Bat Surveys at Theodore Roosevelt National Wildlife Refuge Complex, 2007 With an Emphasis on Rafinesque's Big-eared Bat (*Corynorhinus rafinesquii*) and Southeastern Myotis (*Myotis austroriparius*)

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Final Report
September 2008

ABSTRACT

Mist net, Anabat, telemetry, and roost surveys were conducted from April – October, 2007 to determine bat species diversity and relative abundance on Theodore Roosevelt National Wildlife Refuge (NWR) Complex. An emphasis was placed on locating foraging and roosting habitat for Rafinesque's big-eared bat (*Corynorhinus rafinesquii*) and southeastern myotis (*Myotis austroriparius*). Sixty-one sites were scouted on Morgan Brake NWR, Hillside NWR, Panther Swamp NWR, and Yazoo NWR to determine mist net and/or Anabat suitability. Mist net surveys were conducted at 23 sites over 28 nights (5 sites at Morgan Brake NWR and 6 sites each at Hillside NWR, Panther Swamp NWR, and Yazoo NWR). A total of 201 bats were captured representing 5 species averaging 7.18 bats captured per net night. Forty-seven southeastern myotis were captured representing 22% of the total number of bats captured. Other bat species captured during the survey period included the: evening bat (*Nycticeius humeralis*) (74% of the total bat captures), red bat (*Lasiurus borealis*) (3%), Seminole bat (*Lasiurus seminolus*) (0.5%), and eastern pipistrelle (*Pipistrellus subflavus*) (0.5%). Out of the 4 refuges, Panther Swamp NWR had the highest capture average with 12.88 bats captured per net night. Capture averages for the other 3 refuges were: 6.50 bats captured per net night at Yazoo NWR, 4.57 at Morgan Brake NWR, and 2.80 at Hillside NWR. Yazoo NWR had the highest species diversity with 5 species captured (red bat, evening bat, southeastern myotis, Seminole bat, and eastern pipistrelle). Three species (red bat, evening bat, and southeastern myotis) were captured at each of the other 3 refuges. To further document species diversity and relative bat activity on the refuges, an Anabat Bat Detector was used at 9 locations over 32 nights from June – September, 2007. Over 10,000 calls were recorded and analyzed to determine suitability for analysis and to identify bat species. Many of these calls were not considered for analysis due to bug or other interference which made the call unidentifiable. Using Analook software, thousands of calls were analyzed to identify bat species from recordings. Twenty-nine southeastern myotis calls were identified from 2 sites (1 site on Morgan Brake NWR and 1 on Yazoo NWR) representing 6.37% of the total number of calls identified to species. Additional calls identified were from the: evening bat (214 calls from 5 sites), red bat (185 calls from 5 sites), and eastern pipistrelle (27 calls from 5 sites). Eleven southeastern myotis were fitted with radio transmitters in an attempt to locate roosts using standard radio telemetry procedures. Although signals were received, no roosts were found. One abandoned building at Panther Swamp NWR and 24 bridges located throughout the 4 refuges were surveyed for bat occupancy with no bats observed. Over 750 acres were scouted on foot in an attempt to locate tree roosts for Rafinesque's big-eared bat and southeastern myotis. Although numerous cavity trees were located, no bats were observed.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

INTRODUCTION

Worldwide there are nearly 1,000 bat species representing almost a quarter of all mammal species (Bat Conservation International 2001). They are the second largest order of mammals in number of species, (second only to rodents) and can occupy virtually every habitat worldwide except in the most extreme desert and polar regions (Fenton 1983). Forty-five bat species are native to the United States with 15 living in the southeast. Nearly 40% of these species are threatened or endangered, and around the world, many more are declining at alarming rates (Bat Conservation International 2001). Six U.S. species are listed as endangered and 20 are considered species of special concern by the U.S. Fish and Wildlife Service (Harvey et al. 1999). Out of the 15 bat species found in Mississippi, 2 are endangered and 7 more are species of special concern (Mississippi Natural Heritage Program 2001a).

Conservation Status of Rare Bat Species in Mississippi

The Indiana bat (*Myotis sodalis*) is a federally endangered species that has historically been documented in Mississippi. Indiana bats have not been observed in the state since 1967 and were listed in 1995 as extirpated by the Mississippi Natural Heritage Program (MNHP) (2001a). The gray bat (*Myotis grisescens*) is also federally listed as endangered and has historically been documented in Mississippi. Until 2004, gray bats had not been recorded in Mississippi since 1967. However in September 2004, a dead gray bat was found in Belmont, Mississippi (Sherman and Martin 2006), in Tishomingo County. This is a substantial finding given that the MNHP (2001a) had listed the gray bat in 1995 as extirpated from Mississippi. Gray bats require large caves for roost sites and would likely only be found in the northeastern part of Mississippi while foraging or during migration periods.

The northern long-eared bat (*Myotis septentrionalis*) is listed as a species of special concern in Mississippi with only 1 record documented in the MNHP Database. A single northern long-eared bat was observed in an abandoned chalk mine in Tishomingo County in both 1967 and 2004. Northern long-eared bats require caves to hibernate in during the winter. During the summer months, this species is usually associated with areas containing caves and/or mines. Northern long-eared bats prefer mountainous regions and therefore would likely only be found in the northeastern part of the state.

The hoary bat (*Lasiurus cinereus*) is another special concern species in Mississippi with 5 records documented in the MNHP Database. This species is thought to be a generalist in terms of habitat requirements and fairly common through-out its range. However, given the low number of records for this species in Mississippi, additional surveys are necessary to more adequately determine relative abundance and habitat needs.

We have very few records for the northern yellow bat (*Lasiurus intermedius*), little brown bat (*Myotis lucifugus*), and silver-haired bat (*Lasionycteris noctivagans*) (all of which are special concern species) in Mississippi and it is likely that they no longer occur in the state as year round residents.

Rafinesque's big-eared bat (*Corynorhinus rafinesquii*) and southeastern myotis

(*Myotis austroriparius*) are two special concern species in Mississippi. Due to intensive survey efforts over the last 12 years, county records in the MNHP have increased from 6 to 22 records for Rafinesque's big-eared bat and from 5 to 19 records for southeastern myotis (McCartney 2007). Additional surveys are necessary however, to determine regional and local population trends. These 2 species are the focus species for this project.

Rafinesque's Big-eared Bat and Southeastern Myotis

Rafinesque's big-eared bat and southeastern myotis are two rare bat species found in the southeastern United States. Both of these species have similar geographic and ecological distributions and show a preference for comparable foraging and roosting habitats (National Biological Resources 1995, Clark 2000a). They can be found in bottomland hardwood (BLH) forests using large hollowed out trees as roosts (Horner and Maxey 1998, Clark 2000b, Bat Conservation International 2001, Kentucky Bat Working Group 2003), particularly water tupelo (*Nyssa aquatica*) and bald cypress (*Taxodium distichum*) (Hofmann et al. 1999, Clark 2000a). In the northern states within their range, they are prevalent in caves. However, in states such as Mississippi where caves are rare, they are more commonly found occupying tree roosts and man-made structures. Population numbers for Rafinesque's big-eared bat and southeastern myotis are thought to be declining regionally (Gore and Hovis 1992, Clark 2000b, Bat Conservation International 2001, Kentucky Bat Working Group 2003).

Conservation Status

Rafinesque's big-eared bat and southeastern myotis were formerly listed as category 2 species (a classification no longer in use) under the Federal Endangered Species Act, meaning that these species were possibly endangered or threatened, but sufficient data for classification were lacking. Rafinesque's big-eared bat is federally listed as a species of special concern and state listed as endangered, threatened or a species of special concern throughout its range. Southeastern myotis is federally listed as a species of special concern and state listed as endangered, threatened or a species of special concern in every state within its range, excluding Florida. Surveys conducted prior to 1990 estimated the numbers of southeastern myotis in Florida at 400,000 adult females, located in 15 maternity caves (Gore and Hovis 1992). However, in 1991 fewer than 200,000 female adults were counted and several of these caves showed signs of human disturbance (Gore and Hovis 1992, Nature Serve 2003). It is thought that Florida still has large numbers of this species although there has been a 45-50% decline in the last 30-40 years (Nature Serve 2003). Over 40 officials from states within the range of southeastern myotis have agreed that this species is in decline and should be federally listed as threatened (Hofmann et al. 1999). According to National Biological Resources (1995), Rafinesque's big-eared bat and southeastern myotis are at risk of extinction. Because total populations of both species are thought to be declining (Gore and Hovis 1992, Clark 2000b, Bat Conservation International 2001, Kentucky Bat Working Group 2003), further research is needed to determine the status of regional and local populations.

Habitat Needs

One of the primary causes for bat population declines in the southeastern United States is habitat destruction (Fenton 1983, Clark 2000b). The loss of BLH forests is a prime example of the reduction of ideal bat habitat. These forests were once common in the Southeast, and existing stands contain some of the best remaining habitats for bats. Studies conducted by Cochran (1999) and Clark (2000a) have shown that mature BLH forests are used by 11 of 18 bat species found in the East, including Rafinesque's big-eared bat and southeastern myotis. BLH forests are becoming greatly reduced due to silviculture practices that eliminate mature stands. Fifty-six percent of southern BLH and bald cypress forests were lost between 1900 and 1978 (Bass 1989). Remaining BLH forests are often fragmented. Rafinesque's big-eared bat is reluctant to cross large open areas between roosts (Clark 2000b), making fragmented habitats unsuitable for this species.

BLH forests provide optimal foraging habitat for Rafinesque's big-eared bat and southeastern myotis and often contain large, buttressed trees with cavities for roosting (Horner and Maxey 1998, Clark 2000b). Both species have been found to roost in black gum (*Nyssa sylvatica),* water tupelo, and bald cypress trees with large diameters and a triangular opening at the base (Horner and Maxey 1998, Clark 2000b, Trousdale and Beckett 2001). Roost trees provide sites for mating, hibernation, and rearing of young as well as protection from harsh weather and predators (Kunz 1982). Bats spend over half of their time in roosts, which are considered a limiting factor for Rafinesque's big-eared bat and southeastern myotis (Clark 2000a). As a result of declining habitat, these species can often be found in alternative roost sites such as abandoned houses (Hall 1999, Trousdale and Beckett 2000, Sherman 2004), old cisterns (Harvey et al. 1999, Sherman 2004), and bridges (Trousdale and Beckett 2000, Lance and Garrett 1997). In fact, the majority of known maternity colonies of Rafinesque's big-eared bat are found in abandoned and decayed buildings (Barbour and Davis 1969). The largest maternal colonies known in Mississippi are located in abandoned buildings for Rafinesque's big-eared bat and in cisterns for southeastern myotis (Sherman 2004).

GOALS/OBJECTIVES:

The objectives for this project were to: 1. conduct surveys to examine overall bat species composition, relative abundance of individuals, and activity on Theodore Roosevelt NWR Complex, 2. identify bat foraging and roosting habitats with an emphasis of those being used by Rafinesque's big-eared bat and southeastern myotis, 3. examine colony dynamics at roosts with regard to sex/age class characteristics and number of individuals, 4. determine critical time periods and locations corresponding to reproductive behaviors, and 5. provide management suggestions to aid in conservation practices.

STUDY AREA

Four refuges within the Theodore Roosevelt National Wildlife Refuge (NWR) Complex were the focus for this study: Morgan Brake NWR, Hillside NWR, Panther Swamp NWR, and Yazoo NWR (Figure 1). With 52,500 acres of BLH forests, these

Figure 1. Four refuges within Theodore Roosevelt NWR surveyed for bats from April – October, 2007.

refuges provide ideal habitats for bats, particularly Rafinesque's big-eared bat and southeastern myotis, although none had previously been surveyed. Several bat species have been captured near the Complex in the Delta National Forest during mist net surveys conducted by Wilf (2006) from 1999 – 2001. Evening bats (*Nycticeius humeralis*) were the most commonly captured species (59% of captures) while southeastern myotis was the second most abundantly captured species (22% or 153 individuals). Using radio telemetry, Wilf located three tree roosts for southeastern myotis in the following species; sweetgum, *(Liquidamber styraciflua)*, Nuttall oak (*Quercus texana*), and water hickory (*Carya aquatica*). Two Rafinesque's big-eared bats were also captured. Due to these findings and due to the prevalence of bottomland hardwood forests, the following common species would be expected to be found at Theodore Roosevelt NWR Complex; red bat (*Lasiurus borealis*), evening bat, big brown bat (*Eptesicus fuscus*), Brazilian free-tailed bat (*Tadarida brasiliensis*), Seminole bat (*Lasiurus seminolus*), and eastern pipistrelle (*Pipistrellus subflavus*). The following special concern species would be expected to be found on the Refuge Complex; hoary bat, Rafinesque's big-eared bat, and southeastern myotis.

METHODS

Mist Net Surveys

GPS coordinates were attained for all water bodies close to roads at Morgan Brake NWR, Hillside NWR, Panther Swamp NWR, and Yazoo NWR using topographic maps in ArcView 3.3. These sites were located in the field using a global positioning system (GPS) (Garmin Etrex Vista) to determine mist net and/or Anabat suitability. Mist

net surveys were conducted at suitable sites twice a month in April and May, 6 times a month in July and August and 4 times a month in June, September, and October, 2007 to determine habitat usage by Rafinesque's big-eared bat and southeastern myotis and overall bat species diversity. Surveys were conducted using mist nets (6 m. – 18 m. length, 30 mm mesh, Avinet) (Figure 2 and Figure 3) with nets being opened 15 minutes before sunset and closed approximately four hours later. A minimum of three nets were used per site and were placed above waterways, dirt roads, or other potential flyways. Ambient temperature, relative humidity, and other relevant climatic conditions were recorded when nets were first raised and closed for the evening. Nets were checked every fifteen minutes for captured bats.

