National Park Service
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Natural Resource Stewardship and Science

Amphibian Community Monitoring at Fort Sumter National Monument, 2012

Natural Resource Data Series NPS/SECN/NRDS—2013/549

ON THE COVER
Southern Toad (*Anaxyrus terrestris*)
Photograph by: Briana D. Smrekar

Amphibian Community Monitoring at Fort Sumter National Monument, 2012

Natural Resource Data Series NPS/SECN/NRDS—2013/549

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Southeast Coast Inventory and Monitoring Network
Cumberland Island National Seashore
Saint Marys, Georgia 31558

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Executive Summary

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 and 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; Appendix A). 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. This report summarizes amphibian community vital signs monitoring data collected at Fort Sumter National Monument in 2012.

- During 2012, automated recording devices (ARDs) and visual encounter surveys (VESs) were used to collect data at four spatially balanced random locations in the two Sullivan's Island sections of Fort Sumter National Monument.

- Auditory recordings were collected at the park from 4/4/2012 through 6/20/2012 and visual surveys were conducted on 7/2/2012 and 7/3/2012.

- We detected three amphibian species during 2012 monitoring activities. We detected 29 vocalizations from three identifiable anuran species using the ARDs and two post-metamorphic amphibians in two species during the VESs.

- The Southern toad (*Anaxyrus terrestris*) had the highest frequency of occurrence among amphibians at FOSU in 2012, as well as the highest relative detection frequency of vocalizations during the 77-day ARD recording period.

- Southern toad and squirrel treefrog (*Hyla squirella*) were the only amphibian species detected during VESs in 2012.

- The Southern toad was the most widely distributed amphibian in 2012, and was detected at both of the Sullivan's Island sections of the park.

- The squirrel treefrog was detected for the first time at FOSU during this monitoring effort and was added to the park species list.

- We detected 14 reptiles in three identifiable species during the VESs.

- One reptile was confirmed for the first time in the park and added to the species list; the Eastern box turtle (*Terrapene carolina*).

- No non-native species were detected.

- Amphibian communities will next be sampled in 2016.

- The full dataset and associated metadata can be acquired from the NPS Integrated Resource Management Applications (IRMA) portal at http://irma.nps.gov.

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 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 and 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; Appendix A).

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 as a part of the Southeast Coast Network Vital Signs Monitoring Program's efforts to assess the status and trends of amphibian communities at Fort Sumter National Monument (Byrne et al. 2013 *in review*).

Study Area

Fort Sumter National Monument (FOSU) is located in Charleston, South Carolina (Figure 1). The Monument occurs at the mouth of the Charleston Harbor and on the southern tip of Sullivan's Island. The Monument is co-administered with Charles Pinckney National Historic Site (CHPI), although CHPI was not included as part of this monitoring effort. The Monument is 81-ha (200 ac), of which approximately 50 ha (122 ac) is submerged in the Harbor. Although the Monument is primarily managed as an important cultural site (i.e., it was the site of the first engagement of the Civil War), it also contains natural resources that provide important stop-over

sites for migratory birds. Additionally, an accreted area adjacent to the fort and the beachfront areas on Sullivan's Island provide foraging habitat for shorebirds year-round.

Vegetation is sparse around the fort itself, and consists primarily of early-successional tidal forbs (e.g., *Batis maritima*). The vegetation communities in the unit on Sullivan's Island are somewhat more complex, although impacted from strong anthropogenic use, and consist of primary dune, beach, and maritime hammock communities, and manicured lawn areas. The primary dune is characterized by sea oats (*Uniola paniculata*), while the maritime hammock is dominated by Virginia live oak (*Quercus virginiana*). SECN monitoring activities are restricted to the two Sullivan's Island sections of FOSU.

Fort Sumter National Monument has five known amphibian species, including one species added to the park species list as a result of our 2012 monitoring efforts (NPSpecies 2013; Appendix A). All five amphibian species are Anurans (frogs and toads).

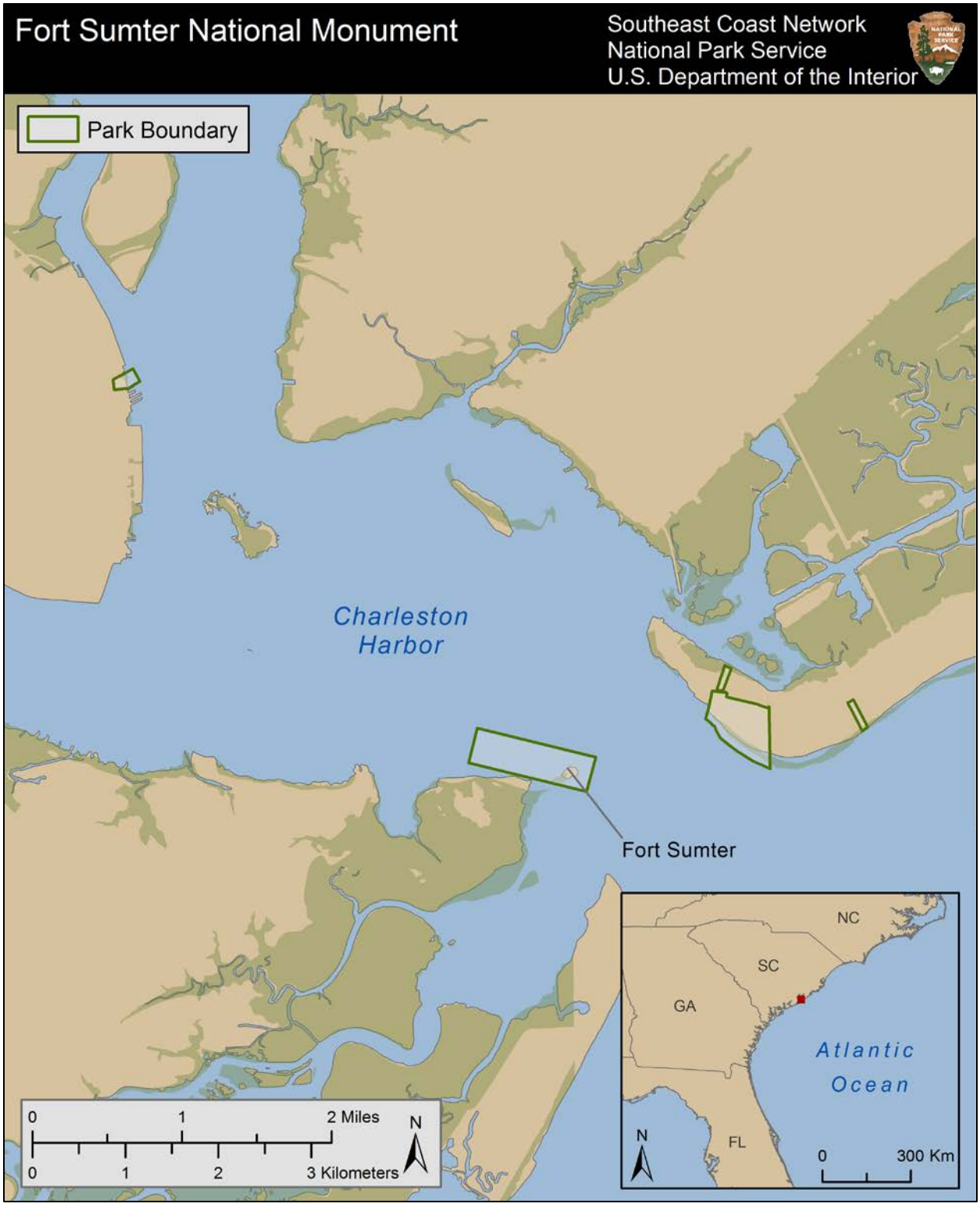


Figure 1. Location of Fort Sumter National Monument.

