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Anuran Community Monitoring at Ocmulgee National Monument

2014 Data Summary

Natural Resource Data Series NPS/SECN/NRDS—2015/983



On the cover:
Southern toad (*Anaxyrus terrestris*) vocalizing
Photograph by Briana Smrekar

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The Natural Resource Data Series is intended for the timely release of basic data sets and data summaries. Care has been taken to assure accuracy of raw data values, but a thorough analysis and interpretation of the data has not been completed. Consequently, the initial analyses of data in this report are provisional and subject to change.

All manuscripts in the series receive the appropriate level of peer review to ensure that the information is scientifically credible, technically accurate, appropriately written for the intended audience, and designed and published in a professional manner. Data in this report were collected and analyzed using methods based on established peer-reviewed protocols and were analyzed and interpreted within the guidelines of the protocols.

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Executive Summary

The southern United States hosts one of the most diverse amphibian communities in the world and supports the highest density of amphibian species in North America (Echternacht and Harris 1993). The South contains 63 species of frogs and toads, 11 of which are endemic; this accounts for almost 40% of the total number of anuran species in the United States (Dorcas and Gibbons 2008, Echternacht and Harris 1993). The park units in the National Park Service (NPS) Southeast Coast Network (SECN) are home to 35 known anuran species (frogs and toads). Given their known population declines, sensitivity to anthropogenic stressors, and the diversity of amphibians in the southeastern United States, anuran communities are a priority for SECN monitoring efforts. This report summarizes anuran community vital signs monitoring data collected at Ocmulgee National Monument (OCMU) in 2014.

- Automated recording devices were used to collect data from 3/12/2014 through 5/30/2014 at 21 spatially balanced random locations.
- Vocalizations from 15 anuran species were identified.
- A total of 268 vocalizations were detected on the recordings. Each detection represents an identifiable observation of a species or species group during one night of monitoring at a sampling location.
- The southern toad (*Anaxyrus terrestris*) was the most frequently occuring anuran detected at OCMU in 2014.
- The bird-voiced treefrog (*Hyla avivoca*) had the highest relative frequency of detection of anuran vocalizations over the 77-day recording period in 2014.
- The southern toad was the most widely distributed species during the 2014 monitoring efforts, and the species was found at locations throughout the north–south and east–west expanses of the park.
- No non-native species were found.
- Anuran communities will next be sampled in 2017.
- 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 declined in North America and many other areas around the world. Several factors have contributed to these 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, their effects can be exacerbated when combined with other anthropogenic stressors.

Amphibians have complex life cycles in which 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 depend can substantially impact the survival, reproduction, and persistence of a species. Given their habitat requirements, anatomy, and physiology, amphibians are considered good indicators of ecological condition.

The southern United States hosts one of the most diverse amphibian communities in the world and supports the highest density of amphibian species in North America (Echternacht and Harris 1993). The South is home to 63 species of frogs and toads, 11 of which are endemic; this accounts for almost 40% of the total number of anuran species in the Unites States (Dorcas and Gibbons 2008, Echternacht and Harris 1993). Units in the National Park Service (NPS) Southeast Coast Network (SECN) have 35 known anuran species (frogs and toads). Given their known population declines, sensitivity to anthropogenic stressors, and the diversity of amphibians in the southeastern United States, anuran 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 anuran 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 anuran communities at Ocmulgee National Monument (OCMU, or Ocmulgee).

Study Area

Ocmulgee National Monument sits on the fall line of the southeastern United States, the transition between the rolling Piedmont and the flat Atlantic Coastal Plain. A portion of Ocmulgee is within the city limits of Macon, Georgia, and the Ocmulgee River borders the southwestern side of the Ocmulgee National Monument (Figure 1). The natural resources of the park have been heavily impacted by human activities, including Interstate Highway 16 and its associated berm, which has essentially cut off the river from its floodplain and altered the natural hydrologic pattern of the area. Despite the anthropogenic influences, Ocmulgee National Monument has high biodiversity. This is likely related to a corridor, or what is known locally as the "Greenway," connecting Ocmulgee to other natural areas to the south. Ocmulgee National Monument primarily consists of a large floodplain, herbaceous wetlands, and adjacent uplands. The floodplain vegetation community is composed of several canopy species, including green ash (*Fraxinus pennsylvanica*), American elm (*Ulmus americana*), hackberry (*Celtis* spp.), and red maple (*Acer rubrum*), while the uplands are characterized by canopy species such as loblolly pine (*Pinus taeda*), sweetgum (*Liquidambar styraciflua*), and oaks (*Quercus* spp.). Rice cutgrass (*Leersia oryzoides*) and broadleaf arrowhead, also known as duck-potato (*Sagittaria latifolia*) dominate the herbaceous wetlands.

Threats affecting the native plants and animals in Ocmulgee result mainly from human activities, and include non-native species invasion, water quality, air quality, development, and the general proximity to the City of Macon. Non-native species are a disruptive influence in Ocmulgee. Non-native invasive plants at Ocmulgee include Chinese privet (*Ligustrum sinense*), Japanese honeysuckle (*Lonicera japonica*), and kudzu (*Pueraria montana*). Non-native animal species include nutria, fire ants (*Solenopsis invicta*), feral pigs (*Sus scrofa*), and domestic/feral dogs and cats. Feral pigs are responsible for a tremendous amount of resource damage in both the main unit and the detached Lamar unit.

Ocmulgee National Monument has 17 known anuran species (NPSpecies 2015; Appendix A).

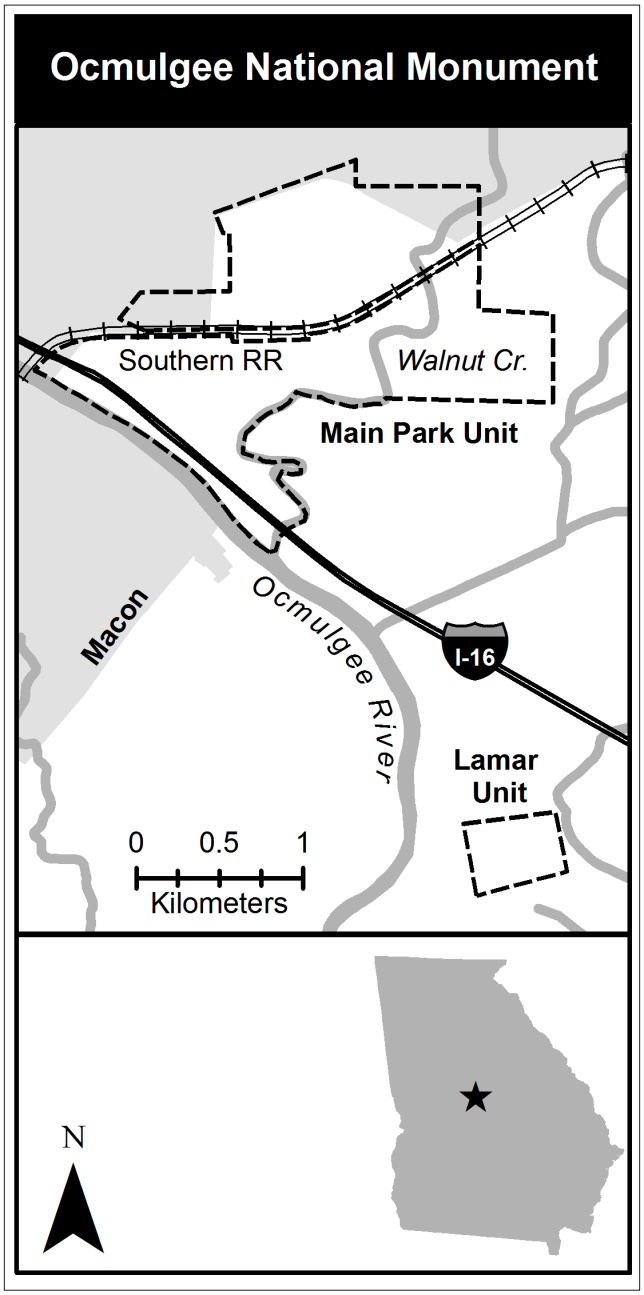


Figure 1. Location of Ocmulgee National Monument.

Monitoring Objectives

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

- Determine the status and trends in species richness and diversity of anuran communities. Species richness and diversity estimates are based on the total number of species detected (native and non-native).
- Determine the status and trends in occupancy by anuran species. Occupancy estimates provide insight into the likelihood of encountering a specific species in a given area. The rarity, diversity, and distribution of a species or group and associated 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 estimate 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.



Cope's gray treefrog. Photo by Briana Smrekar.

Methods

Sampling Design

The sampling design and sampling-location selection is detailed in Appendix B of the SECN Vocal Anuran Community Monitoring Protocol (Byrne et al. 2013) and in the sampling-location selection Standard Operating Procedure #1.1.1 (Byrne 2012). In summary, the park's administrative boundary was used as the sampling frame to allow for park-wide inference. The sampling frame was divided into a systematic 0.5-hectare grid; the center point of each grid cell served as the potential sampling location. A spatially balanced sample was drawn from this grid using the Reversed Randomized Quadrant-Recursive Raster (RRQRR) algorithm (Theobald et al. 2007). Due to accessibility issues, no monitoring activities were performed in the Lamar unit. Alternate points were used when specified selection criteria (e.g., safety issues, accessibility) were not met. In 2014, anuran communities were sampled at 22 locations that met the selection criteria (Figure 2).

Taxonomic Standards

Taxonomy and nomenclature follow standards set forth in the Integrated Taxonomic Information System (ITIS; http://www.itis.gov/). The National Park Service uses the online application NPSpecies (https://irma.nps.gov/npspecies) to document "our knowledge about the occurrence and status of species on National Park Service lands," including maintenance of species lists for NPS properties. The taxonomy and nomenclature in NPSpecies is periodically updated with the most current ITIS catalog. As noted on the ITIS webpage, the system intends not to "serve as a forum for cutting-edge taxonomic classifications," but rather to use "classifications that have gained broad acceptance in the taxonomic literature and by professionals who work with the taxa."

All vocalizations are identified to the finest (i.e., lowest) resolution possible in the taxonomic hierarchy. Only vocalizations identified to the species level are used in the analyses presented herein.

Data Collection

A passive sampling technique was used to collect recordings in the field. Recordings were then manually evaluated using Song Scope software (Wildlife Acoustics, Inc.) and data were extracted to be used in the anuran community monitoring data analysis. Anuran monitoring locations are co-located with the SECN landbird community and vegetation community monitoring locations.

Automated Recording Devices

Automated recording devices (ARDs) are often used to characterize soundscapes. Recently, this technology has been applied to wildlife species monitoring efforts. 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, (b) the assumed broad distribution of many of these species across park lands, (c) the crepuscular and nocturnal calling behavior that predominates among the vocal anurans in SECN park units (Mohr and Dorcas 1999, Bridges and Dorcas 2000, Todd et al. 2003), (d) the safety issues for personnel conducting night-time calling surveys, and (e) the adherence of detection/non-detection data from ARDs to the monitoring objective. Further, the devices produce recordings which serve as a permanent data product that can be further analyzed as technology improves. The recordings can also be analyzed by other researchers, analyzed for other taxa, or used to quantify the soundscape.