Morphometric Data and Standard Measurements

Upon capture, bats were identified to species and sex. Reproductive status (pregnant, lactating, or scrotal) was derived using methods described by Kunz (1988). Age class was estimated by pelage color (Jones and Suttkus 1975) and degree of ossification of epiphyseal caps on phalanges of fingers (Kunz 1988). Weight, using a spring scale (30g. Pesola Micro-Line), (Figure 4) and forearm length, using a plastic dial caliper (Forestry Suppliers) was determined. The time and location of the bat in the net was noted. Diagrams of net placement were made and the habitat type of each site was determined using a Mississippi community key (Mississippi Natural Heritage Program, 2001b). Water body dimensions (depth, length) were estimated and the location of capture was recorded using a GPS.

Anabat Surveys

To obtain additional information concerning bat activity and species diversity on Theodore Roosevelt NWR Complex, an Anabat II Bat Detector (Titley Electronics) (Figure 5) was used at 9 locations (3 locations on Morgan Brake NWR and 2 locations each on Hillside NWR, Panther Swamp NWR , and Yazoo NWR) over 32 nights. An Anabat Bat Detector produces audible output from the ultrasonic (and therefore generally inaudible) sounds which bats generate in order to echolocate. All echolocation calls detected by the Anabat Detector were recorded using an Anabat CF Storage Zcaim (Titley Electronics) and downloaded into a personal computer. Using Anabat 6 ZCE Interface Software (Titley Electronics), recorded sonar calls were graphed based on frequency changes over time and specific parameters were extracted. Parameters extracted that were used for analysis to determine bat species included the maximum, minimum, and mean frequency of the call, the characteristic frequency (the frequency at the end, in time, of the flattest portion of the call when graphed), the frequency of the knee (the point at which the slope abruptly changes from the steep, initial down sweep to the flatter portion of the call), and the duration of the call (Figure 6). These parameters are commonly used by researchers for analyzing bat calls to determine species (Fenton and Bell 1981, Oliveira 1998). Calls were considered unsuitable for analysis if representative parameters of the call were unattainable (graph of the call was not clearly defined) due to several circumstances including bug interference, multiple bats calling at the same time, and/or if only a portion of the call was recorded (Figure 7).

Figure 2. Example of a standard set up to catch bats using mist net surveys.

Figure 3. An eastern pipistrelle caught in a mist net during bat surveys.

Figure 4. Weighing a bat using a spring scale.

Figure 5. An Anabat II Bat Detector used to record and analyze bat echolocation calls.

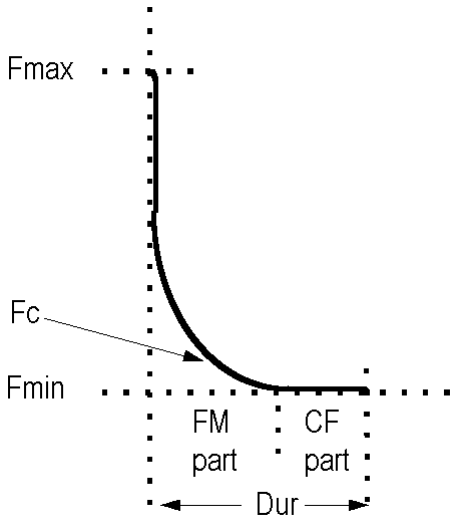

Figure 6. Time and frequency parameters of an idealized bat call used for analysis to determine bat species.
Note: Fmax = maximum frequency of the call, Fmin = minimum frequency, Fmean (not shown) = average frequency of total call calculated as the area under the curve divided by the duration (Corben 2004), CF = characteristic frequency, Fc = knee of the frequency, and Dur = duration or the total time of the call.

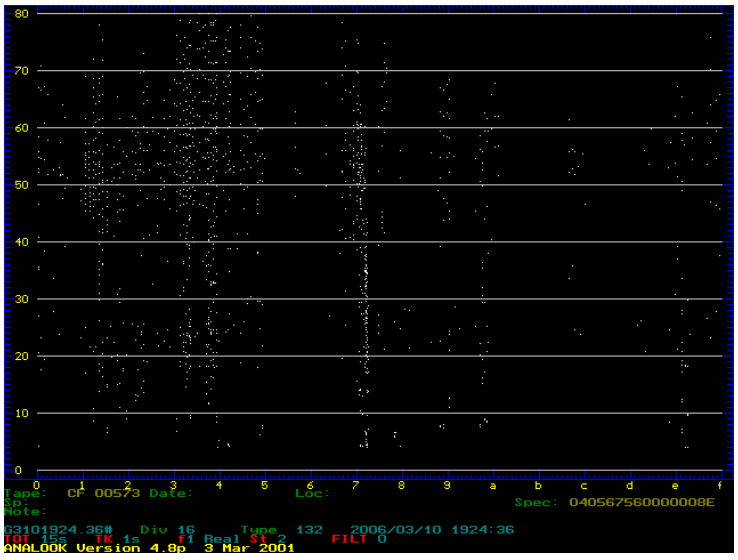

Figure 7. Example of a recorded bat call that was discarded from analysis due to bug interference (parameters could not be extracted due to an undefined graph).
Note: x-axis = time in milliseconds and y-axis = frequency in kHz.

Parameters from recorded calls from unknown species were compared to parameter ranges from reference calls of known species attained from a call library. Calls in the call library were attained from recordings made in the field of hand released bats that had first been properly identified to species (recorded by A. McCartney and C. Corben). Species represented in the call library were: Rafinesque's big-eared bat (sample size = 5 calls), southeastern myotis (n = 16), evening bat (n = 14), eastern pipistrelle (n = 15), red bat (n = 12), big brown bat (n = 5), little brown bat (*M. lucifugus*) (n = 11), hoary bat (*L. cinereus*) (n = 10), Indiana bat (*M. sodalis*) (n = 8), silver-haired bat (*Lasionycteris noctivagens*) (n = 8), and yellow bat (*L. intermedius*) (n = 5). Species were identified from each of the recorded calls when the parameters of the call fell within the range of parameters of a species in the call library. Appendix A documents the parameter ranges attained for each of the species in the call library which was used to identify species from recorded calls. If parameters from a recorded call fell within the range of 2 species from the call library or did not fall within any species range, the call was discarded from analysis.

Roost Surveys

To locate roosts, all bridges and abandoned buildings located on the Refuge Complex were surveyed for bat occupancy. Characteristics of abandoned buildings were documented including dimensions, condition, and surrounding habitat. Characteristics of each bridge were noted including dimensions, presence of water underneath the bridge, waterway dimensions, and bridge substrate and design.

In addition, 750 acres were surveyed on foot to locate suitable trees and roosts. Locations for surveys were chosen on each refuge based on suitable habitat for Rafinesque's big-eared bat and southeastern myotis. During surveys, GPS coordinates were taken at 100 foot intervals to accurately map the area later using ArcView 3.2 Software. All trees within the survey area with basal cavities were inspected using a spotlight to determine bat occupancy.

Radio telemetry was also used in an attempt to locate roosts. After capture via mist net, 11 southeastern myotis individuals were fitted with a LB-2N radio transmitter (Holohil Systems Ltd.) (Figure 8). Using a telemetry receiver and a 3-element folding antenna (Holohil Systems Ltd.), attempts were made to track individuals for a minimum of 3 days each (Figure 9).

RESULTS

Mist Net Surveys

Sixty-one sites were scouted in the field on Morgan Brake NWR, Hillside NWR, Panther Swamp NWR, and Yazoo NWR to determine mist net suitability. Mist net surveys were conducted at 23 sites over 28 nights (5 sites at Morgan Brake NWR and 6 sites each at Hillside NWR, Panther Swamp NWR, and Yazoo NWR). A total of 201 bats were captured representing 5 species averaging 7.18 bats captured per net night (Figure 10). Forty-seven southeastern myotis were captured representing 22% of the total number of bats captured. Other bat species captured during the survey period included the:

Figure 8. A radio telemetry transmitter placed on a bat in an attempt to locate roosts.

Figure 9. A receiver and antennae used during telemetry surveys.

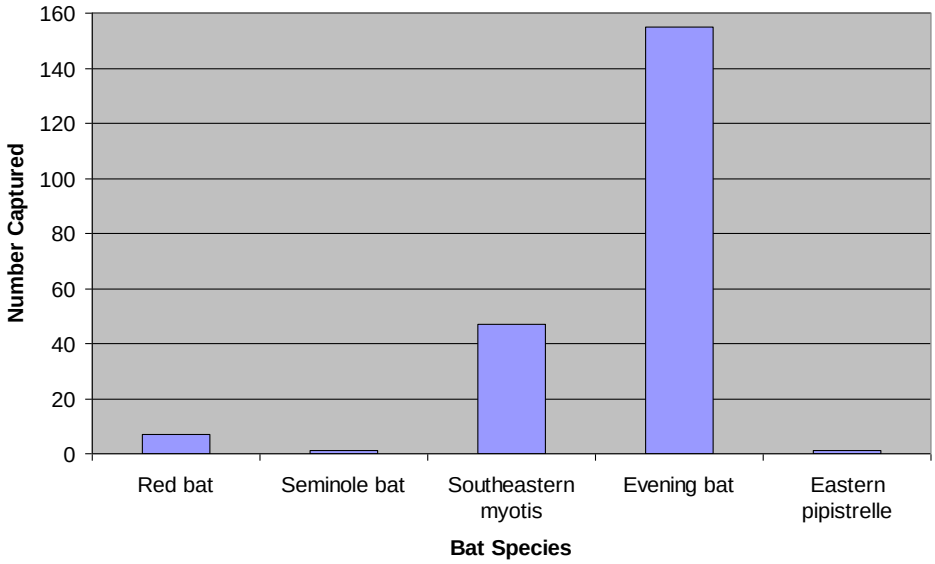

Figure 10. Number of bats captured per species during mist net surveys conducted at 4 refuges within Theodore Roosevelt NWR Complex from April - October, 2007.

evening bat (74% of the total bat captures), red bat (3%), Seminole bat (0.5%), and eastern pipistrelle (0.5%). Out of the 4 refuges, Panther Swamp NWR had the highest capture average with 12.88 bats captured per net night (Figure 11). Capture averages for the other 3 refuges were: 6.5 bats captured per net night at Yazoo NWR, 4.57 at Morgan Brake NWR, and 2.8 at Hillside NWR. Yazoo NWR had the highest species diversity with 5 species captured (red bat, evening bat, southeastern myotis, Seminole bat, and eastern pipistrelle) (Figure 11). Three species (red bat, evening bat, and southeastern myotis) were captured each at the other 3 refuges.

Morgan Brake NWR

Morgan Brake NWR consists of 7,400 acres, 4,000 of which contain BLH forests. Five sites on Morgan Brake NWR were surveyed over 7 nights. Thirty-two bats were captured averaging 4.57 bats captured per net night representing 3 species (Figure 12 and Table 1). Southeastern myotis was the most prevalently captured species with 18 bats captured representing 57% of the total bats captured. Out of the 4 refuges, Morgan Brake NWR had the highest percentage of southeastern myotis captures. Other species captured were the: evening bat (33% of total captures) and red bat (10%).

Eighty-one percent of the total captures occurred at one site (Site #MB8) (Figure 13 and Table 1). Site #MB8 was a small creek/tributary to Tchula Lake ~ 1 – 7 m wide and 0.10 – 1.5 deep with a mucky substrate. The water was clear with a fast flowing current. Logs and debris crossed the creek. Bald cypress was found along the banks and

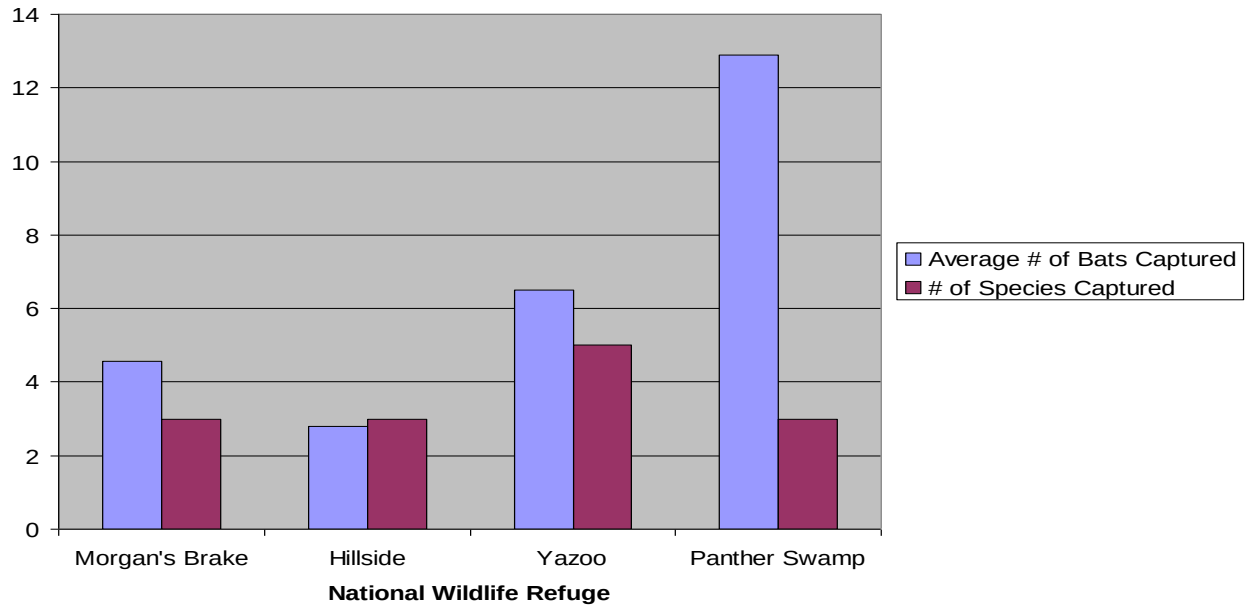

Figure 11. Average number of bats captured per net night and total number of species captured at 4 refuges within Theodore Roosevelt NWR Complex during mist net surveys conducted from April – October, 2007.

