Project Title: Baseline Survey for Bats, Specifically Rafinesque's Big-eared Bats (*Corynorhinus rafinesquii*) and Southeastern Myotis (*Myotis austroriparius*) on the Savannah NWR and Santee NWR

Project Description:
Rafinesque's big-eared bats (RBEB) are considered vulnerable, imperiled, or critically imperiled in every state within their range and southeastern myotis (SEM) are considered vulnerable, imperiled, or critically imperiled in every state within their range except Louisiana. This project addressed Savannah NWR's Objective 1.4.g: Threatened and Endangered Species: monitor for threatened and endangered species and implement steps toward recovery.

Project Objectives
The primary objective of this project was to obtain a baseline inventory on the presence of RBEB and SEM on Santee and Savannah National Wildlife Refuges and assess the potential for the presence of these species based on the presence of potential roost structures and habitat.

Methods and Protocols
RBEB and SEM are primarily associated with bottomland hardwoods and swamp habitats in the Coastal Plains. Thus, we used land cover databases provided by the refuges and the National Wetland Inventory Database (http://www.fws.gov/wetlands/data/) to select appropriate habitats (mature bottomland hardwood or tupelo/cypress forests in temporarily flooded, seasonally flooded, saturated, or semi-permanently flooded areas). Maps of these areas were transferred to a GEO-XT GPS unit for reference during field work. Two people searched each area systematically and examined the interior of every tree encountered that had a cavity with a basal opening. Trees with cavities that were ≥ 30 cm in interior width at the opening and ≥ 1 m high from the ground were given an aluminum tag with a unique number and the following data were recorded: tree number, tree species, tree diameter at breast height (dbh), tree height, tree status (alive or dead), interior cavity height, interior cavity width, cavity opening type (basal only or basal + chimney), cavity surface texture (smooth or rough), and the presence of bats. If bats were present we recorded the species, the number of bats present, and their relative position within the cavity. The location of the tree was recorded with the GEO-XT. Most surveys were conducted in August and September 2012. However, in late April to late May we re-surveyed the potential roost trees located in 2012 on the Savannah NWR, primarily to try to locate maternity colonies. We also surveyed the 4 bridges on SC170 (2 of which had RBEB in 2002 and 2003) during September 2012 and April and May 2013. We conducted acoustic surveys of bats on Pinckney Island NWR and the Solomon Tract section of Savannah NWR using Anabat SD2 bat detectors. The detectors were placed at 2 sites for 2 nights at Solomon Island (along the road and in a bottomland cypress-tupelo area) and 3 nights on Pinckney Island (at Ibis Pond and along the road at the north end of the island) in May 2013. We also ran a mobile transect on Pinckney Island in September 2012 where bats were recorded along the route that stretched the length of the island.

Data Management
Data were recorded into a data dictionary on the GPS unit and imported in ARCGIS 10.0. Location points were intersected with the wetland layers to obtain the wetland type for each tree and the combined table was exported as an Excel file. Information about roost trees were also submitted to the South Carolina and Georgia Natural Heritage Programs.

Data Analysis/Models
For each area on each refuge we determined the number of potential roosts and the number and proportion of potential roosts that had bats. We calculated the mean and standard error of tree characteristics that were used and not used by RBEB and SEM. We also determined the number of roosts and potential roosts in each wetland type. Acoustic files were identified to species using qualitative methods (O'Farrell et al. 1999) because no automatic identification programs are available for coastal plains bats.

Accomplishments and Management Implications
We surveyed 2263 acres at Savannah NWR (1643 acres on Bear Island, 240 acres in Millstone landing, and 380 acres in Solomon Tract; Table 1 and Fig. 1-3). We found 117 potential roost trees of which 18 contained bats. Fifteen trees were used by RBEB, 4 were used by SEM, 1 was used by a bat that could not be identified. Two trees were used by both RBEB and SEM. RBEB used 8 water tupelo (*Nyssa aquatica*), 2 bald cypress (*Taxodium distichum*), 2 sweetgum (*Liquidambar styraciflua*), 2 oaks (*Quercus laurifolia* and *Q. niger*) and 1 American Sycamore (*Platanus occidentalis*). SEM were found in 1 shellbark hickory (*Carya laciniosa*), 2 sweetgum, and 1 water tupelo; the unidentified bat was in a sweetgum. RBEB were found in large diameter trees whereas the diameters of trees used by SEM were considerably smaller (Table 2). All roost trees used by both RBEB and SEM were alive except for 1 snag used by a RBEB. RBEB showed a slight preference for trees with basal+chimney openings. Sixty percent (n = 9) of the roosts used by RBEB had basal+chimney openings whereas these trees represented only 46.2% of the potential roost trees. In contrast, 75% (n = 3) of the roosts used by SEM had basal only openings. RBEB were found primarily in seasonally flooded, semi-permanently flooded, and temporarily flooded habitats (Table 2). SEM were equally distributed among seasonally flooded, semi-permanently flooded, temporarily flooded, and upland habitats.

