Vocal Anuran Community Monitoring with Automatic Recording Devices
at
Mattamuskeet National Wildlife Refuge

Summary Report
2015

Photographs: Cypress-gum swamp at Mattamuskeet NWR by Keith Ramos, USFWS, Cricket Frog (*Acris* spp.) by Briana Smrekar, NPS-SECN

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U.S. Fish and Wildlife Service

Southeast Region Inventory and Monitoring Branch

Final Report

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***Abstract*:**
During 2015, the Southeast Region Inventory and Monitoring Branch conducted the first-ever, pilot vocal anuran monitoring project at Mattamuskeet National Wildlife Refuge. Amphibians have been recognized as important indicators for environmental health. Many refuges in the South Atlantic ecoregion lack baseline data for amphibians.The methodology and data analysis were conducted in accordance with the National Park Service Southeast Coast Network Inventory and Monitoring Branch's protocol for monitoring vocal anuran communities. Twelve Wildlife Acoustic SM2+ automatic recording devices (ARDs) were deployed from March 18 – June 4. Ten species were detected with the ARDs. The southern leopard frog (*Lithobates sphenocphalus*), bullfrog (*Lithobates catesbieanus*), cricket frog (*Acris* spp) and toads (*Bufo* spp.) had the highest frequency of occurrences and relative abundances followed by spring peeper (*Pseudacris crucifer*), green frog (*Lithobates clamitans)* and eastern narrow-mouthed toad(*Gastrophyrne carolinesnsis*). The carpenter frog (*Lithobates virgatipes*) had the lowest frequency of occurrence rate and relative abundance. This monitoring provides a new tool for refuges to collect baseline data on vocal anurans on a refuge.

INTRODUCTION

There is a growing concern about the worldwide decline of amphibian populations and in particular localized extinctions. Globally, some of the most diverse amphibian communities occur in the Southeast. Due to their specialized life histories, dependence on various habitats and sensitivity to environmental stressors, amphibian communities are recognized as good indicators of ecosystem health and change. Most national wildlife refuges located within the South Atlantic Landscape Conservation Cooperative (SALCC) geography lack baseline data on amphibian species composition.

Since 2008, the National Park Service Southeast Coast Network Inventory and Monitoring Program (NPS-SECN) has been conducting amphibian community monitoring on 17 NPS-SECN parks. In 2013, the NPS-SECN completed an evaluation of the SECN data and numerous methodologies implemented during 2008-2012 and released the 2013 Protocol for Monitoring Vocal Anuran

Communities SECN Parks (Byrne et. al. 2013). Byrne et. al (2103)recommended monitoring only post metamorphic vocal anurans with automatic recording devices and eliminate visual encounter surveys. The evaluation determined that the automated recording device methodology was considered the safest, most cost efficient, met logistical challenges of working in a variety of habitat conditions in the SECN parks and provided an effective, standardized technique to monitor amphibians across all amphibian habitat types.

The NPS-SECN protocol included the entire National Park boundary to serve as the sampling frame and as many as 30 Wildlife Acoustics SM2+ Automatic Recoding Devices (ARDs) deployed in a single park. Many of the National Wildlife Refuges (NWRs) in the Southeast are large in size, have reduced staff levels and lack the capacity to implement the NPS SECN I&M Protocol refuge-wide (Stanton 2015a, Stanton 2015b). However, depending on the refuge objective for obtaining baseline data on amphibian communities on the refuge, this protocol can be used to monitor vocal anurans in management units or unique habitats to evaluate management actions directly or indirectly on amphibians or ecosystem health using vocal anurans as an indicator species.

In 2015, the USFWS Southeast Region I&M Branch utilized the 2013 NPS-SECN Protocol for Monitoring Vocal Anuran Communities at Mattmuskeet NWR at the Salyer Ridge and along Wildlife Drive. The objectives of this first- ever, pilot monitoring project were to:

1. Document the presence or absence of vocal anurans species, distribution, species richness, and composition at selected sites.
2. Establish a baseline inventory of vocalization phenology (based on one season of monitoring) of anuran species at two sites.

STUDY AREA

Mattamuskeet NWR is located in Hyde County in northeastern North Carolina (Figure 1). The main habitat types (USFWS 2014) of this 50,180 acre refuge includes the lake (40,276 acres), freshwater marsh (2,046 acres), moist soil unit (1,997 acres), nonriverine swamp forest (1,933acres), mixed pine hardwood forest (1,210 acres), cypress-gum swamp (840 acres) and croplands (190 aces). The habitats sampled for the vocal anuran monitoring include moist soil units, cypress-gum swamp and nonriverine swamp forest. The moist soil units are managed intensely for early successional emergent wetland plants. Dominant tree species in nonriverine swamp forest include loblolly pine (*Pinus taeda*), sweetgum (*Liquidambar styraciflua*), red maple (*Acer rubrum*), and green ash (*Fraxinus pennsylvanica*). Dominant understory species include American holly (*Ilex opaca*), deciduous holly (*I. decidua*), blueberry (*Vaccinium corymbosum*), sweet pepperbush (*Clethra alnifolia*), sweet and bitter gallberry (*Ilex glabra* and *coriacea*), and fetterbush (*Lyonia lucida*). The cypress-gum swamps are dominanted by bald cypress (*Taxodium distichum*) black gum (*Nyssa sylvatica*), red maple, and red bay. Other tree species may include Carolina water ash (*Fraxinus caroliniana*) and green ash.

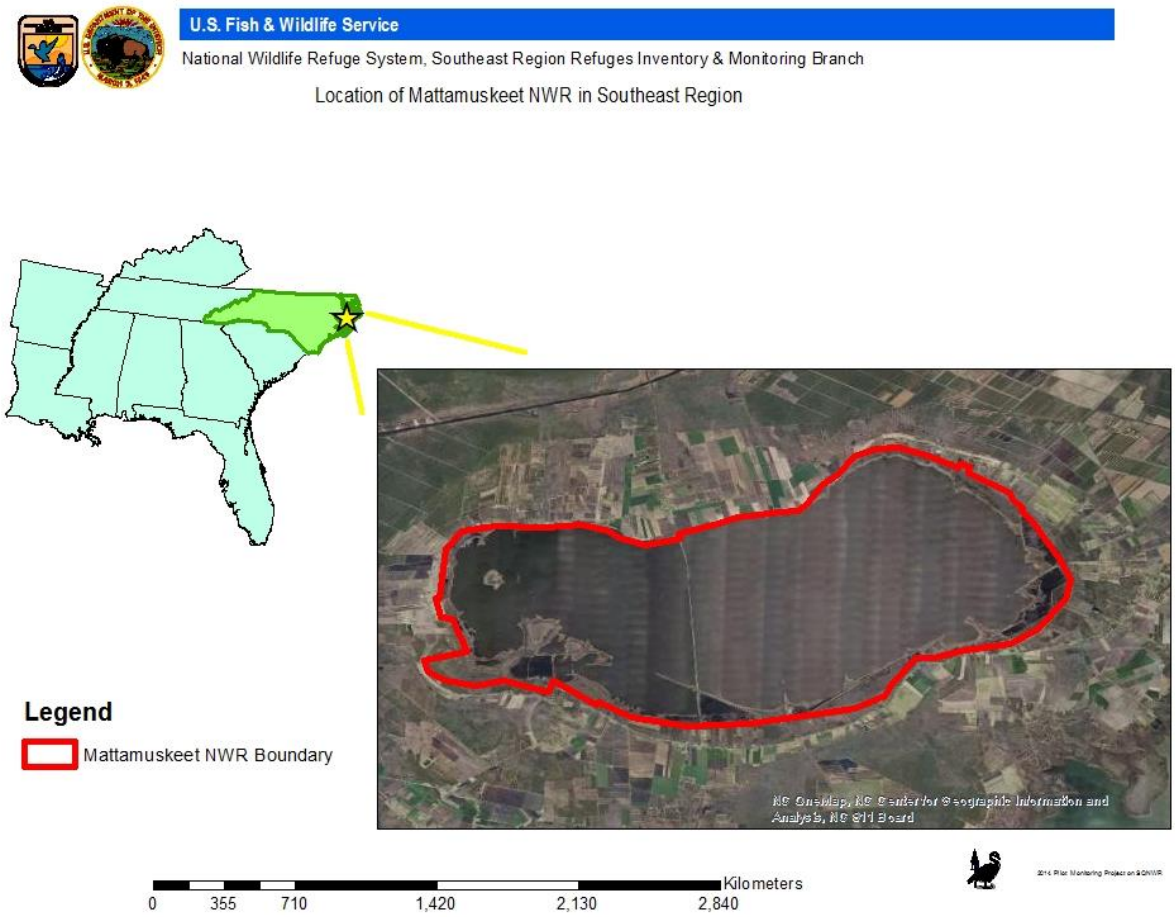

Figure 1. Mattamuskeet NWR is located in northeastern North Carolina in Hyde County.