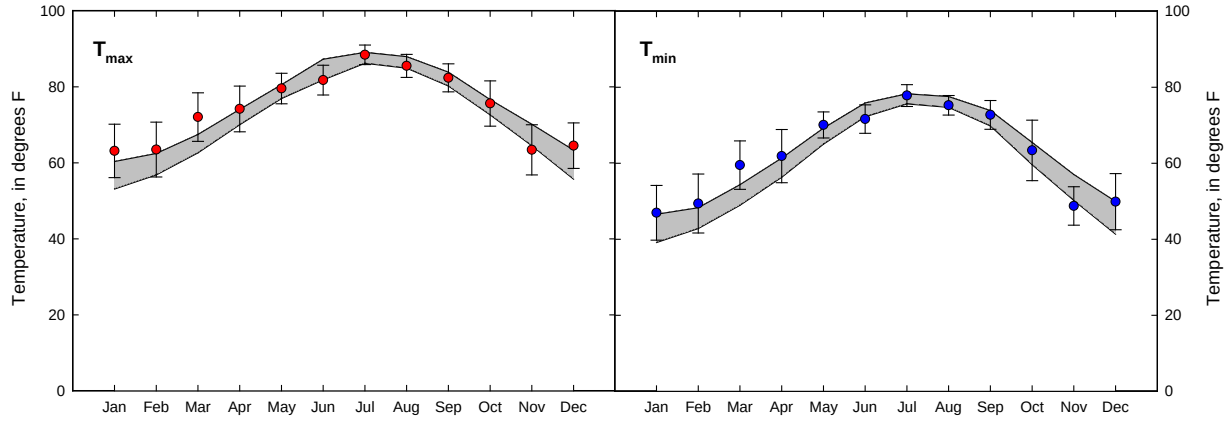
Environmental Setting During Sampling Event

Climatologically, the Southeastern U.S. experienced unusually warm average temperatures throughout the winter and spring (January to May, 2012), and near normal or slightly cooler than average summer and fall temperatures (Wright 2013). Total annual precipitation averaged below normal across the southeastern states in 2012, although Florida and Alabama experienced near normal levels. North Carolina and South Carolina had below normal precipitation, while Georgia averaged well below normal annual precipitation (Wright 2013).

Based on data collected from the Charleston City, Charleston International Airport, and the Charleston tide station weather stations, mean monthly temperatures at FOSU were above average (although not outside the range of variation for the long-term average) for most of the SECN sampling timeframe (April-May 2012), but below average during June 2012 (Wright 2013). The maximum high temperatures during the SECN sampling timeframe ranged from 71.4°F to 85.4°F, while the minimum lows ranged from 55.5°F to 72.0°F. The average temperature during the SECN sampling period was 72.8°F at the Charleston tide station, and June's average temperature was 76.6°F (Figure 2).

Precipitation varied greatly throughout the SECN monitoring timeframe (April to early July, 2012) at Fort Sumter National Monument (Wright 2013). According to the Charleston City weather station, an average of 3.70 inches of precipitation fell during the SECN monitoring timeframe, which is 1.77 inches above normal precipitation levels for that time period (Wright 2013). During April 2012, less precipitation fell than normal, and the average precipitation at the Charleston International Airport weather station was lower than the 25th percentile of the 30-year average (Figure 3B). However, conditions during the latter portion of the monitoring timeframe were wetter than normal. May had average precipitation levels that exceeded the 75th percentile of the long-term average at the Charleston City weather station (Figure 3A). June also experienced wetter conditions than normal, with average precipitation higher than the 75th percentile for the long-term average at the Charleston Airport weather station (Figure 3B). The total annual precipitation for the Charleston area averaged 41.34 inches of precipitation, which is 6.39 inches below average.

A.



B.

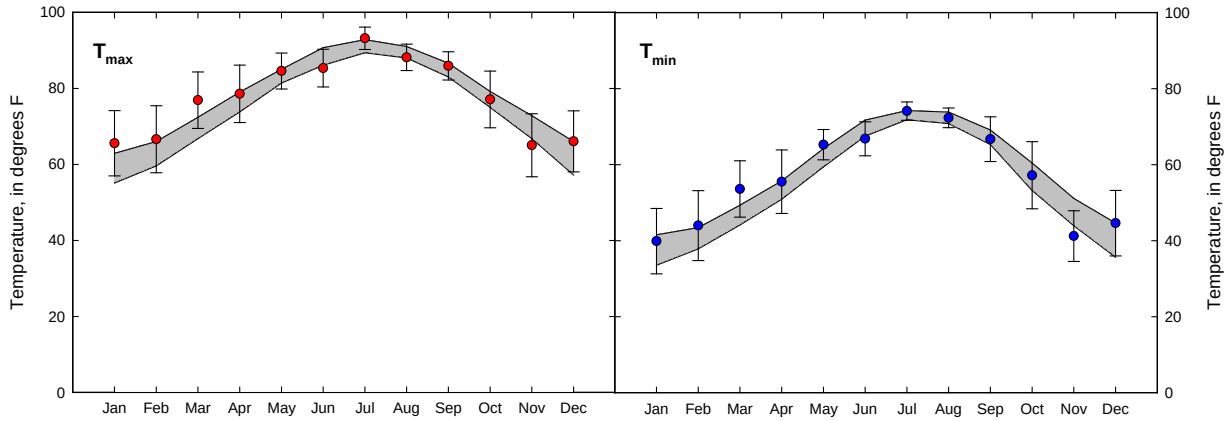
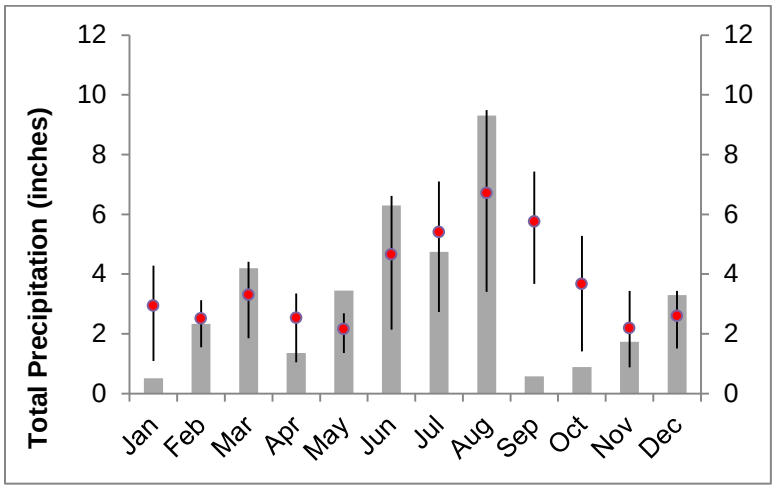


Figure 2. 2012 average monthly temperature and the 30-year (1981 – 2010) average for A. Charleston City and B. Charleston International Airport stations. Units = °F. Points indicate the 2012 average monthly maximum and minimum temperatures. Error bars indicate +/- standard deviation. The dual solid lines bound the standard deviation around the 30-year (1981-2010) mean monthly temperature.

A.



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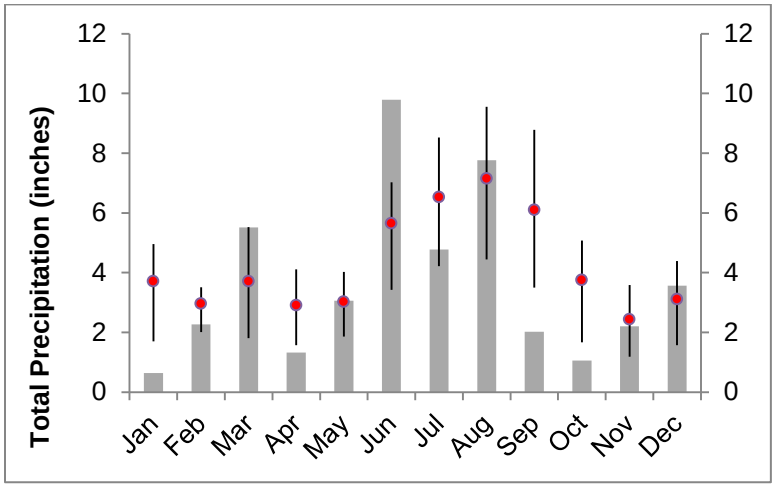

Figure 3. Total monthly precipitation during 2012 and the 30-year (1981 - 2010) monthly averages for A. Charleston City and B. Charleston International Airport stations. The gray columns represent 2012 total monthly precipitation. The red circles represent the 30-year average; the lines indicate the 25th and 75th percentile of the 30-year normal data for each month.