We recorded 1616 bat passes of which we could identify 651 (40.3%). On Pinckney Island we recorded big brown bats (*Eptesicus fuscus*), red bats (*Lasiurus borealis*)/Seminole bats (*L. seminolus*; calls of these closely related species cannot be distinguished from each other), evening bats (*Nycticeius humeralis*), tri-colored bats (*Perimyotis subflavus*), Brazilian free-tailed bats (*Tadarida brasiliensis*), and northern yellow bats (*L. intermedius*). In the Solomon Tract we recorded big brown bats, red bats/Seminole bats, SEM, evening bats, tri-colored bats, and one northern yellow bat. The identification of northern yellow bats in both areas is of particular interest as this is a species of concern in South Carolina. Red bats/Seminole bats were the most commonly recorded species in both areas followed by tri-colored bats (Table 5). These are common foliage roosting bats with wide geographic ranges (Whitaker and Hamilton 1998). However, red bats are suffering heavy mortality at wind energy developments throughout the Appalachians (Arnett et al. 2008) and tri-colored bats in the northeastern U.S. and the mountainous regions of the southeastern U.S. (including South Carolina) are suffering heavy mortality from White-Nose Syndrome (Langwig et al. 2012).

We surveyed 1232 acres on Santee NWR (Table 3). We found 29 potential roost trees on Santee NWR but none of them contained bats (Fig. 4-6). Tree diameters and cavity volumes were considerably smaller than most used and potential roost trees on Savannah NWR (Tables 2 and 4).

Our preliminary data suggest that there is currently good roosting habitat for RBEB and SEM on Savannah NWR. Although we only found solitary individuals of both species, it is likely that there are maternity colonies of both species in the area. Large diameter trees with cavities should be conserved and younger trees, particularly water tupelo, bald cypress, sweetgum, and oaks should be maintained to replace the older trees once they fall. Trees on Santee NWR are at the lower end of the suitable range for RBEB and SEM. Further, the low number of potential roost trees may not be sufficient to support a colony. However, trees with hollows in wetland habitats on Santee NWR should be conserved as they may provide roosting habitat in the future. Pinckney Island should be surveyed further to determine the most suitable habitats for northern yellow bats.

Partners

This project was a partnership between the Santee NWR, Savannah NWR, and USDA Forest Service, Southern Research Station.

Sources of Support

Funding was provided by USFWS Southeast Region Inventory and Monitoring Network. Savannah and Santee NWR's provided housing and personnel time for transporting technicians to the survey sites. The Southern Research Station provided one GS-7 technician for 6 weeks, 1 GS-14 scientist for 2 weeks, and survey equipment.

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Table 1. Potential and actual roost trees by area on the Savannah National Wildlife Refuge, August-September, 2012.

Area	Acres Searched	Number Potential Roost Trees		Number (%) Trees with Bats	Bat Species
		Basal	Basal+Chimney		
Bear Island	1643	30	50	13 (16.25)	RBEB/SEM/UNK[a]
Millstone Landing	240	6	3	3 (33.3)	RBEB
Solomon Tract	380	27	1	2 (7.1)	SEM

[a] RBEB = Rafinesque's big-eared bat
SEM = Southeastern myotis
UNK = Species could not be identified

Table 2. Characteristics of trees that contained Rafinesque's big-eared bats, southeastern Myotis, an unidentified bat, or no bats on Savannah National Wildlife Refuge, August-September, 2012.

