species richness) and the relative abundance of those species (species evenness / dominance) within a defined community (Margalef 1958, Lloyd and Ghelardi 1964, Pielou 1996). Species diversity is often communicated in the form of diversity indices. The term community refers to the assemblage of species populations that occur together in space and time (Begon et al. 1986), and we consider the monument as a whole community as per the conceptual ecological models presented in our monitoring plan (see Chapter 2 in DeVivo et al. 2008).

Because diversity indices respond differently to various mechanisms that influence community change, several indices must be used to adequately characterize diversity in SECN parks (Haedrick 1975, Boyle et al. 1984). After careful appraisal of advantages and disadvantages of the many diversity indices, a suite of alpha diversity indices were selected to summarize these data (Table 1), where alpha diversity is the diversity of species within a defined area, community, or ecosystem (Whittaker 1972).

Species diversity estimates are based only on amphibian observations identified to the species level, as they were the primary target of this monitoring effort. Non-native amphibians were not included in diversity estimates. As previously mentioned, the methodologies used for amphibians are inadequate for the reptile community; therefore diversity indices generated for reptiles would be biased and were not calculated.

### *Composition*

Measures of community composition are often good indicators of abiotic variability, disturbance, or other stressors. Summaries related to sample composition include the total number of individuals and species detected, and proportional abundances of each species in the overall sample. Frequency of occurrence estimates are calculated for all species detected. Counts were also pooled across non-native species to generate frequency of occurrence estimates for all non-natives. Ratios of the individual counts of native to non-native species are also presented. Summaries of composition are presented for all amphibians, reptiles, and reptile sign (e.g., snake skin) detected.

### *Distribution*

The distribution of species on park lands is integral to informed management. Further, changes in species distributions over time provides useful information regarding possible unseen influences that alter wildlife-habitat use and may be indicative of other issues. This section presents maps of all sampling locations where each amphibian, reptile, and reptile sign was detected.

**Table 1.** Diversity indices used, corresponding symbol, community attribute the index reflects, the range of index values, and notes on each index.

| Index | Symbol | Community Attribute | Index Citation | Notes |
|---|---|---|---|---|
| Native Spp. Richness | $S_{obs}$ | Richness | n/a | Value is a positive integer that indicates the number of native species in the sample. Intuitive. Good discriminant ability if sampling effort is comparable; sensitive to sample size, the occurrence of rare species, or those with low detectability; does not account for relative abundances. |
| Chao 1 | **Chao1** | Richness | Chao (1984)<br>Chao (1987) | Values indicate an estimate of species richness; abundance-based estimate; works well with dataset containing several infrequent observations[a]. |
| Chao 2 | **Chao2** | Richness | Chao (1984)<br>Chao (1987) | Values indicate an estimate of total species richness (including species not present in the sample); incidence-based estimate; works well with dataset containing several infrequent observations[a]. |
| Abundance-based Coverage | **ACE** | Richness | Chao and Lee (1992)<br>Chazdon et al. (1998) | Values indicate an estimate of species richness; abundance-based estimate. |
| Incidence-based Coverage | **ICE** | Richness | Lee and Chao (1994)<br>Chazdon et al. (1998) | Values indicate an estimate of total species richness (including species not present in the sample); incidence-based estimate. |
| Jackknife 1 | **Jack1** | Richness | Burnham and Overton (1978)<br>Burnham and Overton (1979)<br>Heltshe and Forrester (1983) | Values indicate an estimate of total species richness (including species not present in the sample); incidence-based estimate; The higher the value the higher the species richness. This procedure requires no assumptions regarding the data distribution. |
| Jackknife 2 | **Jack2** | Richness | Smith and van Bell (1984) | Values indicate an estimate of species richness; incidence-based estimate. |
| Bootstrap | **Boot** | Richness | Smith and van Bell (1984) | Values indicate an estimate of species richness; incidence-based estimate. |
| Fisher's α | **α** | Richness | Fisher et al. (1943) | Value is a positive integer and indicates a relative estimate of species richness; good discriminant ability, low sensitivity to sample size, and robust to deviations in the assumed distribution [b, c, d, e]; abundance-based estimate. |

| Index | Symbol | Community Attribute | Index Citation | Notes |
|---|---|---|---|---|
| Q Statistic | **Q** | Richness | Kempton and Taylor (1976)<br>Kempton and Taylor (1978) | Value is a positive integer and indicates a relative estimate of species richness. Good discriminant ability and low bias with small samples[f], model fit is irrelevant to index performance[g]; value is not weighted towards abundant or rare species; abundance-based estimate. |
| | | | | |
| Smith and Wilson | $\mathbf{E_{var}}$ | Evenness | Smith and Wilson (1996) | Values range from 0 (no evenness) to 1 (perfectly even and all species exists in relatively equal abundance); weighs common species more heavily than rare species (desirable in certain cases). |
| Smith and Wilson 1/D | $\mathbf{E_{1/D}}$ | Evenness | Smith and Wilson (1996)<br>Simpson (1949) | Values range from 0 (no evenness) to 1 (perfectly even and all species exists in relatively equal abundance); weighs rare and abundant species equally (desirable in certain cases). |
| Camargo | **E'** | Evenness | Camargo (1992) | Values range from 0 (no evenness) to 1 (perfectly even and all species exists in relatively equal abundance); performs well estimating **intermediate** values of evenness than the other indices; weighs rare and abundant species equally (desirable in certain cases). |
| Gini | $\mathbf{E_G}$ | Evenness | Gini (1912) | Values range from 0 (no evenness) to 1 (perfectly even and all species exists in relatively equal abundance); Good discriminant ability and low sensitivity to sample size[h]; |
| Berger-Parker | $\mathbf{D_{BP}}$ | Dominance | Berger and Parker (1970) | Values range from 0 (no single-species dominance) to 1 (sample is strongly dominated by a single species); describes the proportional dominance of the single most abundant species; low sensitivity to sample size but poor discriminant ability[i] – not used for across year or site comparisons. |

[a] (Chao 1984), [b](Kempton 2002), [c](Kempton and Taylor 1974), [d](Hayek and Buzas 1997), [e](Wolda 1983), [f](Kempton and Wedderburn 1978), [g](Magurran 1988), [h](Lexerød and Eid 2006), [i](Magurran 2004)

# Results

## Diversity

Diversity indices calculated for these data were selected to reflect community composition (i.e., number of species) and structure (i.e., number of individuals), which include species richness and evenness estimates (Table 2). Confidence intervals for each of the diversity index were estimated with a bootstrap procedure. A brief explanation of interpreting the value is presented in Table 1.

Rank-abundance plots, frequency distributions, and other descriptive approaches were used to explore the abundance distributions and patterns in the dataset, and evaluate the utility of select indices and abundance equitability among species. Southern leopard frog indeed exhibited deviation (i.e., inequitability) due to the comparatively high number individuals of this species detected relative to the few number of other amphibians detected. The data were well fit by a geometric abundance model ($\chi^2$=0.0404, df=2, p=0.998). The species accumulation curve generated from the data asymptotes at approximately six samples (i.e., less than the total number of samples collected of eight), validating the sample size as effective in characterizing amphibian diversity at the monument.

Estimates of amphibian species richness across available indices vary. The resampling estimators (Jack1, Boot) that estimate true species richness appear to generally proximate the observed species richness (i.e., $S_{obs}$) of 6.0 (95% CI 2.47 – 9.42) in the sample (Table 2). Whereas the Chao2 and ICE estimators have a much larger confidence interval (i.e., 2.81 – 26.42), and are less meaningful given the properties of the dataset (Table 2). The sample is strongly dominated ($D_{BP}$ = 0.88) by Southern leopard frog even though this species was only detected in one sampling location. As expected, the sample is uneven (evenness range: 0.210 – 0.267, Table 2), but further evaluation suggests is not uneven aside from the Southern leopard frog observations (i.e., all other species occur in relatively even, and low, abundances). It also appears that species richness and relative abundance is generally consistent across the monument, only with relatively high numbers of Southern leopard frog on the northeast boundary of the monument. Species richness is medium ($\alpha$=1.43, Q=2.73) (Table 2). We consider species richness and evenness medium-high given the size of the monument and distribution of amphibian-habitat types. Because 2009 monitoring efforts were the first for this vital sign, these values will serve as a baseline to which to compare when the monument is sampled again.