To address some of the known influences related to imperfect detection (MacKenzie et al. 2002, MacKenzie et al. 2006), automated recording devices were deployed for 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 by 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.,

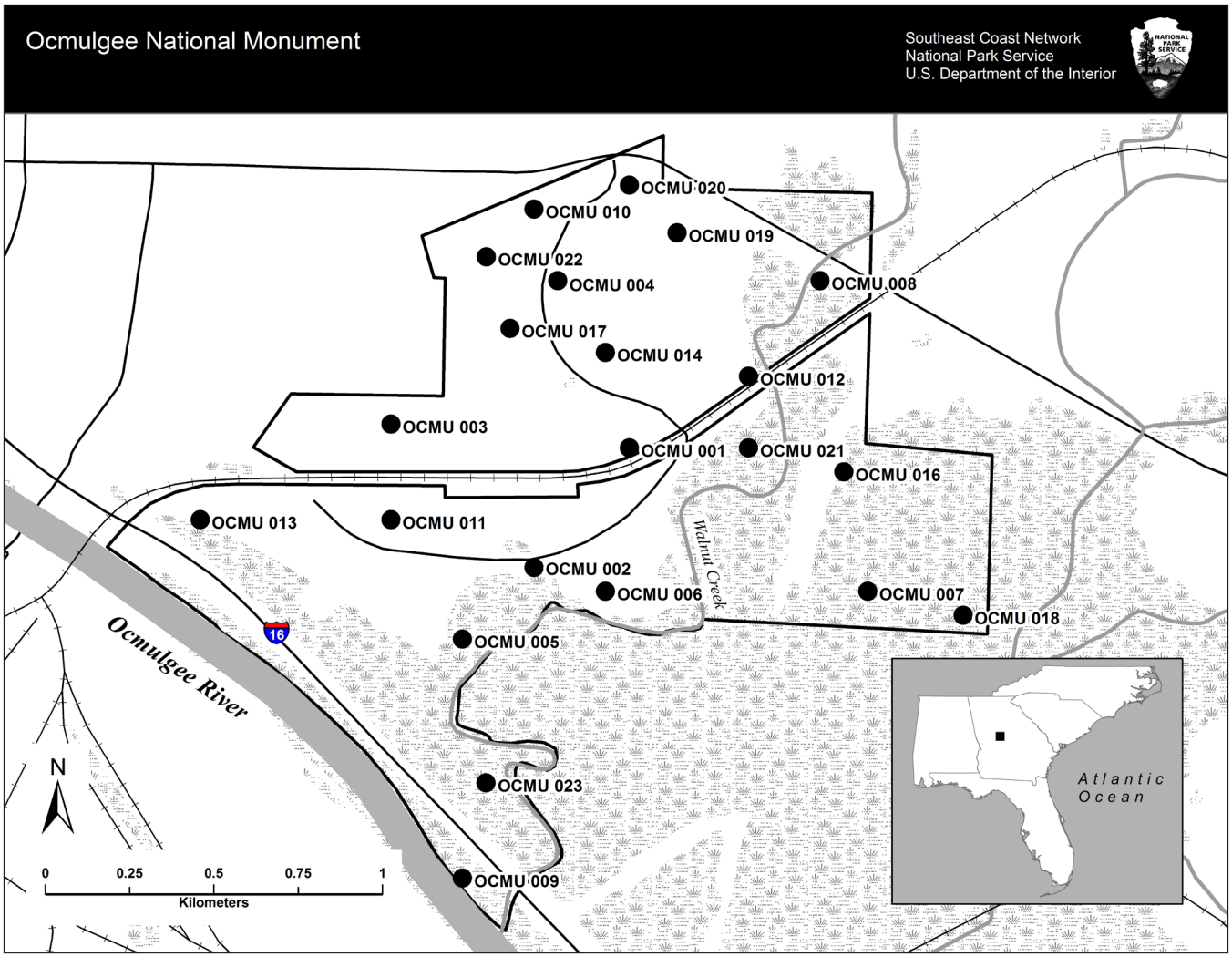


Figure 2. Spatially balanced random sampling locations at Ocmulgee National Monument, 2014.

rainfall, humidity, and temperature). Additionally, while every effort is made to ensure that the recording timeframe is sufficient to encompass most vocalizing anurans, the recordings are only a portion of the time during which anurans are active. Based upon pilot monitoring efforts in the SECN from 2009–2012 and vocalization-phenology information in the region (Dorcas and Gibbons 2008), we determined the most appropriate timeframe for deploying the ARDs in SECN parks to be March through June.

ARDs were deployed at or near the center point of each selected 0.5-hectare grid cell (i.e., the sampling location). The devices were programmed to record every four days from 18:00 (6:00 p.m.) to 06:50 (6:50 a.m.) for 30 seconds every 10 minutes. This recording schedule continued for 11 weeks (i.e., 77 days) and provided 20 distinct sampling events. ARDs were deployed at Ocmulgee National Monument from 3/12/2014 through 5/30/2014. A total of 16,380 minutes was recorded by all of the devices deployed. The microphone(s) on the ARD deployed at sampling location OCMU 021 malfunctioned and we were unable to obtain any recording events from that location in 2014. Therefore, all data analysis in 2014 was completed with data from a total of 21 sampling locations, although the SECN has 22 permanent sampling locations at Ocmulgee.

Species occurrences were derived from the recordings by applying various algorithms in a software environment (i.e., Song Scope), and through a manual-evaluation process implemented to maintain quality assurance and quality control standards. These processes are detailed in SOPs 1.4.2 and 1.4.21 of the SECN Vocal Anuran Community Monitoring Protocol (Byrne et al 2013).

Data Analysis

This protocol collects detection / non-detection data. In contrast to detections made from visual survey methods in which individuals can be seen, differentiated, and counted,

detections from 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 detected multiple times. Individual anurans vocalizing in a chorus also cannot be reliably differentiated by voice alone. 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, 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 (i.e., detectability). Naïve occupancy is also referred to as frequency of occurrence. Naïve occupancy provides insight into the distribution of a species across the park and whether the species can be considered common or uncommon. Species with high values occur at more locations than those with low values.

Relative detection frequency uses the detection history as an index to communicate the frequency at which each species is detected relative to all other species detected in the sample. This estimate conveys information about the detectability of a species or, more specifically, a characteristic that makes a species detectable (e.g., the vocalization behavior). Species with high relative-detection frequency values are detected more frequently than species with low values. 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 regarding how species respond to large-scale influences such as changing land use, climate, hydrology, or habitat availability and condition. Shifting species distributions alter species interactions and the food-web structure, thereby producing cascading effects on ecosystem processes (Montoya and Raffaelli 2010). Distribution maps for all anuran 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 Southeast Coast Network 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. Species should be detected during three or more park-wide sampling events during the survey year to be considered for reporting in phenology. Vocalization start dates are reported for species that typically begin to vocalize well after the start of our recording schedule in SECN parks, while species known to cease vocalizing well before our recording schedule concludes are appropriate candidates for tracking vocalization end dates (Dorcas and Gibbons 2008). Periodic synthesis reports, which will be published after multiple rounds of sampling, will summarize phenological history of anuran species detected across the Southeast Coast Network for which appropriate candidates for trend analysis are available.

Results

Composition

Due to interbreeding, and/or a similar vocalization, it was not always possible to differentiate between related species of vocalizing anurans. For this report, we have identified the Cope's gray treefrog (*Hyla chrysoscelis*), not the common gray treefrog (*Hyla versicolor*), as being present in this park. This conclusion is based on examination of range maps (Dorcas and Gibbons 2008), and not on a microscopic examination, as would be required to definitively differentiate the two species. The northern and southern cricket frogs (*Acris crepitans* and *Acris gryllus*) also could not be reliably differentiated on vocalization alone, and were designated as cricket frog for this report. Additionally, while most of the *Anaxyrus* (i.e., true toad) vocalizations were distinct, there were several instances when the vocalizations could not be accurately differentiated between southern or American toad (*Anaxyrus terrestris* or *Anaxyrus americanus*). When these two toad species were vocalizing at the same time or when the vocalizations were indistinct, we identified the species occurrence as southern or American toad for the data analysis purposes of this report.

We detected 94% of the anuran species known to be present at Ocmulgee National Monument (Table A-1). No non-native anuran species were detected at Ocmulgee in 2014.

Species richness and diversity was high at Ocmulgee in 2014. Fifteen distinct species were detected, with seven species found to be present at over 20% of the sampling locations (Table 1). The southern toad (*Anaxyrus terrestris*), detected at nearly half of the sampling locations at Ocmulgee National Monument, was the most frequently encountered anuran during our 2014 surveying period (Table 1). The spring peeper (*Pseudacris crucifer*), bird-voiced treefrog (*Hyla avivoca*), and Cope's gray treefrog (*Hyla chrysoscelis*) were each detected vocalizing at one-third of the sampling locations in Ocmulgee. Other frequently occurring species include the southern leopard frog (*Lithobates sphenocephalus*), present at 6 of the 21 sampling locations, as well as the American toad (*Anaxyrus americanus*) and the squirrel treefrog (*Hyla squirella*), detected at nearly one-quarter of the sampling locations. The eastern narrowmouth toad (*Gastrophryne carolinensis*) had the lowest frequency of occurrence at Ocmulgee in 2014, having been detected at only one sampling location (Table 1).

Several of the sampling locations at Ocmulgee proved to be exceptionally species-rich, with counts far above the park median of three species per site (Table A-2). Sampling location OCMU 005, where 10 species were detected vocalizing during our survey effort, had the highest anuran species richness of all locations. Sampling locations OCMU 008 and OCMU 005 were found to have eight and seven species present, respectively. Finally, six species were detected at each of the following sampling locations: OCMU 007, OCMU 011, OCMU 012, and OCMU 018 (Table A-2).

The bird-voiced treefrog had the highest relative detection frequency of vocalizations recorded by ARDs over the 77-day sampling period, accounting for just over 20% of the total vocal detections. This species was detected during 54 park-wide sampling events (Figure 3). The southern toad accounted for the second-highest number of vocal detections, and was detected during 35 park-wide sampling events in 2014. The cricket frog (*Acris crepitans* or *gryllus*) and spring peeper were each responsible for approximately 12% of the total vocal detections. They were heard vocalizing during 33 and 31 total park-wide sampling events, respectively. The eastern narrowmouth toad had the lowest relative detection frequency of vocalizations and was detected on only one sampling event and at one sampling location in Ocmulgee in 2014.

Based on observations of anuran monitoring efforts across all parks of the Southeast Coast Network from 2011 to 2014, it appears that anuran species with the highest naïve occupancy rates (i.e. the most commonly observed species) are also usually the anurans with the highest relative detection frequencies of vocalizations. At Ocmulgee National Monument in 2014, the cricket frog, the southern toad, the squirrel treefrog, the bird-voiced treefrog, the southern chorus frog (*Pseudacris nigrita*), and the green frog (*Lithobates clamitans*) showed notable departures from this observation (Table 1, Figure 3). The cricket frog was detected at only four sampling locations at Ocmulgee, but was the third-most vocally detected anuran, having been detected during 33 distinct park-wide sampling events. In contrast, two other species detected at only four sampling locations contributed far fewer of the total vocal detections; the green frog was detected during six sampling events, and the southern chorus frog was found vocalizing during four sampling events. Similarly, the squirrel treefrog was detected at almost one-quarter of the sampling locations in Ocmulgee, yet accounted for only seven total vocal detections (2.6%).

Despite having high naïve occupancy rates and relative detection frequencies, the southern toad and the bird-voiced treefrog also displayed disparate vocalization detection rates. The southern toad was found at almost half of the park sampling locations, but was detected during only 35 park-wide sampling events. In contrast, the bird-voiced treefrog was detected at one-third of the sampling locations, but was detected vocalizing during 19 more discrete park-wide sampling events than the southern toad. Indications are that some species, while present at a sampling location, are detected vocalizing only infrequently at each location over the duration of our ARD deployment period. Individual species vocalization patterns and responses to weather events, as well as limitations in Song Scope software recognizer file operations, are the most likely causes of these apparent discrepancies in vocal detection efficiency.

New Species Records

All anuran species detected during the monitoring event were previously known to occur at Ocmulgee National Monument.

Distribution

The southern toad was the most widely distributed anuran species at Ocmulgee National Monument in 2014, and was found at sampling locations throughout the north–south and east–west expanses of the park (Figure B-3, Appendix B). Cope's gray treefrog, also distributed throughout the east–west and northern expanses of Ocmulgee, went undetected at the sampling locations in the most southern section of the park (Figure B-7). Fowler's toad (*Anaxyrus fowleri*), cricket frog, bird-voiced treefrog, squirrel treefrog, spring peeper, and green frog were distributed in most areas of the park, but were not detected at locations in the northwestern section of the park (Figures B-2, B-5, B-6, B-9, B-10, and B-15), while the southern leopard frog went undetected in the northeastern section of the park (Figure B-16). Finally, green treefrog (*Hyla cinerea*) was found in the southern half of Ocmulgee, but was not detected at any location north of the railroad that bisects the park (Figure B-8). The narrowest distribution was found for the eastern narrowmouth toad, which was detected at only one sampling location in the southern half of Ocmulgee (Figure B-13). Distribution maps for all anurans detected during the monitoring event are presented in Appendix B.