	Rafinesque's BEB (n = 15)	Southeastern Myotis (n = 4)	Unknown Species (n = 1)	No Bats (n = 99)
DBH (cm)	125.2 ± 6.6[a]	84.7 ± 17.8	124.5	115.3 ± 4.7
Tree height (m)	18.4 ± 0.9	19.9 ± 0.9	23.0	19.1 ± 0.4
Cavity volume (m^3)	4.0 ± 0.9	3.5 ± 0.7	2.6	6.8 ± 1.5
# Live Trees	14	4	1	107
# Trees w/ Basal Openings	6	3	1	53
# Trees w/ Basal + Chimney openings	9	1	0	44
# in Semi-Permanently Flooded Habitats	4	1	0	35
# in Seasonally Flooded Habitats	7	1	0	24
# in Temporarily Flooded habitats	4	1	1	23
# in Uplands	0	1	0	15

[a]Mean ± 1 S.E.

Table 3. Potential roost trees by area on the Santee National Wildlife Refuge, July and September, 2012.

Area	Acres Searched	Number Potential Roost Trees	
		Basal	Basal+Chimney
Bluff	100	3	1
Cuddo	662	0	11
Dingle	170	0	0
Pine Island	300	1	13

Table 4. Characteristics of potential roosts on Santee National Wildlife Refuge, July and September, 2012.

Variable	
DBH (cm)	74.0 ± 3.7
Tree height (m)	15.7 ± 0.9
Cavity volume (m^3)	0.75 ± 0.17
# Trees w/ Basal Openings	28
# Trees w/ Basal + Chimney openings	2
# in Saturated Habitats	1
# in Seasonally Flooded Habitats	3
# in Temporarily Flooded habitats	17
# in Uplands	7

Table 5. Number of echolocation passes by bats of each species at each site. Note that sampling length was variable among sites (~ 1 hr on the transect, 3 nights at Pinckney Island North Road, and 2 nights at the 2 sites on Solomon Tract).

Site	EPFU[a]	LABO/LASE	LAIN	MYAU	NYHU	PESU	TABR	UNK
Pinckney Island Transect	4	7	0	0	0	4	1	9
Pinckney Island North Road	5	219	8	0	14	46	0	739
Solomon Tract Bottomland	1	16	1	2	3	25	0	138
Solomon Tract Road	0	242	0	0	7	46	0	371

[a] EPFU = Big brown bats, *Eptesicus fuscus*
LABO = Red bats, *Lasiurus borealis*
LASE = Seminole bats, *L. seminolus*
LAIN = Northern yellow bats, *L. intermedius*
MYAU = Southeastern myotis, *Myotis austroriparius*
NYHU = Evening bats, *Nycticeius humeralis*
PESU = Tri-colored bats, *Perimyotis subflavus*
TABR = Brazilian free-tailed bats, *Tadarida brasiliensis*
UNK = Unknown