**Table 2.** Amphibian alpha-diversity estimates at FOFR, 2009.

| Index | Symbol | Value | Lower 95% CI | Upper 95% CI | Value Interpretation |
|---|---|---|---|---|---|
| Native Spp. Richness | $S_{obs}$ | 6.00 | 2.47 | 9.52 | Number of native species detected; good given the size of the monument |
| Chao 1 | **Chao1** | 6.50 | 6.03 | 14.26 | Estimated true species richness; overestimate due to dataset properties |
| Chao 2 | **Chao2** | 8.62 | 6.33 | 26.42 | Estimated true species richness; overestimate due to dataset properties |
| Abundance-based Coverage | **ACE** | 7.25 | 4.47 | 10.03 | Estimated true species richness |
| Incidence-based Coverage | **ICE** | 13.20 | 2.81 | 23.59 | Estimated true species richness; overestimate due to dataset properties |
| Jackknife 1 | **Jack1** | 9.50 | 9.83 | 13.17 | Estimated true species richness |
| Jackknife 2 | **Jack2** | 11.85 | 7.71 | 15.99 | Estimated true species richness |
| Bootstrap | **Boot** | 7.49 | 5.65 | 9.33 | Estimated true species richness |
| Fisher's α | **α** | 1.43 | 0.84 | 2.02 | Baseline value; suggests moderate diversity; we consider diversity medium-high given the size of the park |
| Q Statistic | **Q** | 2.73 | 0.00 | 5.21 | Baseline value; suggests moderate diversity although large variability; we consider diversity medium -high given the size of the park |
| Smith and Wilson | $E_{var}$ | 0.267 | 0.184 | 0.346 | Species occur in a variety of relative abundances – low evenness |
| Smith and Wilson 1/D | $E_{1/D}$ | 0.210 | 0.199 | 0.356 | Species occur in a variety of relative abundances – low evenness |
| Camargo | **E'** | 0.254 | 0.243 | 0.406 | Species occur in a variety of relative abundances – low evenness |
| Gini | $E_G$ | 0.253 | 0.166 | 0.346 | Species occur in a variety of relative abundances – low evenness |
| Berger-Parker | $D_{BP}$ | 0.891 | 0.815 | 0.955 | Sample strongly dominated by one species |

## Composition

### *Amphibians*

We detected 93 amphibians in six species or order. The vast majority of the sample was composed of Southern leopard frog (Figure 3). All other species occurred in relatively low counts. The frequency of occurrence for amphibians detected during 2009 sampling effort is presented in Table 3. Frequency of occurrence provides insight into the abundance of detected species across the monument and whether a species is commonly or uncommonly encountered; however this is strongly influenced by a species' detectability as more-easily detected species may be more frequently encountered (and vice versa). The non-native greenhouse frog was the most frequently encountered species (i.e., 0.38); all other amphibians were infrequently encountered (Table 3). Eastern narrow-mouthed toad was the most frequently encountered native species. The ratio of the total counts of native amphibians to non-native amphibians is 30:1; which we consider a low ratio. Two of the amphibian species detected were the first recorded occurrences at the monument and additions to the species list; Southern cricket frog and Southern leopard frog.

### *Reptiles*

We detected 100 reptiles in 13 species, genera, or families. The majority of the sample was composed of ground skink, followed by green anole, and five-lined skink (Figure 4). The frequency of occurrence for reptiles detected during 2009 sampling effort is presented in Table 4, where ground skink and green anole were equally the most frequently encountered species. No non-native reptiles were detected. Two of the reptile species detected were the first recorded occurrences at the monument and additions to the species list; five-lined skink and Eastern box turtle.