Table 1. Percentage of sampling locations where each anuran species was detected (i.e., naïve occupancy) by method and across methods at Ocmulgee National Monument, 2014.

Anuran Species	Naïve Occupancy
Southern Toad	47.6
Bird-voiced Treefrog	33.3
Cope's Gray Treefrog	33.3
Spring Peeper	33.3
Southern Leopard Frog	28.6
American Toad	23.8
Squirrel Treefrog	23.8
Northern or Southern Cricket Frog	19.0
Fowler's Toad	19.0
Green Treefrog	19.0
Southern Chorus Frog	19.0
Green Frog	19.0
American or Southern Toad	14.3
Upland (Southeastern) Chorus Frog	14.3
Bullfrog	9.5
Eastern Narrowmouth Toad	4.8
Total Locations Surveyed	**21**

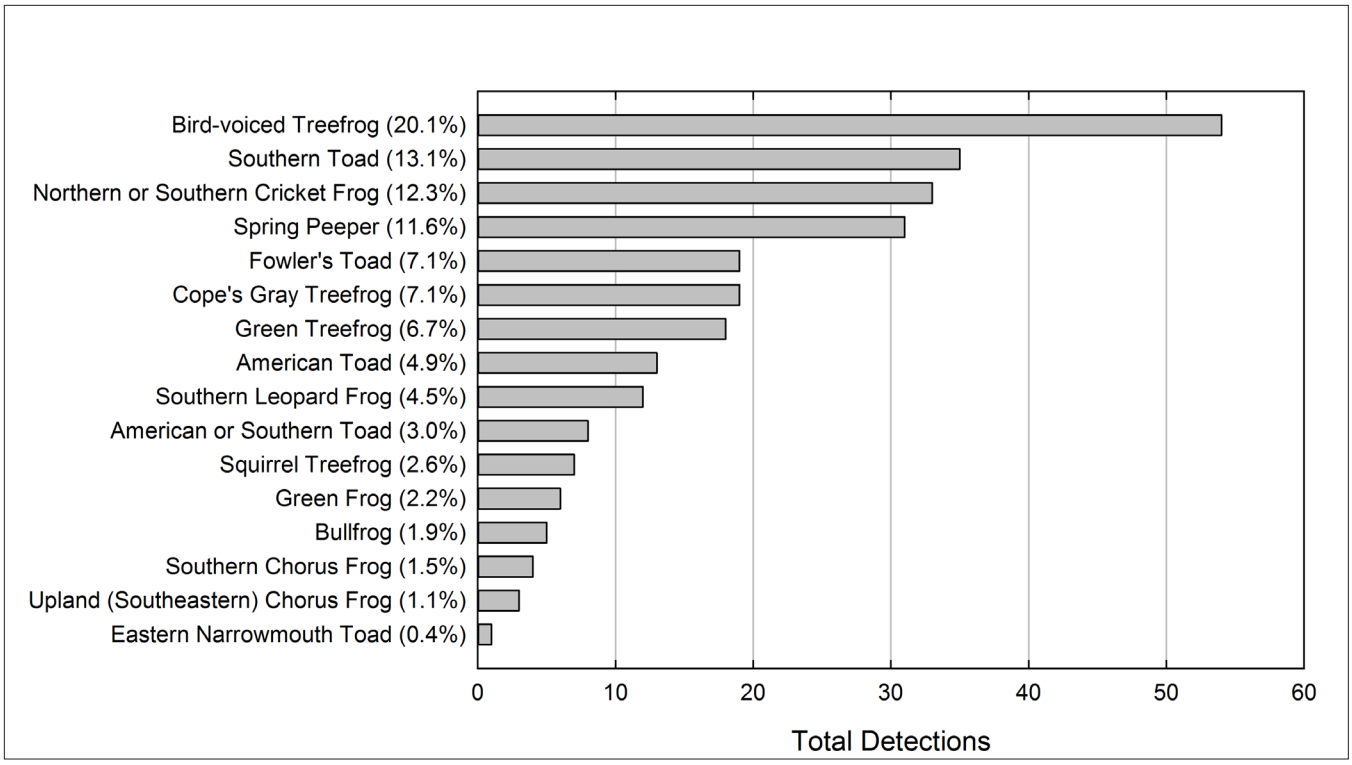


Figure 3. Number of anuran vocalization detections and percent relative detection frequency (i.e., number of species vocalizations compared to all species' vocalizations) of recorded calls during automated recording device deployment (12 March to 30 May 2014) at Ocmulgee National Monument. Based on n=268 detections.

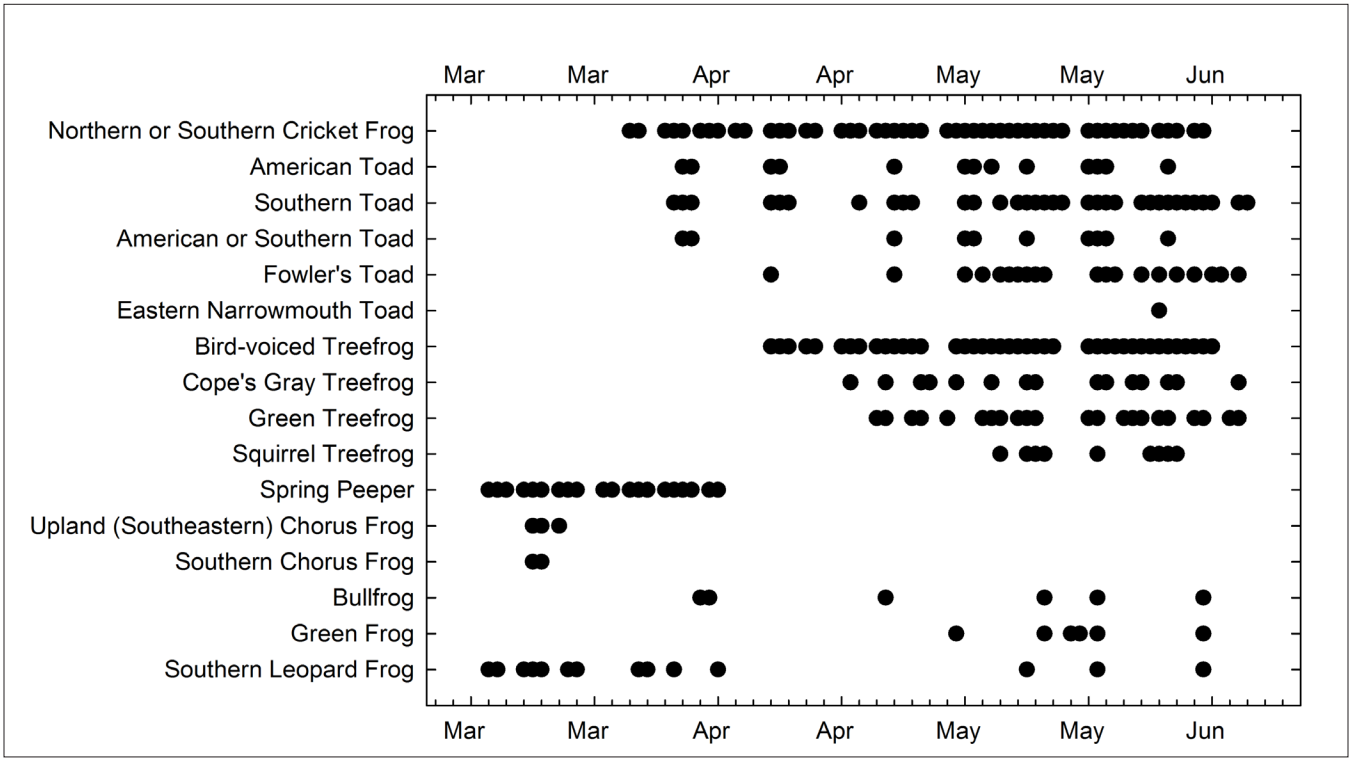


Figure 4. Vocalization phenology for species detected using automated recording devices at Ocmulgee National Monument, from 12 March to 30 May 2014. Based on n=268 detections.

Phenology

Six species are appropriate candidates to determine trends in vocalization start dates. The first vocal detections of both the bird-voiced treefrog and the Fowler's toad occurred on 4/13/2014. Cope's gray treefrog was first found vocalizing on 4/22/2014 and the green treefrog was first detected advertising his territory and calling for mates on 4/25/2014. Finally, the green frog was not detected until 5/4/2014, while the squirrel treefrog began vocalizing on 5/9/2014. Two species are appropriate candidates for tracking vocalization end dates. The southern chorus frog was last detected vocalizing at Ocmulgee National Monument on 3/18/2014, while the spring peeper was not detected after 4/7/2014 (Figure 4).



Cricket frog. Photo by Briana Smrekar.

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Appendix A—Anuran Species Detection Data

Table A-1. Anuran species known to occur at Ocmulgee National Monument based on the park's certified species list (NPSpecies 2015) and those detected during this sampling effort.

Scientific Name	Common Name	NPSpecies	ARD
Anaxyrus americanus	American Toad	X	X
Anaxyrus fowleri	Fowler's Toad	X	X
Anaxyrus terrestris	Southern Toad	X	X
Acris crepitans/gryllus	Northern or Southern Cricket Frog	X	X
Hyla avivoca	Bird-voiced Treefrog	X	X
Hyla chrysoscelis	Cope's Gray Treefrog	X	X
Hyla cinerea	Green Treefrog	X	X
Hyla squirella	Squirrel Treefrog	X	X
Pseudacris crucifer	Spring Peeper	X	X
Pseudacris feriarum	Upland (Southeastern) Chorus Frog	X	X
Pseudacris nigrita	Southern Chorus Frog	X	X
Pseudacris ornata	Ornate Chorus Frog	X	
Gastrophryne carolinensis	Eastern Narrowmouth Toad	X	X
Lithobates catesbeianus	Bullfrog	X	X
Lithobates clamitans	Green Frog	X	X
Lithobates sphenocephalus	Southern Leopard Frog	X	X

Table A-2. Anuran species detected at each sampling location at Ocmulgee National Monument, 2014.

Species	1	2	3	4	5	6	7	8	9	10	11	12	13	14	16	17	18	19	20	21	22	23
American Toad							X	X	X			X							X			
Fowler's Toad						X		X	X			X										
Southern Toad		X			X	X		X	X		X	X					X					
American or Southern Toad									X			X							X			
Northern or Southern Cricket Frog		X			X							X					X					
Bird-voiced Treefrog		X			X	X	X	X				X					X					
Cope's Gray Treefrog	X						X				X	X	X				X		X			
Green Treefrog		X			X	X	X															
Squirrel Treefrog	X				X	X		X			X											
Spring Peeper		X	X		X		X	X			X						X					
Southeastern (Upland) Chorus Frog	X									X												X
Southern Chorus Frog				X			X									X		X				
Eastern Narrowmouth Toad					X																	
Bullfrog					X			X														
Green Frog		X			X			X														
Southern Leopard Frog		X			X				X		X					X	X					