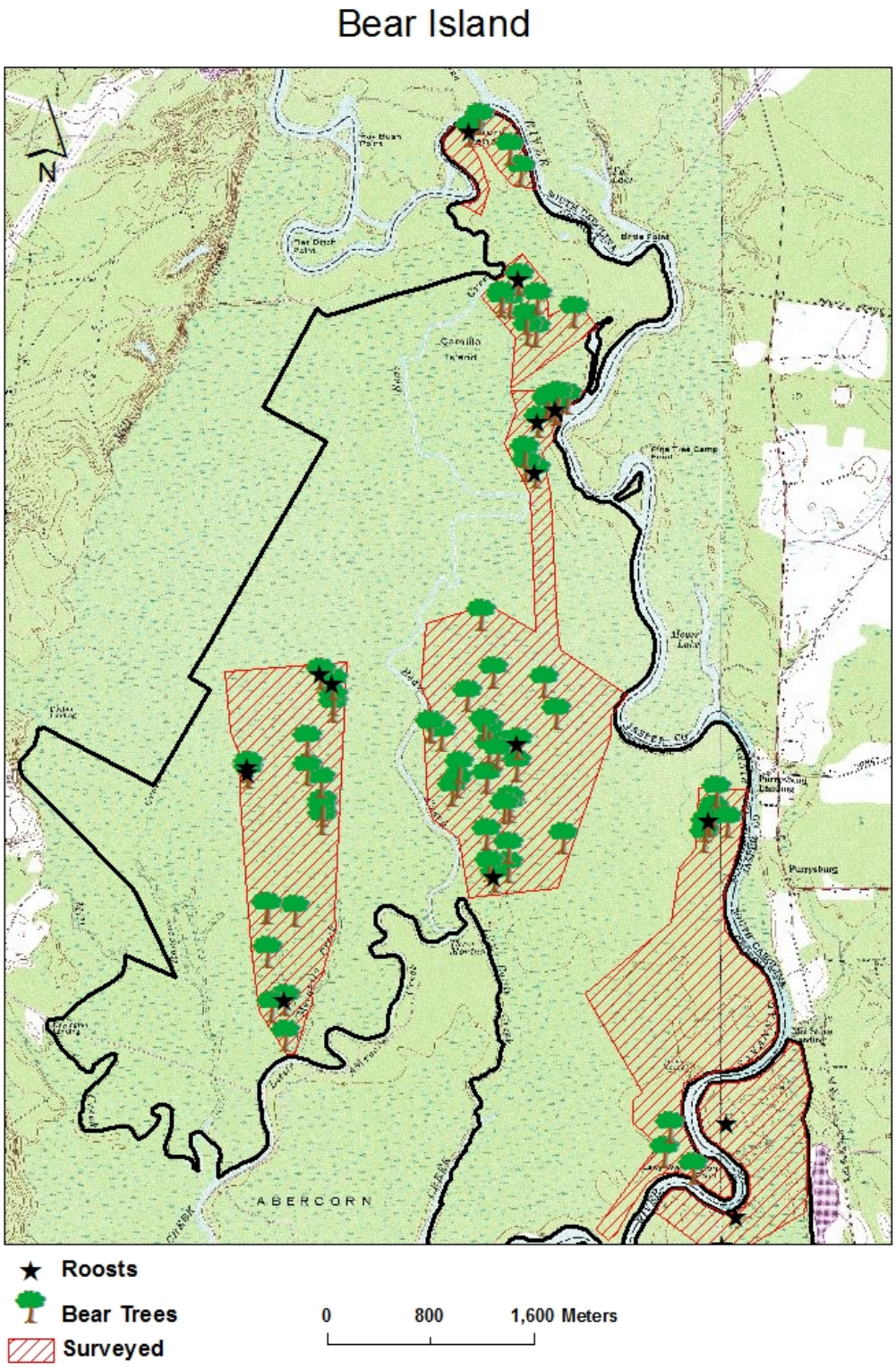

Fig. 1. Location of potential roosts and those with bats on Bear Island on the Savannah National Wildlife Refuge, 2012-2013.