At the time visual encounter surveys were conducted (7/2/2012 and 7/3/2012), conditions were extremely dry with no precipitation observed and soil moisture averaged approximately 1% at FOSU (Table 1).

Table 1. Environmental variables during visual encounter surveys conducted at Fort Sumter National Monument, 2012. Averages for Noise, Precipitation, and Wind Speed are calculated as the mode of parameter codes (see footnote for code definitions).

Parameter	Average	Standard Deviation	Notes
Noise	1.5	N/A	Slight to moderate effects on sampling with somewhat noticeable reduction to hearing
Precipitation	0.00	N/A	No Precipitation
Relative Humidity (%)	76.08	12.24	
Soil Moisture (%)	1.20	0.87	
Temperature (ºF)	82.90	6.46	
Wind Speed	1.00	N/A	1-3 mph

[1] Noise codes are determined in the field as follows: 0 – No appreciable effect, no background noise; 1 – Slightly affecting sampling, barely reduces hearing; 2 – Moderately affecting sampling, noticeable reduction of hearing; 3 – Seriously affecting sampling, noticeable reduction of hearing; 4 – Profoundly affecting sampling, greatly reduced hearing.

[2] Precipitation codes are determined in the field as follows: 0 – None; 1 – Mist or fog; 2 – Light drizzle; 3 – Light rain; 4 – Heavy rain; 5 – Sleet; 6 – Snow.

[3] Wind speed codes are determined in the field as follows: 0 – Calm (< 1mph), smoke rises vertically; 1 – Light air (1-3 mph), smoke drifts, weather vane inactive; 2 – Light breeze (4-7 mph), leaves rustle, can feel wind on face; 3 – Gentle breeze (8-12 mph), leaves and twigs move around, small flags extend; 4 – Moderate breeze (13-18 mph), moves thin branches, raises loose papers; 5 – Fresh breeze (19-24 mph), small trees begin to sway; 6 – Strong breeze (>24 mph), large branches moving, wind whistling.

Monitoring Objectives

Analysis of amphibian monitoring data is based on detections of vocal anurans using automated recording devices, where a detection is considered to be one or more observations of a species or species group during one night of monitoring at a sampling location. The SECN has four monitoring objectives related to amphibian communities based on amphibian post-metamorphic anuran vocalization data collected from March to late June in non-saline wetland and upland vegetation communities in all Southeast Coast Network parks (Byrne et al. 2013 *in review*):

- *Determine the status and trends in species richness and diversity of amphibian communities.* Species richness and diversity estimates are based on the total number of species detected (i.e., native and non-native).

- *Determine the status and trends in occupancy by amphibian species.* Occupancy estimates provide insight into the likelihood of encountering a specific species, rarity, diversity, and distribution of a species or group, and relative comparisons provide insight into the composition of the sample.

- *Determine the status and trends in frequency of detection of vocal anurans.* Frequency of detection is the number of nights a species or species group is observed during the sampling event at each sampling location.

- *Determine trends in the vocalization phenology of select anurans with high detectability*. Vocal anuran calling patterns of species with high detectability (i.e., an unbiased detectability estimated generated from the occupancy-modeling process) will be analyzed to determine the status and trends in the first and last dates on which species are detected.

Additional amphibian and reptile data based on visual encounter methods that were being tested as a part of protocol development in FY 2012 are also presented below.

Methods

Sampling Design

To allow for park-wide inference, the FOSU administrative boundary was used as the sampling frame, within which a spatially-balanced sample was drawn 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. In 2012, amphibian communities were sampled at four locations that met the selection criteria (i.e., safety and access considerations) as described in Byrne et al (2013 *in review*) (Figure 4). Due to the lack of amphibian habitat at the Fort structure, monitoring activities were restricted to the sections of the park located on Sullivan's Island.

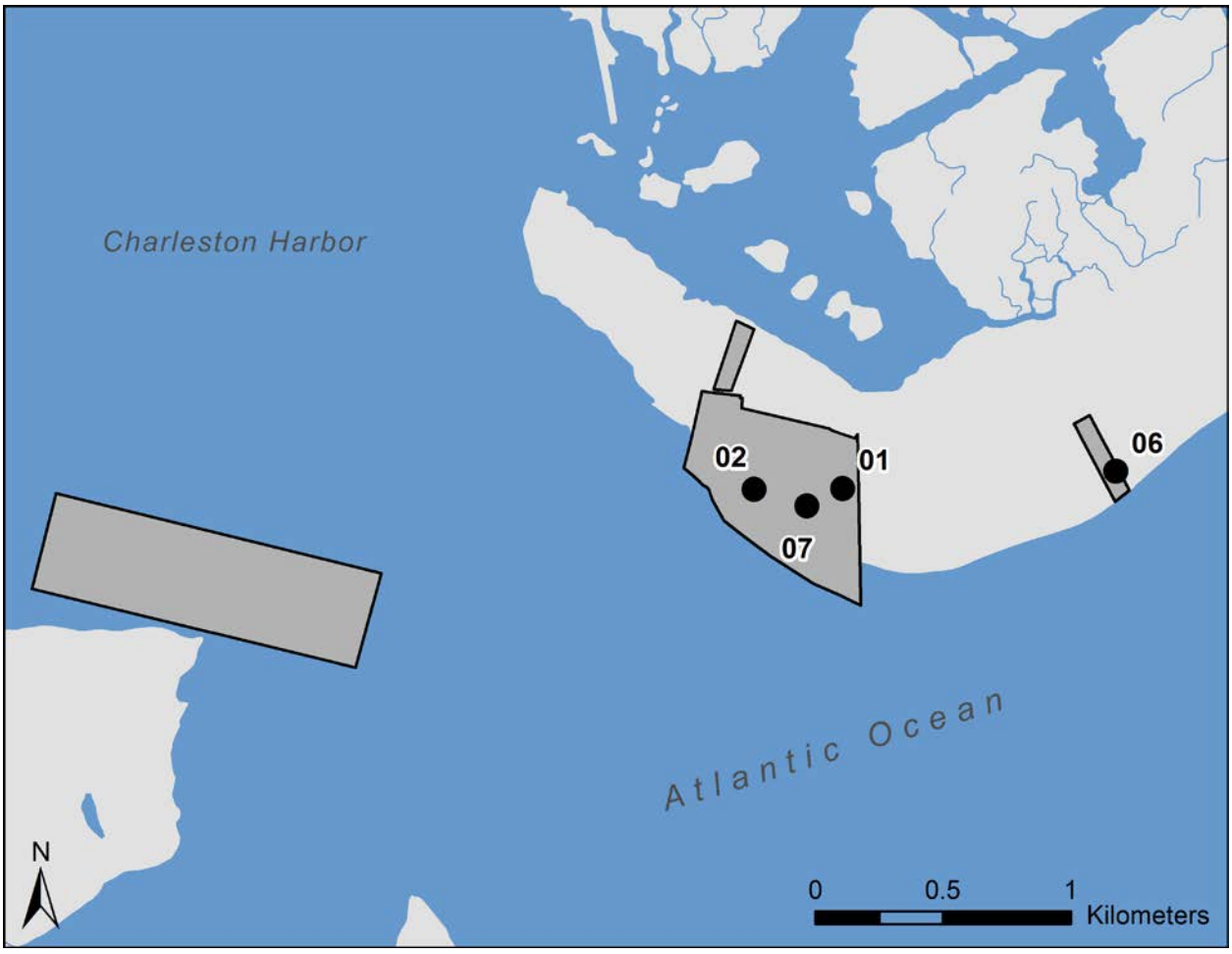

Figure 4. Spatially-balanced random sampling locations on the Sullivan's Island sections of Fort Sumter National Monument, 2012.