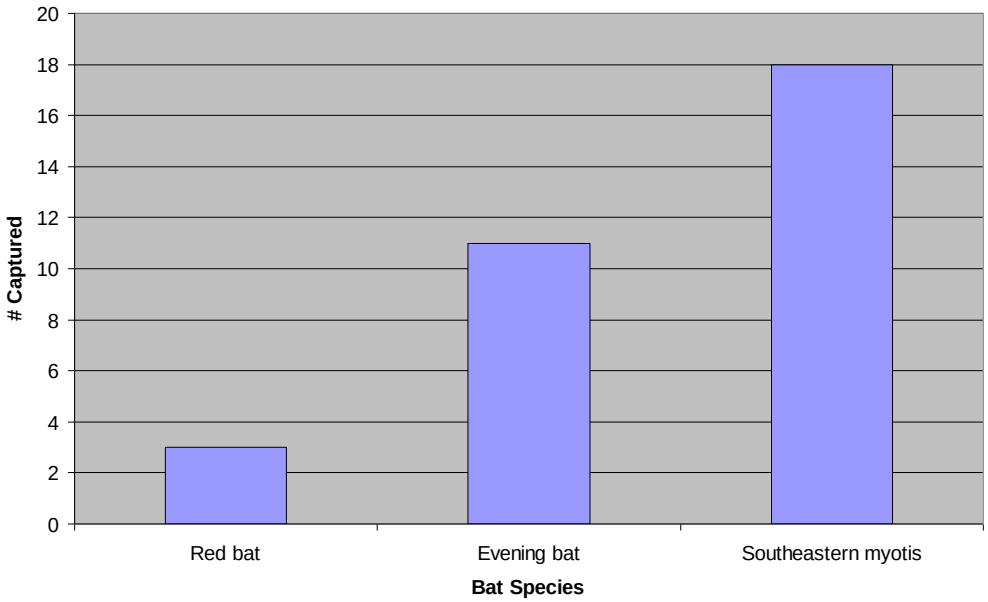

Figure 12. Number of bats captured per species at Morgan Brake NWR during mist net surveys conducted from April – October, 2007.

Table 1. Mist net survey site information for bats captured at Morgan Brake NWR during surveys conducted from April – October, 2007.
Note: MYAU = southeastern myotis, NYHU = evening bat, and LABO = red bat.

SITE #	DATE	LOCATION	SPECIES	#
MB4	4/26/07	MB NWR, Providence Rd. east of Head Quarters	MYAU	1
MB5	5/22/07	MB NWR, Slough off Providence Rd. east of Site #MB4	LABO MYAU	1 1
MB8	6/12/07	MB NWR, Creek crossing HWY 49 East, north of Providence Rd.	NYHU MYAU	1 2
MB8	8/16/07	MB NWR, Creek crossing HWY 49 East, north of Providence Rd.	NYHU LABO MYAU	10 1 12
MB11	8/23/07	MB NWR, Tupelo stand on east side of HWY 49 East just south of MB8	MYAU LABO	2 1
MB13	10/12/07	MB NWR, Bluff on south end of refuge	0	
MB8	10/20/07	MB NWR, Creek crossing HWY 49 East, north of Providence Rd.	0	

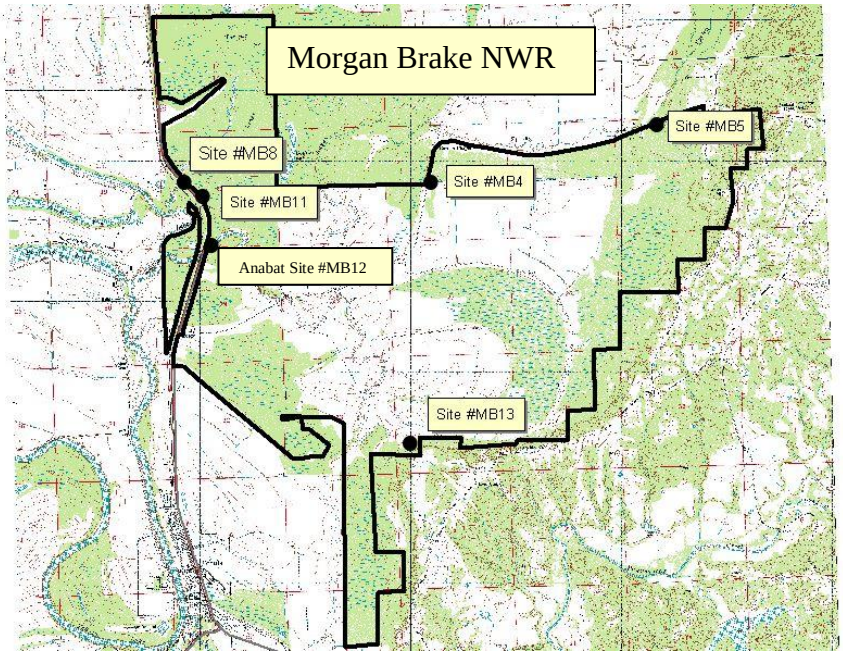

Figure 13. Sites chosen for mist net surveys at Morgan Brake NWR during bat surveys conducted from April – October 2007.

within the creek, some of which were quite large. The area was surrounded by a mixed bottomland hardwood forest. The dominant tree species was bald cypress (*Taxodium distichum*). Other species surrounding the creek was honey locust (*Gleditsia triacanthos*). Only 1 site out of 5 on the refuge resulted in no bat captures. This site was the only one chosen that did not have a stream or pond. Instead nets were placed within the forest interior.

Southeastern myotis was captured at 4 out of 5 sites (#MB4, MB5, MB8, and MB11). Site #MB4 was a small thin creek ~ 2 m wide and 0.25 – 1 m in depth that ran 20 m south of the road before bordering agricultural land. Mixed hardwood forests surrounded the stream on the east and west sides with a swamp slough area located ~ 100 m east. The stream had 100% canopy cover with tree limbs located ~ 5 – 15 m above the water surface. Surrounding vegetation included: American elm (*Ulmus Americana*), winged elm *(U. alata*), black locust (*Robinia pseudoacacia*), and persimmon *(Diospyros virginiana*). Site #MB5 was a slough ~ 18 X 8 m and ranged from 0.25 – 0.75 m deep with a mucky substrate. The site was surrounded by a mixed hardwood forest with some trees growing in the water. Dominant tree species were box elder (*Acer nugundo*) and sugar maple (*A. saccharinum*). Other vegetation included: sweetgum (*Liquidambar styracilfua*), red maple (*A. rubrum*), honey locust, black willow (*Salix nigra*), sycamore (*Platanis occidentalis*), water tupelo (*Nyssa aquatica*), swamp chestnut oak (*Quercus michauxii*), and American elm. Site #MB11 was a Tupelo stand ~ 12 – 20 m wide and 0.10 – 0.25 m deep with a mucky substrate. This site contained debris, logs, leaf litter and trees in the water with a heavy cover of duckweed on the water surface. This stand was surrounded by a bottomland hardwood forest. Dominant tree species were water tupelo with some bald cypress in the water. Surrounding vegetation included overcup oak (*Q. lyrata*), water hickory (*Carya aquatica*), persimmon, and box elder. See Appendix B for habitat characteristics for all sites.

Hillside NWR

Hillside NWR consists of 15,500 acres, 12,000 of which contain BLH forests. Five sites were surveyed over a five night period. A total of 14 bats were captured averaging 2.8 bats captured per net night representing 3 species (Figure 14 and Table 2). Hillside NWR had the lowest capture average of the 4 refuges surveyed. One southeastern myotis was captured representing 7% of the total bat captures. Hillside NWR had the lowest number of captures for southeastern myotis (1 capture). Other species captured included the: evening bat (79% of total captures) and red bat (14%).

Bats were captured at all 5 sites. The southeastern myotis was captured at Site #HS11 (Figure 15). Site #HS11 was a tupelo/cypress swamp ~ 40 m wide and at least 100 m long. Water depth ranged from 0.25 – 1.25 m with a mucky substrate. The swamp contained large amounts of leaf litter and logs in the water. This site was surrounded by a bottomland hardwood forest. Dominant tree species were water tupelo and bald cypress. Other tree species was: silver maple. See Appendix B for habitat characteristics for all sites.

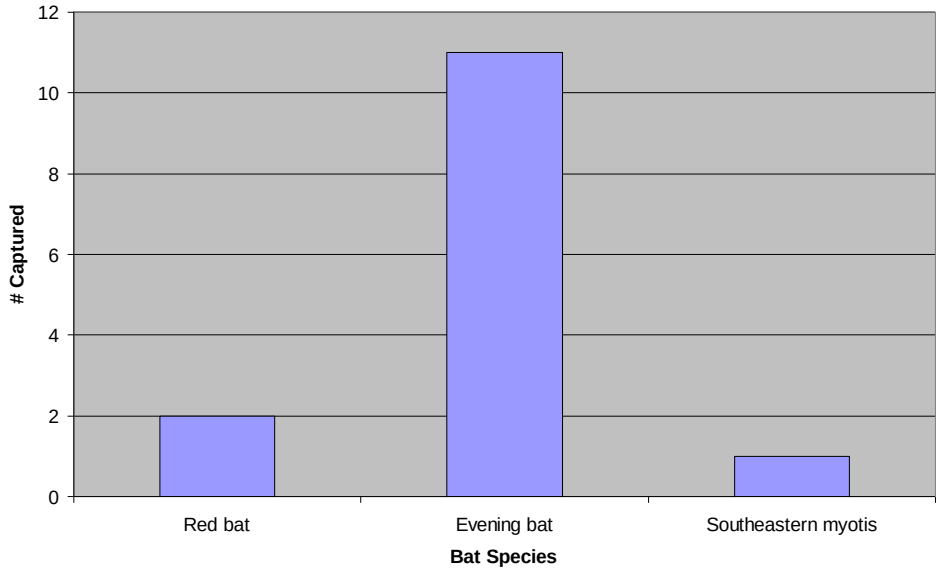

Figure 14. Number of bats captured per species during mist net surveys conducted at Hillside NWR from April – October, 2007.

Table 2. Mist net survey site information for bats captured at Hillside NWR during surveys conducted from April – October, 2007.
Note: MYAU = southeastern myotis, NYHU = evening bat, and LABO = red bat.

SITE #	DATE	LOCATION	SPECIES	#
HS1	4/27/07	HS NWR, Alligator Slough	NYHU	1
HS15	5/21/07	HS NWR, Tipton Bayou ¼ mile down rd.	NYHU	2
HS11	7/26/07	HS NWR, Swamp on E side of Levee Rd. ~ 2 miles E/NE of HWY 49 E	MYAU NYHU LABO	1 4 1
HS2	7/27/07	HS NWR, Tipton Bayou N of Site #HS15	NYHU LABO	2 1
HS4	8/24/07	HS NWR, Fannegusha Creek, < 1/8 of a mile S on W levee rd	NYHU	2

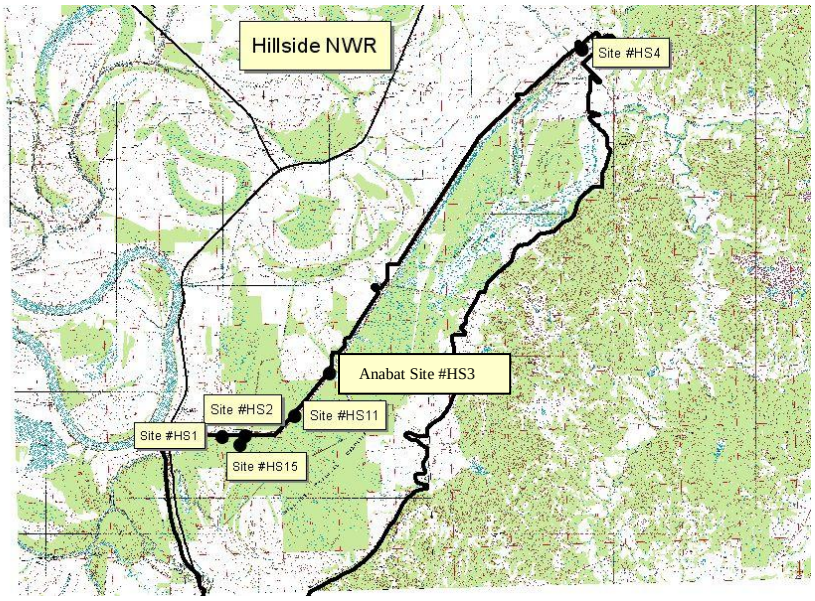

Figure 15. Sites chosen for mist net surveys conducted at Hillside NWR from April – October, 2007.

Panther Swamp NWR

Panther Swamp consists of 38,600 acres, 30,000 of which contain BLH forests. Six sites were surveyed over 8 nights. A total of 103 bats were captured averaging 12.88 bats captured per net night representing 3 species (Figure 16 and Table 3). Panther Swamp had the highest capture average out of the four refuges surveyed. Ten southeastern myotis individuals were captured representing 10% of the total captures. Other species captured included the: evening bat (89 % of total captures) and red bat (1%).