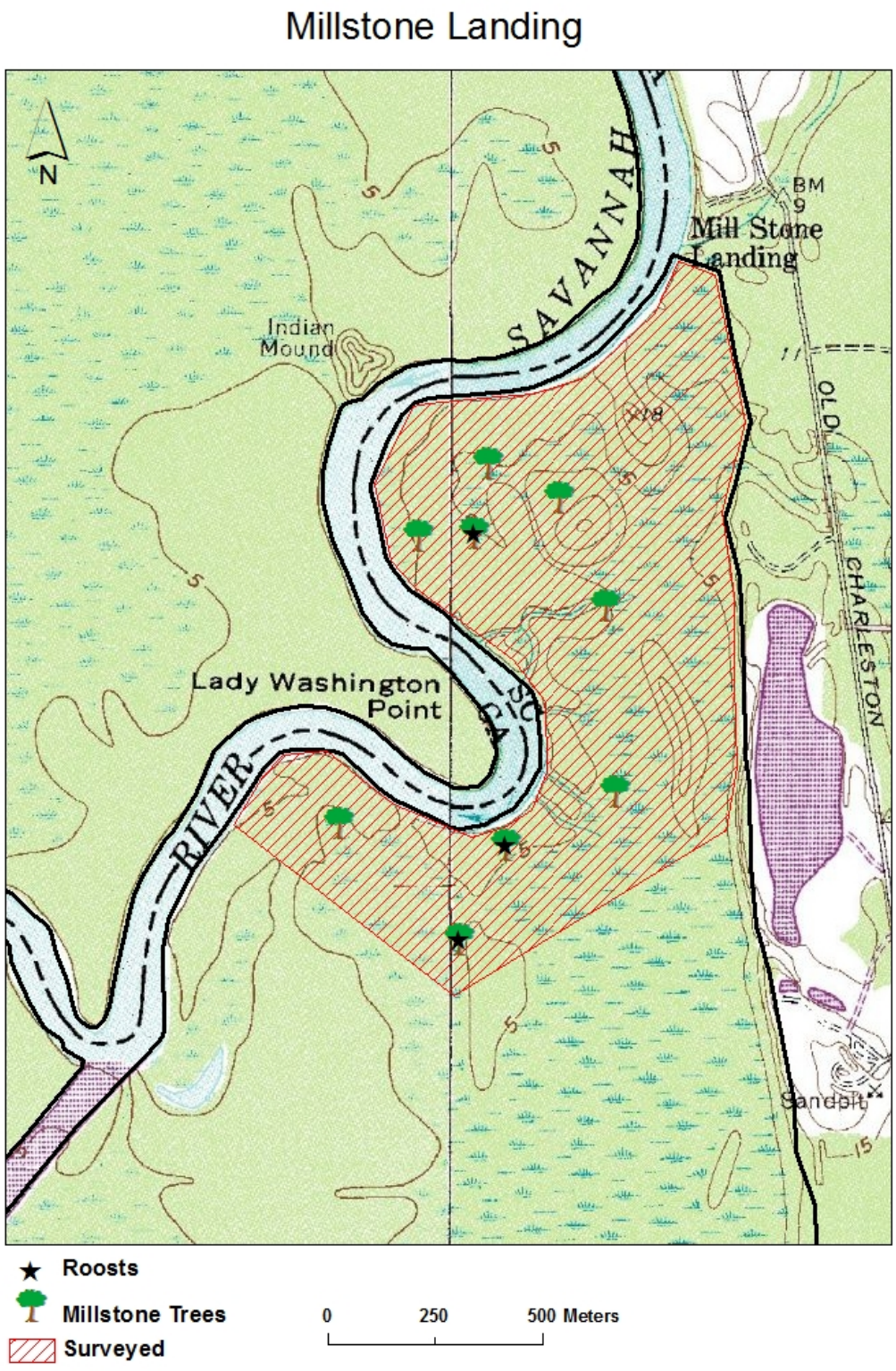

Fig. 2. Location of potential roosts and those with bats in Millstone Landing on the Savannah National Wildlife Refuge, 2012-2013.