Appendix B—Distribution Maps for Anuran Species Encountered

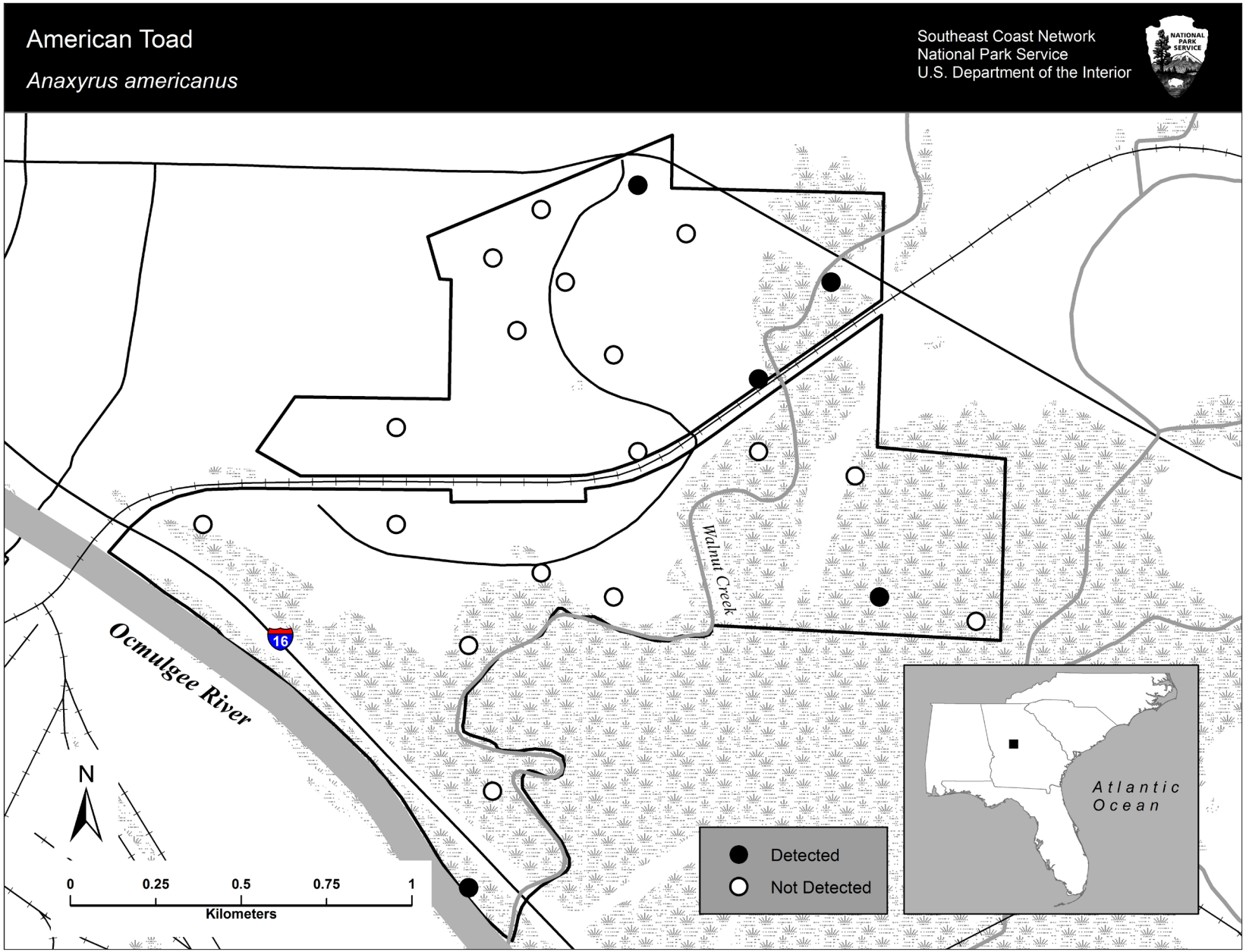


Figure B-1. Sampling locations where American toad (*Anaxyrus americanus*) was detected at Ocmulgee National Monument, 2014.

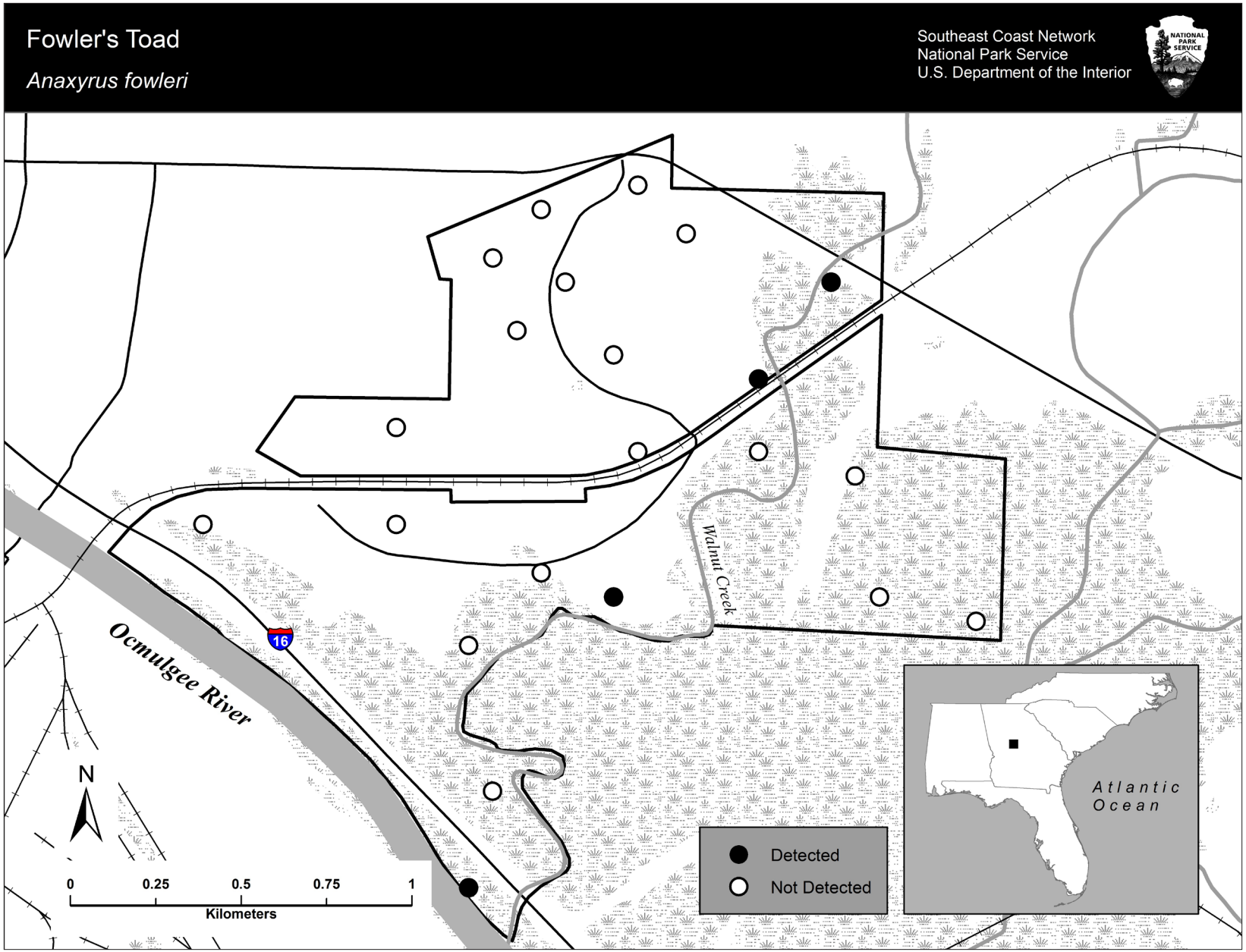


Figure B-2. Sampling locations where Fowler's toad (*Anaxyrus fowleri*) was detected at Ocmulgee National Monument, 2014.

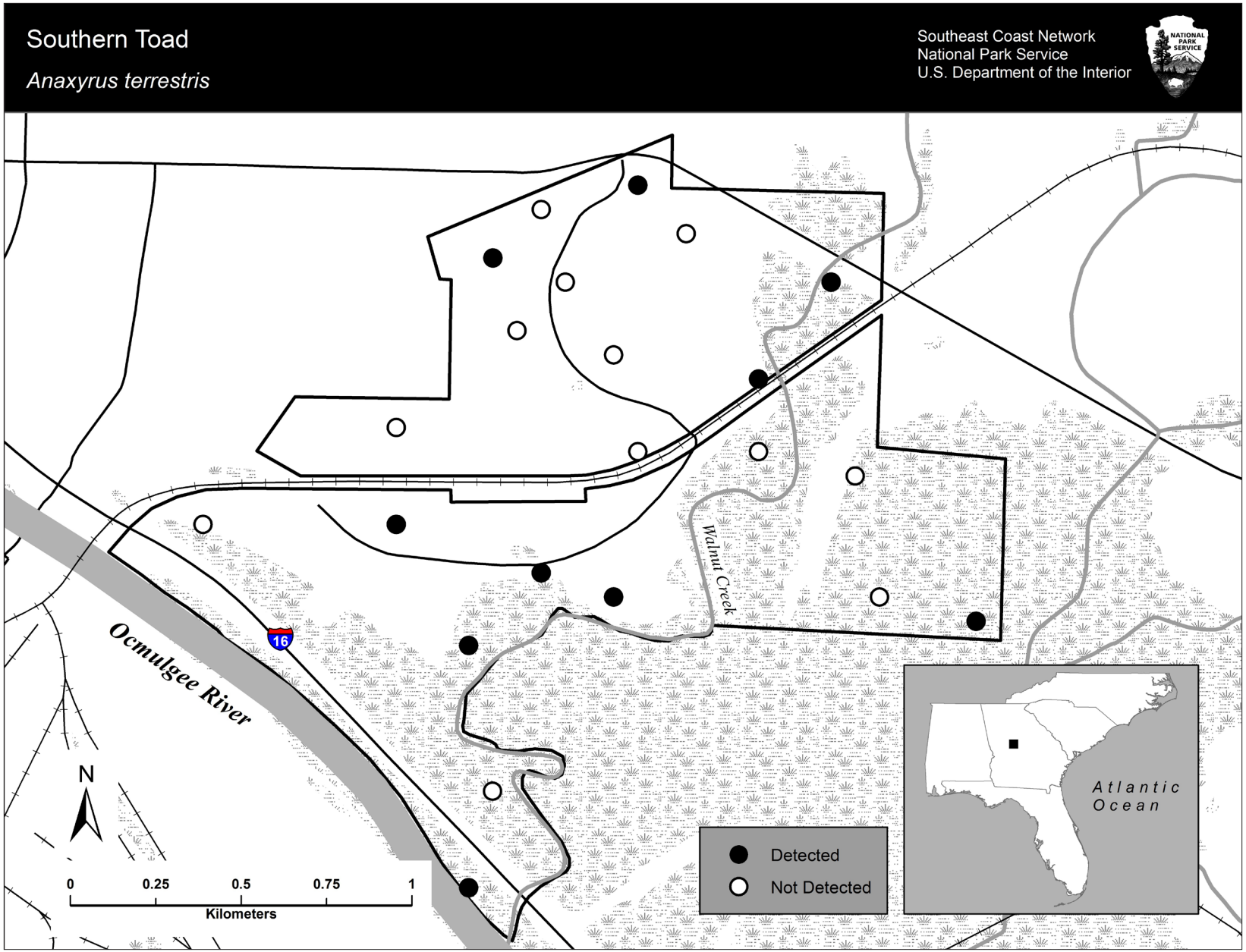


Figure B-3. Sampling locations where southern toad (*Anaxyrus terrestris*) was detected at Ocmulgee National Monument, 2014.