Bats were captured at all 8 sites. Southeastern myotis individuals were captured at Sites # PS14, PS19, PS20, and PS21 (Figure 17). Site #PS14 was a slough area ~10 X 40 m and 0.10 – 0.50 m deep with a clayey substrate. Some logs and small trees were located in the water along banks. This site was surrounded by a bottomland hardwood forest. Dominant tree species were overcup oak, willow oak (*Q. phellos*), honey locust, and water hickory. Other species included slippery elm (*U. rubra*) and sugarberry (*Celtis laevigata*). Site #PS19 was a water ditch draining from a marsh running parallel to a gravel road. The ditch was ~ 4 – 6 m wide, 18 m long and 0.10 – 1 m deep with a silty substrate surrounded by a bottomland hardwood forest. Dominant species along the ditch and road included: laurel oak, overcup oak, pecan (*Carya illinoensis*), and eastern hornbeam. Site #PS20 was a water tupelo stand ~ 0.10 – 0.50 m deep with a mucky substrate. Logs, debris, and trees were in the water. The dominant tree species was water tupelo. Other species was sugarberry. Site #PS21 was a medium size creek ~ 6 -20 m

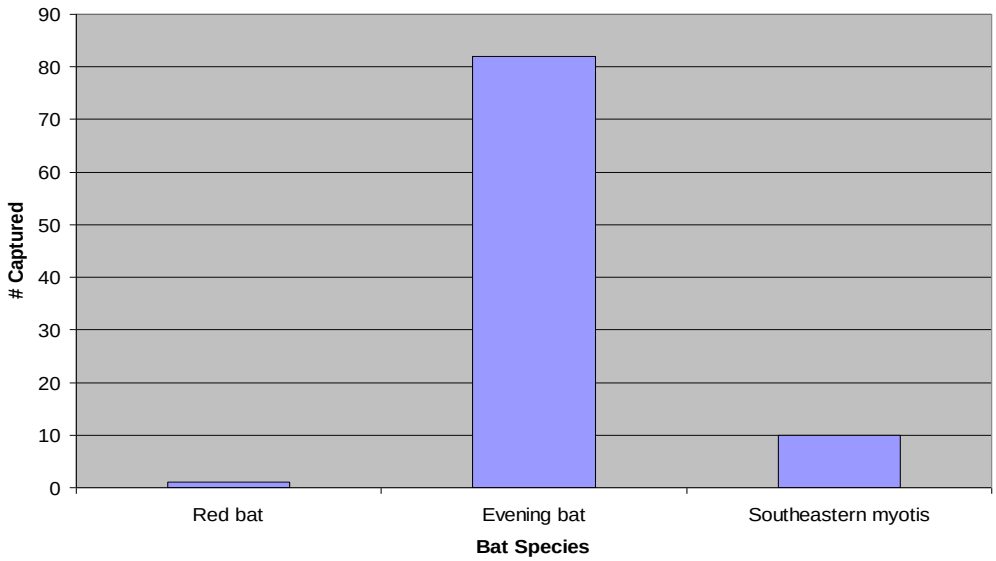

Figure 16. Number of bats captured per species during mist net surveys conducted at Panther Swamp NWR from April – October, 2007.

Table 3. Mist net survey site information for bats captured at Panther Swamp NWR during surveys conducted from April – October, 2007.
Note: MYAU = southeastern myotis, NYHU = evening bat, and LABO = red bat.

SITE #	DATE	LOCATION	SPECIES	#
PS5	7/28/07	PS NWR, W portion of refugee, S of cleared land	NYHU	8
PS13	8/7/07	PS NWR, Off power line gravel rd. leading to Duck Camp	NYHU	4
PS14	8/17/07	PS NWR, Pipeline gravel road E of E levee towards Duck Camp, W of Site #PS13	NYHU MYAU	19 2
PS20	8/18/07	PS NWR, Gravel Rd. behind Head Quarters	NYHU MYAU LABO	10 3 1
PS14	9/6/07	PS NWR, Pipeline gravel road E of E levee towards Duck Camp, W of Site #PS13	NYHU	17
PS20	9/7/07	PS NWR, Gravel Rd. behind Head Quarters	MYAU NYHU	1 2
PS21	10/13/07	PS NWR, Tributary to Panther Creek off Pipeline Rd.	NYHU MYAU	10 1
PS19	10/19/07	PS NWR, Water ditch draining into marsh off of gravel rd. S of road leading to refuge head quarters	NYHU MYAU	22 3

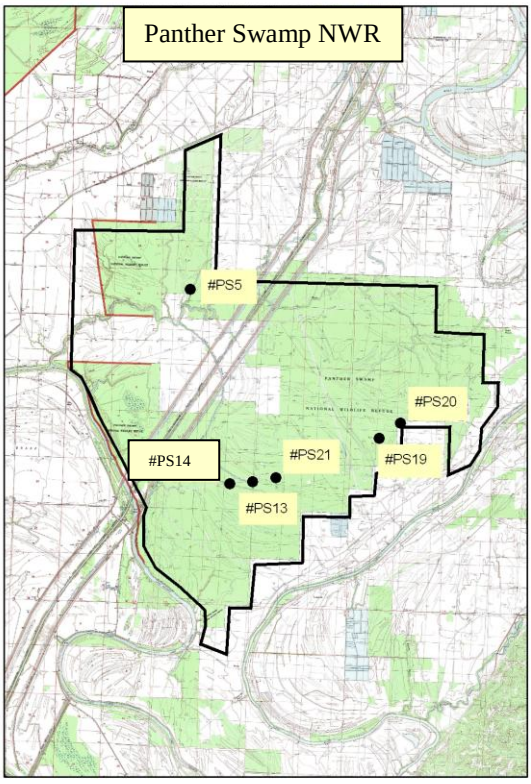

Figure 17. Sites chosen for mist net surveys conducted at Panther Swamp NWR from April – October 2007.

wide and 0.10 – 0.75 m deep with a silty substrate surrounded by a bottomland hardwood forest. Dominant species along the creek bank included small: button bush (*Cephalantis occientalis*), possomhaw holly (*Ilex decidua*), pecan, and sugar berry. Dominant species away from the banks included: overcup oak, and willow oak. These trees ranged from 18 – 25 m tall with little understory.

Yazoo NWR

Yazoo NWR consists of 13,000 acres, 6,500 of which is BLH forests. Six sites were surveyed over 8 nights. Fifty-two bats were captured averaging 6.5 bats captured per net night representing 5 species (Figure 18 and Table 4). Yazoo NWR had the highest species diversity out of the 4 refuges surveyed. Eighteen southeastern myotis were captured representing 36% of the total captures. Other species captured included the: evening bat (61% of total captures), red bat (1%), Seminole bat (1%), and eastern pipistrelle (1%).

Bats were captured at 4 of the six sites. Southeastern myotis individuals were captured at 3 sites; Sites #YZ2, YZ4, and YZ8 (Figure 19). Site #YZ2 was a slough/swamp area with periodic pools ranging from 20 – 30 X 40 – 60 m and 0.10 – 1.5

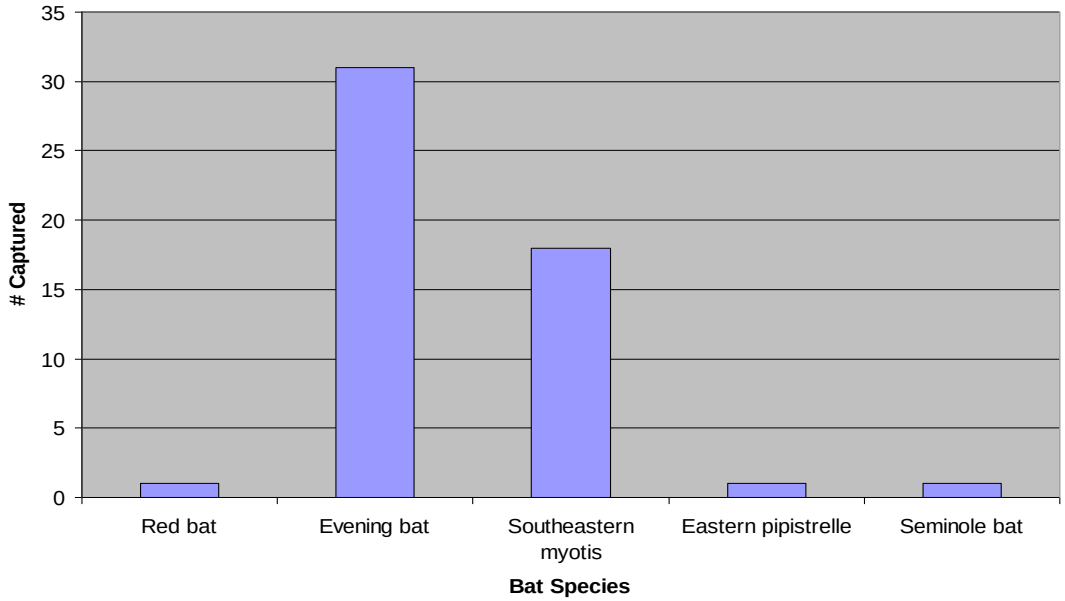

Figure 18. Number of bats captured per species during mist net surveys conducted at Yazoo NWR from April – October, 2007.

Table 4. Mist net survey site information for bats captured at Yazoo NWR during surveys conducted from April – October, 2007.
Note: MYAU = southeastern myotis, NYHU = evening bat, LABO = red bat, LASE = Seminole bat, and PISU = eastern pipistrelle.

SITE #	DATE	LOCATION	SPECIES	#
YZ2	6/27/07	YZ NWR, Hoots Dump Slough, SW of HQ	NYHU MYAU LASE	6 3 1
YZ4	8/1/07	YZ NWR, Closed area on gravel rd. going W off Yazoo Refuge Rd.	MYAU	3
YZ14	6/28/07	YZ NWR, Creek off Surveilance Station Rd.	0	
YZ17	7/18/07	YZ NWR, Slough off gravel rd. going to Lizards Lake	NYHU	1
YZ4	7/19/07	YZ NWR, Closed area on gravel rd. going W off Yazoo Refuge Rd.	MYAU NYHU PISU	7 1 1
YZ1	7/20/07	YZ NWR, Hoots Dump Slough, SW of HQ, N of Site #YZ20		
YZ2	9/20/07	YZ NWR, Hoots Dump Slough, SW of HQ	NYHU MYAU	4 2
YZ8	9/21/07	YZ NWR, Tributary to Silver Lake	NYHU LABO MYAU	19 1 3

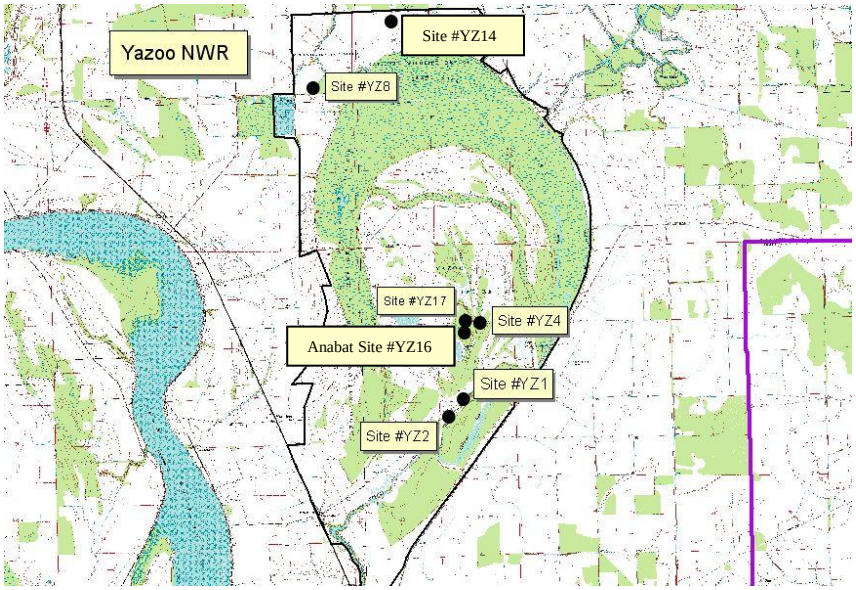

Figure 19. Sites chosen for mist net surveys conducted at Yazoo NWR from April – October, 2007.

m in depth. The site was surrounded by a BLH forest with some bald cypress located in the water. Dominant tree species were bald cypress, swamp privet, and post oak (*Q. lyrata*). Other vegetation included: water oak (*Q. nigra*), sweetgum, sugarberry, persimmon, pecan, and American elm. Site #YZ4 was a ditch running parallel to the road that was periodically filled with water ~ 4 m wide and 0.10 – 1.10 deep. The ditch had deeply incised banks with a clayey substrate. This site was surrounded by an old growth mixed hardwood forest. Dominant tree species were sweetgum, box elder, black locust, sugarberry, green ash (*Fraxinum pennsylvanica*), and slippery elm. Site #YZ8 was a thin creek ~ 8 - 10 m wide and 0.25 – 1.25 m deep with a silty clay substrate. The creek had deeply incised banks and was surrounded by a mixed hardwood buffer. Fallow cropland surrounded the streamside zone. Dominant tree species were bald cypress, red maple, winged elm, honey locust, green ash, and box elder.

Morphometric Data and Standard Measurements

Out of 201 captured bats, 88 were females, 109 were males, and 4 escaped before being processed. One-hundred and eighty-five were adults and 9 were juveniles. Out of the 88 females, 2 were pregnant, 3 were lactating, and 83 were non-reproductive. Out of 109 males, 81 were scrotal and 26 were non-reproductive (Appendix C).

Seven red bats were caught; 4 of which were females, 2 males, and 1 escaped before processing. All 6 of the processed individuals were non-reproductive adults. The average weight was 11.95 g for females and 10.75 g for males. Average forearm length was 41.10 mm for females and 40.61 mm for males.

One juvenile non-reproductive female Seminole bat was captured. Her weight

was 8.3 g and her forearm length was 43.9 mm.

Forty-seven southeastern myotis were captured; 23 were females, 22 were males, and 2 escaped before being processed. Twenty-one of the females were adults and 2 were juveniles. One adult female was pregnant (captured on 4/26/07), 2 were lactating (6/12/07), and 1 was post-lactating (7/19/07). Twenty of the males were adults and 2 were juveniles. Three of the adult males were scrotal (captured on 8/16/07 and 10/19/07). The average weight was 7.68 g for females and 6.8 for males. Average forearm length was 37.51 mm for females and 36.52 for males.

One-hundred and forty-five evening bats were captured; 59 were females, 83 were males, and 3 escaped before being processed. Fifty-seven of the females were adults, 1 was a juvenile, and 1 was not determined. Fifty-six of the females were non-reproductive and 1 was lactating (captured on 6/27/07). Eighty males were adults, 2 were juveniles, and 1 was undetermined. Seventy-eight of the males were scrotal (captured June – October, 2007) and 5 of the males were non-reproductive. Average weight was 12.28 g for females and 10.93 g for males. Average forearm length was 37.14 mm for females and 35.35 mm for males.