METHODS

The 2013 NPS-SECN Monitoring Vocal Anuran Communities protocol and standard operating procedures for using Wildlife Acoustics SM2+ Automatic Recoding Devices (Byrne et. al. 2013) were used to monitor vocal anurans on the refuge. The ARDs were programed to record every fourth night for 30 seconds per 10-minute interval from 18:00 – 06:50. This totals approximately 20 sampling nights at each sampling location, over an approximately 77 day period.

The sampling universe was stratified random to address access issues in the Mattamuskeet NWR. The NPS SECN SOP for *Generating Spatially-balanced Sampling Points with ArcGIS 10* (Asper. 2012) was used to select half hectare plots. The two sites selected for the sampling frame included the Salyer Ridge and Wildlife Drive. The ARDs were placed in the center of half hectare plots located in moist soil units, nonriverine

swamp forest, and cypress-gum swamp habitats. A half hectare was chosen for the size of the sampling location (i.e., plot) because this is the minimum mapping unit for the SECN vegetation mapping inventory. Also, under calm weather conditions, a half hectare plot provides an area to accurately detect and identify most vocal anuran species with the SM2+ ARDs and analysis with the *Wildlife Acoustics Song Scope* program.

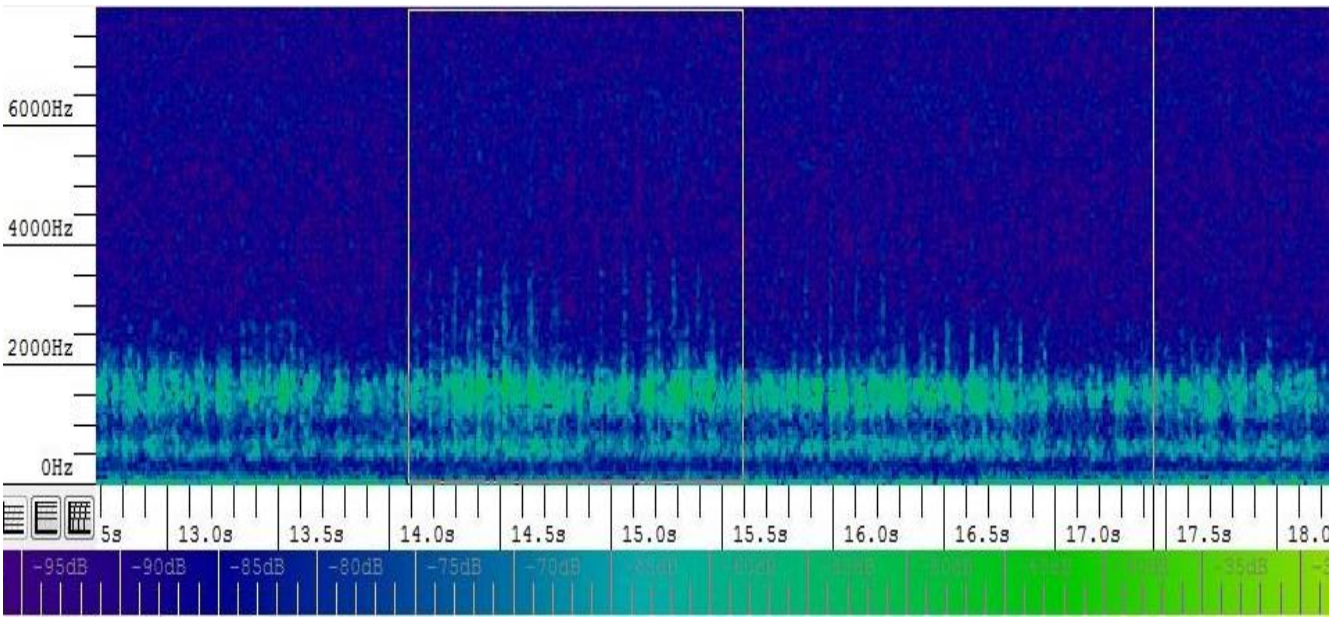

Figure 2. Spectrogram of a southern leopard frog vocalization recorded with Wildlife Acoustics SM2+ automatic recording device at Mattamuskeet NWR. The *Wildlife Acoustics Songscope* program is used to identify the anuran vocalizations by comparing the recordings with a known southern leopard frog recognizer. The polygons on the spectrogram indicate positive detections which are then confirmed during quality assurance and quality control.

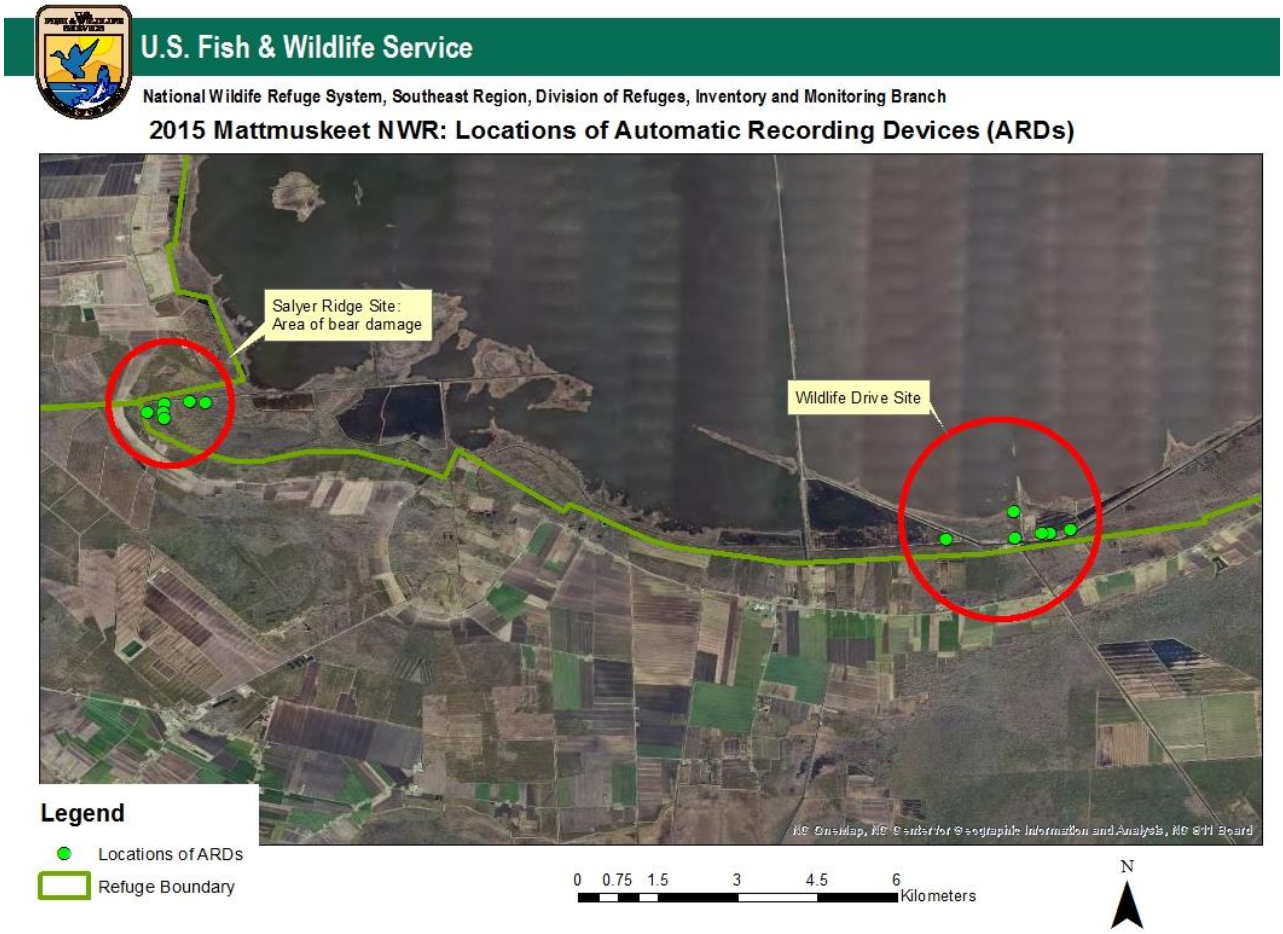

Figure 3. Location of Automatic Recording Devices (ARDs) on Mattamuseet NWR.