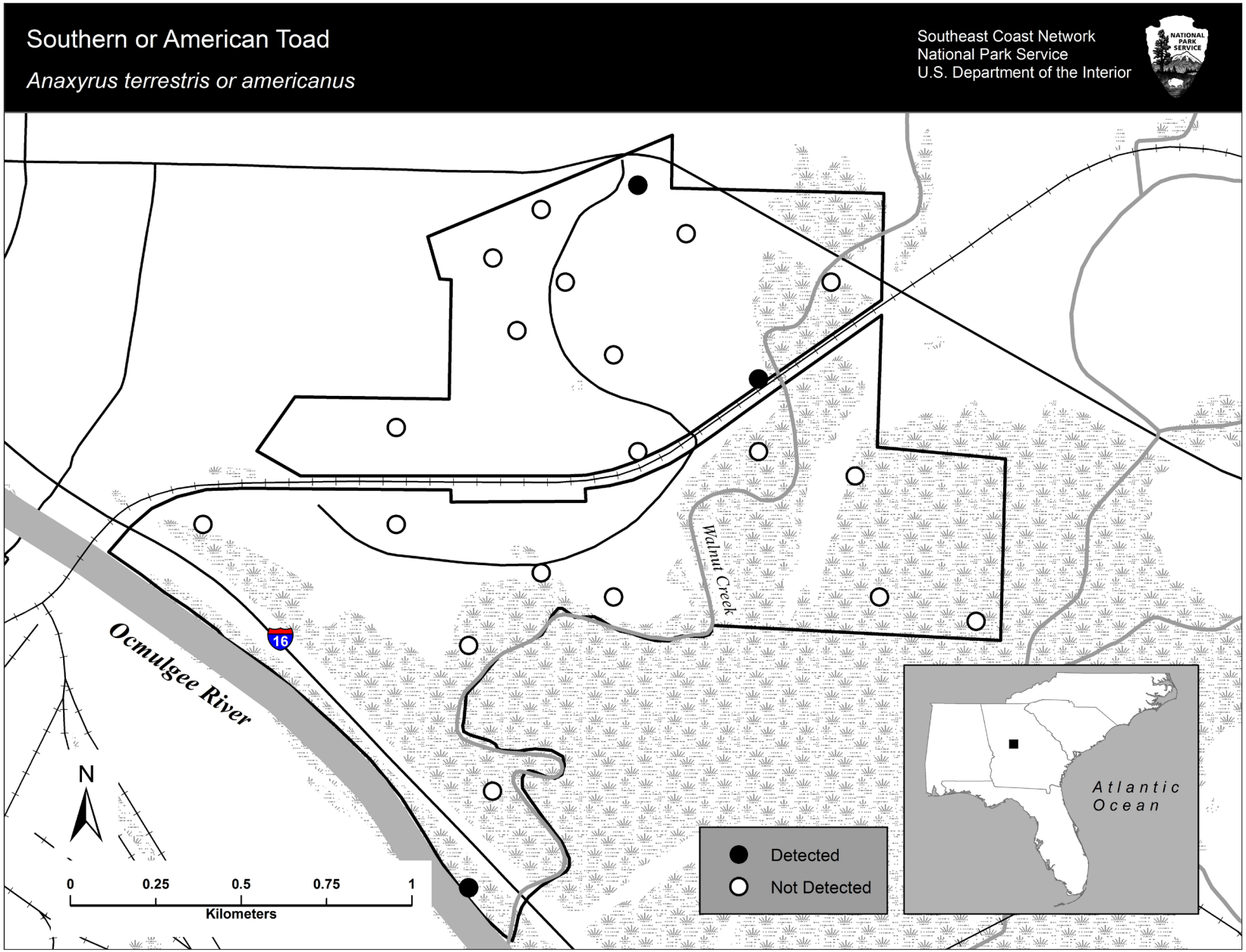


Figure B-4. Sampling locations where American or southern toad (*Anaxyrus americanus* or *terrestris*) was detected at Ocmulgee National Monument, 2014.

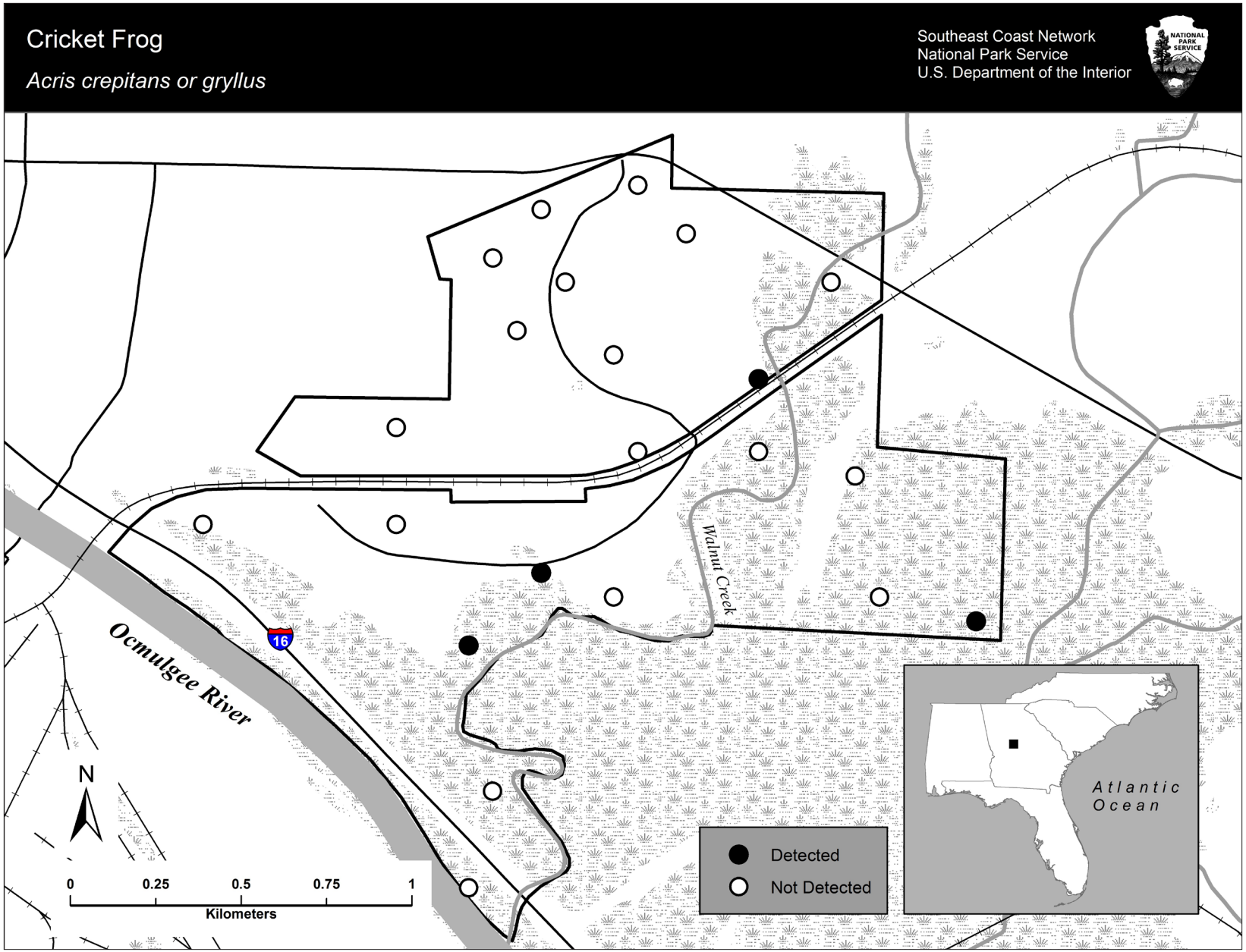


Figure B-5. Sampling locations where northern or southern cricket frog (*Acris crepitans* or *gryllus*) was detected at Ocmulgee National Monument, 2014.

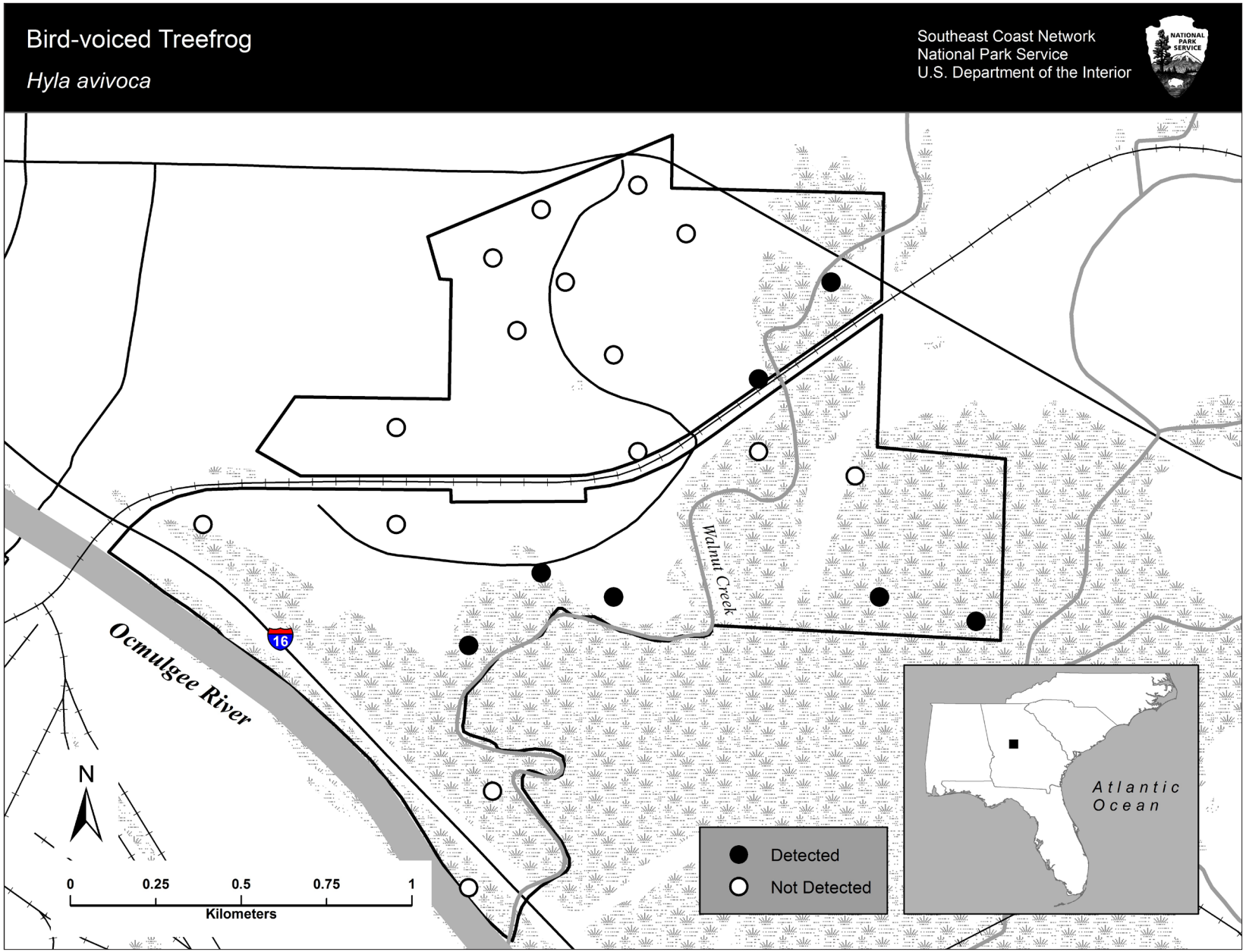


Figure B-6. Sampling locations where bird-voiced treefrog (*Hyla avivoca*) was detected at Ocmulgee National Monument, 2014.

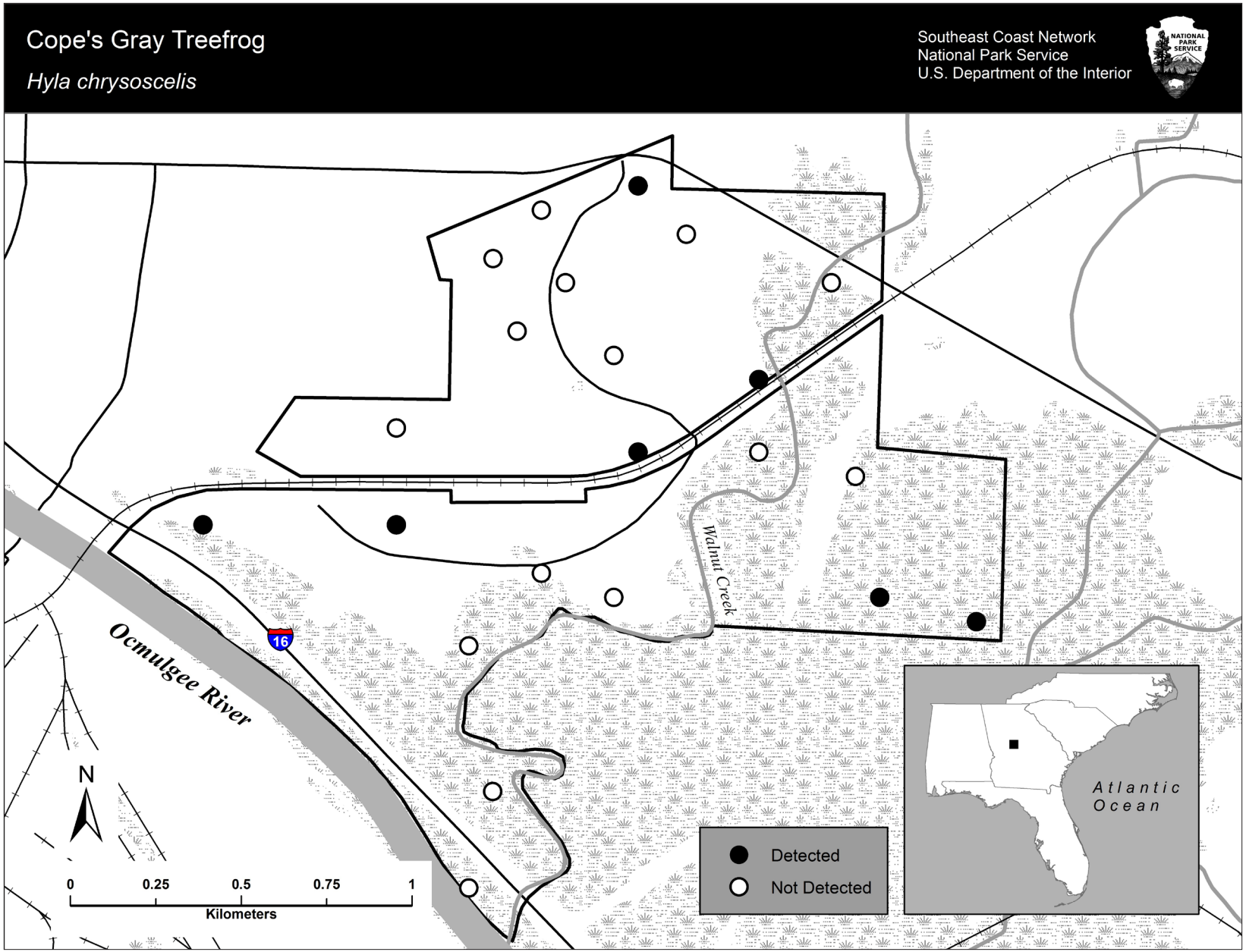


Figure B-7. Sampling locations where Cope's gray treefrog (*Hyla chrysoscelis*) was detected at Ocmulgee National Monument, 2014.