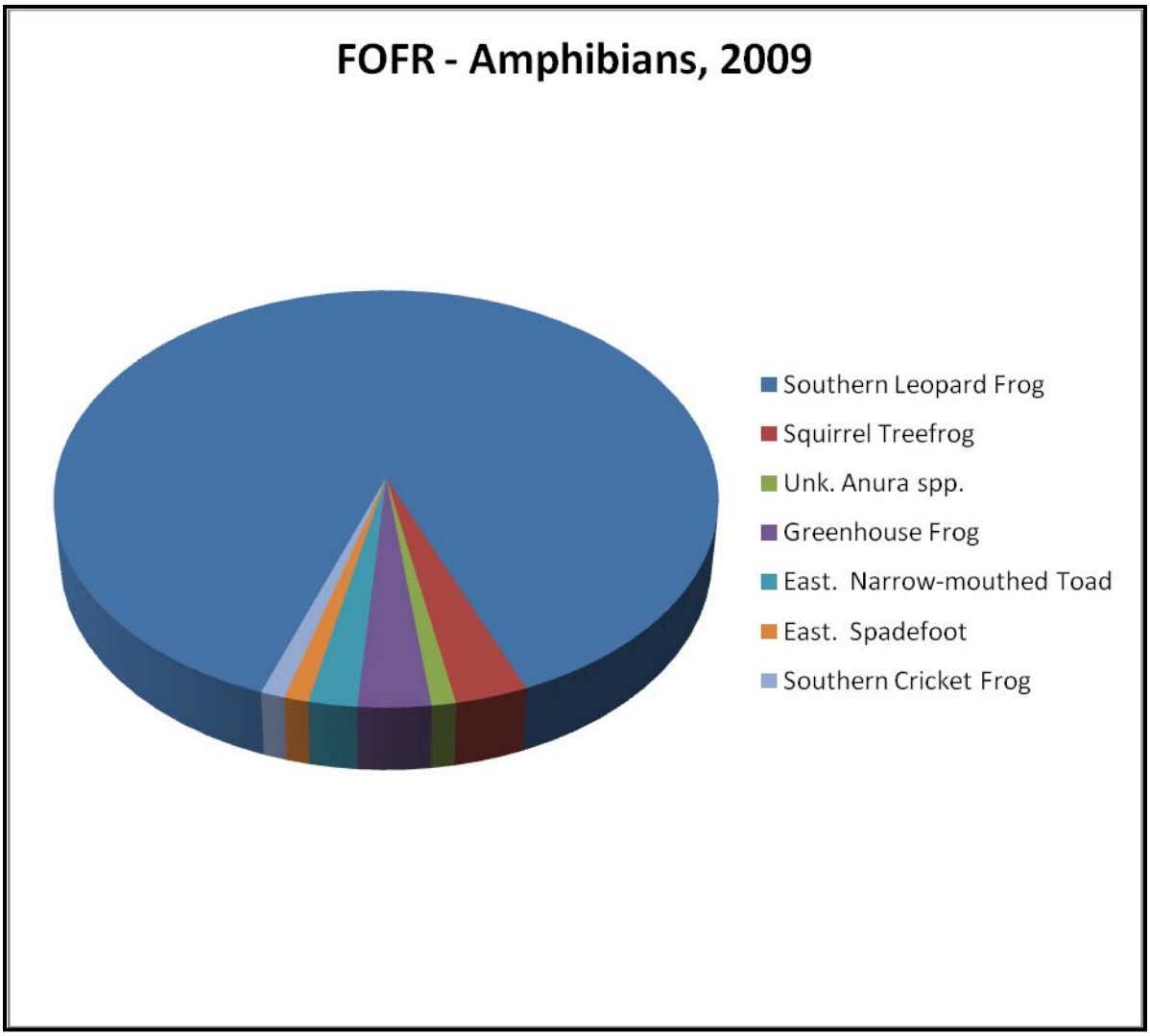


**Figure 3.** Proportions of amphibian species in the 2009 FOFR sample.

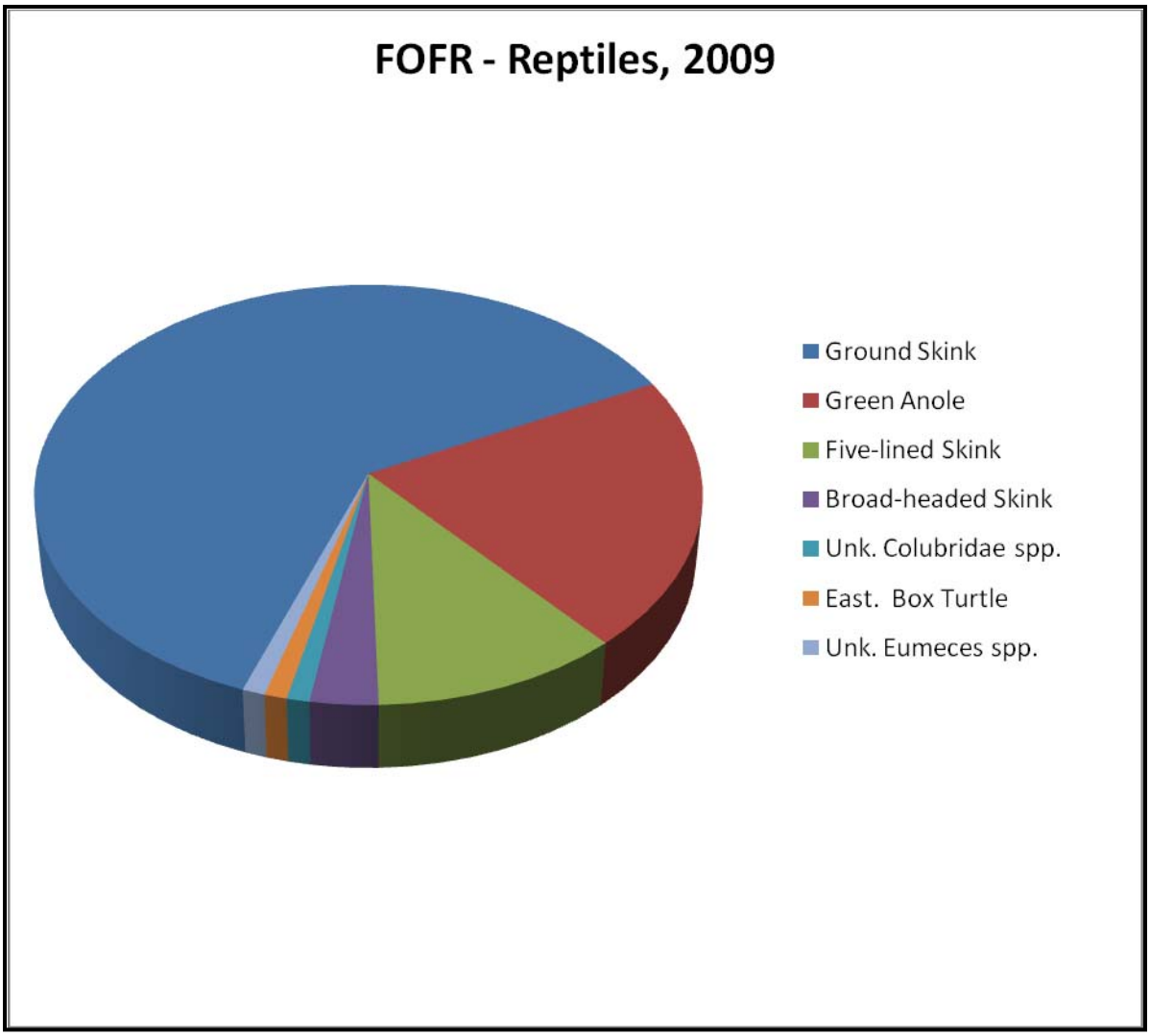


**Figure 4.** Proportions of reptile species in the 2009 FOFR sample.

**Table 3.** Frequency of occurrence of amphibians at FOFR, 2009.

| Common Name | Frequency of Occurrence |
|---|---|
| Greenhouse Frog | 0.38 |
| East. Narrow-mouthed Toad | 0.25 |
| Southern Cricket Frog | 0.13 |
| Squirrel Treefrog | 0.13 |
| Unk. Anura spp. | 0.13 |
| Southern Leopard Frog | 0.13 |
| Eastern Spadefoot | 0.13 |

**Table 4.** Frequency of occurrence of reptiles and reptile sign at FOFR, 2009.

| Common Name | Frequency of Occurrence |
|---|---|
| Green Anole | 0.88 |
| Ground Skink | 0.88 |
| Five-lined Skink | 0.38 |
| Broad-headed Skink | 0.25 |
| Unk. Colubridae spp. | 0.13 |
| Eastern Box Turtle | 0.13 |
| Unk. Eumeces spp. | 0.13 |

## Distribution

### *Amphibians*

Most species were only detected at only one or two locations at the monument (**Figure 5**, **Figure 6**, **Figure 8**, **Figure 9**, and **Figure 11**); however the non-native greenhouse frog was detected throughout the monument (**Figure 7**).

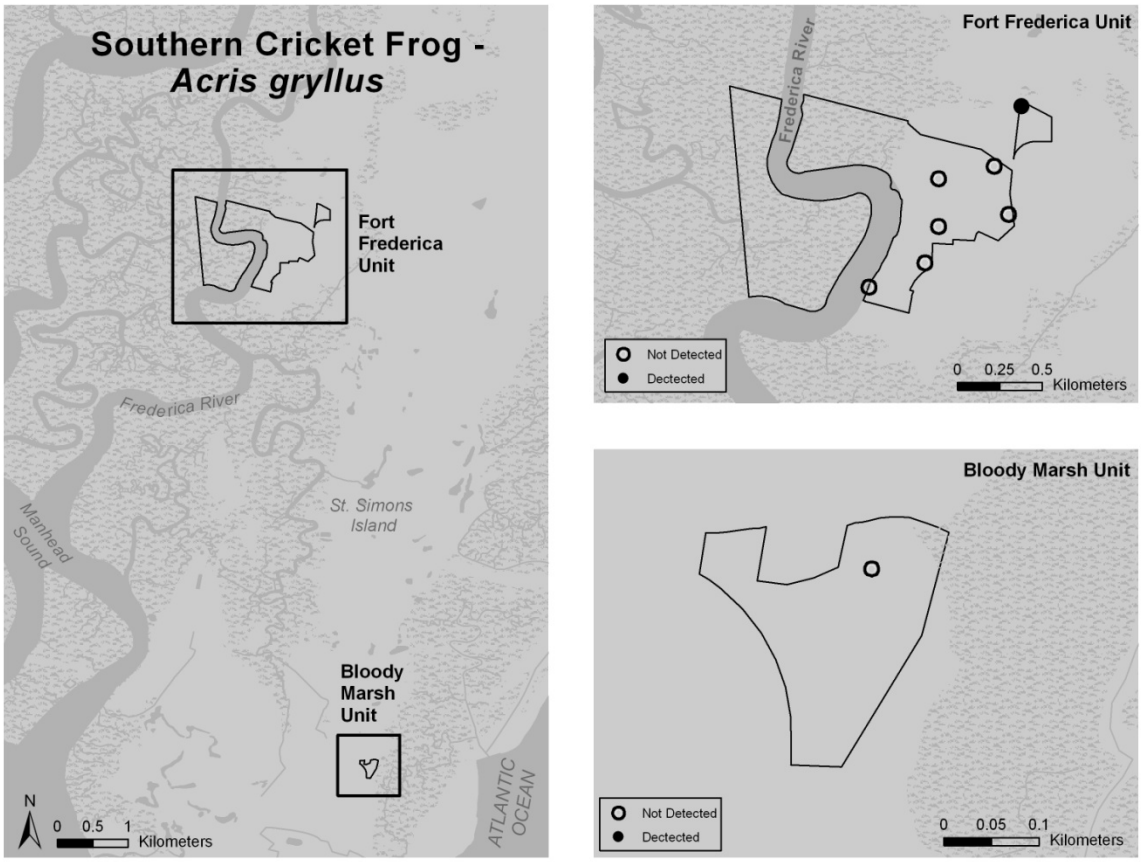


**Figure 5.** Sampling locations where Southern cricket frog (*Acris gryllus*) was detected at FOFR, 2009. ● = detected, ○ = not detected.

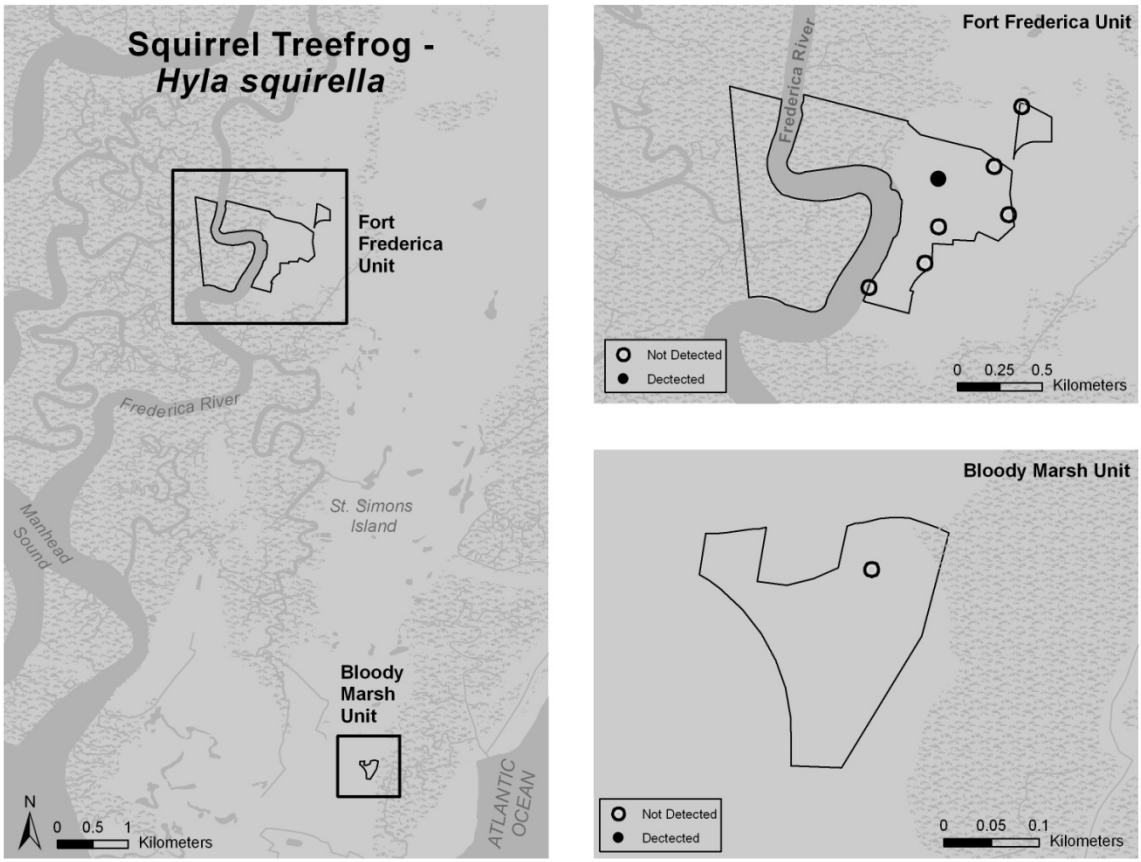


**Figure 6.** Sampling locations where squirrel treefrog (*Hyla squirella*) was detected at FOFR, 2009. ● = detected, ○ = not detected.