Sampling Methodology

Three sampling techniques were used as part of SECN amphibian monitoring, including a combination of active and passive sampling techniques. The active techniques were a time- and area-constrained medium-intensity visual encounter survey (VES) that was conducted systematically through the 0.5-ha macroplot, and the dip-net techniques incorporated in sampling

locations with aquatic communities. All species or species sign detected by sight or sound were recorded as part of the VESs. The passive technique was an automated-recording device (ARD) programmed to record every four days from 18:00 (6:00 pm) to 06:50 am for 30 seconds of every 10 minutes. 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). The sampling techniques were co-located, with the ARDs deployed at the center point of each 0.5-ha macroplot where VES sampling occurred (Figure 5). All three techniques adequately detect any species that occurs in the 0.5-ha macroplot.

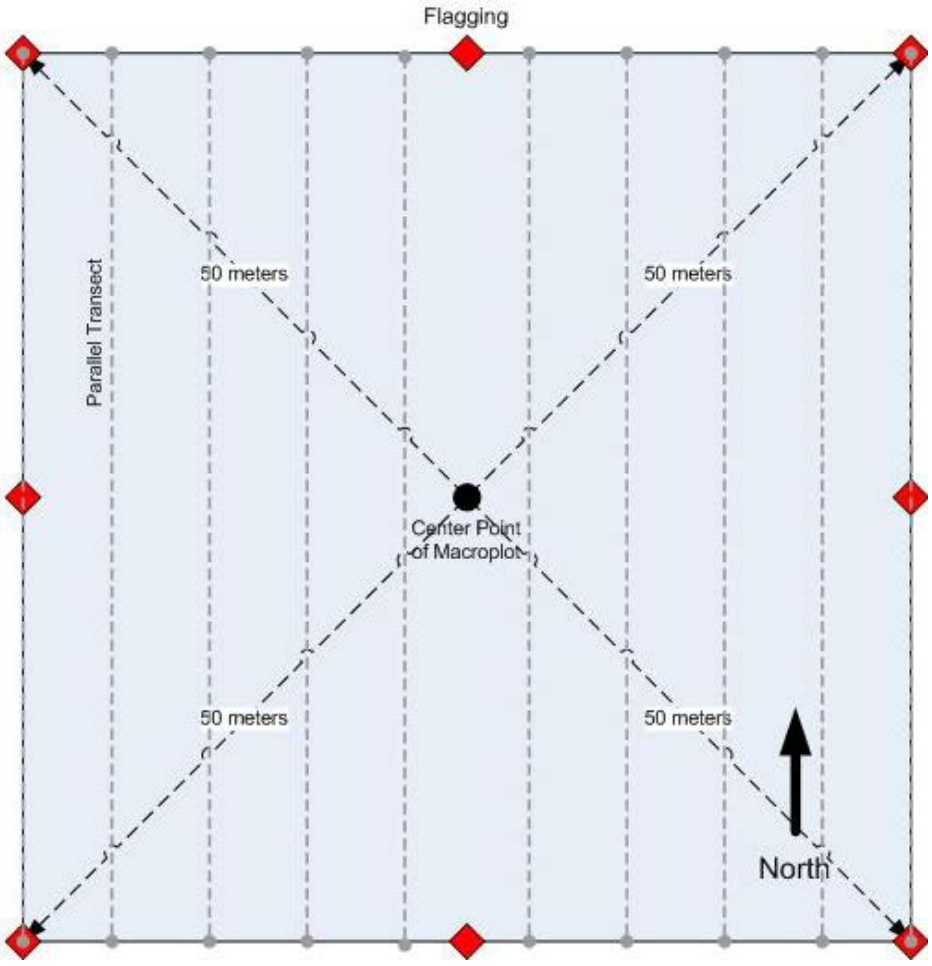

Figure 5. Macroplot (0.5-ha) layout for amphibian community monitoring in Southeast Coast Network parks. Visual encounter surveys (VESs) occur along parallel transects within the macroplot; Automated recording devices (ARDs) are deployed for 77 days at or near the center point of the macroplot.

Automated Recording Devices

Automated recording devices are often used to characterize soundscapes. Recently this technology has been applied to monitoring wildlife species. The use of ARDs is advantageous in SECN parks because of (a) the high number of vocal anurans (i.e., vocalizing frogs and toads) in SECN parks (i.e., 35), (b) many of these species are assumed to be broadly distributed across park lands, (c) crepuscular and nocturnal calling behavior predominates the vocal anurans in SECN parks (Mohr and Dorcas 1999, Bridges and Dorcas 2000, Todd et al. 2003), (d) night-time calling surveys are a concern given the safety issues for personnel conducting the surveys, and

(e) the resultant detection/non-detection data of ARDs adheres to the monitoring objective. Further, the devices produce a permanent data product (i.e., recordings) that can be further analyzed as technology improves, analyzed by other researchers, analyzed for other taxa, or to quantify the soundscape.

To address some of the known influences related to imperfect detection (MacKenzie et al. 2002, MacKenzie et al. 2006), devices were deployed for a duration of 77 days to ensure detection of species present at the park as well as to assess changes in calling phenology. After the deployment period, the devices were retrieved and audio files were analyzed by SECN staff to determine the date, time, and species of all vocal anurans that were detected.

As is the case with all data collected with ARDs, the information derived is based on species' detectability. The occupancy estimates and phenology trends are based on methodology and data collection that does not account for environmental cues that initiate calling behavior (e.g., rainfall, humidity, and temperature). Additionally, while every effort is made to ensure that our recording timeframe is sufficient to encompass most vocalizing anurans, the recordings are only a portion of the time during which anurans are active. To adequately characterize the anuran community, we determined the most appropriate timeframe for deploying the ARDs in SECN parks to be March through June based on vocalization-phenology information (Dorcas and Gibbons 2008) and data from 2009-2012 recordings in National Park units across the SECN. The most appropriate anuran candidate species' vocalization dates are published in this report.

ARDs were deployed from 4/4/2012 to 6/20/2012. A total of 3,120 minutes was recorded by all four of the devices deployed at the park. All ARDs functioned properly and recorded for the entirety of the deployment period.

Visual Encounter Surveys

The VES consisted of a medium-intensity time-constrained survey, the duration of which is determined at the sampling location based on vegetation density prior to initiation of the survey. All potential cover objects (e.g., leaf litter, under logs/rocks, other potential cover items) within the plot were searched and all species detected were identified and recorded (including reptiles). Cover objects were returned to their original position to reduce habitat impacts from monitoring activities. Animals were captured only to facilitate accurate identification. If streams or wetlands were encountered within the macroplot, dip-nets and hand-capture techniques were used to detect and identify aquatic amphibians or larvae.

Visual Encounter Surveys were conducted at Fort Sumter National Monument on 7/2/2012 and 7/3/2012.

Taxonomic Standards

Despite a well-trained field crew, complete identification of all individuals encountered was not always possible due to the quick and evasive nature of many species. Species are, 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. While the majority of these species could most likely be identified to the genus or family level (i.e., Unknown *Lithobates* or Ranidae in this instance) based upon knowledge of the location and the local fauna, a conservative estimation is used and these species are identified to Order as "Anuran species".

Data Analysis

This protocol collects detection / non-detection data, which, although somewhat inaccurately, is also often referred to as presence / absence data. In contrast to detections made from visual survey methods where individuals can be seen, differentiated, and counted, detections from our other surveying method, automated recording devices, cannot be reliably associated with more than one individual. In general, one individual will vocalize multiple times during the survey period and is likely to be detected multiple times. Consequently, data-summary techniques do not equate one vocalization with one individual and are conducted accordingly.