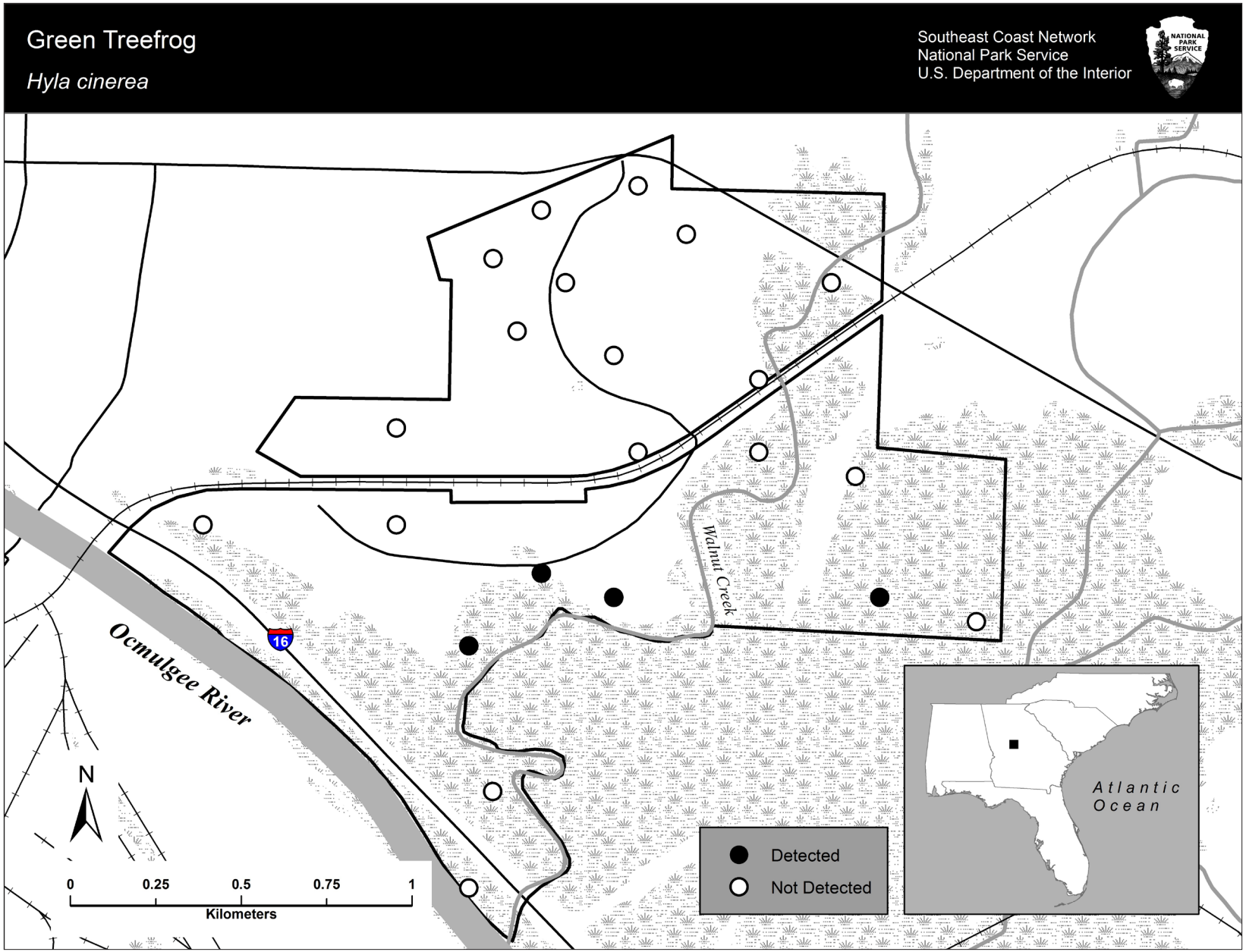


Figure B-8. Sampling locations where green treefrog (*Hyla cinerea*) was detected at Ocmulgee National Monument, 2014.

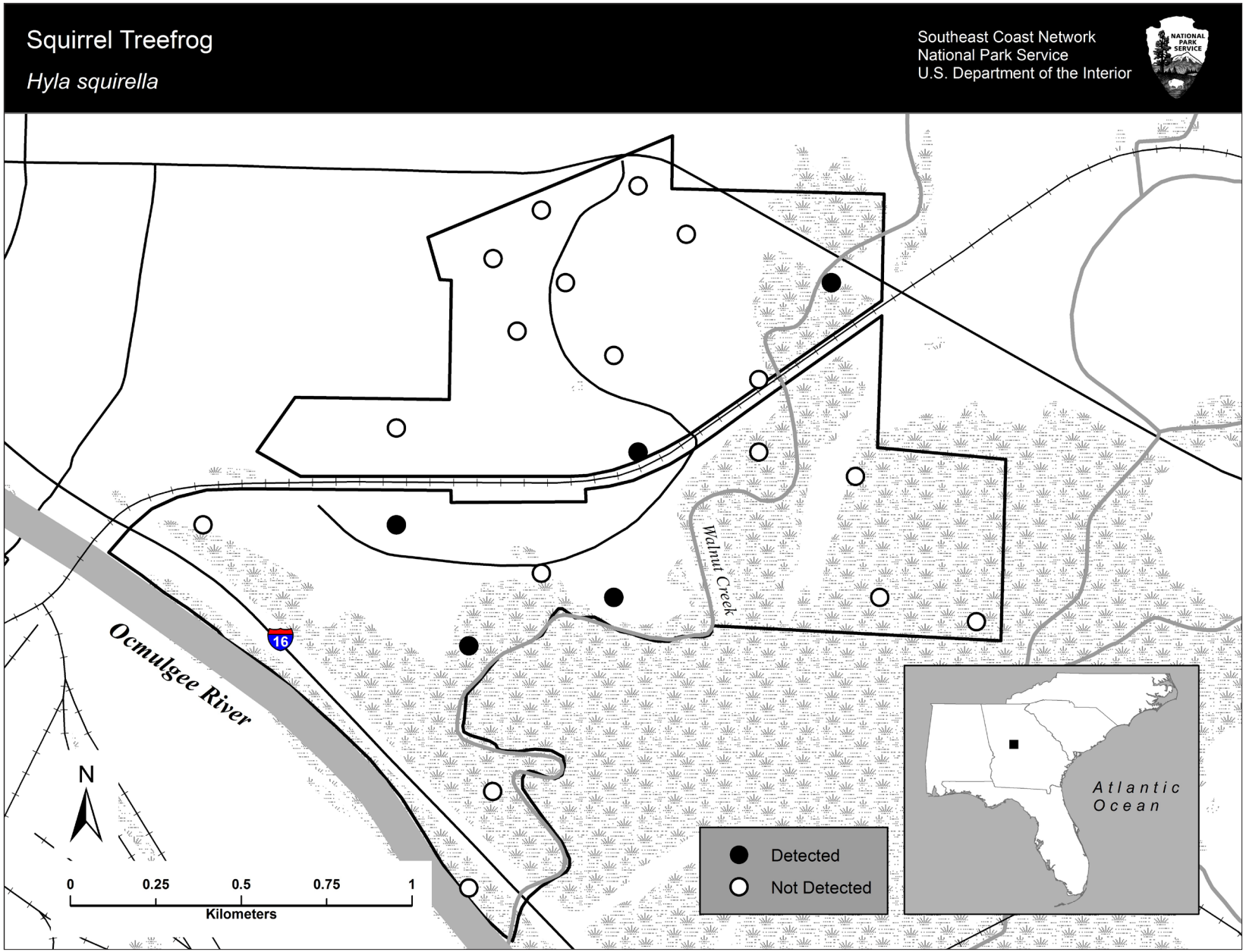


Figure B-9. Sampling locations where squirrel treefrog (*Hyla squirella*) was detected at Ocmulgee National Monument, 2014.

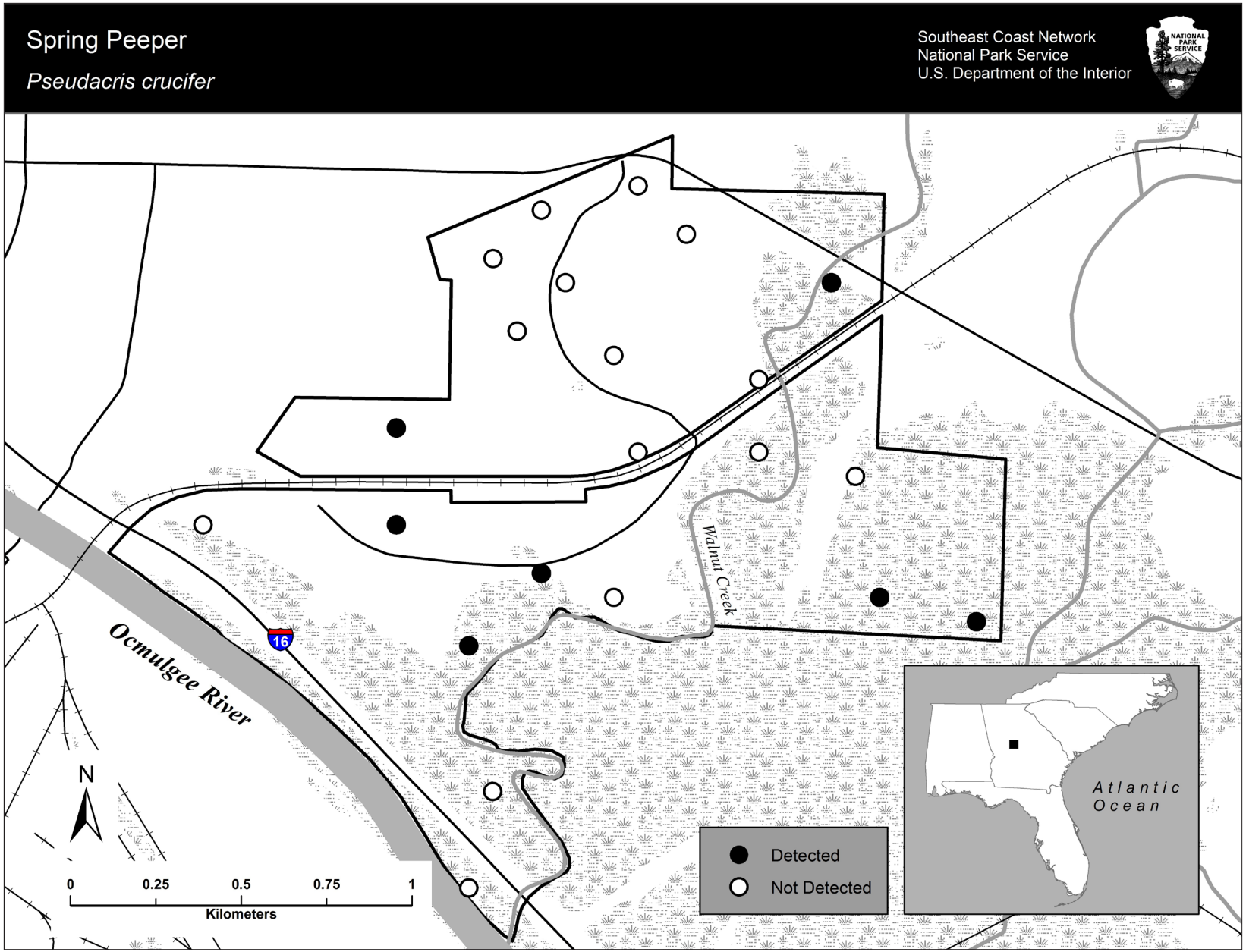


Figure B-10. Sampling locations where spring peeper (*Pseudacris crucifer*) was detected at Ocmulgee National Monument, 2014.