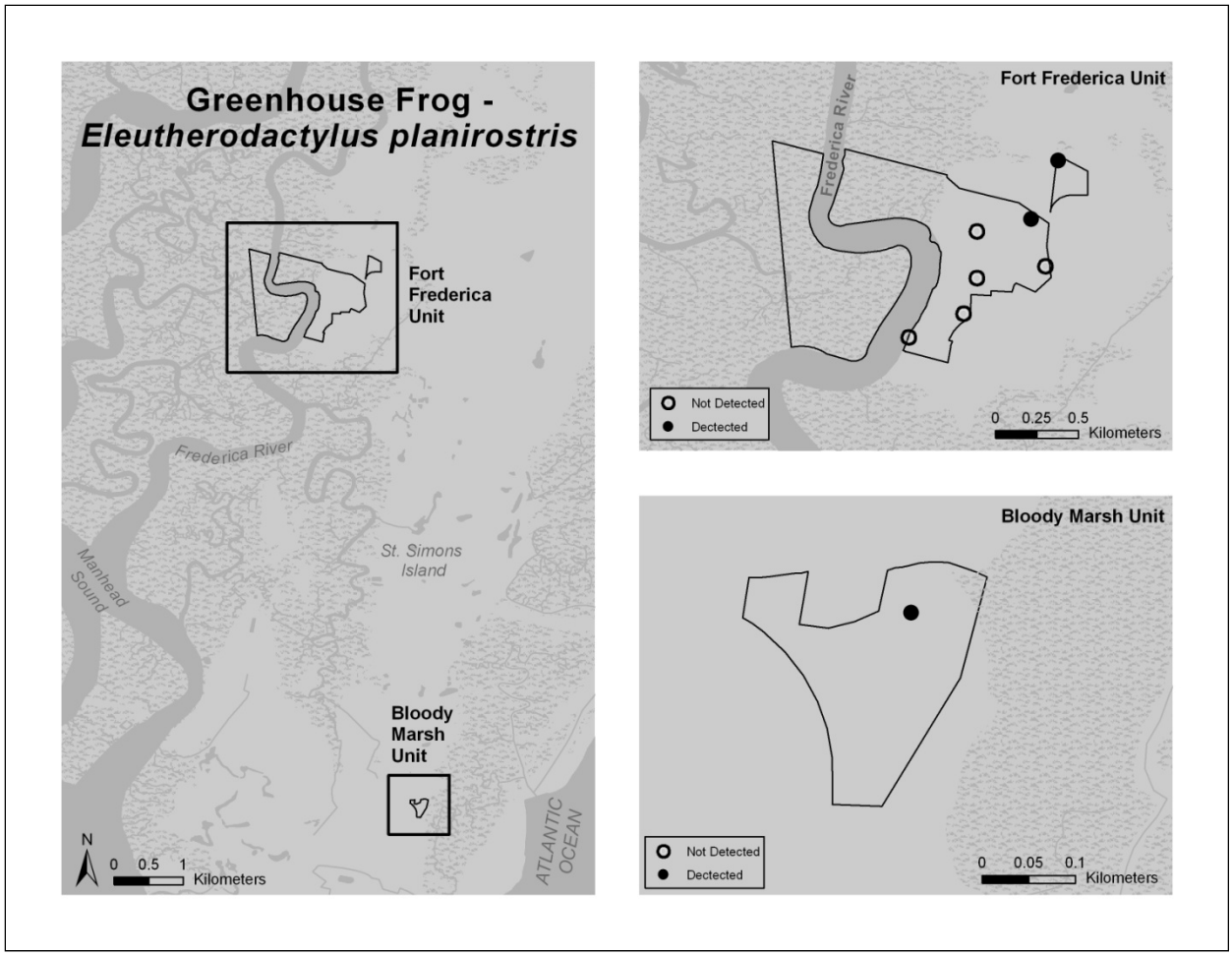


**Figure 7.** Sampling locations where greenhouse frog (*Eleutherodactylus planirostris*) was detected at FOFR, 2009. ● = detected, ○ = not detected.

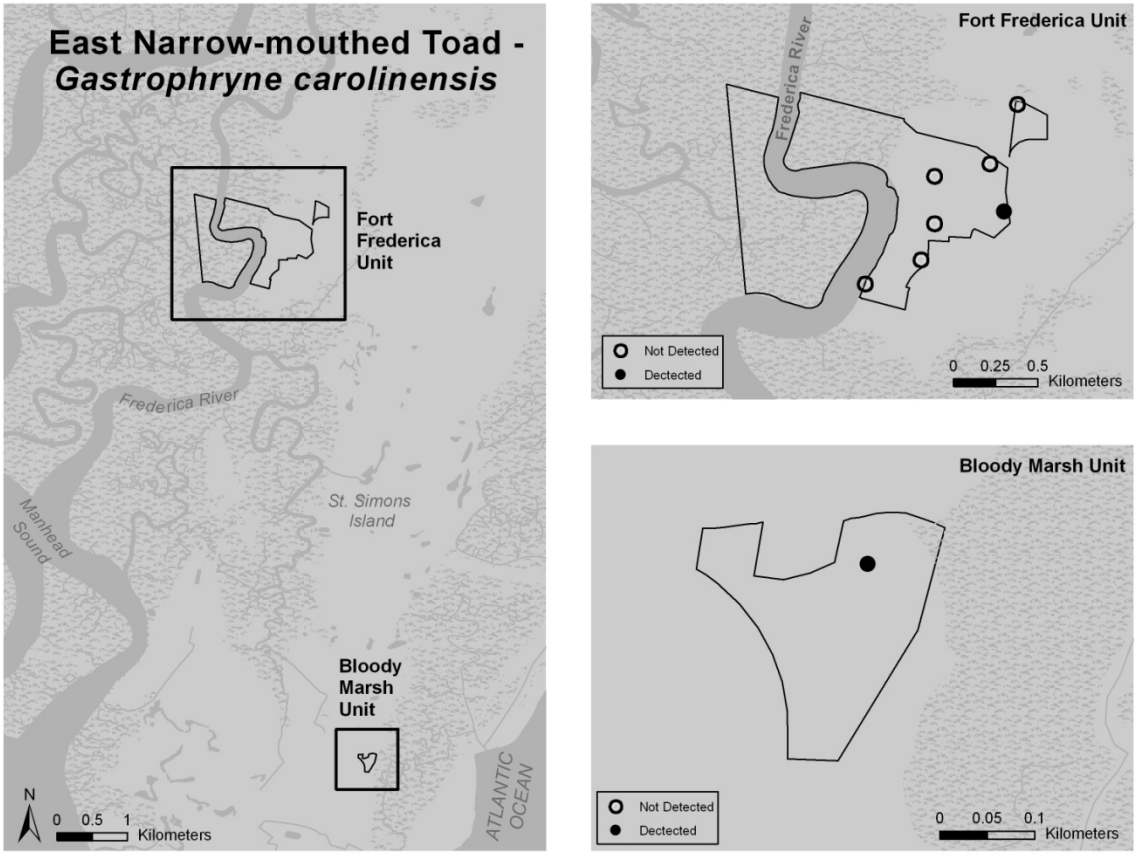


**Figure 8.** Sampling locations where Eastern narrow-mouthed toad (*Gastrophryne carolinensis*) was detected at FOFR, 2009. ● = detected, ○ = not detected.