On March 17 and 19, 2015, 12 ARDs were deployed on Mattamuskeet NWR (six at Salyer Ridge; six at Wildlife Drive). During the retrieval of ARDs on June 17 at the Salyer Ridge site, it was discovered that five were damaged by bears(four had been pulled from trees by bears and found on the ground). One ARD is still missing, one failed to record and are not included in the data analysis. The three ARDs located on the ground had shorter recording lengths (Table1). At the Wildlife Drive site, one ARD had a damaged microphone, had approximately two centimeters of water present inside the unit and had a shorter recording length. Table 1 shows the range of recording dates and species detected for each ARDs. The 10 remaining ARDs (Figure 3) were collected on June 17, 2015. The recorded data were analyzed using *Wildlife Acoustics Song Scope program version 3.4*. All QAQC were conducted in accordance with the NPS SECN I&M protocol and SOPs.

Figure 4. Photograph of a deployed Wildlife Acoustics SM2+ automatic recording device used to record vocalizations of anuran species. Note the small predator guards used to protect the microphones from *small* animal damage. They were not effective deterrents to bears.

DATA ANALYSIS

The NPS SECN I&M vocal anuran communities protocol collects detections / non-detection data. These data can be interpreted as presence / absence data. However, ARDs cannot provide absolute abundance (i.e., population size). Each vocalization by species recorded on an ARD is associated with one individual and one individual may vocalize many times during the survey period.

The data analysis measures community composition which includes species richness, naïve occupancy, relative abundance and relative detection frequency. Species richness is the total number of native species detected. Naïve occupancy also referred to as frequency of occurrence is the percent of the sampling locations (ARD sites) where a species was detected without adjusting for detectability. Relative abundance is the percent of sampling sites where a particular species was detected divided by the total number of species detected. Relative detectability is unknown for this site because this is the first year data were collected at this refuge.

The vocalizations of some species of similar anurans or interbreeding species cannot be accurately differentiated. These species are identified to the genus level. For this survey, due to similarity of vocalizations, the northern cricket frog (*Acris crepitans*) and the southern cricket frog (*Acris gryllus*) were identified to *Acris* species. Although according to range maps, these

frogs were probably southern cricket frogs. Both the Fowler's toad *(Bufo fowleri*) and the southern toad (*Bufo terrestris*) are known to occur in Hyde County, North Carolina and interbreed. Hybrid individuals often have a vocalization that extends longer than the typical Fowler's toad's four second call but shorter than the up to 30 seconds trill call of the southern toad. Due to similarity of these vocalizations and potential hybrids, these vocalizations were identified as *Bufo* species.

RESULTS AND DISCUSSION

During the 2015 vocal anuran monitoring season, the 10 ARDs that were deployed recorded 16,215 events (8,107.5 minutes). Ten species (Table 1) of anurans were identified. Southern leopard frog (*Lithobates sphenocphalus*), bullfrog (*Lithobates catesbieanus*), cricket frog (*Acris* spp) and toads (*Bufo* spp.) were was detected at 70% of the sampling locations and tied for the highest frequency of occurrence rates (naïve occupancy) and relative abundance (Figures 5 and 6). Spring peeper *(Pseudacris crucifer)* was detected at 60% of the sampling locations and had the fourth highest frequency of occurrence and relative abundance. The green treefrog was detected at 50% of the sampling locations and had fifth highest frequency of occurrence and relative abundance. Green frog and eastern narrow-mouthed toad were detected at 20% of the sampling locations and tied for the sixth highest frequency of occurrence and relative abundance. Carpenter frog (*Lithobates virgatipes*) was detected at one location and had the lowest frequency of occurrence rate and relative abundance (Figures 5 and 6). Distribution maps of detected anuran species (Naïve occupancy) by sampling site are included in Appendix A.

Table 1. This table shows detections by species at each sampling location (ARD). *Note; A single *or multiple vocalizations of the same species at a sampling location is considered to be one* individual or naïve occupancy for that species at that sampling location. This assumes that one individual frog can make a single or multiple vocalizations across many nights. There were a total of 48 "individuals" or naïve occupancies detected at the sampling locations.

Sampling Location (ARD #)	Range of ARD Recording Dates	Bufo Species	Cricket Frog	Eastern Narrow-mouthed Toad	Green Treefrog	Squirrel Treefrog	Spring Peeper	Bullfrog	Southern Leopard Frog	Green Frog	Carpenter Frog	Total Species
*1	3/26 – 6/2/2015		X					X	X	X	X	5
*2	3/19 -5/15/2015	X	X		X			X	X			5
4	3/19 -6/3/2014	X	X	X	X	X		X	X			7
5	3/20 – 6/3/2015	X	X	X	X	X		X	X	X	X	9
8	3/19 -6/4/2015	X	X		X	X	X	X	X			7
*9	3/18- 4/19/2015	X					X					2
10	3/19 – 6/3/2015	X	X				X	X	X			5
*11	3/18 -3/22/2015						X					1
*12	3/17 – 3/22/2015						X					1
13	3/19 -6/4/2015	X	X		X		X	X	X			6
Total sampling locations detected		7	7	2	5	3	6	7	7	2	2	48

*During retrieval of ARDs, these units were found damaged. ARDs, 9, 12, and 11 were pulled from trees by bears and damaged. ARD 1 was damaged by bears (both microphones were chewed off,) but remained on the tree. ARD 7 (not included in the table) was also pulled from a tree and has not been found. ARD 2 had one microphone missing with tooth and scratch marks present.