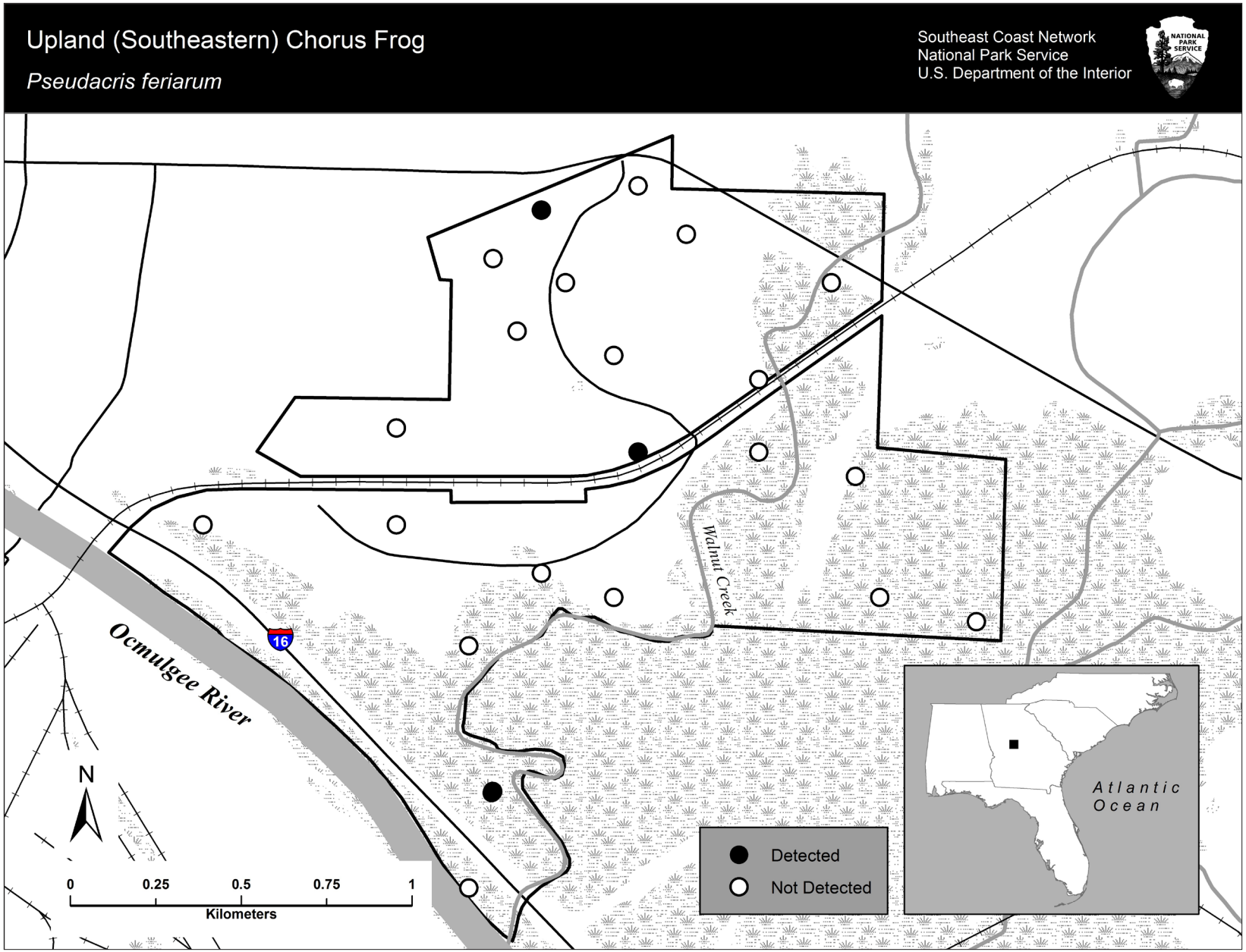


Figure B-11. Sampling locations where upland (southeastern) chorus frog (*Pseudacris feriarum*) was detected at Ocmulgee National Monument, 2014.

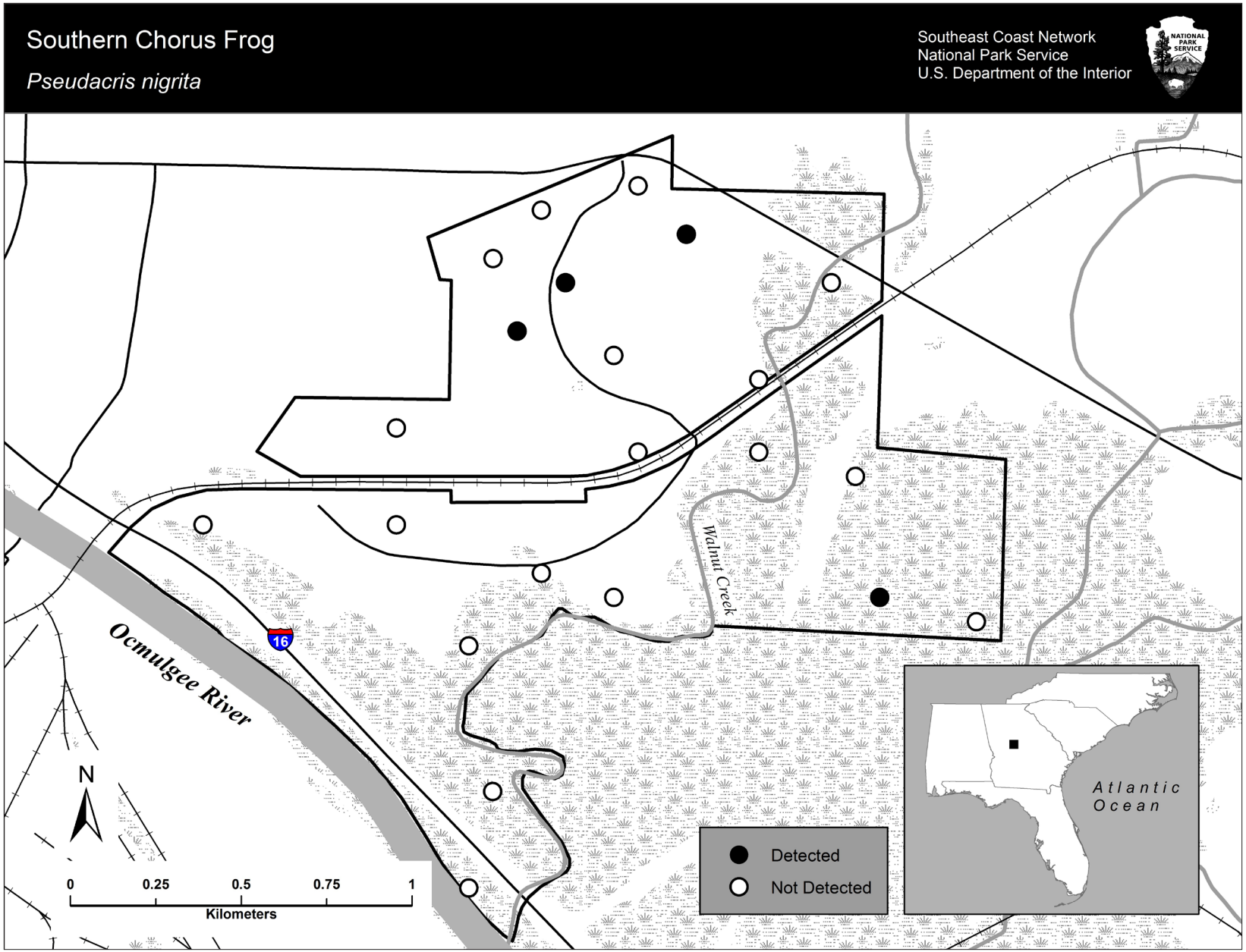


Figure B-12. Sampling locations where southern chorus frog (*Pseudacris nigrita*) was detected at Ocmulgee National Monument, 2014.

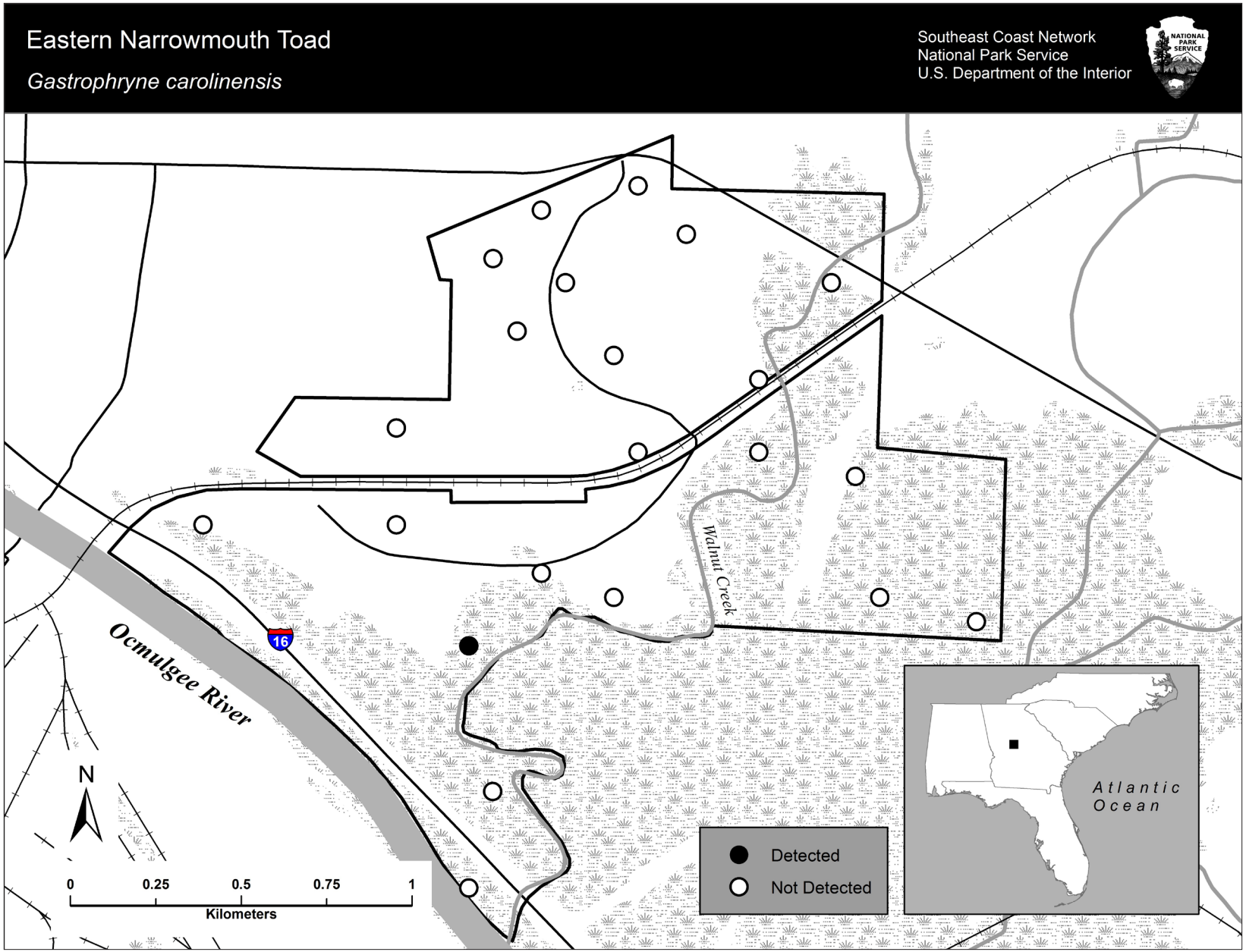


Figure B-13. Sampling location where eastern narrowmouth toad (*Gastrophryne carolinensis*) was detected at Ocmulgee National Monument, 2014.