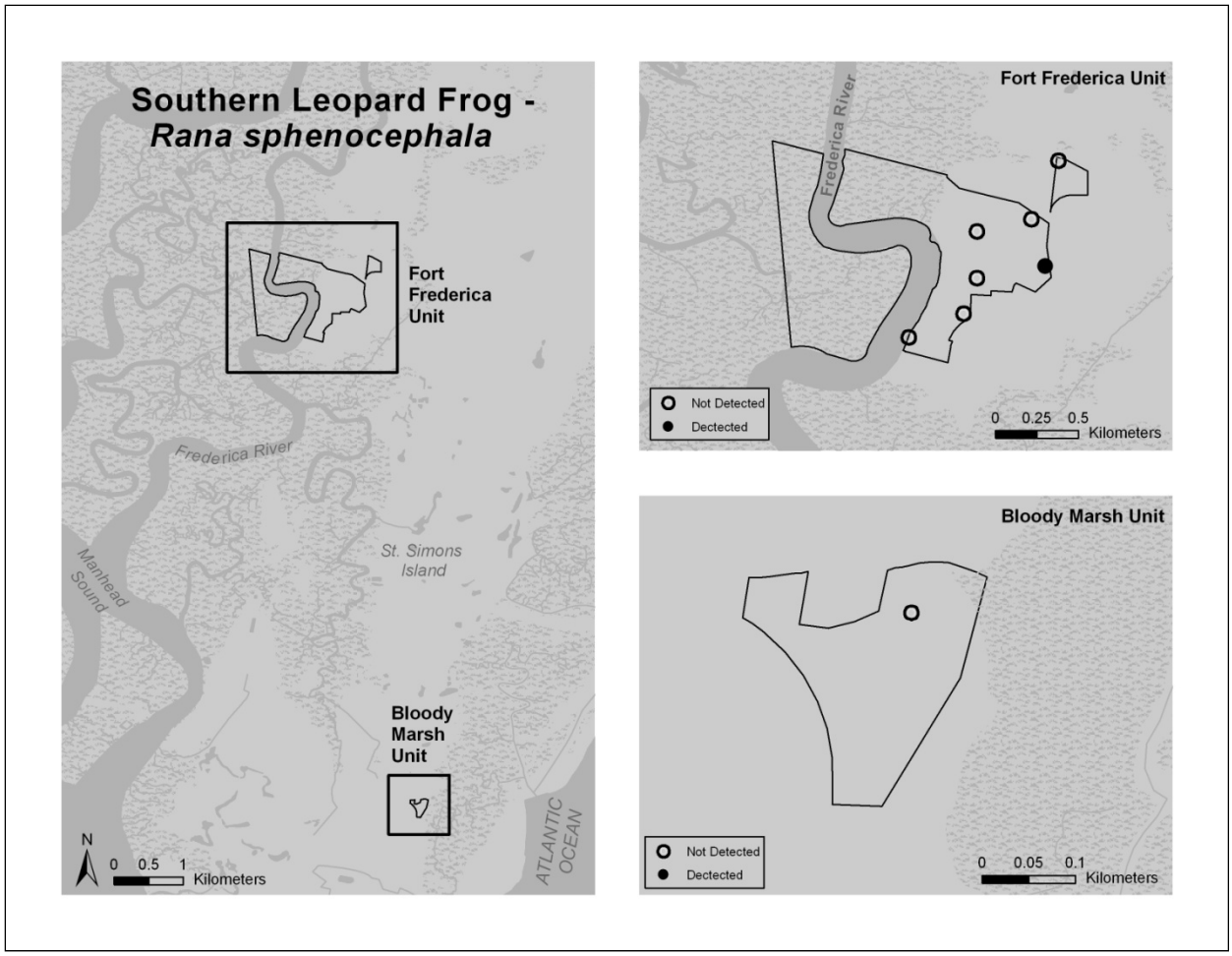


**Figure 9.** Sampling locations where Southern leopard frog (*Rana sphenocephala*) was detected at FOFR, 2009. ● = detected, ○ = not detected.

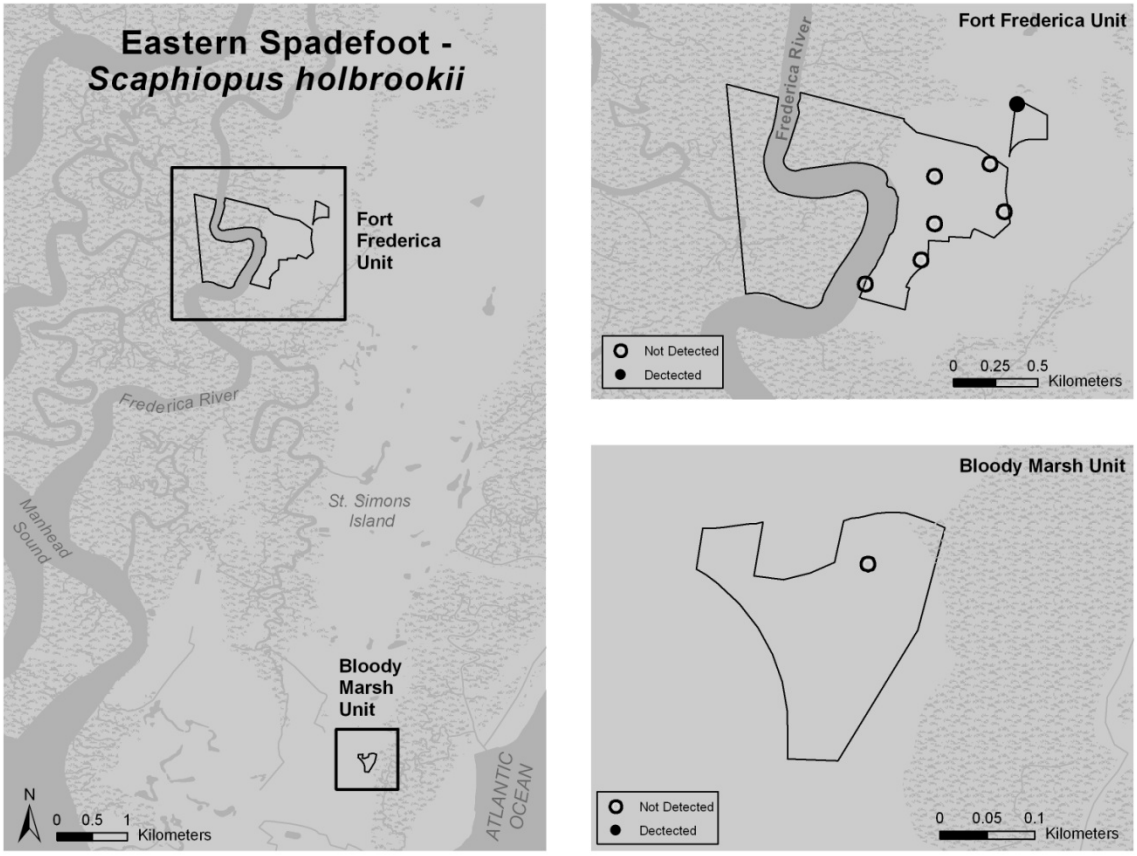


**Figure 10.** Sampling locations where Eastern spadefoot (*Scaphiopus holbrookii*) was detected at FOFR, 2009. ● = detected, ○ = not detected.

### *Reptiles*

Green anole (**Figure 11**) and ground skink (**Figure 15**) were the most widely distributed reptiles detected.

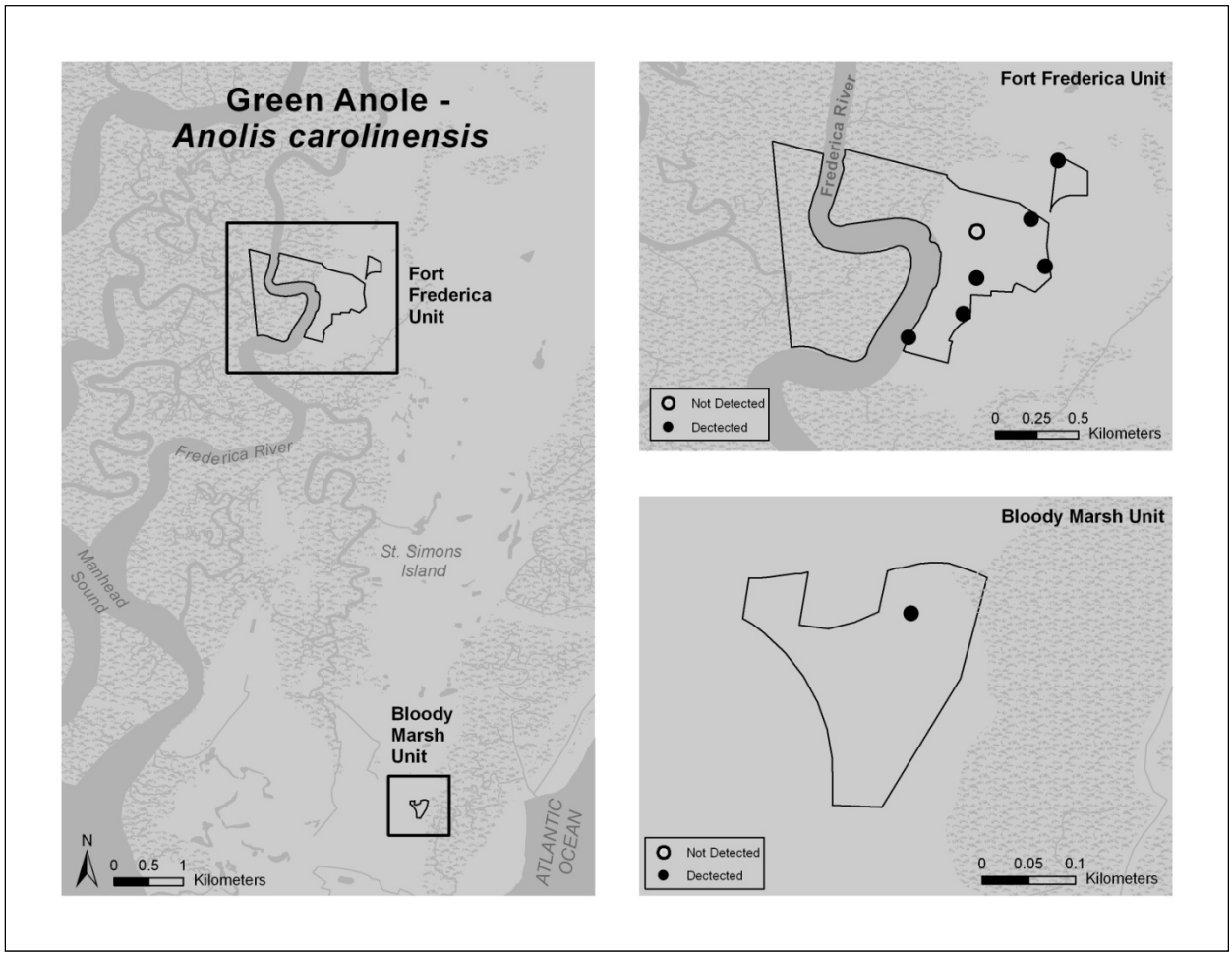


**Figure 11.** Sampling locations where green anole (*Anolis carolinensis*) was detected at FOFR, 2009. ● = detected, ○ = not detected.