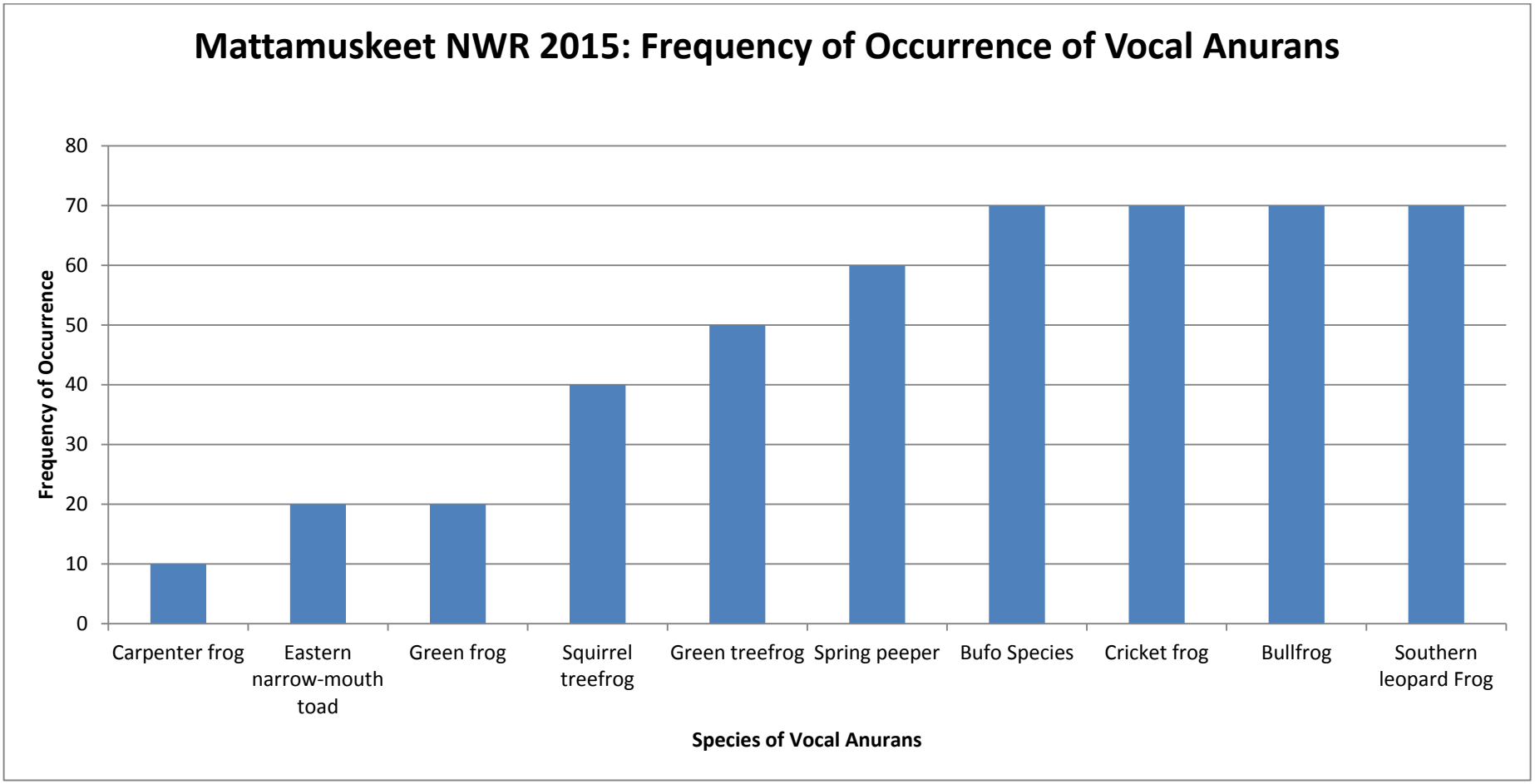

Figure 5. Frequency of occurrence (naïve occupancy) of vocal anuran species at Mattamuskeet NWR. Naïve occupancy is the percent of the sampling locations (ARD sites) (n=10) where a species was detected without adjusting for detectability.

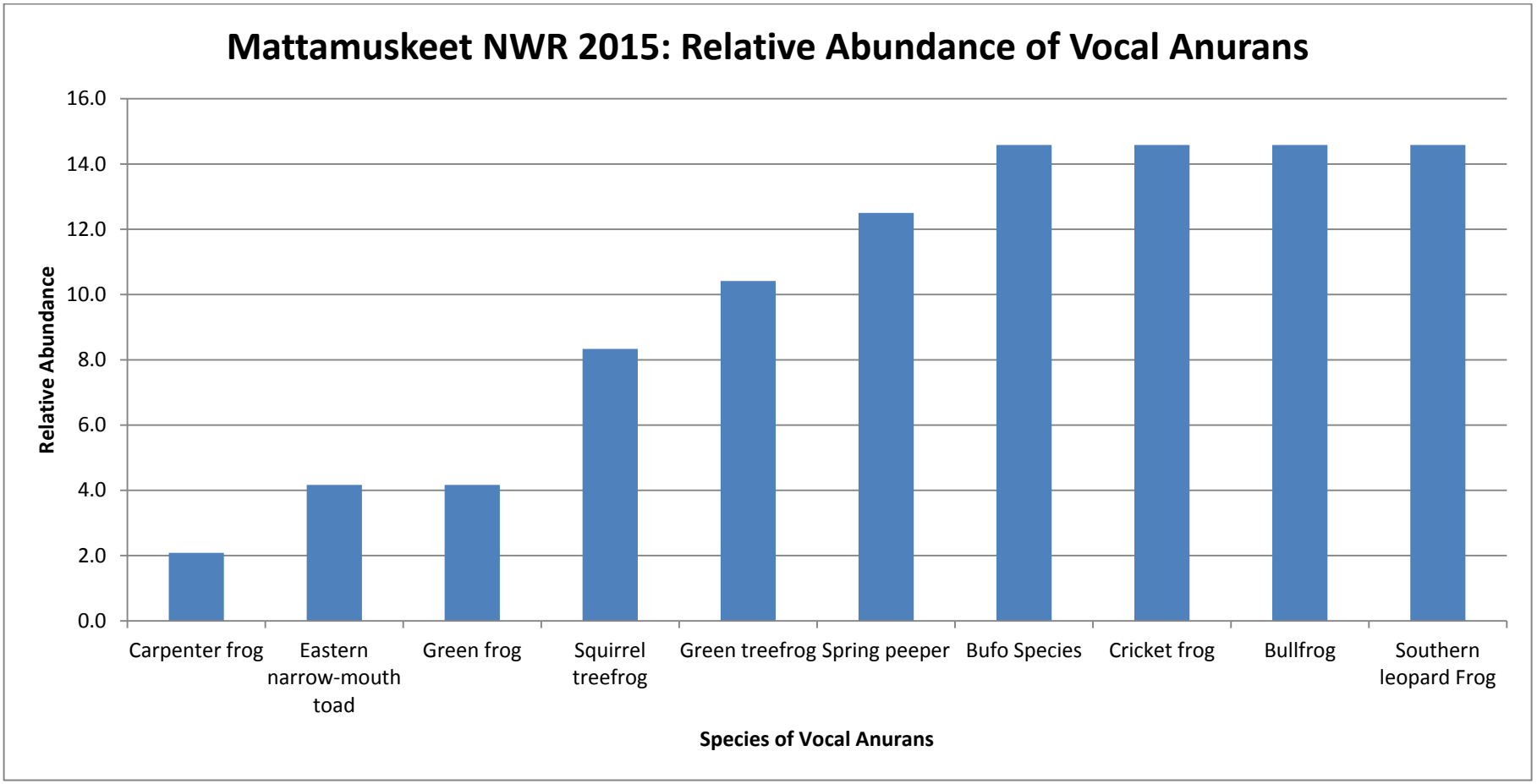

Figure 6. The relative abundance of detected vocal anuran species at Mattamsukeet NWR during the 2015 season. Relative abundance is represented as a percentage of the number of individuals of a particular species by the total number of species in the sample. The sample size (n = 48) is the total number of species counted at all sampling locations at the refuge.

Table 2. Vocalization phenology for species detected using automated recording device (ARDs) at Mattamuskeet National Wildlife Refuge, from 18 March to 3 June 2015.

	March			April			May			June		
Bufo Species American and / or Fowler's Toad				X	X	X	X	X	X			
Cricket Frog		X	X	X	X	X	X	X	X	X		
Eastern Narrow-mouthed Toad				X					X	X		
Green Treefrog						X	X	X	X	X		
Squirrel Treefrog								X	X	X		
Spring Peeper		X	X	X								
Bullfrog				X	X	X	X	X	X	X		
Southern Leopard Frog			X	X	X	X	X	X	X	X		
Green Frog								X	X			
Carpenter frog		X		X								

Certain Hylidae species have been identified to monitor changes in phenology of anuran vocalizations over time (Byrne et al 2013). For this survey, a table describing timing of vocalizations by species at sampling locations is included (Table 2). The earliest vocalizations detected with ARDs included spring peeper, cricket frog and carpenter frog in late March. The latest vocalizations detected were in early June and included southern leopard frog, bullfrog, squirrel treefrog, green treefrog, eastern narrow-mouthed toad, and cricket frog.