One adult non-reproductive male eastern pipistrelle was captured. His weight was 7.5 g and forearm length 35.1 mm.

Anabat Surveys

To further document species diversity and relative bat activity on the refuges, an Anabat Bat Detector was used at 9 locations over 32 nights from June – September, 2007 (Table 5). Over 10,000 calls were recorded and analyzed to determine suitability for analysis and to identify bat species. Many of these calls were not considered for analysis due to bug or other interference which made the call unidentifiable. Twenty-nine southeastern myotis calls were identified from 2 sites representing 6.37% of the total number of calls identified to species (Figure 20). Twelve southeastern myotis calls were recorded at Site #HS3 which was a large pond at Hillside NWR on the east side of the levee, south of Bear Lake. This site was not netted during this survey however, it was netted during the MS Bat Working Group Fourth Annual Mist Net Event on 6/12/07. During the Event, 1 southeastern myotis was captured at this site. Seventeen southeastern myotis calls were recorded from Site #MB8, which was a small creek/tributary to Tchula Lake lined with bald cypress trees and surrounded by a bottomland hardwood forest. Fourteen southeastern myotis were captured at this site during mist net surveys over a 2 night period. Additional calls identified were from the: evening bat (214 calls from 5 sites) (Figure 21), red bat (185 calls from 5 sites) (Figure 22), and eastern pipistrelle (27 calls from 5 sites) (Figure 23). Calls were recorded from 5 of the 9 sites. No recordings were made at 4 sites due to either a lack of activity, or more likely due to bug interference or an equipment malfunction. Mist net surveys were conducted at three of these sites with bats captured. Site #YZ16 was the only 1 of these 4 sites that did not also have a mist net survey.

Table 5. Anabat site information for surveys conducted at Morgan Brake NWR, Hillside NWR, Panther Swamp NWR, and Yazoo NWR conducted from April – October, 2007. *Note. LABO = red bat, NYHU = evening bat, PISU = eastern pipistrelle, and MYAU = southeastern myotis.*

Date	ID	Site #	Site Descripton
6/27/07	26 LABO, 5 NYHU	YZ1	Yazoo NWR, Hoots Dump Slough
6/28/2007	18 LABO, 24 NYHU, 11 PISU	YZ1	across from equipment entrance
6/29/2007	12 LABO, 5 NYHU	YZ1	to Headquarters
7/18/07	No Recordings	YZ16	Yazoo NWR, Closed area, gravel
7/19/2007	No Recordings	YZ16	road leading to Lizards Lake
7/20/2007	No Recordings	YZ16	
7/21/2007	No Recordings	YZ16	
7/22/2007	No Recordings	YZ16	
7/23/2007	No Recordings	YZ16	
7/24/2007	No Recordings	YZ16	
7/25/2007	No Recordings	YZ16	
7/26/2007	No Recordings	YZ16	
7/27/07	No Recordings	HS1	Hillside NWR, Alligator Slough
7/28/2007	No Recordings	HS1	
7/29/07	No Recordings	HS1	
7/29/2007	No Recordings	HS3	Hillside NWR, Large pond on E side
7/30/2007	Primarily Bug Noise, 1 LABO	HS3	of levee, south of Bear Lake
7/31/2007	Primarily Bug Noise, 7 LABO, 3 NYHU, 1 MYAU	HS3	
8/1/2007	65 LABO, 11 NYHU, 4 PISU, 11 MYAU	HS3	
8/2/2007	10LABO, 4 NYHU, 2 PISU	HS3	
8/3/2007	8 LABO, 3 NYHU, 1 PISU	HS3	
8/7/07	19 NYHU, 2 LABO	PS13	Panther Swamp NWR, Power Line
8/8/07	4 LABO, 75 NYHU, 3 PISU	PS13	Rd., east of levee, leading to Duck
8/9/07	55 NYHU, 2 LABO, 1 PISU	PS13	Camp
8/10/07	1 NYHU	PS13	
8/17/07	No Recordings	MB8	Morgan Brake NWR, Tributary of
8/18/07	20 LABO, 3 PISU, 11 MYAU, 2 NYHU	MB8	Tchula Lake, east of HWY 49 E (N)
8/19/07	6 LABO, 6 MYAU, 1 NYHU	MB8	
8/19/07	No Recordings	MB11	Morgan Brake NWR, Tupelo stand
8/23/07	Bug Noise Only	MB11	S of Site #MB8 off HWY 49 E (N)
8/23/07	Bug Noise Only	MB12	Morgan Brake NWR, Large creek
8/24/07	6 NYHU, 4 LABO, 2 PISU	MB12	of MB11 on HWY 49 E
8/25/07	Bug Noise Only	MB12	
9/6/07	No Recordings	PS21	Panther Swamp NWR, Tributary to Panther Creek

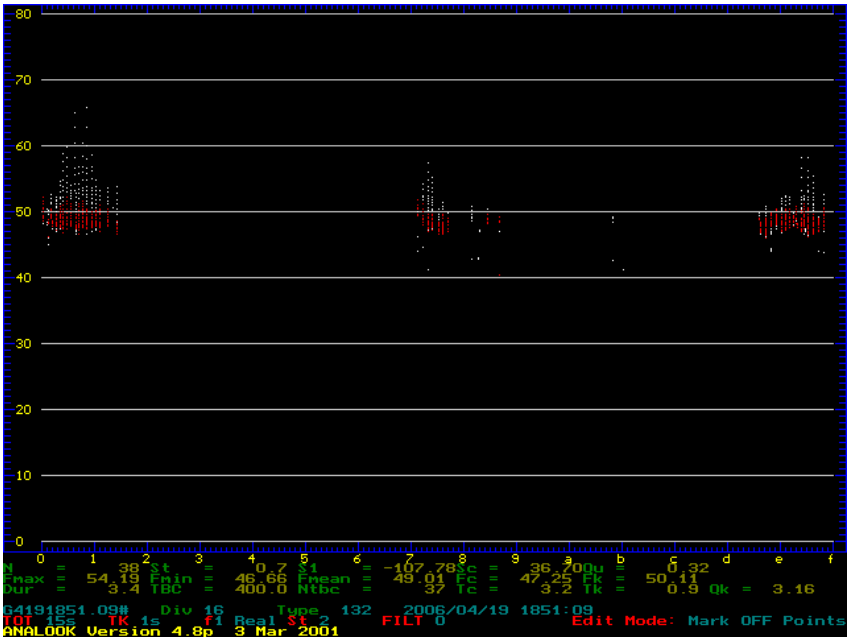

Figure 20. Graph of frequency changes over time of a southeastern myotis echolocation call recorded on an Anabat, including extracted parameters used for species analysis.

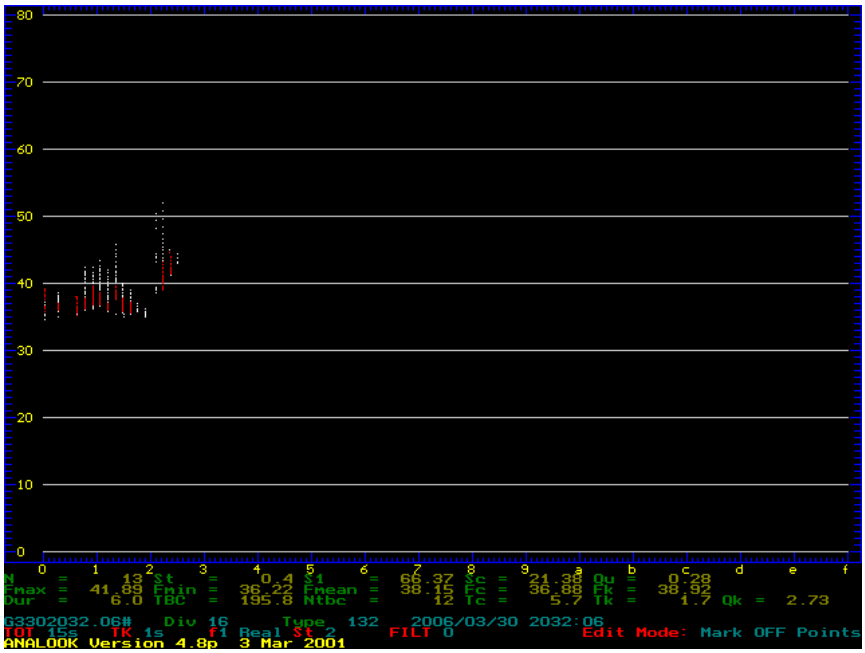

Figure 21. Graph of frequency changes over time of an evening bat echolocation call recorded on an Anabat, including extracted parameters used for species analysis.

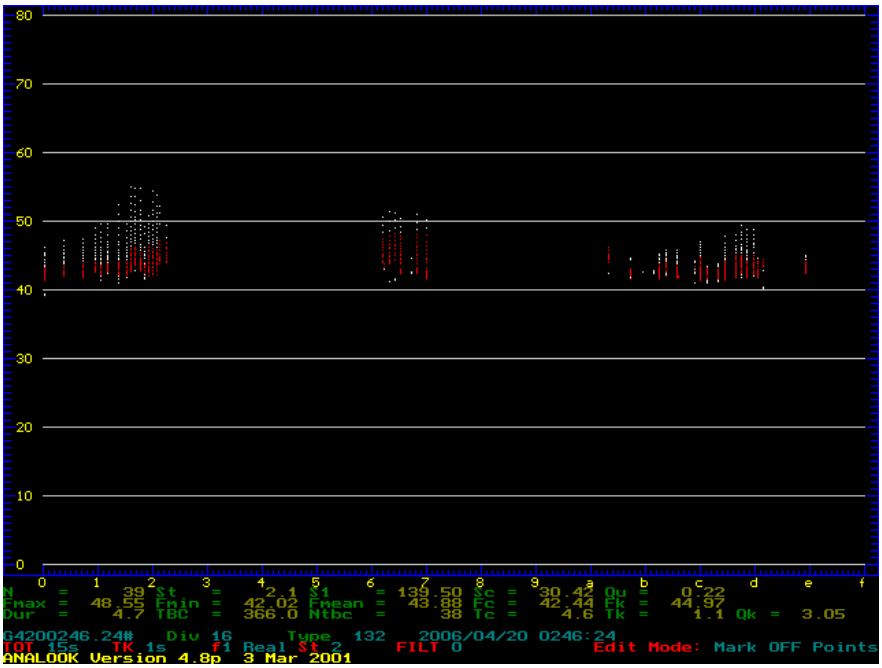

Figure 22. Graph of frequency changes over time of a red bat echolocation call recorded on an Anabat, including extracted parameters used for species analysis.

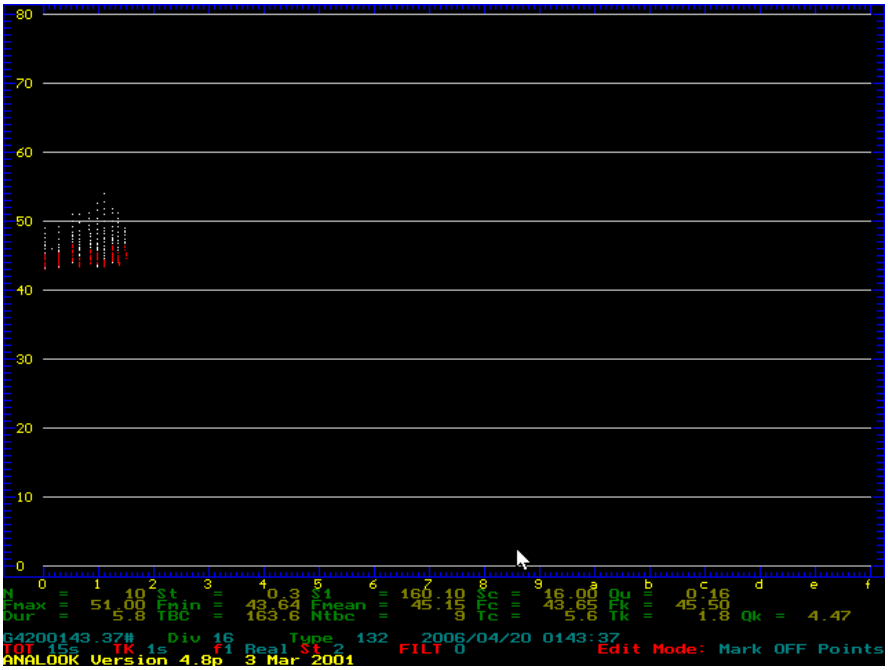

Figure 23. Graph of frequency changes over time of an eastern pipistrelle echolocation call recorded on an Anabat, including extracted parameters used for species analysis.

Roost Surveys

Man-made Roosts

One abandoned house located on Panther Swamp NWR and 24 bridges located on Morgan Brake NWR (4 bridges), Hillside NWR (8), Panther Swamp NWR (4), and Yazoo NWR (8) were surveyed for bat occupancy (Table 6). Bats have been documented to prefer concrete bridges as opposed to wood bridges and those bridges with cells or recessed areas underneath as opposed to a flat slab bridge (Lance 2001, Trousdale and Beckett 2000) (Figure 24). Eight of the 24 bridges surveyed were deemed suitable as roost sites because they were concrete bridges with multiple recessed cells underneath. Eleven bridges were deemed as probably suitable because they had similar characteristics as documented preferred bridges with minor differences (i.e. – larger cells). Four bridges were deemed as probably not suitable because either the cells were too large or the concrete bridge was built on wood pilings that smelled of creosote. One bridge was deemed as not suitable because it was a flat concrete slab bridge. No bats or evidence of bats were observed in the abandoned house or under any of the bridges on the dates surveyed.