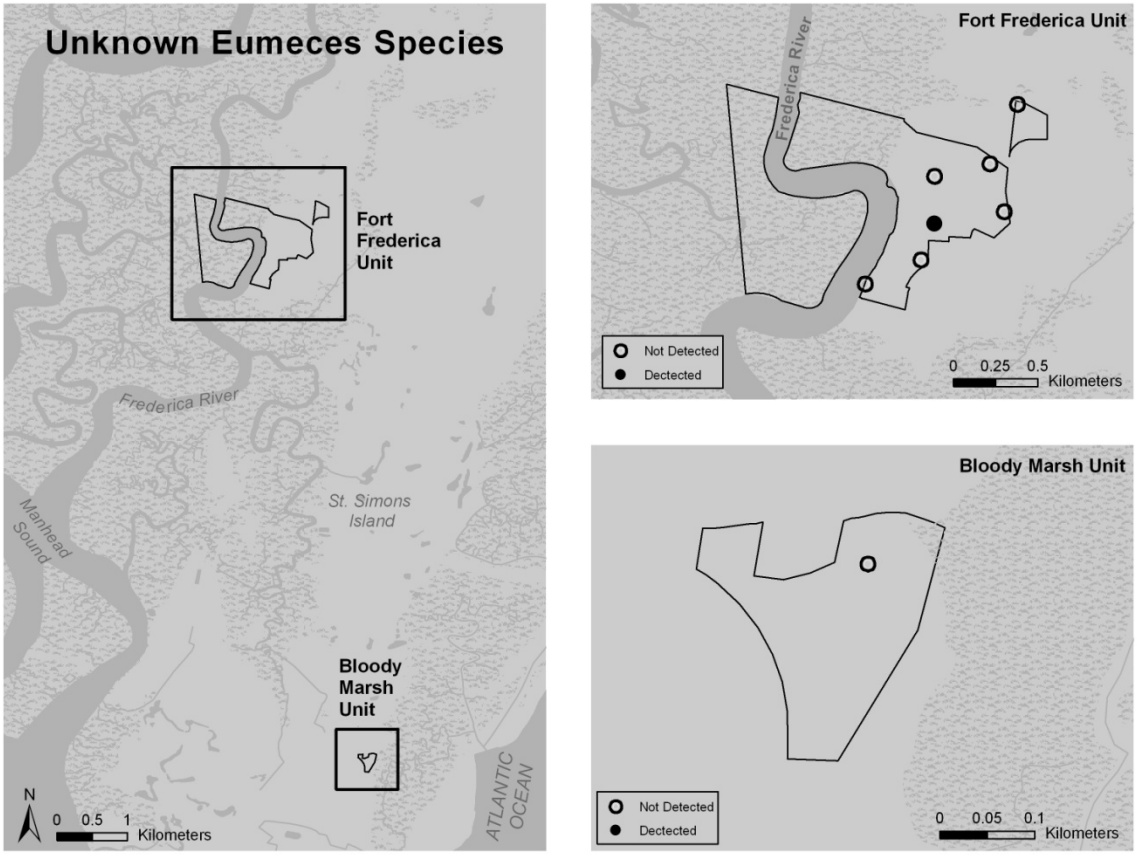


**Figure 12.** Sampling locations where unknown *Eumeces* sp. was detected at FOFR, 2009. ● = detected, ○ = not detected.

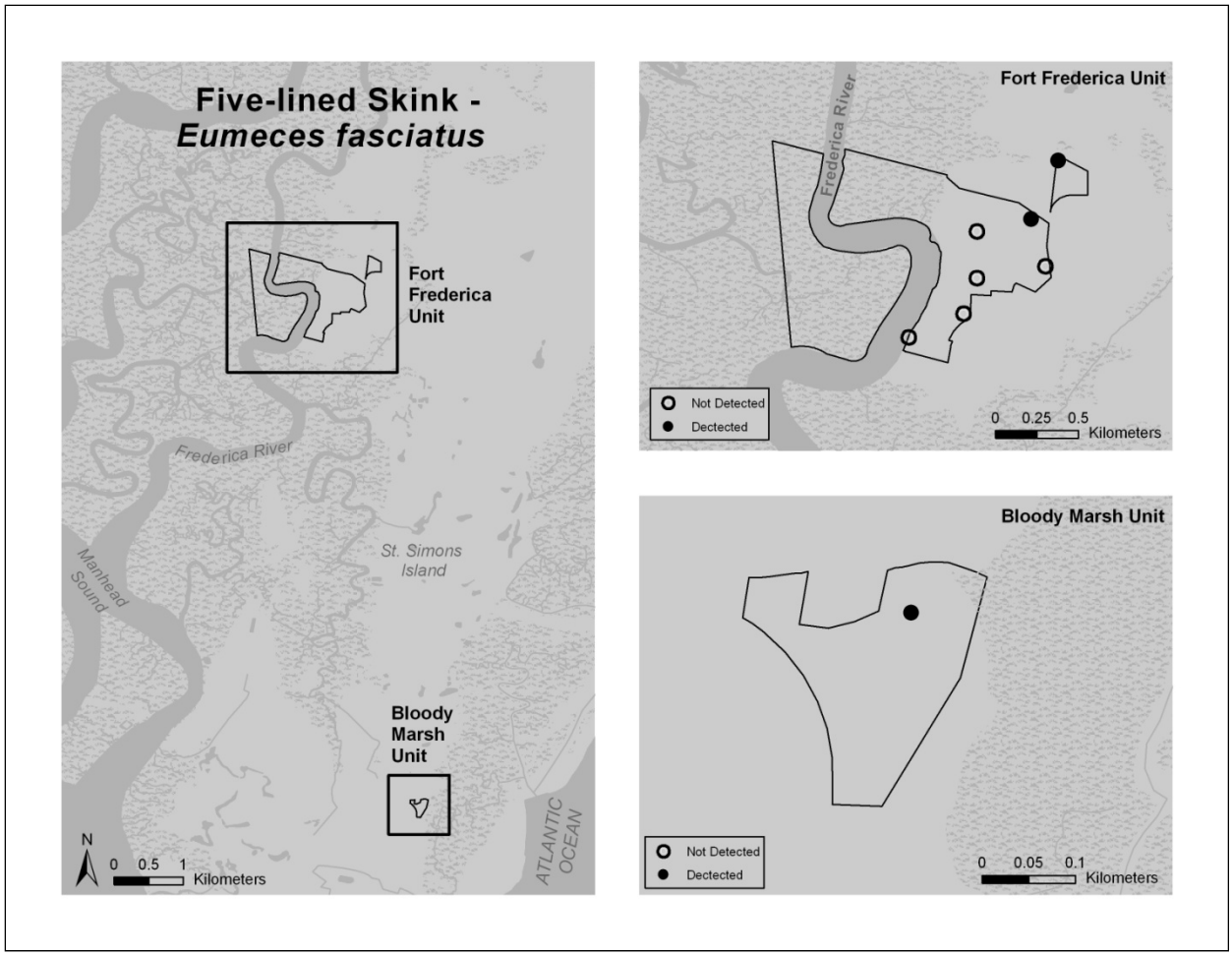


**Figure 13.** Sampling locations where five-lined skink (*Eumeces fasciatus*) was detected at FOFR, 2009. ● = detected, ○ = not detected.