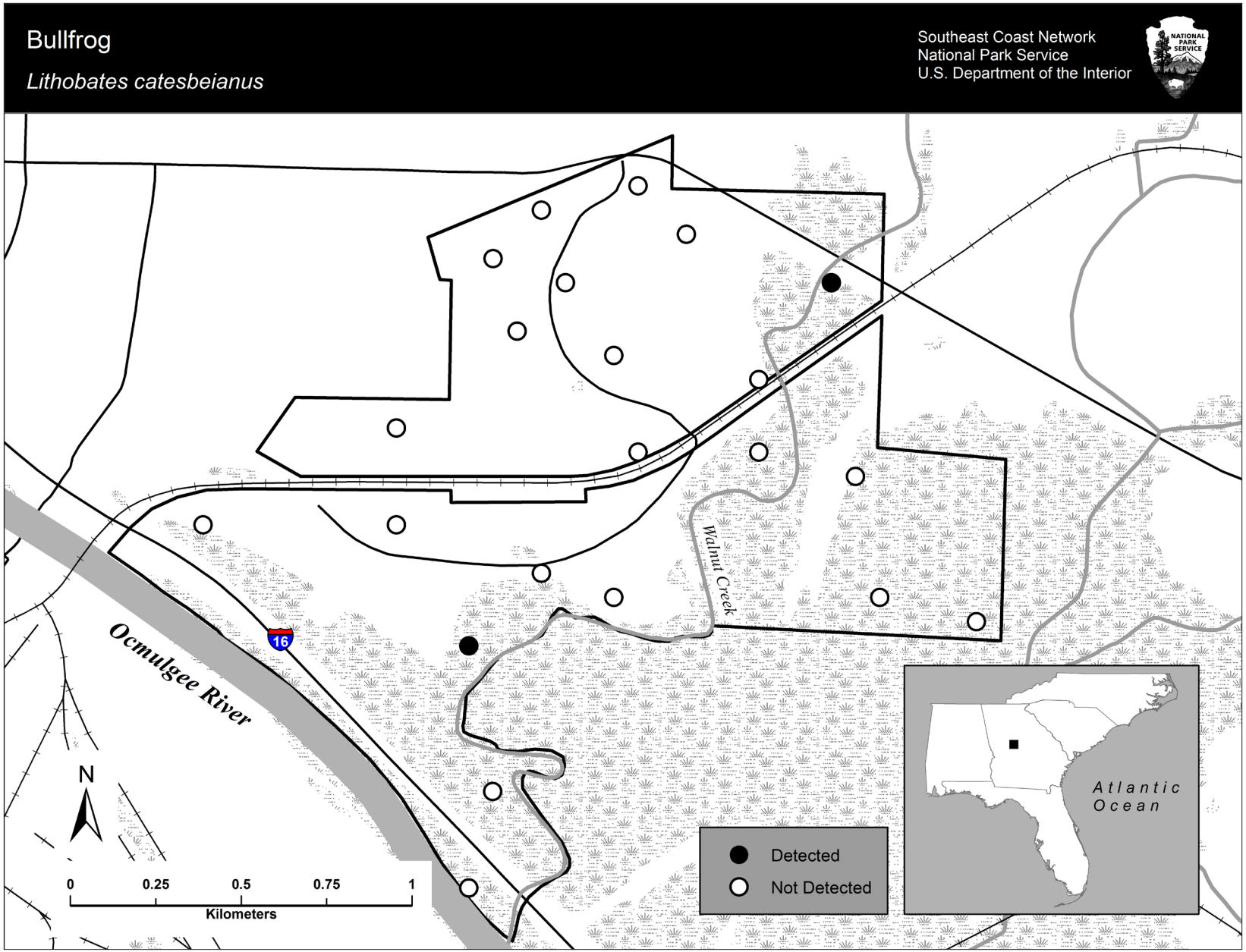


Figure B-14. Sampling locations where bullfrog (*Lithobates catesbieanus*) was detected at Ocmulgee National Monument, 2014.

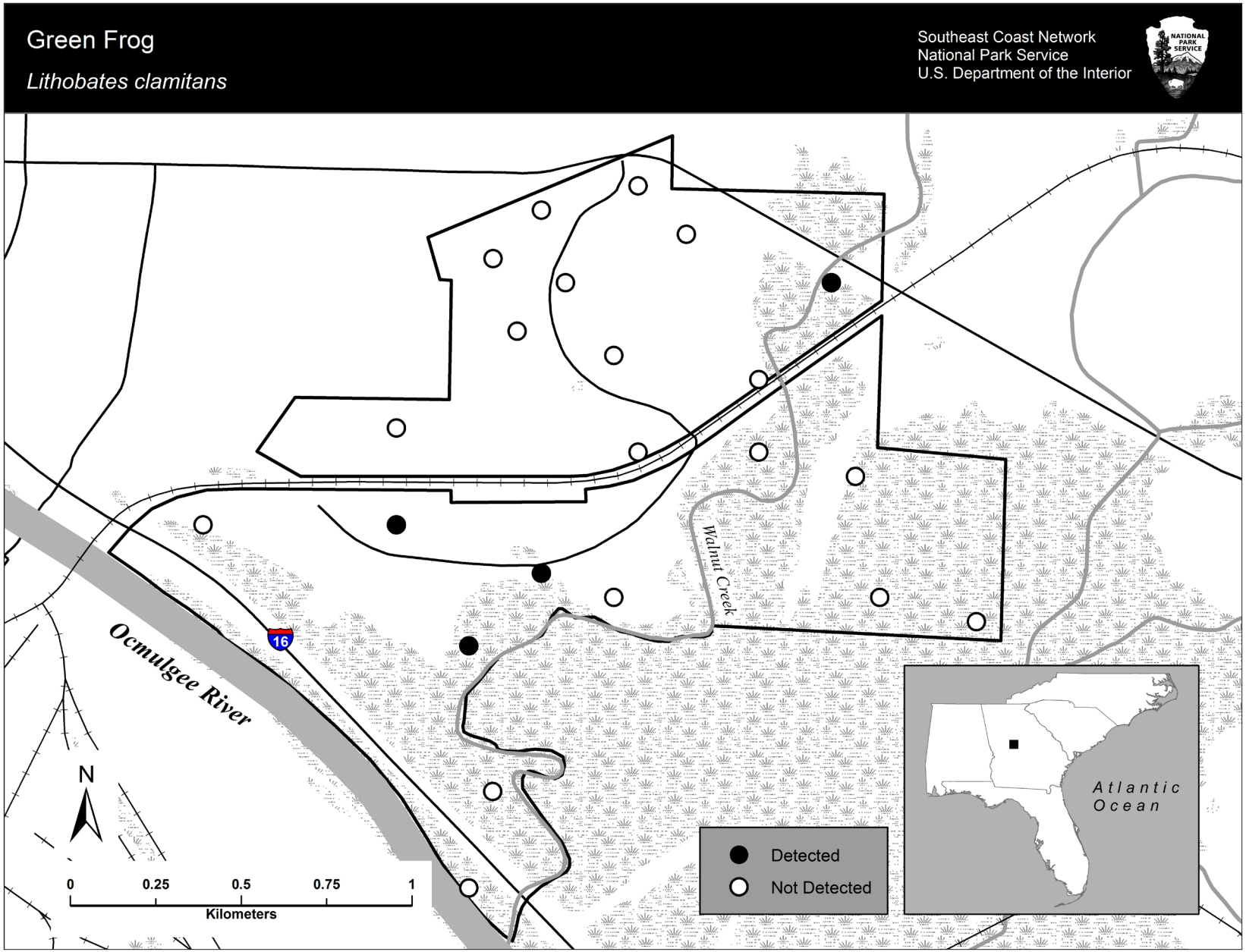


Figure B-15. Sampling locations where green frog (*Lithobates clamitans*) was detected at Ocmulgee National Monument, 2014.

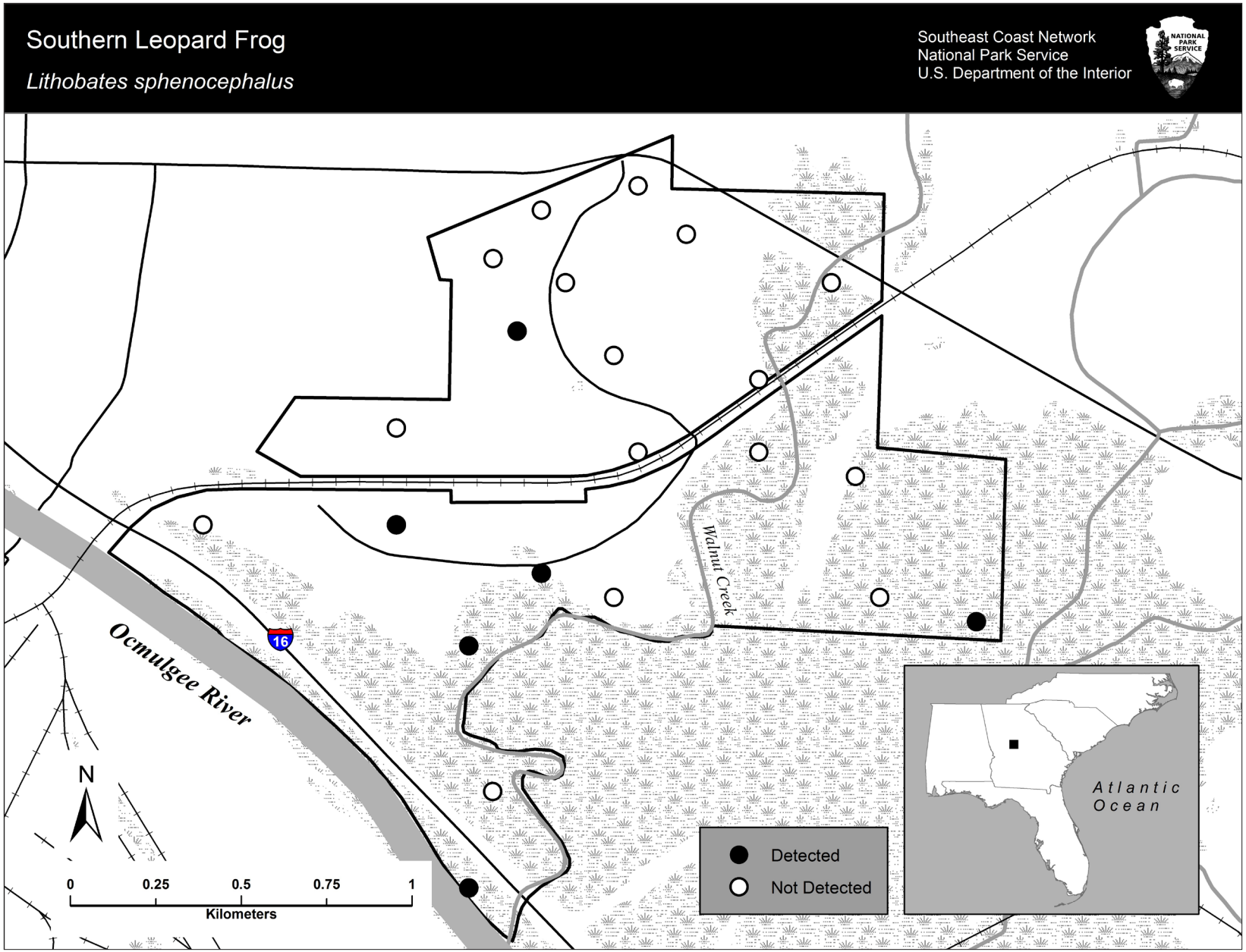


Figure B-16. Sampling locations where southern leopard frog (*Lithobates sphenocephalus*) was detected at Ocmulgee National Monument, 2014.

The Department of the Interior protects and manages the nation's natural resources and cultural heritage; provides scientific and other information about those resources; and honors its special responsibilities to American Indians, Alaska Natives, and affiliated Island Communities.

NPS 363/130229, October 2015

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