Natural Roosts

Over 750 acres were scouted on foot in an attempt to locate tree roosts for Rafinesque's big-eared bat and southeastern myotis (Table 7). Five-hundred and seventy-two acres were surveyed in tupelo brakes and bottomland hardwood forests at Morgan Brake NWR. Ninety cavity trees were surveyed with no bats observed. One-hundred and ninety-eight acres of tupelo brakes and bottomland hardwood forests were surveyed on Panther Swamp NWR. Thirty cavity trees were surveyed with no bats observed. Five acres of bottomland hardwood forests were surveyed at Yazoo NWR. Four cavity trees were surveyed with no bats observed. Forty acres of mixed hardwood forests were surveyed at Hillside NWR. Twenty cavity trees were surveyed with no bats observed (Figure 25).

Telemetry Surveys

After capture via mist net, eleven southeastern myotis individuals were fitted with radio telemetry transmitters in an attempt to locate roosts (Table 8). Three individuals were captured on 7/20/07 at Yazoo NWR (Site #YZ4) and were tracked for 7 days. Signals were heard on 2 days for 2 separate individuals but could not be narrowed down to a specific tree. Three individuals were captured and tagged on 8/16/07 at Morgan Brake NWR (Site #MB8). One of the individuals was tracked for 5 days and the other 2 were tracked for 3 days. All roads within and immediately surrounding the refuge were slowly driven down while I was in the back of the truck with the telemetry receiver and antennae. Several miles surrounding the capture site were also surveyed on foot. Signals were never heard for these 3 individuals. Five individuals were captured and tagged at Yazoo NWR (2 at Site #YZ2 on 9/20/07 and 3 at #YZ8 on 9/21) and were tracked for 3 days without receiving any signals.

Table 6. Bridge information for man-made roost surveys conducted at Morgan Brake NWR, Hillside NWR, Panther Swamp NWR, and Yazoo NWR from April – October 2007.

Refuge	Date Surveyed	Bridge #	Location	Suitability
Panther Swamp NWR	9/13/2007	PSB1	1st bridge over Deep Bayou on Pipeline Rd.	Suitable
Panther Swamp NWR	9/13/2007	PSB2	2nd bridge on Pipeline Road	Suitable
Panther Swamp NWR	9/13/2007	PSB3	3rd bridge on Pipeline Road	Probably Not Suitable
Panther Swamp NWR	9/13/2007	PSB4	Road E of E Levee, N of Pipeline Road	Suitable
Yazoo NWR	9/21/2007	YZB1	Bridge crossing Steele Bayou on Bear Garden Road at main entrance to refuge	Probably Suitable
Yazoo NWR	9/24/2007	YZB2	Bridge crossing Steele Bayou on HWY 436 just E of HWY 1	Probably Suitable
Yazoo NWR	9/24/2007	YAB3	Bridge over tributary to Silver Lake on cox Road, N of cox Ponds and near Site #YZ8	Suitable
Yazoo NWR	9/24/2007	YZB4	Bridge over Silver Lake on Surveilance Station road	Probably Not Suitable
Yazoo NWR	9/24/2007	YZB5	Bridge over creek crossing Surveilance Station Road, E of YZB4	Probably Suitable
Yazoo NWR	9/24/2007	YZB6	Bridge over Sawmill road (1st N bridge)	Probably Suitable
Yazoo NWR	9/24/2007	YZB7	Bridge over Sawmill road (2nd N bridge)	Probably Not Suitable
Yazoo NWR	9/24/2007	YZB8	Bridge over Sawmill road (3rd N bridge)	Probably Not Suitable
Hillside NWR	10/20/2007	HSB1	1st bridge coming from the south on HWY 49 E (N)	Probably Suitable
Hillside NWR	10/20/2007	HSB2	2nd bridge coming from the south on HWY 49 E (N)	Not Suitable
Hillside NWR	10/20/2007	HSB3	3rd bridge coming from the south on HWY 49 E (N)	Probably Suitable
Hillside NWR	10/20/2007	HSB4	4th bridge coming from the south on HWY 49 E (N)	Probably Suitable
Hillside NWR	10/20/2007	HSB5	1st bridge coming from the west on Thorton Rd.	Suitable
Hillside NWR	10/20/2007	HSB6	2nd bridge coming from the west on Thorton Rd.	Suitable
Hillside NWR	10/20/2007	HSB7	3rd bridge coming from the west on Thorton Rd.	Suitable
Hillside NWR	10/20/2007	HSB8	Bridge over Fannegusha Creek	Suitable
Morgan Brake NWR	10/20/2007	MBB1	1st bridge coming from the south on HWY 49 E (N)	Probably Suitable
Morgan Brake NWR	10/20/2007	MBB2	2nd bridge coming from the south on HWY 49 E (N)	Probably Suitable
Morgan Brake NWR	10/20/2007	MBB3	3rd bridge coming from the south on HWY 49 E (N)	Probably Suitable
Morgan Brake NWR	10/20/2007	MBB4	4th bridge coming from the south on HWY 49 E (N)	Probably Suitable

Figure 24. Example of a bridge with characteristics that bats are documented to prefer.

Table 7. Number of acres surveyed for bat tree roosts at Morgan Brake NWR, Hillside NWR, Panther Swamp NWR, and Yazoo NWR from April – October, 2007.

Refuge	# of Acres	Habitat Type	# of Cavity Trees	# of Bat Roosts Located
Morgan Brake	569	Tupelo Stand	75	0
Panther Swamp	102.4	Tupelo Stand	20	0
Panther Swamp	96	Bottomland Hardwood Forest	10	0
Yazoo	5	Bottomland Hardwood Forest	4	0
Morgan Brake	3	Bottomland Hardwood Forest	15	0
Hillside	40	Mixed Hardwood Forest	20	0

Figure 25. Example of southeastern myotis tree roost.

Table 8. Information regarding telemetry surveys conducted on Yazoo NWR and Morgan Brake NWR from June – September, 2007.

Capture Location	Date	# of Days Tracked	# of Days Signal Detected	Roost Located?
Site #YZ4	7/20/2007	7	2	No
Site #YZ4	7/20/2007	7	2	No
Site #YZ4	7/20/2007	7	0	No
Site #MB8	8/16/2007	5	0	No
Site #MB8	8/16/2007	3	0	No
Site #MB8	8/16/2007	3	0	No
Site #YZ2	9/20/2007	3	0	No
Site #YZ2	9/20/2007	3	0	No
Site #YZ8	9/21/2007	3	0	No
Site #YZ8	9/21/2007	3	0	No
Site #YZ8	9/21/2007	3	0	No

CONCLUSION

Mist Net Surveys

Species Abundance

Morgan Brake NWR, Hillside NWR, Panther Swamp NWR, and Yazoo NWR were 4 of 13 study areas in MS where intensive mist net surveys were conducted from March 2002 – October 2007 (McCartney 2007). Other study areas included: St. Catherine Creek NWR, Noxubee NWR, Laurel Hill Plantation (a private land holding adjacent to St. Catherine Creek NWR), Camp Shelby, Camp McCain, Meridian Naval Air Station, Caney Creek Wildlife Management Area (WMA), Divide Section WMA, and Canal Section WMA (Figure 26). Of these 13 study areas, Panther Swamp NWR had the highest capture average (averaging 12.88 bats captured per net night) (Table 9). Studies conducted by Miller (2004) have shown that species diversity and relative abundance of bats in an area can be considered indicators of overall forest health. This implies a positive linear relationship in which with the increase of health and diversity of a forest there will be an increase in bat activity and species diversity. Results from this study help to confirm this theory. For example, Panther Swamp NWR contains 30,000 acres of BLH forests with a diverse fauna and had a high capture average with 12.88 bats captured per net night. In comparison, Camp McCain contains less acreage (13,000 acres) with the majority of land being clear cut or planted pine plantations and had a low capture average with 2.58 bats captured per net night.

During this study, there was a surprisingly low number of mist net sites with 0 captures. Three out of 22 sites netted on Theodore Roosevelt NWR Complex yielded no captures (13.63% of the total number of sites were unsuccessful). In comparison, 14 out of 22 mist net sites yielded no captures at St. Catherine Creek NWR (63.63%) during surveys conducted from 2002 – 2003. Five out of 14 mist net sites yielded no bat captures at Camp McCain (35.71%) from 2005 - 2007. This shows that bat activity is high with a high number of productive mist net sites at Morgan Brake NWR, Hillside NWR, Panther Swamp NWR, and Yazoo NWR compared to other survey areas in MS.

Species Diversity

Because of the habitats found on Theodore Roosevelt NWR Complex, we expected to capture the following common bat species; evening bat, red bat, eastern pipistrelle, Seminole bat, big brown bat, and Brazilian free-tailed bat. Out of the common bat species that we would expect to find at Theodore Roosevelt NWR Complex, the Brazilian free-tailed bat and big brown bat are the only species that we did not capture using mist net surveys. Brazilian free-tailed bats are rarely, if ever, captured using mist net survey techniques (Kalcounis 2006) and have never been captured using this method in Mississippi (MS Natural Heritage Program 2001a), so it is not surprising that we did not capture this species. Although big brown bats are common in all habitat types, they are usually not the most abundantly captured bat species during mist net surveys (McCartney 2007). For example, there were no big brown bat captures for 9 of the 13 study areas above where extensive mist net surveys were conducted in Mississippi. Also, big brown bats were the least frequently captured species (accounting for 3% of the total captures) during extensive surveys (49 net nights) at St. Catherine Creek NWR.

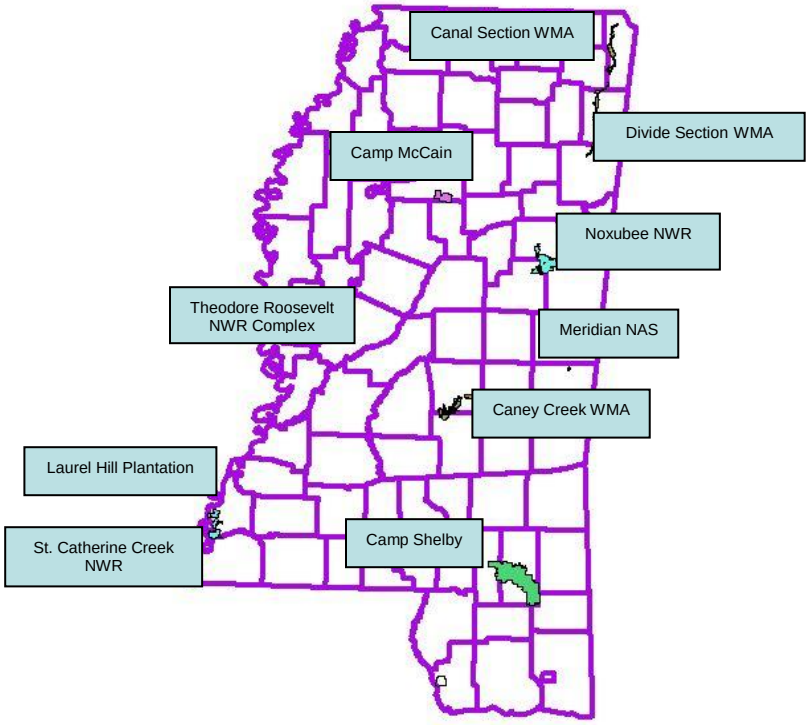

Figure 26. Thirteen study areas chosen for mist net surveys conducted from 2002 – 2007 in Mississippi.

Table 9. Average number of bats captured per net night during mist net surveys conducted at 13 locations in Mississippi from 2002 – 2007.

STUDY AREA	NIGHTS NETTED	# OF SITES	TOTAL BAT CAPTURES	AVG. # OF BATS CAPTURED PER NET NIGHT
Noxubee NWR	10	9	61	6.10
St. Catherine Creek NWR	49	22	65	1.33
Laurel Hill Plantation	2	2	7	3.50
Camp Shelby	19	18	175	9.21
Camp McCain	19	16	43	2.58
Meridian NAS	9	8	50	5.56
Caney Creek WMA	2	2	16	8.00
Canal Section WMA	1	1	0	0
Divide Section WMA	1	1	5	5.00
Panther Swamp NWR	8	6	103	12.88
Yazoo NWR	8	6	52	6.50
Morgan Brake NWR	7	5	32	4.57
Hillside NWR	5	5	14	2.50

Red bats are one of the most common bat species captured in Mississippi during mist net surveys. Out of the 9 study areas above (excluding Theodore Roosevelt NWR Complex), red bats were captured at 7 areas and were either the most frequently captured or the second most frequently captured species at each. It is therefore surprising that red bats were captured in such low numbers for refuges within Theodore Roosevelt NWR Complex. Seven red bats were caught out of a total of 201 captures at Morgan Brake NWR, Hillside NWR, Panther Swamp NWR, and Yazoo NWR. Possible causes for this low capture rate are unknown.

Rafinesque's Big-eared Bat and Southeastern Myotis

The special concern species that we expected to capture during this study were the: hoary bat, Rafinesque's big-eared bat, and southeastern myotis. We have only 5 records for hoary bats in Mississippi, so it's not entirely surprising that we did not capture this species. It is surprising however that southeastern myotis was the second most prevalently captured species during this study representing 22 % of the total captures. Out of the 13 study areas noted above that were surveyed for bats in Mississippi from 2002 – 2007, southeastern myotis was the most prevalently captured species at only 2 locations: Morgan Brake NWR and Laurel Hill Plantation. There were 3 locations where southeastern myotis was the second most prevalently captured species: Panther Swamp NWR, Yazoo NWR, and Caney Creek NWR. Out of the 13 areas surveyed, these 5 contained the highest percentages of bottomland hardwood forests and had an abundance of bald cypress swamps and/or tupelo brakes. Considering this species is of special concern and considering also the high capture rates at Morgan Brake NWR, Panther Swamp NWR, and Yazoo NWR, these areas are of great interest and importance for the conservation of this species. It is imperative that habitats remain intact and unaltered at Theodore Roosevelt NWR Complex to continue aiding in the conservation of southeastern myotis.