Table B.1 in Appendix B shows a comparison of the 2015 ARD vocal anuran detections to species range maps for Hyde County, North Carolina as documented in the field guides *Amphibians & Reptiles of the Carolinas and Virginia* (Beane et al 2010) and *Frogs and Toads of the Southeast* (Dorcas and Gibbons 2006). The two field guides document that 18 species of anuran species occur in Hyde County, North Carolina.

FUTURE RECOMMENDATIONS

The extensive bear damage on five of the ARDs (one is still missing) limited the range of data collection at the Salyer Ridge site. Two of the bear damaged ARDs stopped working in March and only spring peepers were detected. The third ARD, which had both microphones chewed off, continued to record during the entire sampling period and detected five species, but it is unknown when the microphones were damaged. The missing microphones would limit the recording ability

of the unit. However, the small predator guards (Figure 4) used to protect the microphones are effective for small animals, but provides no deterrent against bears. If ARDs are used in high-bear density areas or if bear sign is observed while deploying the units, one recommendation is to attach the units at heights of at least 15 feet in a tree or on a metal pole. A second recommendation is to re-evaluate the refuge objective and consider using other techniques to survey vocal anurans.

Acknowledgments

We would like to thank Refuge Manager Pete Campbell for allowing this pilot to be conducted at this refuge and NCPARC Wildlife Biologist Jeff Hall for confirming species identification. We would also like to acknowledge the hard work of the following staff and volunteers who provided invaluable assistance in the field:

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Daniel Stanton, High School Volunteer, Columbia High School, Columbia, NC

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APPENDIX A. Distribution Maps for Vocal Anuran Species Detected at Swanquarter NWR in 2014.

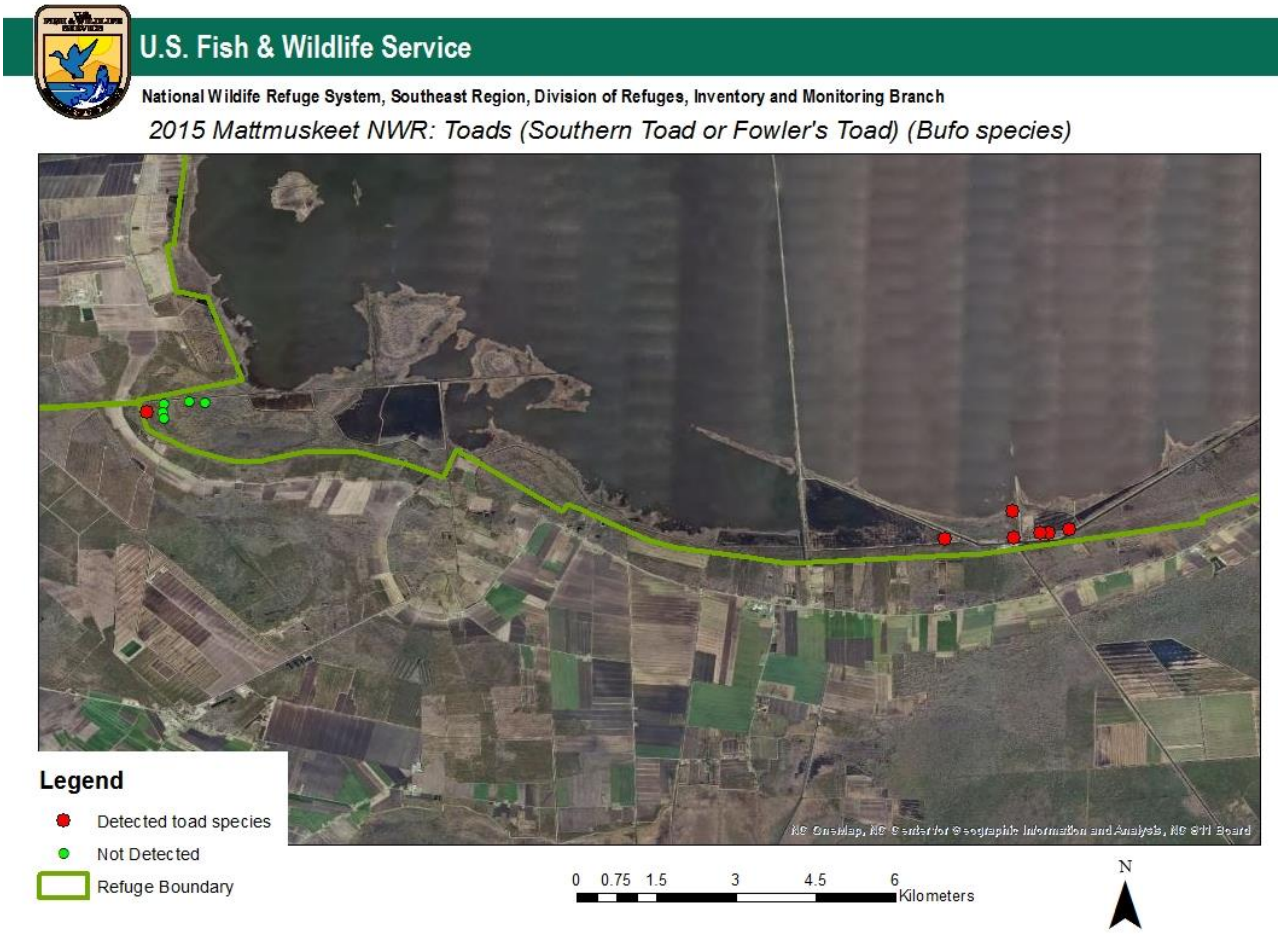

Figure A-1. Sampling locations where toad (*Bufo* spp.) was detected at Mattamuskeet National Wildlife Refuge, 2015.