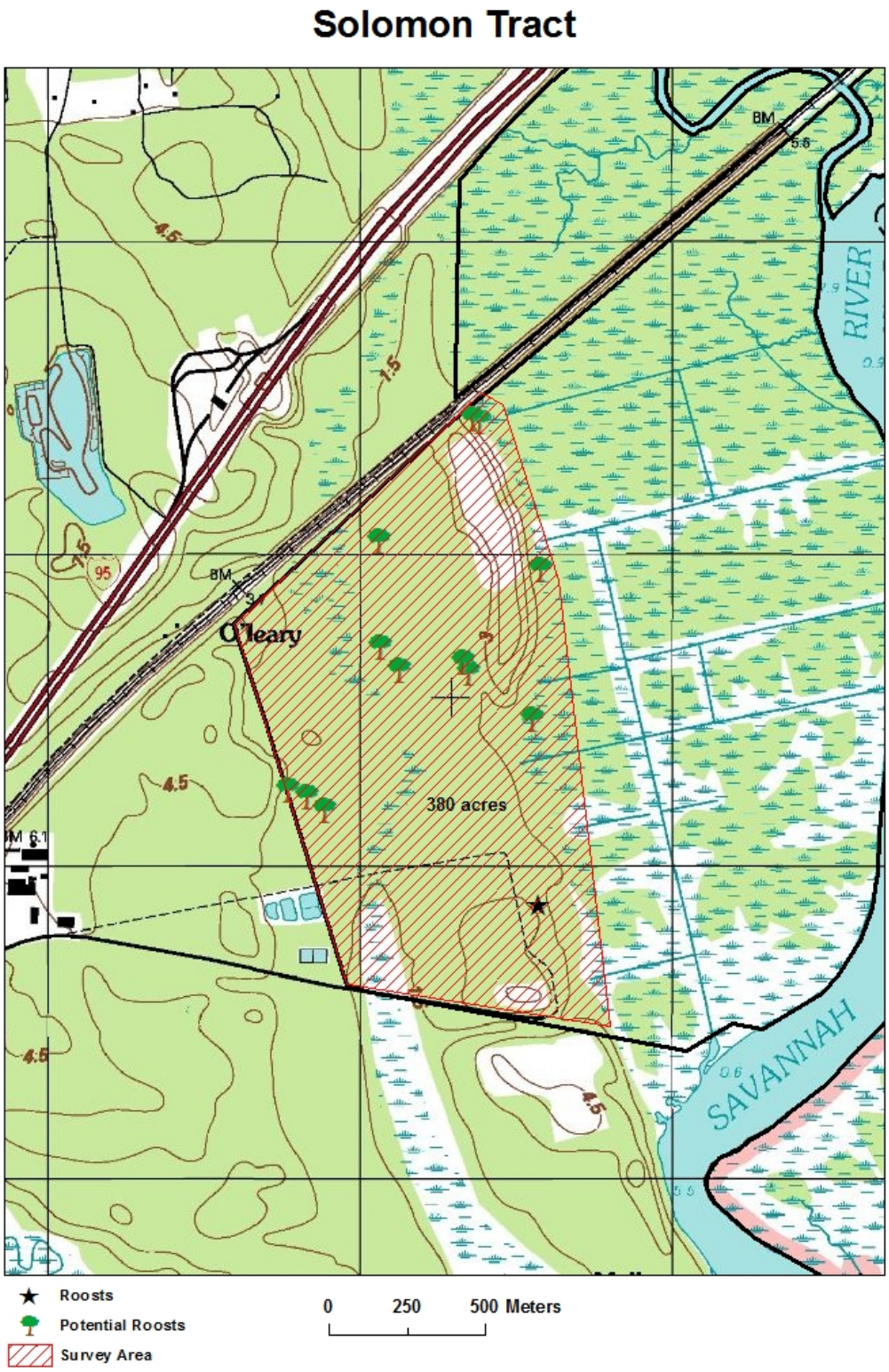

Fig. 3. Location of potential roosts and those with bats in the Solomon Tract on the Savannah National Wildlife Refuge 2012-2013.