Out of 9 mist net sites located on Theodore Roosevelt NWR Complex that contained cypress swamps and/or tupelo brakes, southeastern myotis was captured at 7. Southeastern myotis was not captured at Site #HS1 which was a beautiful cypress/water tupelo swamp. However this site was surveyed in April which is a time of the year that bat activity is low due to cooler weather (McCartney 2007). Summer months tend to have higher bat activity rates and therefore higher capture rates during mist net surveys than the rest of the year due to higher temperatures and bug activity, and the increase in bat population numbers due to volant pups (Lambert 2005). Southeastern myotis was also not captured at Site # YZ1 which was a cypress swamp. The night that this site was surveyed, it started raining shortly after sunset and did not stop until nets were closed for the evening. Bat activity is documented as being very low during rain events due to a decrease in bug activity (Baldwin 2006). Out of 7 mist net survey sites within bottomland hardwood forests, southeastern myotis was captured at 5 of them. Out of 6 sites that contained mixed hardwood forests, 0 southeastern myotis were captured. These results help to confirm documented studies showing that southeastern myotis tends to prefer bottomland hardwood forests, particularly cypress swamps and tupelo stands (Horner and Maxey 1998, Hofmann et al. 1999, Clark 2000b, Bat Conservation International 2001, Kentucky Bat Working Group 2003).

Although there were no Rafinesque's big-eared bat captures during this study, I think it is very likely that this species occurs in the area. Rafinesque's big-eared bat has been documented as being hard to capture using mist net survey methods. For example, surveys conducted by Trousdale and Beckett (2000) in southern Mississippi yielded no captures of Rafinesque's big-eared bat, although surveys took place near known roost sites for this species. Lance and Garrett (1997) only had 1 capture for this species during extensive mist net surveys in Louisiana, although some surveys took place near known roost sites. Given the prevalence of cypress swamps and tupelo brakes on the Refuge Complex, I think that it is very likely that Rafinesque's big-eared bat is utilizing this area even though there were no captures. Additional mist net and Anabat surveys are needed to better determine the population status of Rafinesque's big-eared bat at Theodore Roosevelt NWR Complex.

Anabat Surveys

Four species were recorded using an Anabat Bat Detector, all of which were also captured during mist net surveys (southeastern myotis, evening bat, red bat, and eastern pipistrelle). The Seminole bat is the only species that was captured during mist net surveys but was not recorded during Anabat surveys. However, only 1 Seminole bat was captured during mist net surveys indicating that numbers for this species are probably low on Theodore Roosevelt NWR, so it is not surprising that calls were not recorded. Evening bats were the most prevalently captured species during mist net surveys and also had the highest number of Anabat recordings (representing 47% of the total number of recorded calls at all 5 sites where calls were recorded). The combined use of mist net surveys with Anabat surveys during a project is a recommended technique to give a more accurate representation of bat species diversity in an area.

It is of interest that so many red bat calls were recorded during Anabat surveys given that so few were captured during mist net surveys. A total of 185 red bat calls representing 41% of the total number of calls were recorded at all 5 of the sites where calls were recorded. It is possible that this high number of red bat calls could be due to mistaken identification. The accuracy of analysis of recorded Anabat calls to species is entirely reliant upon a call library. Therefore, small sample sizes in a call library can greatly influence analysis. The extracted parameters that were used for analysis are very similar for both red bat and evening bat calls (Appendix A). It is possible that some of the calls that were identified as red bats were actually evening bats. It is recommended that a larger call library be used to increase the likelihood of accurately identifying calls to species.

During Anabat surveys it is important to note that the number of calls recorded does not equal the number of bats at a specific site. Bats often circle sites while foraging and can easily emit dozens of calls in a single minute. For example, Site #PS13 had the highest number of bat calls recorded (162 calls representing 3 species), however during a mist net survey conducted on 8/7/07 only 4 evening bats were captured at this site. This discrepancy could be due to a natural variation of bat activity that can occur on different nights or could also have been caused by a few individuals calling repetitively. Although an Anabat cannot determine exact numbers of bats at a site, it can give important data

regarding species diversity and relative bat activity. Zero bat calls were recorded at 4 of the nine Anabat survey sites. This could be due to a lack of bat activity at these sites or more likely due to bug interference and/or equipment malfunction. Additional anabat surveys should be conducted to make up for any nights with no recordings due to equipment malfunction. With an adequate number of sampling nights it is possible to tell what areas are being used by bats more frequently than others as well as what species are using that area.

Roost Surveys

Bridges are commonly used by both Rafinesque's big-eared bat and southeastern myotis as roosts (Lance 2001, Trousdale and Beckett 2002, Wolters 2005). It is very surprising that out of 24 bridges surveyed on Theodore Roosevelt NWR Complex, no bats were observed. It is possible that with the prevalence of ideal habitat and numerous natural roosts for these 2 species, man-made roosts or alternative structures are not necessary. Studies conducted by Trousdale and Beckett (2002) and McCartney (2007) have shown that bats using a roost will usually only move to a nearby artificial roost when the first roost has become unsuitable (i.e. – the tree is torn down). It is possible that there are so many ideal natural roosts at Theodore Roosevelt NWR Complex, that man-made roosts or artificial roosts are unnecessary. All bridges were only surveyed one time during the study period. It might be beneficial to survey these bridges several more times during different seasons to more accurately determine bat usage.

It is also very surprising that with hundreds of cavity trees surveyed, no bats were observed. I think it's likely that there are numerous roost trees on the Refuge Complex being used but were not observed due to the abundance of possibilities. Site #MB8 is an area that should be further inspected for possible tree roosts. Twenty-three bats (12 of which were southeastern myotis) were captured using mist net surveys at this site in August however 0 bats were captured in October. It is possible that maternal colonies are roosting in this area making bat activity very high during the maternal season (May – September) but low during the remainder of the year. This is an area that should be surveyed further.

Telemetry work during this survey was unsuccessful with 0 bats tracked to roosts. Very few signals were picked up for tagged bats implying that these individuals either left the area completely or forest density was too thick to pick up a signal. During optimal telemetry survey conditions (cleared, flat land), the signals emitted with the radio transmitters used during this survey can be picked up by the telemetry receiver when it is within a 0.5 mile radius. Bats can fly many miles from roosting sites to foraging sites. It is possible that bats tagged during this survey flew many miles from where they were initially captured and tagged making it impossible to pick up their signal and locate their roost. As technology advances, telemetry receivers should be able to pick up signals at greater distances making telemetry surveys a more successful process with more signals received and therefore more roosts located.

Management Suggestions

Theodore Roosevelt NWR Complex contains ideal habitat for both Rafinesque's

big-eared bat and southeastern myotis. More intensive surveys over multiple years would more than likely yield higher capture numbers for these 2 species and give us a better understanding of relative abundance on the refuge. I would recommend that all sites be surveyed again particularly those where southeastern myotis individuals were captured previously and particularly those sites that were netted early (April) or late (October) in the year when bat activity is low compared to summer months. Site # MB8 and Site #YZ2 should be netted more extensively in an attempt to catch Rafinesque's big-eared bat since these 2 sites held the most promise for this species. Additional areas should be scouted to locate new survey sites. Anabat surveys are recommended in conjunction with mist net surveys for increased data and increased likelihood of detecting Rafinesque's big-eared bat calls, particularly at Site # MB8 and Site # YZ2.

Additional roost surveys are also recommended. Bridges should be surveyed again during different seasons to more accurately assess bat usage. Additional tree surveys should be conducted, particularly in areas where bat activity was found to be high either through mist net or anabat surveys.

It is easy to conclude from this project that Theodore Roosevelt NWR is an important area for bats. Bat abundance is high in this area as compared to other locations of the state particularly for southeastern myotis. As BLH forests continue to decline due to silvicultural practices, it is essential that we continue to maintain undeveloped areas like Theodore Roosevelt NWR for all our bat species, particularly those whose population numbers are declining.

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APPENDIX A: Call Library - Parameters Attained from Bat Echolocation Calls of Known Species Used to Analyze and Determine Species of Recorded Bat Calls from Unknown Species

Note: LABO = red bat, NYHU = evening bat, PISU = eastern pipistrelle, MYAU = southeastern myotis, LACI = hoary bat, CORA = Rafinesque's big-eared bat, EPFU = big brown bat, MYLU = little brown bat, MYSO = Indiana bat, LAIN = yellow bat, LANO = silver-haired bat.
Fmax = maximum frequency, Fmin = minimum frequency, Fmean = mean frequency, Fc = characteristic frequency, Fk = frequency of the knee, Dur = call duration.

Species	Fmax	Fmin	Fmean	Fc	Fk	Dur (ms)
LABO	46.72	35.71	40.17	38.89	41.43	0.96
LABO	43.67	32.31	38.82	39.41	41.04	1.55
LABO	55.76	45.32	48.4	46.31	49.16	0.47
LABO	50.45	40.28	43.9	42.1	44.96	0.43
LABO	45.86	38.74	40.9	39.48	41.51	0.27
LABO	46.58	38.51	41.4	40.02	42.8	3.5
LABO	49.98	40.1	43.66	42.85	45.94	2.3
LABO	57.04	46.55	49.88	47.18	50.83	1.8
LABO	51.95	46.51	48.32	48.34	51.95	1.5
LABO	41.49	37.3	39.48	39.09	40.3	3.9
LABO	48.72	43.76	45.76	44.86	47.87	2
LABO	48.72	42.66	45.24	43.48	47.47	2.3
MIN	**41.49**	**37.3**	**39.48**	**39.09**	**40.3**	**1.5**
MAX	**57.04**	**46.55**	**49.88**	**48.34**	**51.95**	**3.9**
N=12						
NYHU	45.44	36.73	39.49	37.4	40.29	3.3
NYHU	49.06	37.1	41.47	40.44	42.82	3.1
NYHU	47.84	37.44	41.34	38.83	42.56	4
NYHU	48.84	37.07	41.7	40.27	43.02	6.3
NYHU	40.59	33.36	35.18	34.17	35.91	7.7
NYHU	37.51	31.52	34.73	34.43	35.47	6.9
NYHU	43.36	31.87	37.12	36.32	38.2	5.5
NYHU	45	35.47	38.21	36.62	38.75	5.7
NYHU	40.67	35.16	37.01	36.32	36.73	10.2
NYHU	32.15	29.29	30.22	30.3	30.03	11.4
NYHU	30.46	26.15	28.22	28.8	28.83	4
NYHU	51.73	41.85	45.19	43.48	46.45	1.9
NYHU	42.35	36.1	38.57	37.68	39.32	4.1
NYHU	41.97	35.9	38.06	36.7	38.05	4.1
MIN	**30.46**	**26.15**	**28.22**	**28.8**	**28.83**	**1.9**
MAX	**51.73**	**41.85**	**45.19**	**43.48**	**46.45**	**11.4**
N=14						
PISU	47.27	39.37	41.56	40.14	42.14	4.6
PISU	49.29	42.34	43.71	42.63	43.9	5.6
PISU	50.82	41.87	44.17	43.3	44.28	4.7
PISU	49.06	42.03	43.71	42.67	44.36	4.5
PISU	45.88	39.86	41.82	41.01	42.74	3.7
PISU	47.67	43.76	44.7	44.04	45.36	4.9
PISU	49.4	44.23	45.78	44.84	46.77	3.3

Species	Fmax	Fmin	Fmean	Fc	Fk	Dur (ms)
PISU	50.61	43.48	45.38	44.1	46.25	4
PISU	52.56	43.49	45.85	44.14	46.68	4
PISU	50.76	43.73	45.69	44.13	46.79	3.5
PISU	53.99	44.24	47.56	45.7	49.06	3
PISU	49.17	41.11	43.94	42	45.73	2.4
PISU	48.18	41.27	43.83	42.39	46.32	1.8
PISU	46.91	41.79	43.47	42.34	45.24	2.5
PISU	49.05	43.59	45.68	45.19	47.81	2.6
MIN	**46.91**	**41.11**	**43.47**	**42**	**45.24**	**1.8**
MAX	**53.99**	**44.24**	**47.56**	**45.7**	**49.06**	**3**
N=15						
TABR	25.91	21.1	24.04	23.69	25.29	10.5
MYAU	57.41	47.83	51.48	48.5	52.59	2.5
MYAU	59.71	46.1	51.53	48.17	54.28	2.5
MYAU	59.7	47.26	52.04	49.2	53.6	1.8
MYAU	58.45	45.89	50.43	47.46	52.63	2
MYAU	59.96	46.38	51.59	49.55	54.63	1.9
MYAU	58.63	45.72	50.49	48.93	53.17	2
MYAU	54.51	39.71	47.02	48.15	47.48	4.6
MYAU	54.14	40.33	46.46	47.65	47.9	3.4
MYAU	55.1	43.26	47.48	46.56	49.36	1.8
MYAU	58.97	45.48	50.11	49.81	53.65	1.7
MYAU	60.11	47.63	52.02	51.91	54.77	1.4
MYAU	62.87	46.72	51.6	50.05	53.84	1.4
MYAU	61.95	44.89	51.31	48.74	52.84	2.3
MYAU	61.67	46.41	52.09	52.12	56.82	1.9
MYAU	54.11	43.18	47.11	45.5	49.25	1.8
MYAU	59.93	46.51	51.42	47.66	50.31	1.7
MIN	**54.11**	**43.18**	**47.11**	**45.5**	**49.25**	**1.4**
MAX	**62.87**	**46.72**	**52.09**	**52.12**	**56.82**	**2.3**
N=16						
LACI	31.36	21.21	24.47	22.98	24.66	0.86
LACI	25.42	18.16	21.23	20.82	21.81	1.05
LACI	28.6	21.17	24.22	23.87	25.3	1.17
LACI	26.89	19.82	22.22	21.31	22.64	0.34
LACI	32.97	21.34	24.94	23.15	24.99	0.64
LACI	31.41	21.31	24.73	23.53	25.48	0.74
LACI	28.4	20.87	24.03	23.33	24.97	0.81
LACI	29.92	21.83	24.47	23.37	25.28	0.4
LACI	30.99	21.3	24.55	23.21	24.82	0.59
LACI	23.87	18.59	20.49	19.71	20.83	0.38
MIN	**23.87**	**18.59**	**20.49**	**19.71**	**20.83**	**0.38**