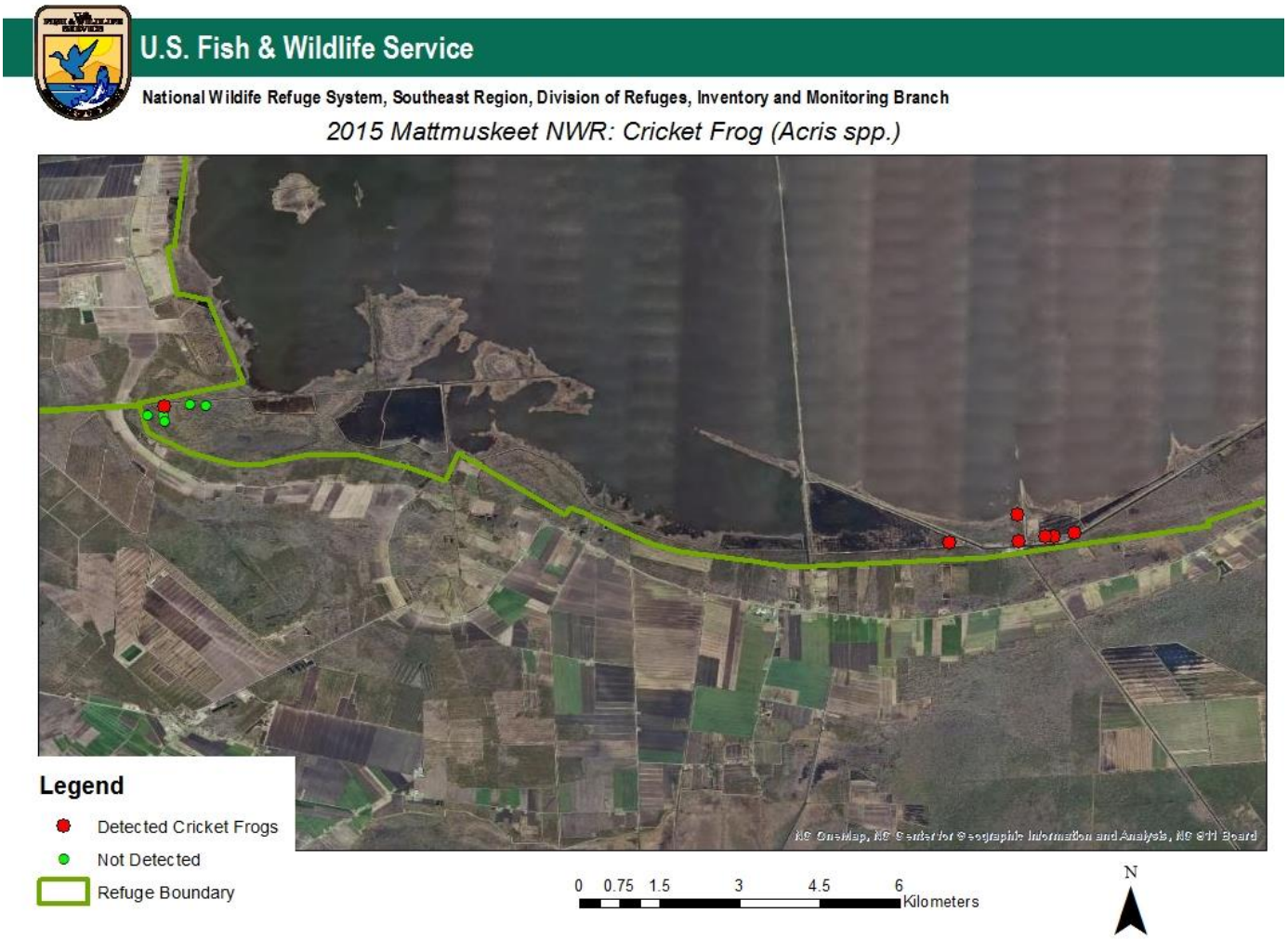

Figure A-2. Sampling locations where cricket frog (*Acris* spp.) was detected at Mattamuskeet National Wildlife Refuge, 2015.

Figure A-3. Sampling locations where green treefrog (*Hyla cinerea*) was detected at Mattamuskeet National Wildlife Refuge, 2015.

Figure A-4. Sampling locations where squirrel treefrog (*Hyla squirrella*) was detected at Mattamuskeet National Wildlife Refuge, 2015.

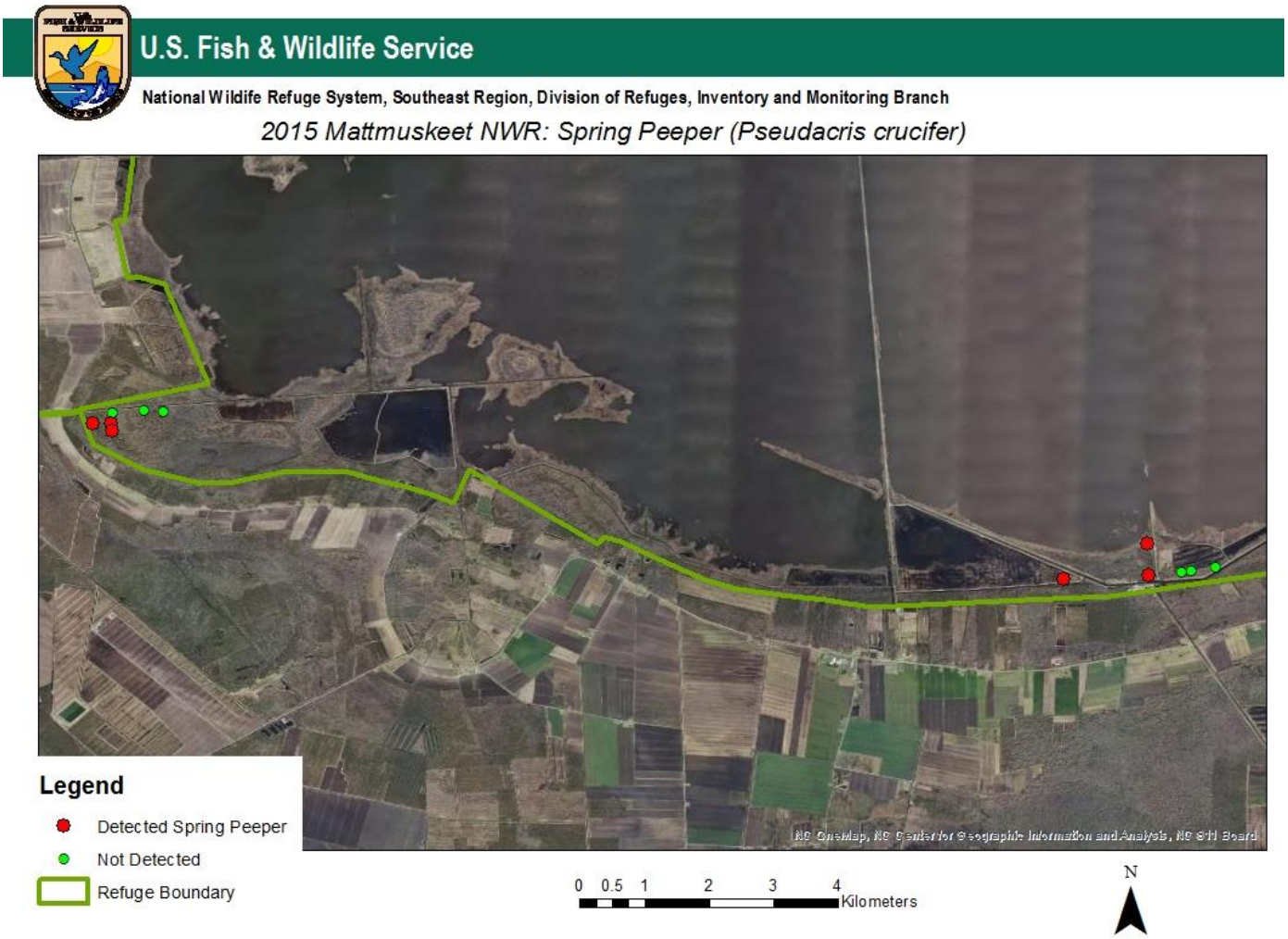

Figure A-5. Sampling locations where spring peeper (*Psuedacris crucifer*) was detected at Mattamuskeet National Wildlife Refuge, 2015.