Composition

Measures of community composition are often good indicators of abiotic variability, disturbance, or other stressors. Summaries related to composition include the total number of species detected (i.e., species richness), naïve occupancy, relative abundance, and relative detection frequency. Species richness is simply the number of native species detected. Naïve occupancy is the percentage of the sampling locations where a species was detected at least once, without adjusting for probability of detection. Naïve occupancy is also referred to as frequency of occurrence. Relative abundance is the number of individuals of a particular species expressed as a percentage of the total number of amphibians in the sample. The sample size is the total number of amphibians counted at all sampling locations in the park. Relative detection frequency uses the detection history as an index of abundance to communicate the composition of each species detected relative to all other species detected in the sample. To minimize the bias inherent in this summary from the influences of detectability, vocalization behavior, sound properties, and various aspects of the automated analysis process, the estimate of relative detection frequency is derived by pooling across the detection histories and sampling locations for each species.

Distribution

Understanding changes in the distribution of amphibian species is integral to informed management of species and their requisite habitats. Changes in species distributions over time provide useful information at both the local and landscape scale relating to how species respond to large-scale influences such as changing land use, climate, hydrology, or habitat availability and condition. Shifting species distributions can produce cascading effects through altered species interactions and alterations within the food-web structure, thereby affecting ecosystem processes (Montoya and Raffaelli 2010). Distribution maps for all amphibian species encountered are presented in Appendix B.

Phenology

Phenology, the periodic life-cycle events of plants and animals as they are influenced by changes in the seasons, is an increasingly useful tool in monitoring climate change and its potential effects on amphibian populations (Blaustein et al. 2001, Gibbs and Breisch 2001, Corn 2005, Parmesan 2007, Blaustein et al. 2010, Todd et al. 2011). The timing of anuran territorial and mating vocalizations can provide insight into the initiation of the breeding season for these animals, and tracking these dates may prove to be a robust method for monitoring climate change, as it presents in the southeastern United States. The SECN reports the earliest and latest vocalization dates of select anuran species based on their known annual vocalization pattern, and the recording window of our methodology. Periodic synthesis reports, which will be published after multiple rounds of sampling, will summarize phenological history of amphibian species detected across the SECN for which appropriate candidates for trend analysis are available.

Results

Community Composition

While the primary purpose of this SECN monitoring effort was to detect amphibians, due to their common habitat use reptiles were also encountered during VESs. It is important to note that VESs and ARDs are not considered effective tools to survey for many reptile species, nor was the intent of VES implementation to target reptiles. Although not the target of the SECN's amphibian sampling protocol, we have included a reptile species detection data summary in Appendix C.

We detected three amphibian species during sampling activities at FOSU in 2012 (Table 2). Using ARDs we detected vocalizing anurans in three species, and during the VESs we detected just two post-metamorphic amphibians in two species. No larval stage amphibians were detected during the VESs (Table A-3).

The Southern toad (*Anaxyrus terrestris*), detected at 75% of the sampling locations, had the highest frequency of occurrence (naïve occupancy) of all amphibians detected during our 2012 surveying efforts (Table 2). The squirrel treefrog (*Hyla squirella*), with a naïve occupancy rate of nearly 50% had the next highest frequency of occurrence, while the Eastern narrow-mouth toad (*Gastrophryne carolinensis*) had a frequency of occurrence of 25% at FOSU in 2012.

The Southern toad also had the highest relative detection frequency of vocalizations recorded by ARDs over the 77-day sampling period, accounting for over 62% of all vocalizations detected in 2012 (Figure 6). Squirrel treefrog vocalizations composed over 34% of the vocal detection sample. The Eastern narrow-mouth toad had the lowest relative detection frequency of vocalizations during the recording period.

Amphibian diversity was very low during VESs in 2012, with only two individuals from two species detected. We detected one Southern toad and one squirrel treefrog during the visual surveys at FOSU in 2012 (Table A-3). There were no larval stage amphibians or non-native species detected during this monitoring effort.

Table 2. Percentage of sampling locations where each amphibian species was detected (i.e., naïve occupancy) by method and across methods at Fort Sumter National Monument, 2012. NA indicates that the method does not apply to this species.

	Detection Method		
Species	**All**	**VES**	**ARD**
Southern Toad	75.0	*25.0*	*75.0*
Squirrel Treefrog	50.0	*25.0*	*50.0*
Eastern Narrow-mouthed Toad	25.0	*0.0*	*25.0*
Total Locations Surveyed	**4**	***4***	***4***

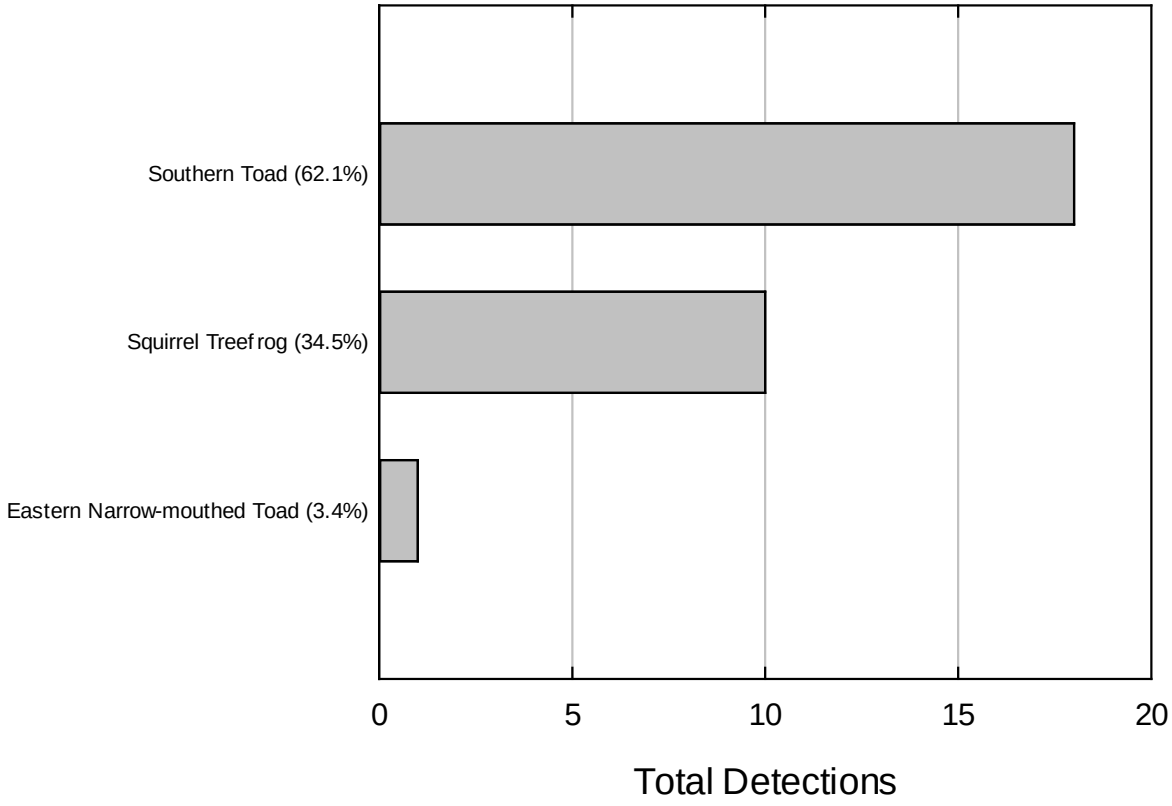

Figure 6. Number of anuran vocalization detections and the percent relative detection frequency (i.e., number of species vocalizations compared to all species' vocalizations) of recorded calls during Automated Recording Device (ARD) deployment (4 April to 20 June 2012) at Fort Sumter National Monument. Based on n=29 detections.