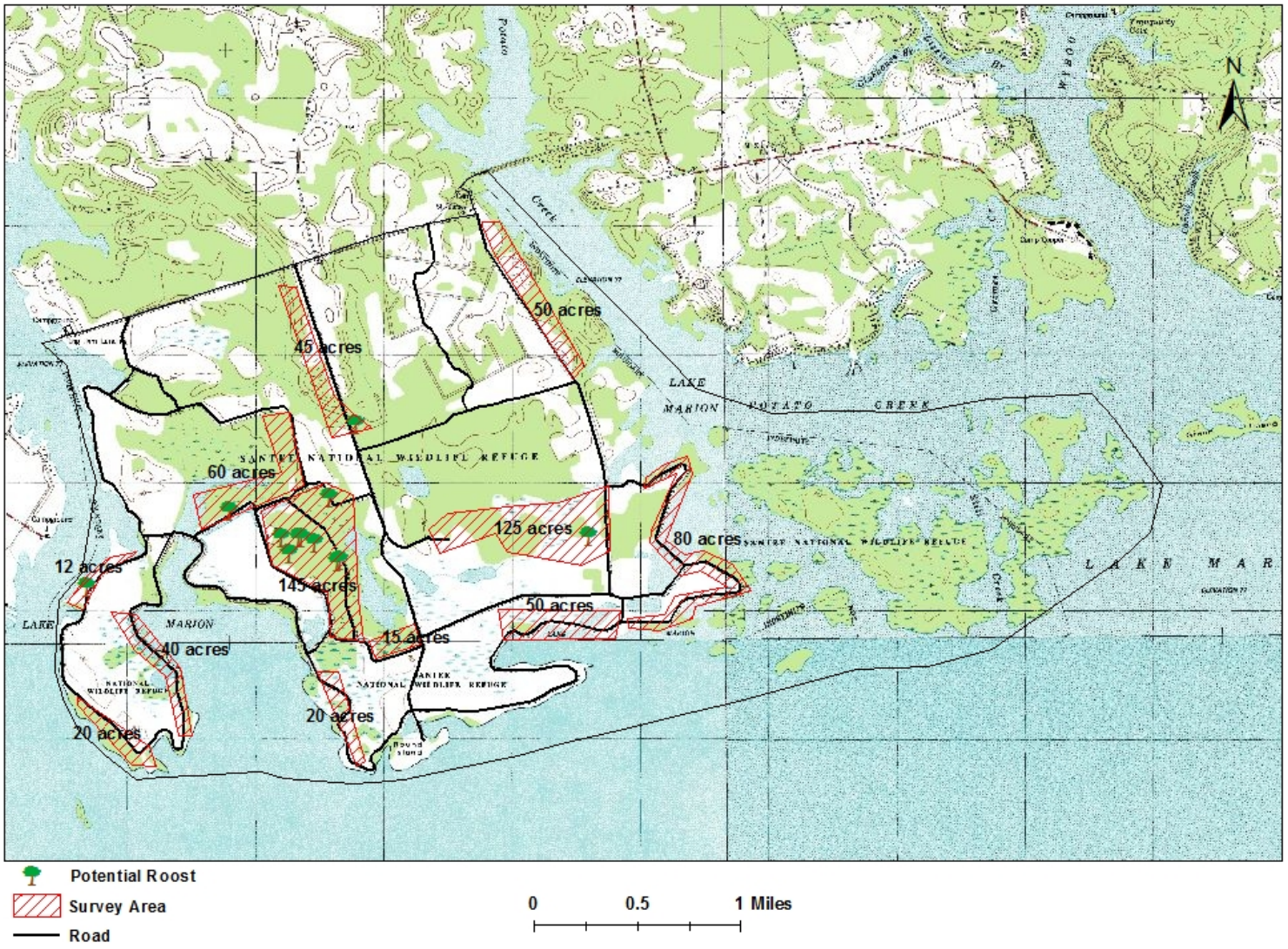

Fig. 4. Location of potential roosts in the Cuddo Tract on the Santee National Wildlife Refuge, 2012.

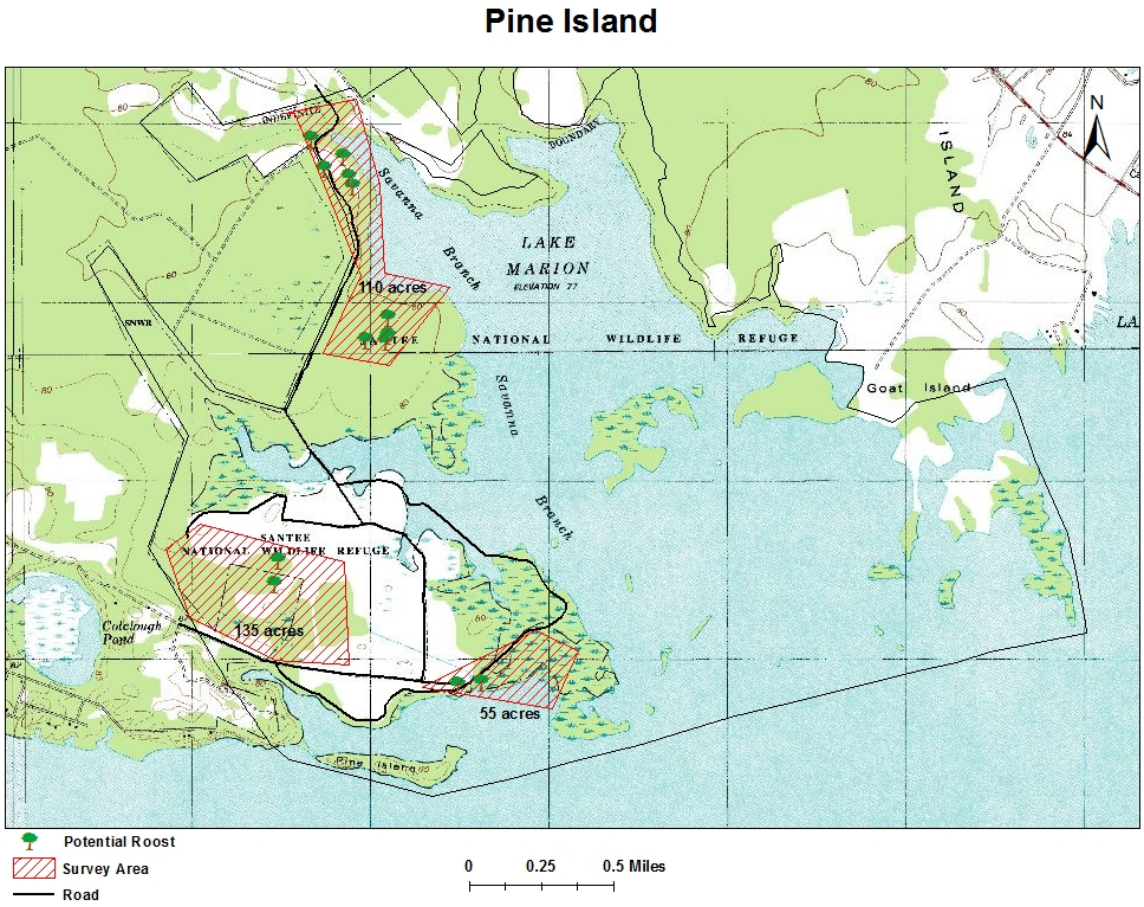

Fig. 5. Location of potential roosts in the Pine Island Tract on the Santee National Wildlife Refuge, 2012.