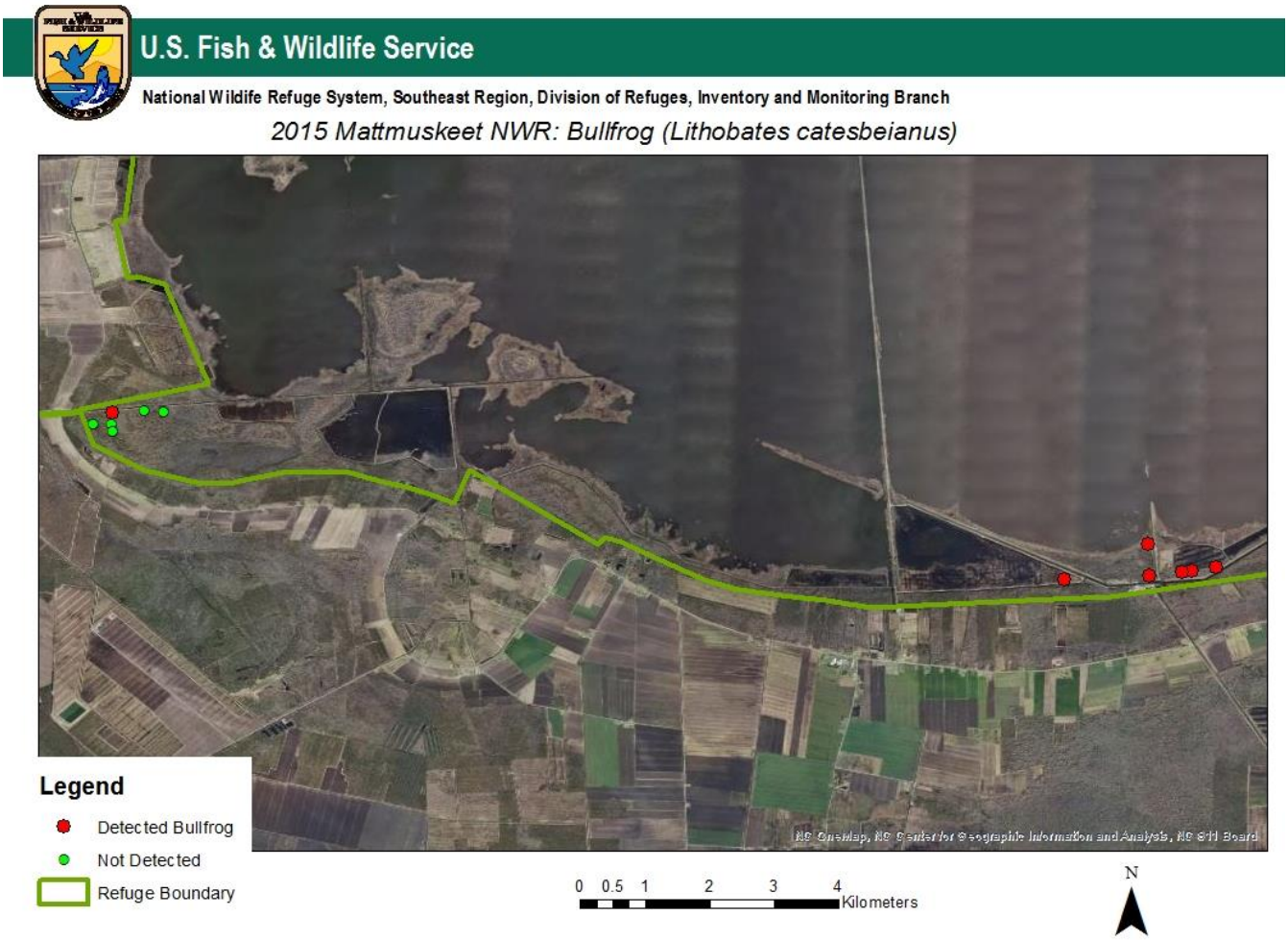

Figure A-6. Sampling locations where bullfrog (*Lithobates catesbeianus*) was detected at Mattmuskeet National Wildlife Refuge, 2015.

Figure A-7. Sampling locations where southern leopard frog (*Lithobates sphenocephalus*) was detected at Mattamuskeet National Wildlife Refuge, 2015.

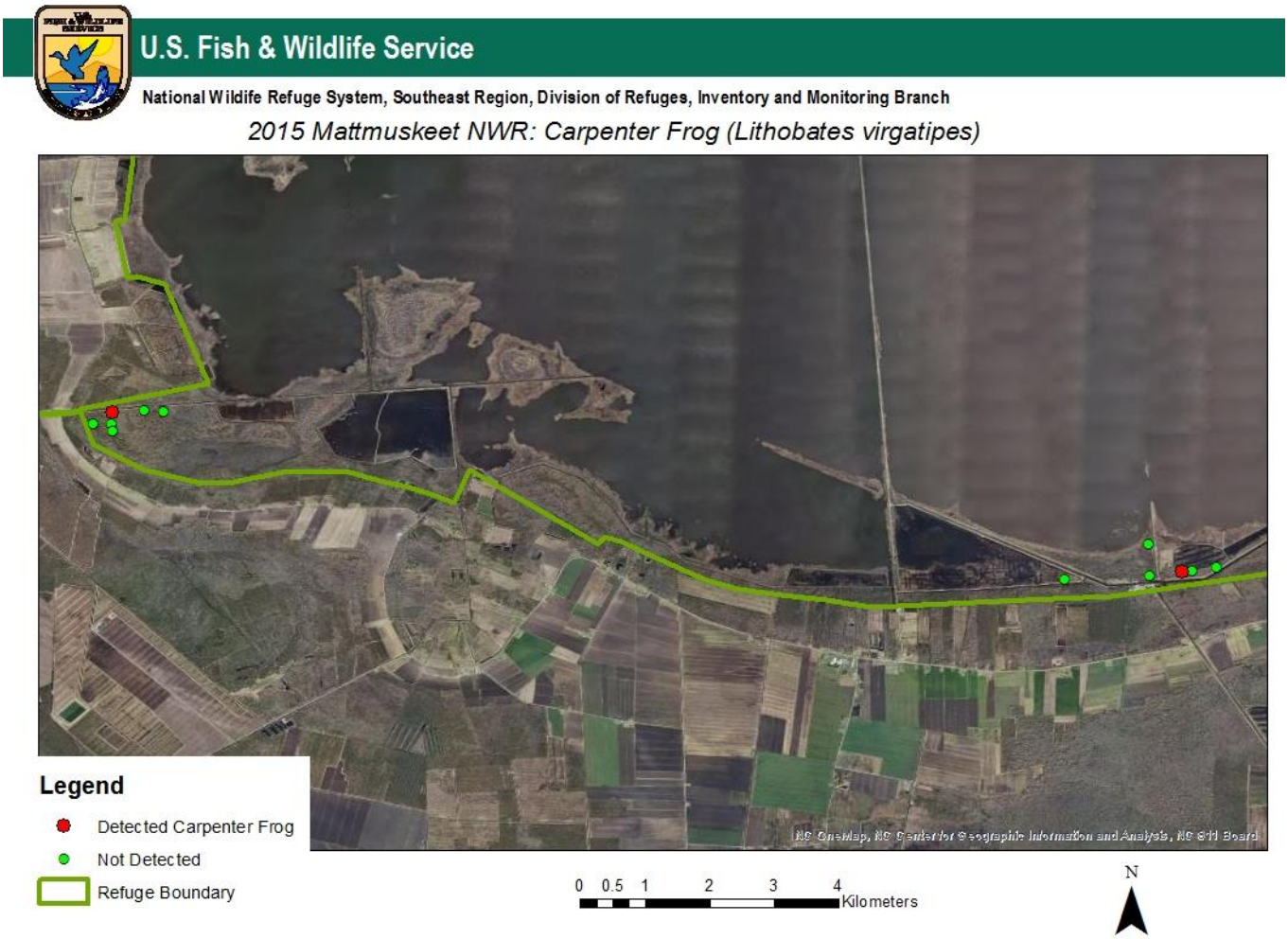

Figure A-8. Sampling locations where carpenter frog (*Lithobates virgatipes*) was detected at Mattamuskeet National Wildlife Refuge, 2015.