New Species Records

One species not previously known to occur in the park was added to the Fort Sumter National Monument species list as a result of 2012 monitoring activities. The squirrel treefrog (*Hyla squirella*) was detected using ARDs and during the VESs.

Table 3. New amphibian species detected at Fort Sumter National Monument and recommended NPSpecies classifications.

Scientific Name	Common Name	Abundance	Residency	Nativity	Pest	Management Priority	Exploitation Concerns
Hyla squirella	Squirrel Treefrog	Unknown	Resident	Native	No	No	No

Amphibian Distribution

The Southern toad was the most widely distributed amphibian at Fort Sumter in 2012, found in three-quarters of the sampling locations and at both Sullivan's Island sections of the park (Table 2; Appendix B). Squirrel treefrog was detected at two sampling locations in the largest section of the park on Sullivan's Island, which is the area located across the road from FOSU's headquarters and visitor center. The Eastern narrow-mouthed toad was detected at one location in the section of the park near FOSU's visitor center as well. Distribution maps for all amphibians that were detected during the monitoring event are presented in Appendix B.

Vocalization Phenology

Of the anurans detected using ARDs at Fort Sumter in 2012, two species would be appropriate candidates to determine trends in vocalization start dates; squirrel treefrog and Eastern narrow-mouthed toad. These species were considered appropriate candidates because they typically begin to vocalize well after the start of our recording schedule in the SECN parks (Dorcas and Gibbons, 2008). Squirrel treefrog was first detected on the first date of recording, 4/4/2012, and the Eastern narrow-mouthed was only detected one time, on 6/7/2012 (Figure 7). We failed to detect any anuran species that would be appropriate candidates for tracking end dates due to the timing of their typical vocalization windows in the Southeast. None of the species we detected are known to have vocalization windows that close well before our recording schedule concludes, and so we are not reporting vocalization end dates at this time (Dorcas and Gibbons, 2008).

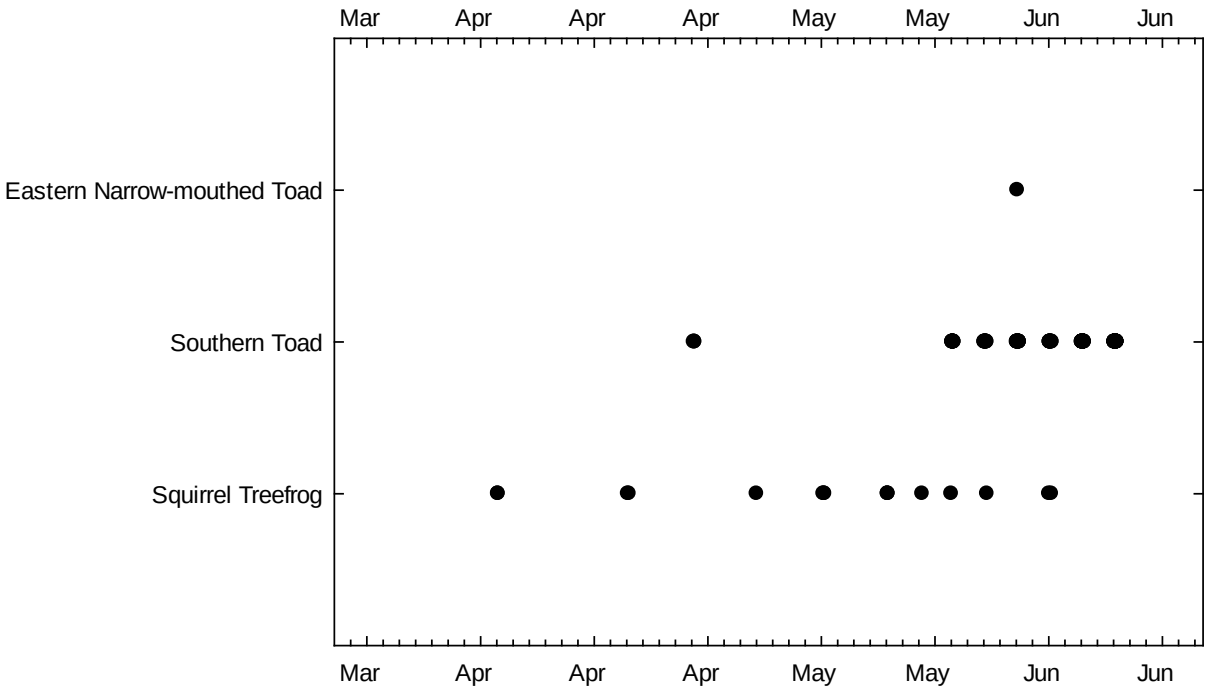

Figure 7. Vocalization phenology for species detected using automated recording devices (ARDs) at Fort Sumter National Monument, from 4 April to 20 June 2012. Based on n=29 detections.

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Appendix A. Amphibian Species Detection Data

Table A-1. Amphibian species known to occur Fort Sumter National Monument based on the Park's certified species list (NPSpecies 2013) and those detected during this sampling effort.

Scientific Name	Common Name	NPSpecies	ARD	VES
Anaxyrus terrestris	Southern Toad	X	X	X
Hyla cinerea	Green Treefrog	X		
Hyla squirella	Squirrel Treefrog		X	X
Gastrophryne carolinensis	Eastern Narrow-mouthed Toad	X	X	
Scaphiopus holbrookii	Eastern Spadefoot Toad	X		

Table A-2. Amphibian species or species sign detected at each sampling location at Fort Sumter National Monument, 2012.

	Sampling Location			
Species	**1**	**2**	**6**	**7**
Southern Toad	X		X	X
Squirrel Treefrog	X			X
Eastern Narrow-mouthed Toad	X			

Table A-3. Total numbers of larval and post-metamorphic detections of amphibian species during visual encounter surveys at Fort Sumter National Monument, 2012.

	Species	Number of Post-Metamorphic Detections	Number of Larval Detections	Species Total Detections
Anura	Southern Toad	1	0	**1**
	Squirrel Treefrog	1	0	**1**
	Total Detections	**2**	**0**	**2**