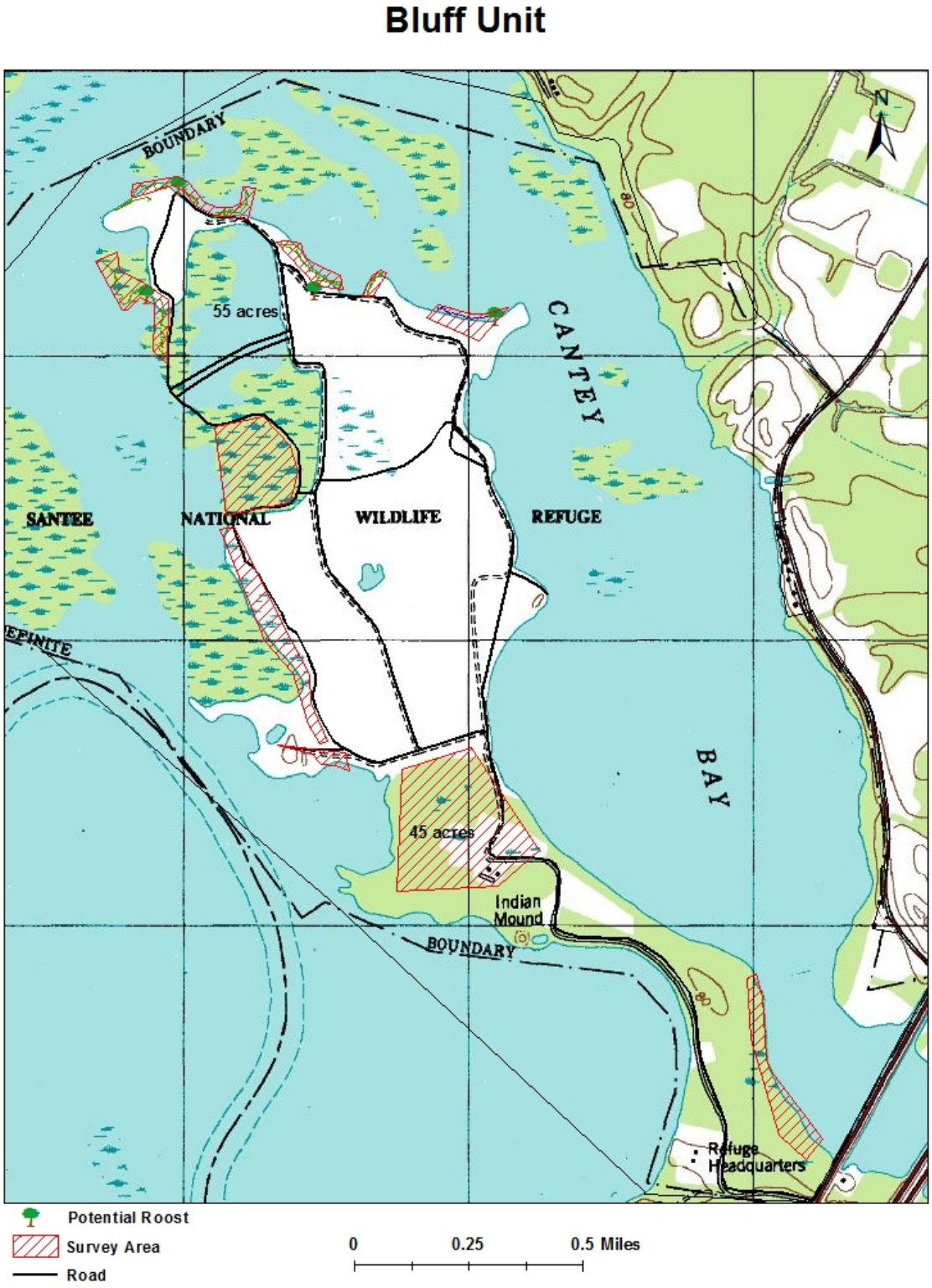

Fig. 6. Location of potential roosts in the Bluff Tract on the Santee National Wildlife Refuge, 2012.