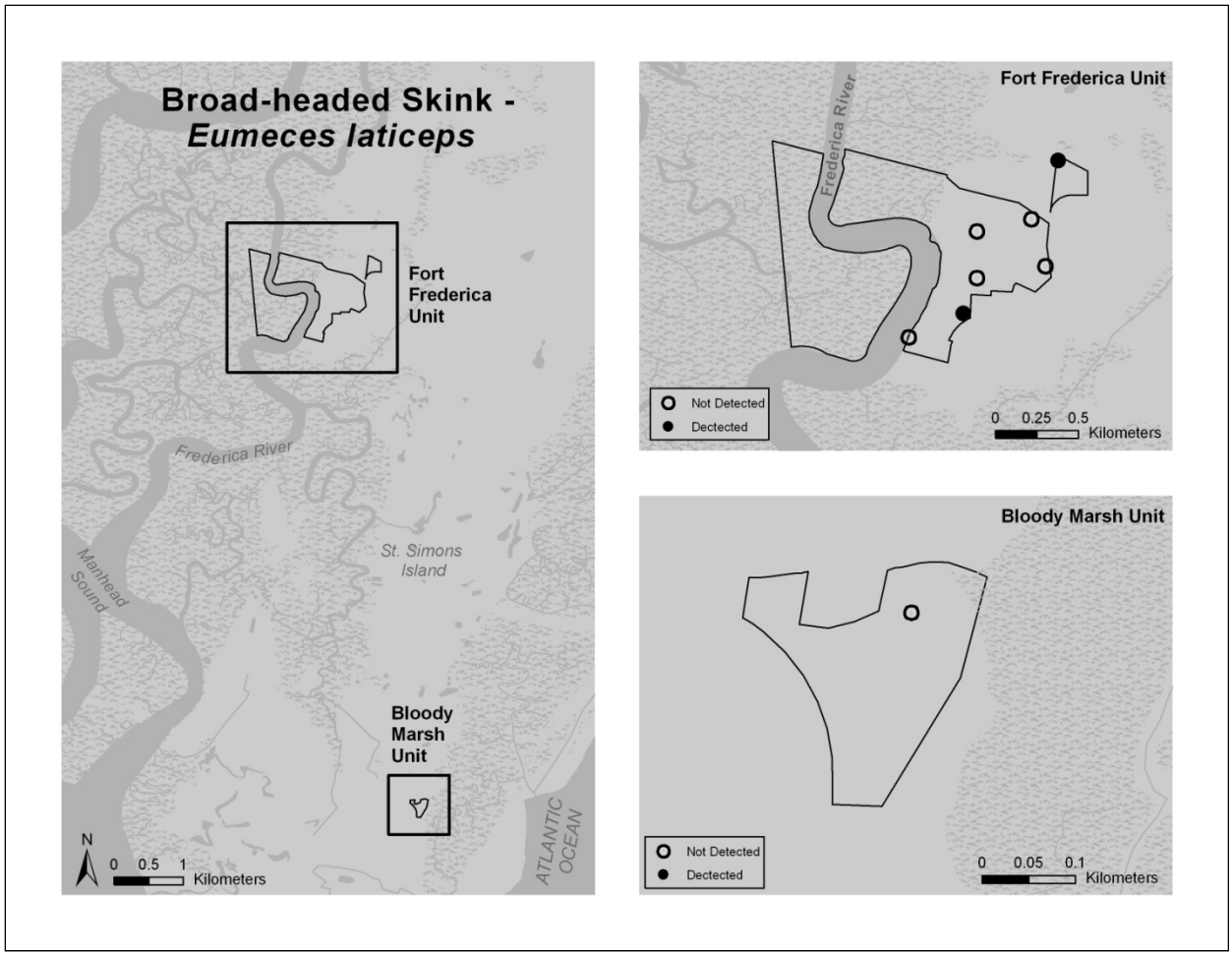


**Figure 14.** Sampling locations where broad-headed skink (*Eumeces laticeps*) was detected at FOFR, 2009. ● = detected, ○ = not detected.

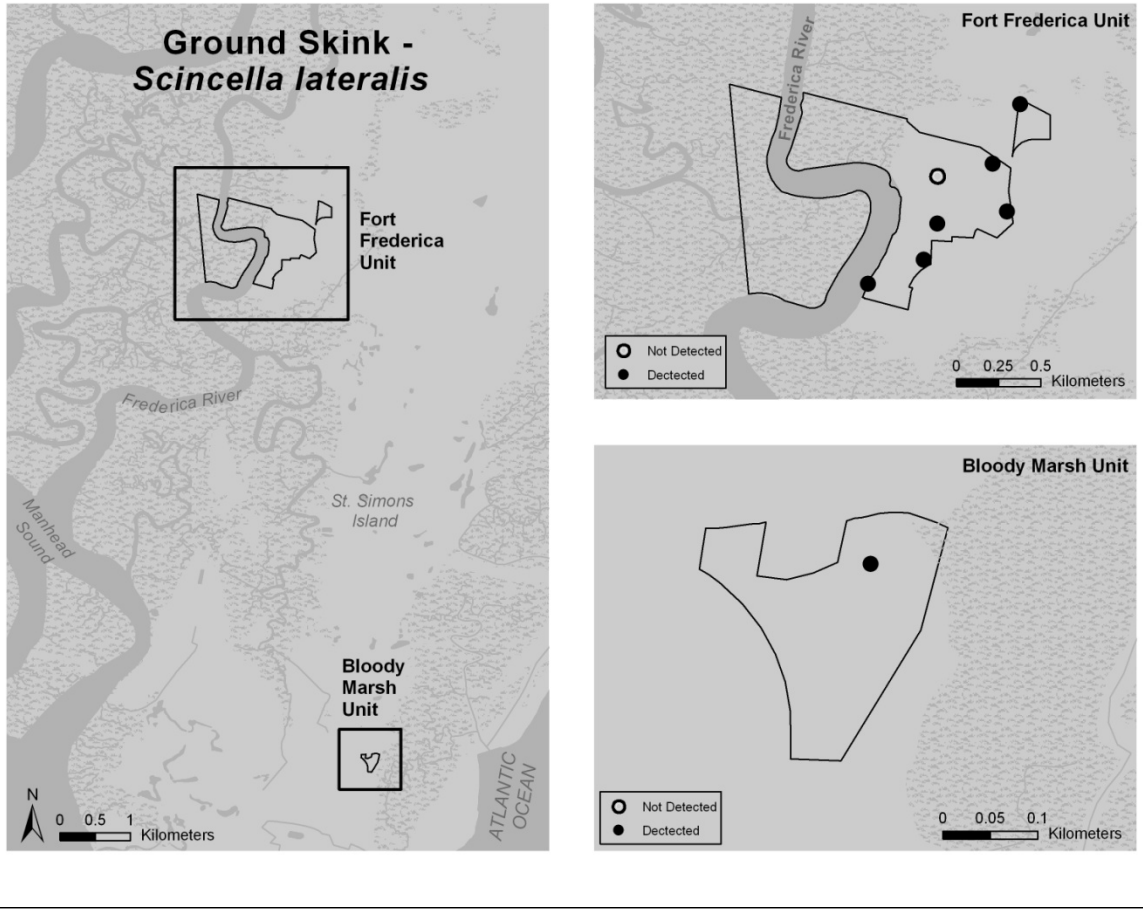


**Figure 15.** Sampling locations where ground skink (*Scincella lateralis*) was detected at FOFR, 2009. ● = detected, ○ = not detected.

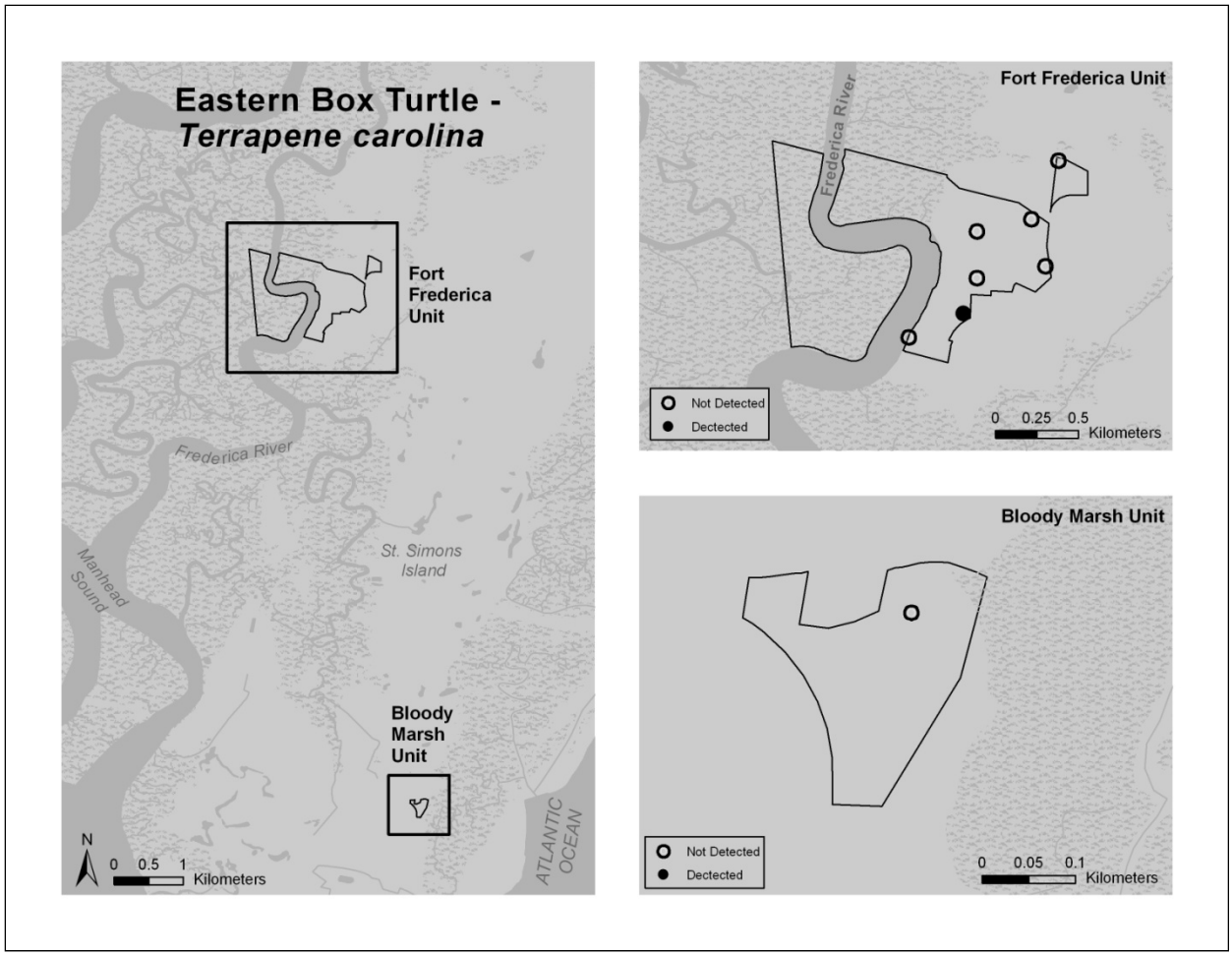


**Figure 16.** Sampling locations where Eastern box turtle (*Terrapene lateralis*) was detected at FOFR, 2009. ● = detected, ○ = not detected.