Appendix B. Distribution Maps for Amphibian Species Encountered

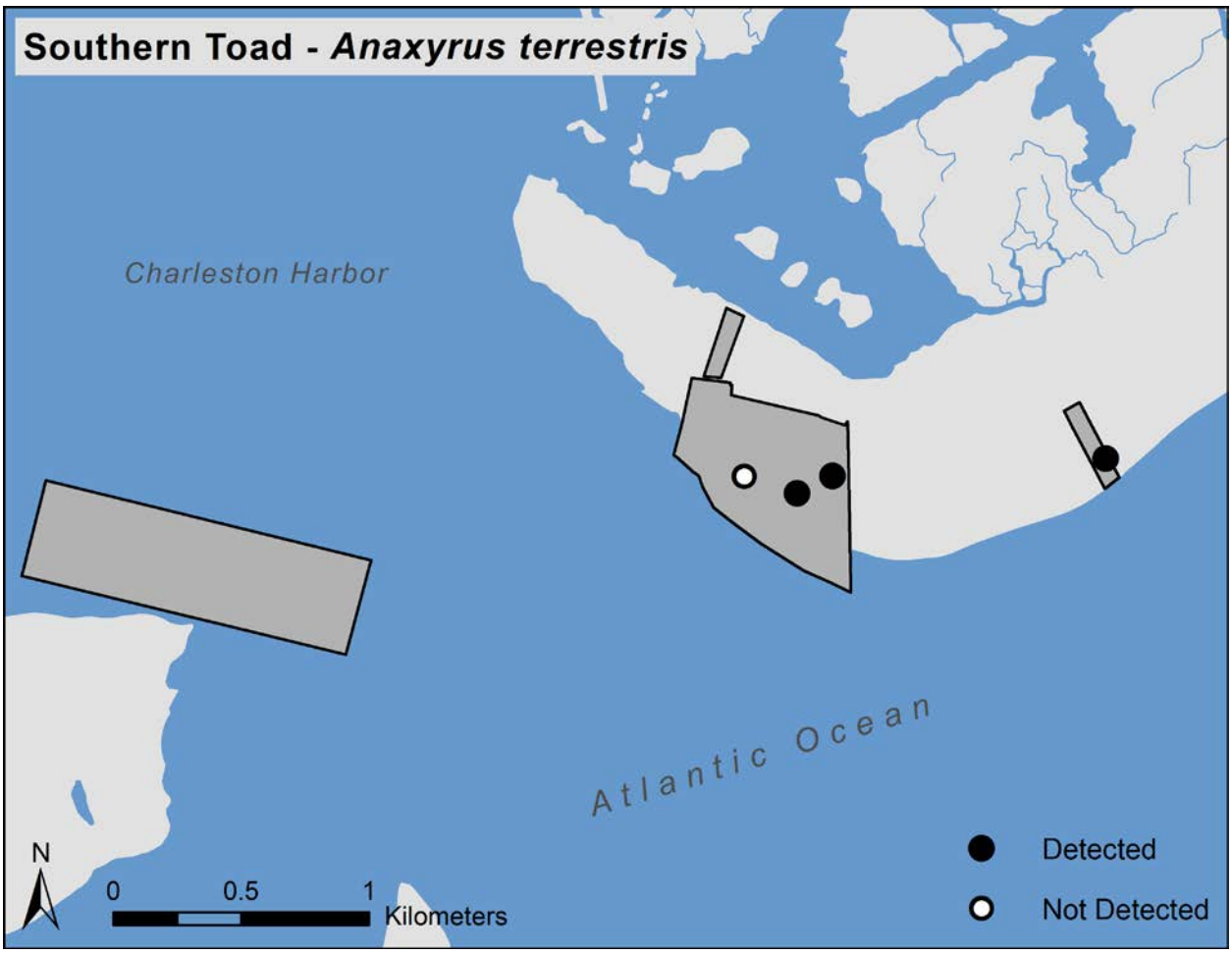

Figure B-1. Sampling locations where Southern Toad (*Anaxyrus terrestris*) was detected at Fort Sumter National Monument, 2012.

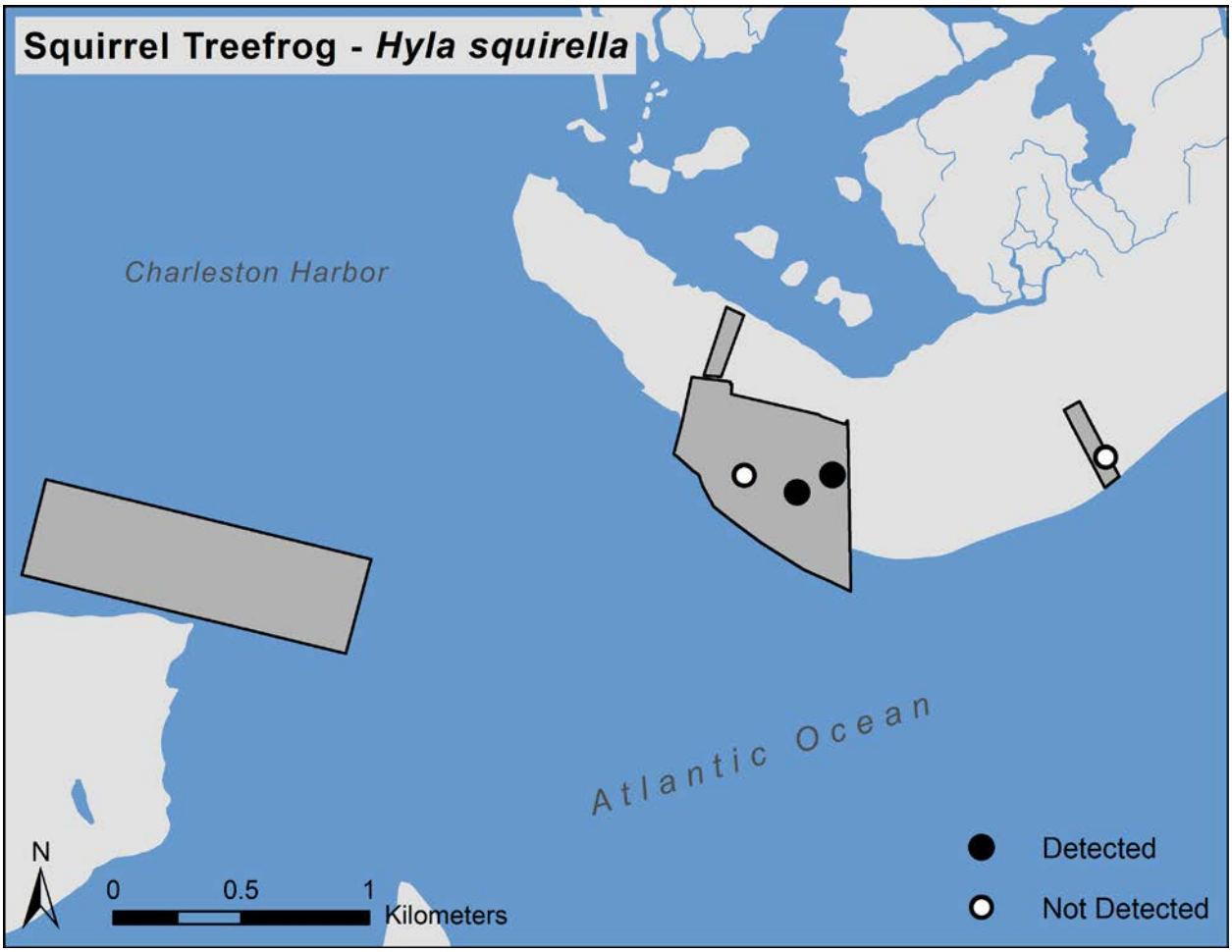

Figure B-2. Sampling locations where squirrel treefrog (*Hyla squirella*) was detected at Fort Sumter National Monument, 2012.