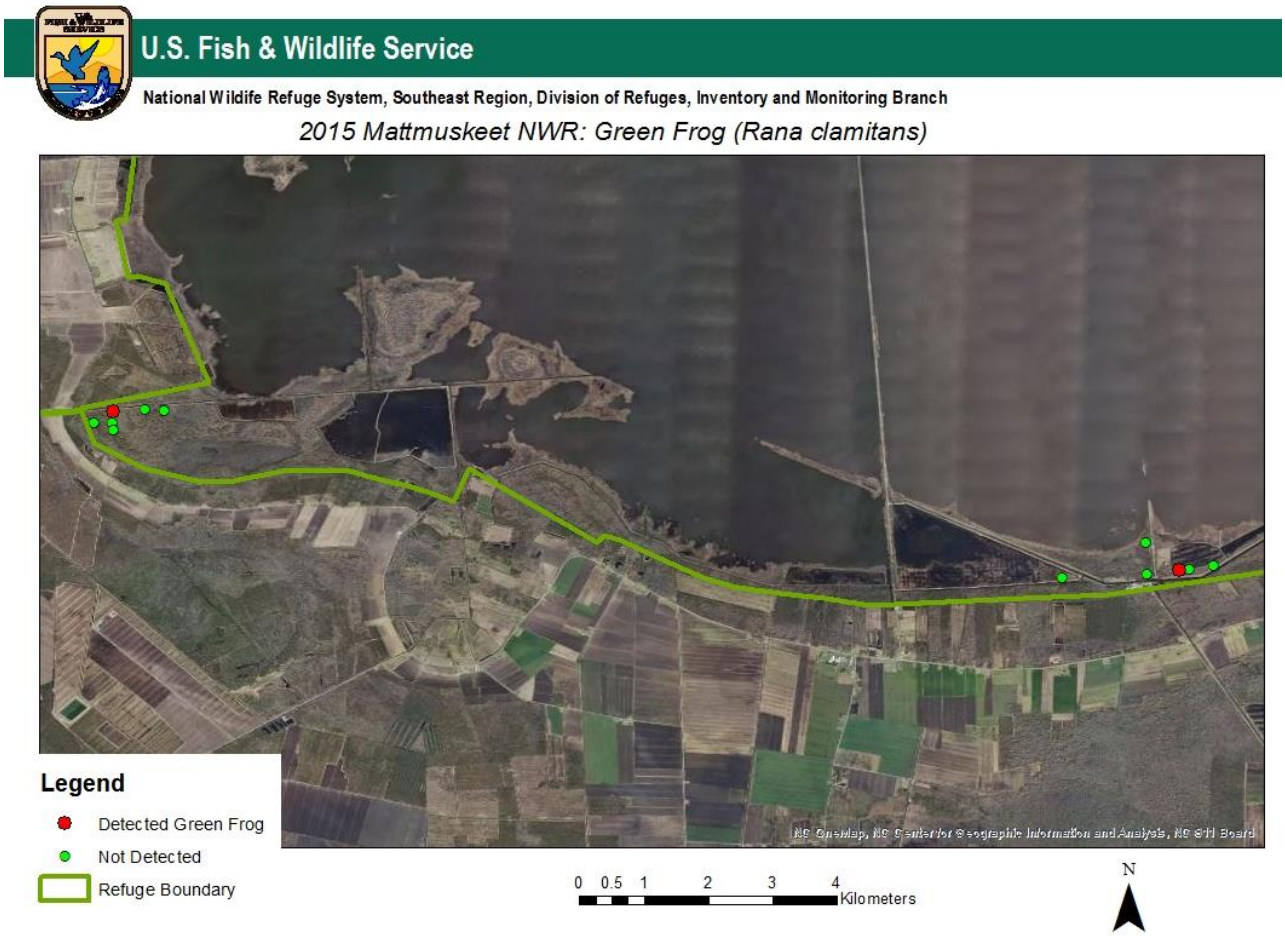

Figure A-9. Sampling locations where Green Frog (*Lithobates clamitans)* was detected at Mattamuskeet National Wildlife Refuge, 2015.

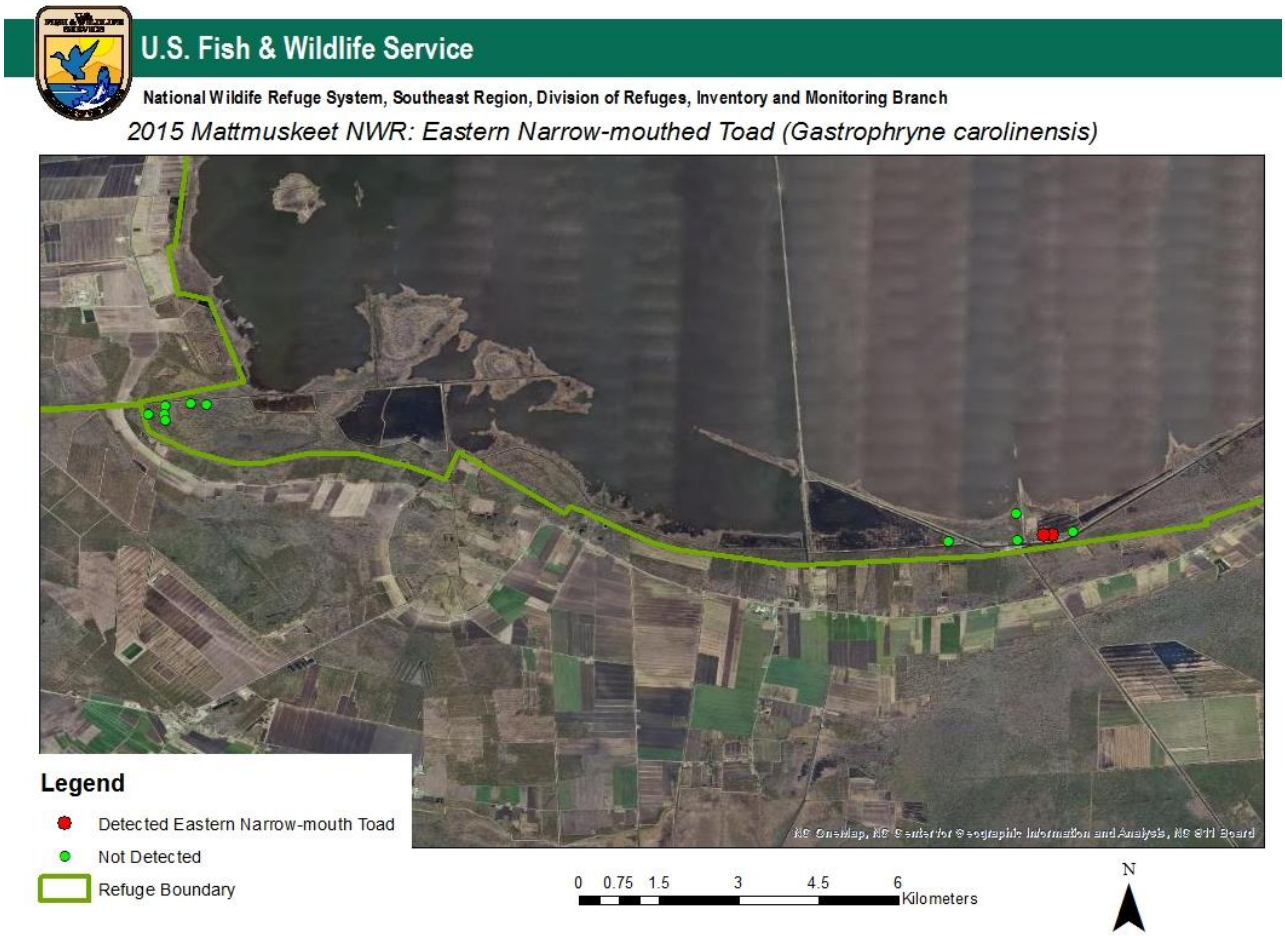

Figure A-10. Sampling locations where eastern narrow-mouthed toad (*Gastrophryne carolinensis)* was detected at Mattamuskeet National Wildlife Refuge, 2015.

APPENDIX B. Comparison of 2014 ARD Vocal Anuran Detections to Field Guide.

Table B-1. Comparison of the confirmed 2015 ARD detections and species range maps for Hyde County, North Carolina documented in the field guide *Amphibians & Reptiles of the Carolinas and Virginia* (Beane et al 2010) and *Frogs and Toads of the Southeast* (Dorcas and Gibbons 2006).

Scientific Name	Common Name	Beane et al 2010	Dorcas & Gibbons 2006	2015 ARD	Notes
Scaphiopus holbrookii	Eastern spadefoot	X	X		
Bufo fowleri	Fowler's toad	X	X	X	Identified as *Bufo* spp
Bufo quericus	Oak toad	X	X		
Bufo terresttris	Southern toad	X	X	X	Identified as *Bufo* spp
Acris gryllus	Southern cricket frog	X	X	X	Identified as *Acris* spp
Hyla chrysoscelis	Cope's gray treefrog	X	X		
Hyla cinerea	Green treefrog	X	X	X	
Hyla femoralis	Pine woods treefrog	X	X		
Hyla squirella	Squirrel treefrog	X	X	X	
Pseudacris brimleyi	Brimley's chorus frog	X	X		
Pseudacris crucifer	Spring peeper	X	X	X	
Pseudacris ocularis	Little grass frog	X	X		
Gastrophyrne carolinensis	Eastern narrow-mouthed toad	X	X	X	
Lithobates catesbeianus	American bullfrog	X	X	X	
Lithobates clamitans	Green frog	X	X	X	
Lithobates sphenocephala	Southern leopard frog	X	X	X	
Lithobates sylvatica	Wood frog	X			Relict populations in Hyde County (Beane et al 2010)
Lithobates virgatipes	Carpenter frog	X	X	X	