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# Appendix A. Amphibians and Reptiles Known to Occur at FOFR

**Table A-1.** Amphibians and reptiles known to occur at FOFR based upon records in NPSpecies or from current monitoring efforts presented herein.

| Order | Family | Scientific Name | Common Name | NPSpecies | ARD | VES |
|---|---|---|---|---|---|---|
| Anura | Bufonidae | *Bufo terrestris* | Southern Toad | X | | |
| Anura | Hylidae | *Acris gryllus* | Southern Cricket Frog | | | X |
| Anura | Hylidae | *Hyla gratiosa* | Barking Treefrog | X | | |
| Anura | Hylidae | *Hyla squirella* | Squirrel Treefrog | X | X | X |
| Anura | Leptodactylidae | *Eleutherodactylus planirostris* | Greenhouse Frog | X | X | X |
| Anura | Microhylidae | *Gastrophryne carolinensis* | Eastern Narrow-mouthed Toad | X | X | X |
| Anura | Ranidae | *Rana sphenocephala* | Southern Leopard Frog | | | X |
| Anura | Scaphiopodidae | *Scaphiopus holbrookii* | Eastern Spadefoot | X | | X |
| Crocodilia | Alligatoridae | *Alligator mississippiensis* | Alligator | X | | |
| Squamata | Anguidae | *Ophisaurus ventralis* | Eastern Glass Lizard | X | | |
| Squamata | Colubridae | *Cemophora coccinea* | Scarlet Snake | X | | |
| Squamata | Colubridae | *Coluber constrictor* | Racer | X | | |
| Squamata | Colubridae | *Elaphe guttata* | Corn Snake, Red Rat Snake | X | | |
| Squamata | Colubridae | *Elaphe obsoleta* | Common Rat Snake | X | | |
| Squamata | Colubridae | *Lampropeltis getula* | Common Kingsnake | X | | |
| Squamata | Colubridae | *Storeria occipitomaculata* | Red-bellied Snake | X | | |
| Squamata | Colubridae | *Thamnophis sirtalis* | Garter Snake | X | | |
| Squamata | Polychrotidae | *Anolis carolinensis* | Green Anole | X | | X |
| Squamata | Scincidae | *Eumeces laticeps* | Broad-headed Skink | X | | X |
| Squamata | Scincidae | *Eumeces fasciatus* | Five-lined Skink | | | X |
| Squamata | Scincidae | *Scincella lateralis* | Ground Skink | X | | X |
| Squamata | Teiidae | *Cnemidophorus sexlineatus* | Six-lined Racerunner | X | | |
| Testudines | Emydidae | *Deirochelys reticularia* | Chicken Turtle | X | | |
| Testudines | Emydidae | *Malaclemys terrapin* | Diamondback Terrapin | X | | |
| Testudines | Emydidae | *Terrapene carolina* | Eastern Box Turtle | | | X |

# Appendix B. Map of sampling locations with point labels.

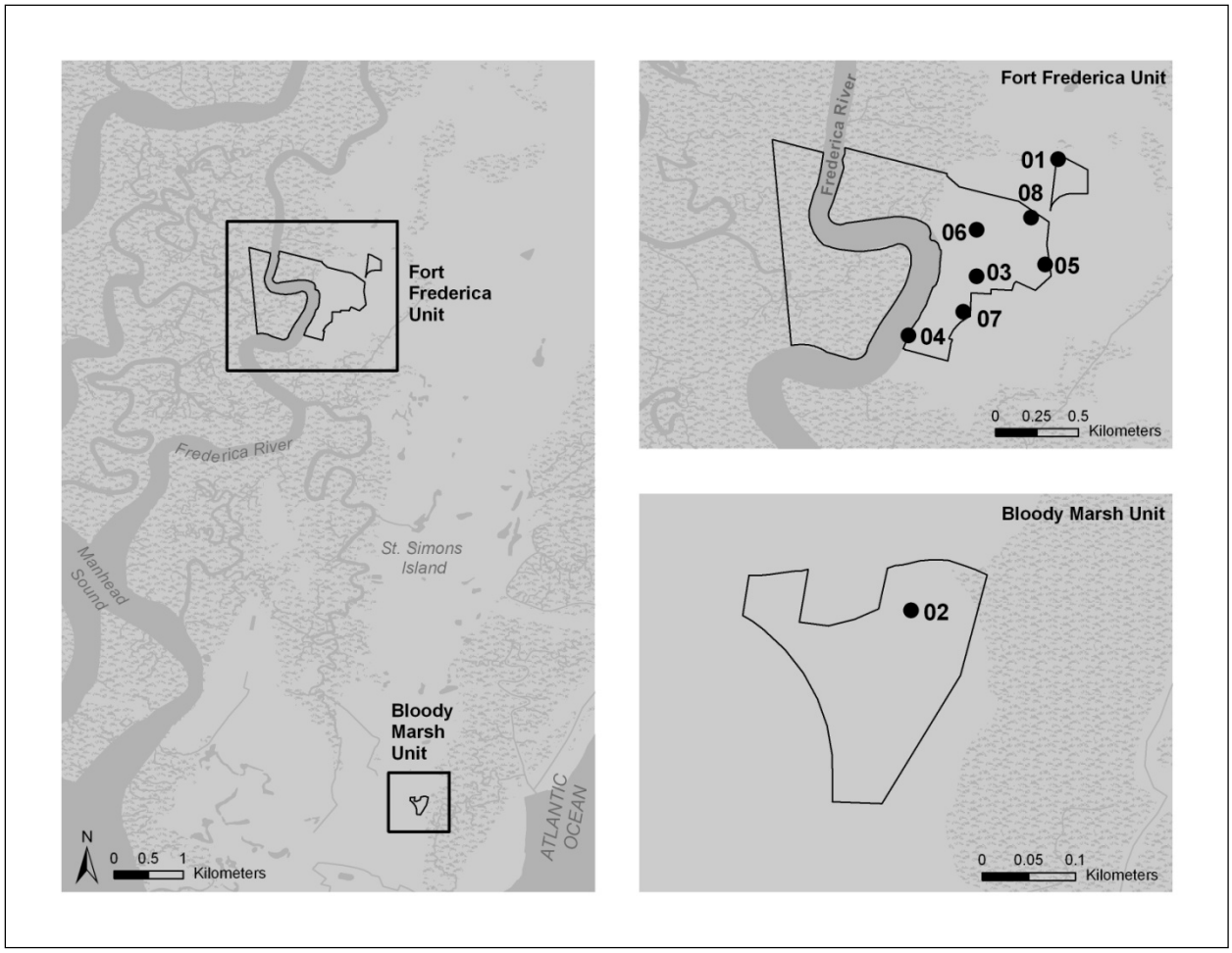


**Figure B-1.** Spatially-balanced random sampling locations at FOFR with labels, 2009.

# Appendix C. Table of species detections by sampling location.

**Table C-1.** Species or species sign detected at each sampling location at FOFR, 2009. Refer to Appendix B for labeled sampling-locations.

| | Sampling Location | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Species** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** |
| Southern Cricket Frog | X | | | | | | | |
| Squirrel Treefrog | | | | | | X | | |
| Greenhouse Frog | X | X | | | | | | X |
| Eastern Narrow-mouthed Toad | | X | | | X | | | |
| Unk. Anura spp. | | | | | X | | | |
| Southern Leopard Frog | | | | | X | | | |
| Eastern Spadefoot | X | | | | | | | |
| Unk. Colubridae spp. | | | | | | | | X |
| Green Anole | X | X | X | X | X | | X | X |
| Unk. *Eumeces* spp. | | | X | | | | | |
| Five-lined Skink | X | X | | | | | | X |
| Broad-headed Skink | X | | | | | | X | |
| Ground Skink | X | X | X | X | X | | X | X |
| Eastern Box Turtle | | | | | | | X | |