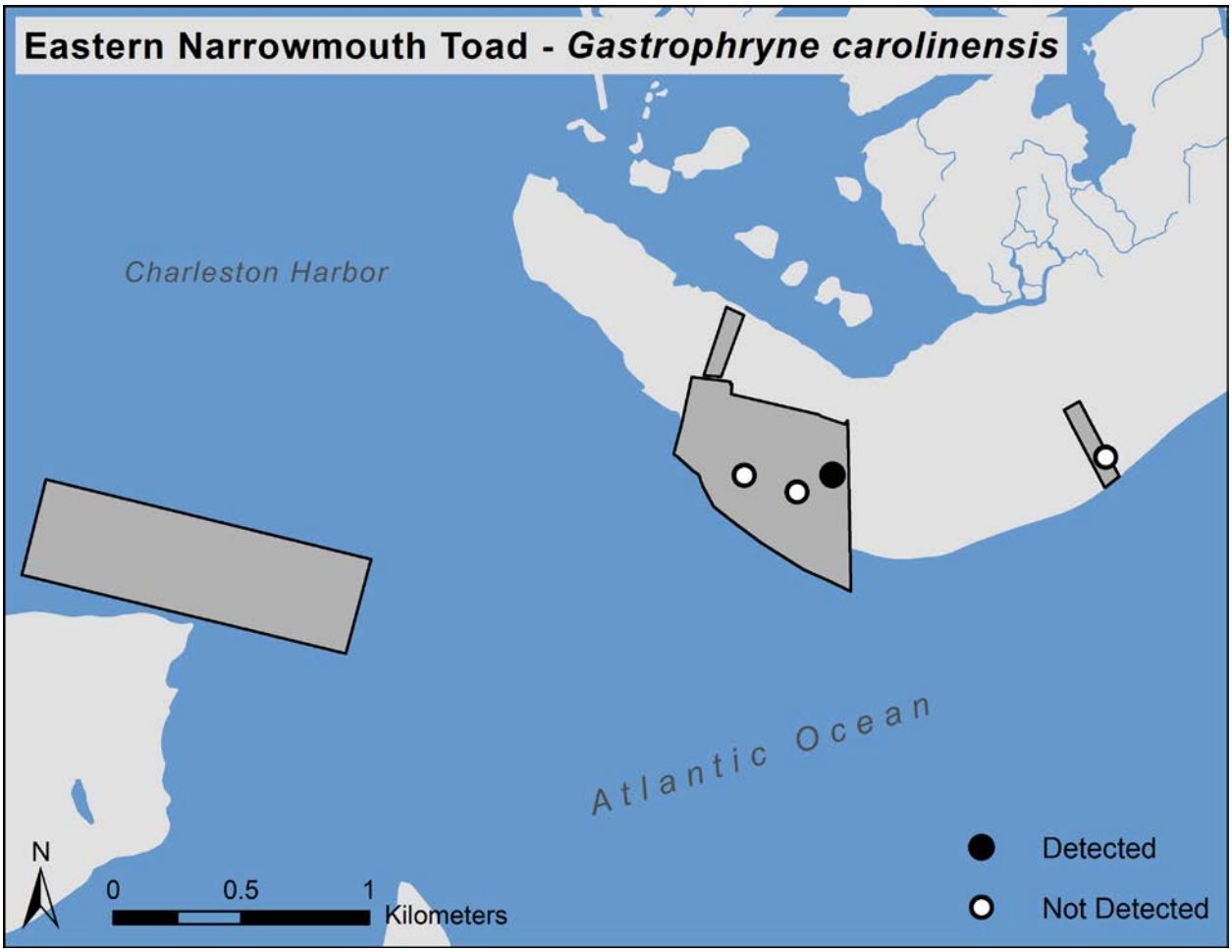

Figure B-3. Sampling location where Eastern narrow-mouthed toad (*Gastrophryne carolinensis*) was detected at Fort Sumter National Monument, 2012.

Appendix C. Reptile Species Detection Data

Fort Sumter National Monument has six known reptile species, consisting of five species in *Squamata* (e.g. lizards, snakes, geckos, and skinks) and one species in *Testudines* (turtles and tortoises) (Table C-1). One reptile species, the Eastern box turtle (*Terrapene carolina*), was added to the park species list as a result of our 2012 monitoring efforts. It is currently the only *Testudines* species on the FOSU reptile list. We detected a male and a female Eastern box turtle together, as well as the remains of a juvenile box turtle at one sampling location within the FOSU park boundaries.

We detected 14 reptiles or reptile signs from three identifiable species at FOSU in 2012 (Table C-1; Figure C-1). One species, the six-lined racerunner (*Cnemidophorus sexlineatus*), composed over 71% of the reptiles detected during monitoring activities at FOSU in 2012 and was found at 100% of the sampling locations. The Eastern box turtle and the Eastern glass lizard (*Ophisaurus ventralis*), which accounted for 14% and 7% of all reptile sightings respectively, were each detected at 25% of the sampling locations at FOSU (Table C-2; Figure C-1). No non-native reptile species were detected.

Table C-1. Reptile species known to occur at Fort Sumter National Monument based on the Park's certified species list (NPSpecies 2013) and those detected during the 2012 sampling effort.

Scientific Name	Common Name	NPSpecies	VES
Ophisaurus ventralis	Eastern Glass Lizard	X	X
Coluber constrictor	Black Racer	X	
Elaphe obsoleta	Black Rat Snake	X	
Anolis carolinensis	Green Anole	X	
Cnemidophorus sexlineatus	Six-lined Racerunner	X	X
Terrapene carolina	Eastern Box Turtle		X

Table C-2. Reptilian species or species sign detected at each sampling location at Fort Sumter National Monument, 2012.

	Sampling Location			
Species	**1**	**2**	**6**	**7**
Six-lined Racerunner	X	X	X	X
Eastern Glass Lizard				X
Eastern Box Turtle	X			
Eastern Box Turtle shell	X			

Table C-3. New reptile species detected at Fort Sumter National Monument and recommended NPSpecies classifications.

Scientific Name	Common Name	Abundance	Residency	Nativity	Pest	Management Priority	Exploitation Concerns
Terrapene carolina	Eastern Box Turtle	Unknown	Resident	Native	No	No	No

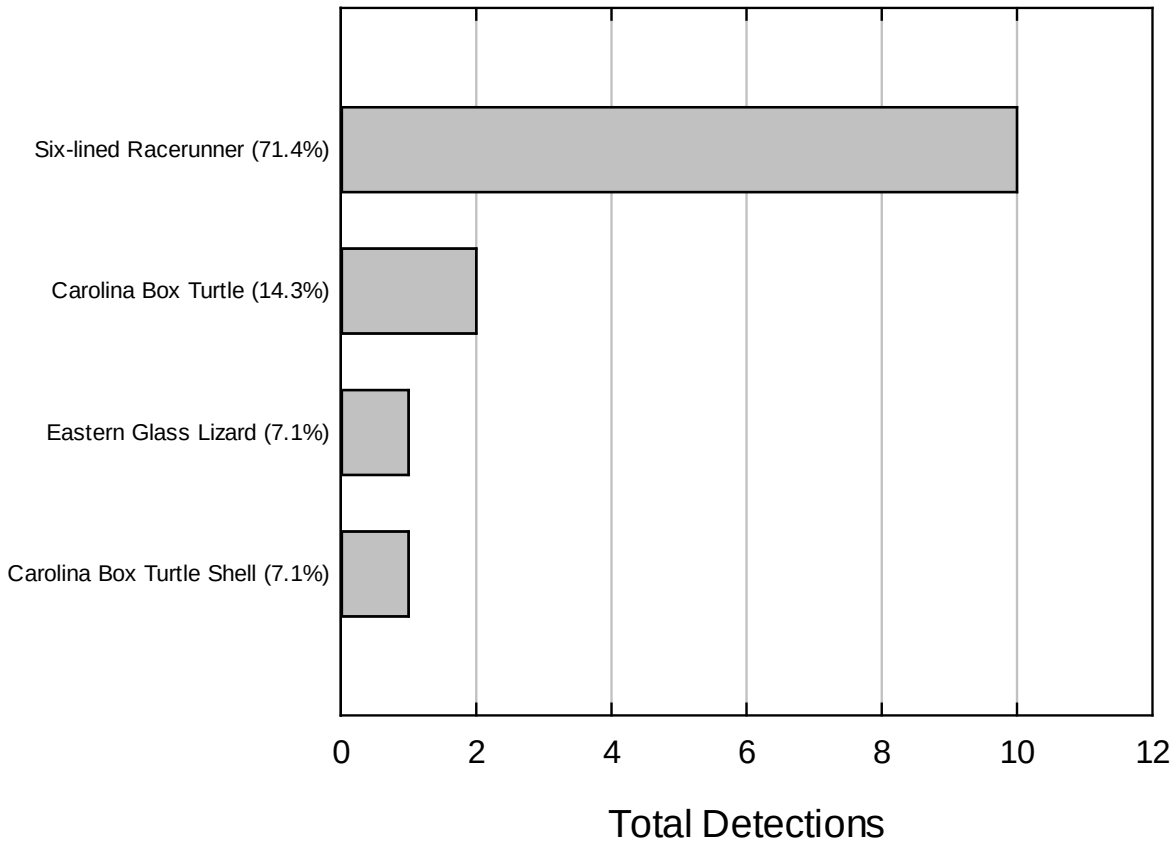

Figure C-1. Number of individual reptiles and reptile signs detected and percent species composition during visual encounter surveys at Fort Sumter National Monument, 2012. Based on n=14 detections.