Species	Fmax	Fmin	Fmean	Fc	Fk	Dur (ms)
MAX N=10	**31.41**	**21.83**	**24.73**	**23.53**	**25.48**	**0.81**
CORA	42.51	27.54	34.22	35.31	35.84	7.2
CORA	32.48	7.58	17.44	21.77	22.81	24.6
CORA	35.49	14.41	23.97	28.42	27.81	13
CORA	20.74	6.93	13.05	17.18	17.48	19
CORA	32.01	16.37	23.25	24.95	25.67	13.7
MIN	**20.74**	**6.93**	**13.05**	**17.18**	**17.48**	**7.2**
MAX N=5	**42.51**	**27.54**	**34.22**	**35.31**	**35.84**	**24.6**
EPFU	34.02	25.5	28.36	26.37	28.63	0.43
EPFU	40.54	25.83	29.86	26.9	29.38	0.39
EPFU	35.63	24.85	27.86	25.76	27.83	0.35
EPFU	37.63	27.68	30.89	28.88	30.91	0.89
EPFU	37.64	28.24	31.75	28.3	33.24	5.9
MIN	**34.02**	**24.85**	**27.86**	**25.76**	**27.83**	**0.35**
MAX N=5	**40.54**	**28.24**	**31.75**	**28.88**	**33.24**	**5.9**
MYLU	57.18	40.97	47.44	44.67	50.95	2.8
MYLU	52.7	39.82	44.6	41.89	45.25	2.6
MYLU	56.39	40.81	46.46	41.98	49.15	4.6
MYLU	52.34	39.95	44.65	40.63	46.99	4.1
MYLU	54.28	39.75	45.48	40.76	46.35	4.8
MYLU	46.55	36.06	39.65	36.49	39.26	4.6
MYLU	43.14	36.17	38.89	36.19	39.02	3.8
MYLU	49.37	36.97	41.24	38.07	42.08	3.4
MYLU	45.32	33.22	37.79	34.58	38.9	4.2
MYLU	49.35	36.13	41.16	38.88	43.21	3.7
MYLU	48.83	36.03	40.63	38.14	41.45	2.7
MIN	**43.14**	**33.22**	**37.79**	**34.58**	**38.9**	**2.7**
MAX N=11	**49.37**	**36.97**	**41.24**	**38.88**	**43.21**	**4.2**
MYSE	61.04	41.59	48.64	51.2	54.87	1.6
MAX	**61.04**	**41.59**	**48.64**	**51.2**	**54.87**	**1.6**
MYSO	59.64	41.63	48.45	46.6	50.66	2.6
MYSO	60.92	41.53	48.32	42.71	46.18	3.4
MYSO	55.76	38.72	44.68	39.66	43.33	3.3
MYSO	55.87	40.98	46.01	42.69	45.69	2.8
MYSO	51.36	39.09	43.26	40.02	43.29	3.2
MYSO	63.01	44.27	50.86	48.99	52.81	2.3
MYSO	59.01	41.26	47.36	44.23	46.82	2.6

Species	Fmax	Fmin	Fmean	Fc	Fk	Dur (ms)
MYSO	59.44	40.55	47.35	45.8	48.84	2.8
MIN	**51.36**	**39.09**	**43.26**	**40.02**	**43.29**	**2.3**
MAX	**63.01**	**44.27**	**50.86**	**48.99**	**52.81**	**3.2**
N=8						
LAIN	32.06	26.89	28.55	27.24	29.62	7.3
LAIN	33.05	26.94	28.83	27.52	29.39	5.8
LAIN	36	30.14	32.26	31.02	32.94	5.1
LAIN	36.73	30.34	32.67	31.42	33.7	5
LAIN	36.04	29.54	31.66	30.38	32.57	6.9
MIN	**32.06**	**26.89**	**28.55**	**27.24**	**29.39**	**5**
MAX	**36.73**	**30.34**	**32.67**	**31.42**	**33.7**	**7.3**
N=5						
LANO	31.48	26.01	28.4	27.49	29.04	5.3
LANO	31.97	26.45	28.08	26.9	28.72	5.8
LANO	28.26	23.79	25.78	24.99	26.53	11.7
LANO	28.58	24.44	26.33	25.4	27.21	10.2
LANO	30.5	23.66	26.45	25.46	26.99	9.9
LANO	32.35	25.13	27.69	26.28	28.68	7.1
LANO	30.43	25.61	26.99	25.87	27.88	5.8
LANO	31.33	26.49	28.13	26.95	29.45	4.8
MIN	**28.58**	**23.66**	**26.33**	**25.4**	**26.99**	**4.8**
MAX	**32.35**	**26.49**	**28.13**	**26.95**	**29.45**	**10.2**

APPENDIX B: Mist Net Data Forms for Surveys Conducted at Morgan Brake NWR, Hillside NWR, Panther Swamp NWR, and Yazoo NWR From April – October, 2007

APPENDIX C: Morphometric Data and Standard Measurements of Bats Captured During Mist Net Surveys Conducted at Morgan Brake NWR, Hillside NWR, Panther Swamp NWR, and Yazoo NWR From April – October, 2007

DATE	TIME	SPECIES	SEX	AGE	REPRO. STATUS	FA (MM)	WT (G)	NET	NOTES
4/27/2008	2026	*Nycticeius humeralis*	F	A	P	36.1	15.2	B	
4/26/2008	1910	*Myotis austroriparius*	F	A	P	35.6	10.7	A	Mites
8/24/2008	2024	*Nycticeius humeralis*	F	A	NR	37.7	9.5	A	
8/24/2008	2040	*Nycticeius humeralis*	F	A	NR	37.5	9.5	B	
8/16/2008	2010	*Myotis austroriparius*	M	A	NR	34.6	6.7	C	
8/16/2008	2010	*Nycticeius humeralis*	M	A	S	35.3	9	D	
8/16/2008	2020	*Nycticeius humeralis*	M	A	S	33.7	8.7	D	
8/16/2008	2025	*Myotis austroriparius*						D	Escaped
8/16/2008	2040	*Myotis austroriparius*	M	A	NR	35.8	6.8	C	Red belly
8/16/2008	2040	*Myotis austroriparius*	F	A	NR	37.2	8	C	Tagged #880
8/16/2008	2040	*Myotis austroriparius*	M	A	NR	36.9	7.3	C	Tagged #879
8/16/2008	2050	*Nycticeius humeralis*	F	A	NR	36.6	11	C	
8/16/2008	2053	*Nycticeius humeralis*	F	A	NR	36.6	12	C	
8/16/2008	2055	*Myotis austroriparius*	M	A	NR	35.7	7.3	D	Red belly, Tagged #878
8/16/2008	2055	*Myotis austroriparius*	F	A	NR	37.9	7.5	D	Red belly
8/16/2008	2055	*Nycticeius humeralis*	F	A	NR	36.4	11.5	D	
8/16/2008	2055	*Myotis austroriparius*	M	A	NR	35.1	7.7	D	Red belly, white mites
8/16/2008	2100	*Nycticeius humeralis*	F	A	NR	38.1	11.7	D	
8/16/2008	2105	*Nycticeius humeralis*	F	A	NR	39	11	D	
8/16/2008	2115	*Nycticeius humeralis*	F	A	NR	37.6	10.7	B	
8/16/2008	2115	*Nycticeius humeralis*	M	A	S	35.5	9	B	
8/16/2008	2125	*Nycticeius humeralis*	F	A	NR	34.5	9.5	D	
8/16/2008	2125	*Myotis austroriparius*	F	A	NR	36	12	D	
8/16/2008	2125	*Myotis austroriparius*	F	A	NR	36.1	10.5	D	
8/16/2008	2150	*Lasiurus borealis*	F	A	NR	43.3	11.5	A	Lots of blood on bag, no injury
8/16/2008	2220	*Myotis austroriparius*	M	A	S	35.7	8	D	
8/16/2008	2345	*Myotis austroriparius*	M	A	S	35.6	9.5	C	
8/23/2008	2115	*Myotis austroriparius*	M	A	NR	37	6.3	C	
8/23/2008	2117	*Myotis austroriparius*	M	A	NR	36.5	6.5	C	Red belly
8/23/2008	2142	*Lasiurus borealis*	F	A	NR	41.3	16.5	C	
8/7/2008	2015	*Nycticeius humeralis*	F	A	NR	37.5	9	A	
8/7/2008	2030	*Nycticeius humeralis*	M	A	S	34.9	6.7	A	
8/7/2008	2110	*Nycticeius humeralis*	M	A	S	34.3	10	A	
8/7/2008	2110	*Nycticeius humeralis*	M	A	S	36.4	10.5	A	
8/17/2008	1950	*Nycticeius humeralis*	M	A	S	37.9	9	B	
8/17/2008	2040	*Myotis austroriparius*	M	A	NR	38.4	6.5	B	Red belly with white/gray patch
8/17/2008	2050	*Nycticeius humeralis*	M	A	S	35.8	8	C	
8/17/2008	2050	*Nycticeius humeralis*	F		NR	37.2	8.5	C	
8/17/2008	2110	*Nycticeius humeralis*	M	A	S	36	10.5	C	
8/17/2008	2110	*Nycticeius humeralis*	F	A	NR	37.2	11	B	
8/17/2008	2110	*Nycticeius humeralis*	M	A	S	35.6	9.5	A	
8/17/2008	2115	*Nycticeius humeralis*	M	A	S	33.8	9	A	
8/17/2008	2115	*Nycticeius humeralis*	M	A	S	36.1	9	A	
8/17/2008	2115	*Nycticeius humeralis*	F	A	NR	37.1	11.5	A	
8/17/2008	2125	*Nycticeius humeralis*	F	A	NR	37.2	11.5	A	
8/17/2008	2125	*Nycticeius humeralis*	M	A	S	35.1	10.5	A	
8/17/2008	2130	*Nycticeius humeralis*	F	A	NR	36	10	A	
8/17/2008	2130	*Nycticeius humeralis*	M	A	S	33.6	8.5	A	
8/17/2008	2140	*Nycticeius humeralis*	M	A	S	35.4	8.7	A	
8/17/2008	2205	*Myotis austroriparius*	M	A	NR	37.1	7	A	Red belly with white/gray patch
8/17/2008	2205	*Nycticeius humeralis*	M	A	S	35	9	A	
8/17/2008	2205	*Nycticeius humeralis*	F	A	NR	37.2	11	A	
8/17/2008	2205							B	Escaped
8/17/2008	2229	*Nycticeius humeralis*	F	A	NR	37.1	10	A	

DATE	TIME	SPECIES	SEX	AGE	REPRO. STATUS	FA (MM)	WT (G)	NET	NOTES
8/17/2008	2308	*Nycticeius humeralis*	F	A	NR	38.2	10	A	
8/17/2008	2310	*Nycticeius humeralis*	M	A	S	37.2	9	C	
8/18/2008	2000	*Nycticeius humeralis*	M	A	S	36.4	8.5	B	
8/18/2008	2007	*Nycticeius humeralis*	M	A	S	35.6		A	Escaped
8/18/2008	2040	*Nycticeius humeralis*	M	A	S	35.3	8.5	A	
8/18/2008	2045	*Nycticeius humeralis*	M		S	35.8	10.5	B	
8/18/2008	2045	*Nycticeius humeralis*	M	A	S	36.8	10	B	
8/18/2008	2047	*Myotis austroriparius*	M	A	NR	35	6	B	
8/18/2008	2047	*Nycticeius humeralis*	F	A	NR	38.2	10	B	
8/18/2008	2050	*Lasiurus borealis*	F	A	NR	41.7	11.3	B	
8/18/2008	2054	*Myotis austroriparius*	F	A	NR	37.5	6.7	B	Red with gray patches
8/18/2008	2100	*Nycticeius humeralis*	M	A	S	34.9	10	A	
8/18/2008	2119	*Nycticeius humeralis*						B	Escaped
8/18/2008	2119	*Myotis austroriparius*						B	Escaped
8/18/2008	2119	*Nycticeius humeralis*	F	A	NR	36.2	10	B	
8/18/2008	2159	*Nycticeius humeralis*	F	A	NR	37.6	10.7	A	
8/1/2007	2115	*Myotis austroriparius*	F	A	NR	37.5	7.3	E	90% red color: balding on back
8/1/2007									
8/1/2007	2115	*Myotis austroriparius*	M	A	NR	35.8	6	C	Normal color
8/1/2007	2245	*Myotis austroriparius*	F	A	NR	39.6	7	B	Red pelage
7/26/2007	2005	*Nycticeius humeralis*	F	A	NR	37.1	10	A	
7/26/2007	2240	Escaped						C	
7/26/2007	2240	*Nycticeius humeralis*	M	A	S	34.7	8	C	
7/26/2007	2240	*Myotis austroriparius*	M	A	NR	37.5	6.5	C	
7/26/2007	2240	*Nycticeius humeralis*	F	A	NR	38.1	10.7	A	
7/26/2007	2240	*Nycticeius humeralis*	F	A	NR	36.7	11.5	A	
7/26/2007	2340	*Lasiurus borealis*	M	A	NR	38.8	10.5	C	
7/27/2007	2100	*Lasiurus borealis*						A	Escaped
7/27/2007	2200	*Nycticeius humeralis*	M	A	S	36.1	9.5	B	
7/27/2007	2200	*Nycticeius humeralis*	M	A	S	35.2	9.3	B	
7/28/2007	2045	*Nycticeius humeralis*	M	A	NR	35.8	7.3	A	
7/28/2007	2045	*Nycticeius humeralis*	M	A	S	35.1	9.59.5	A	
7/28/2007	2155	*Nycticeius humeralis*	M	A	S	34.5	9.39.0	A	
7/28/2007	2155	*Nycticeius humeralis*	M	A	S	34.9	8.5	A	
7/28/2007	2215	*Nycticeius humeralis*	F	A	NR	37.6	11	A	
7/28/2007	2215	*Nycticeius humeralis*	F	A	NR	37.3	11.5	A	
7/28/2007	2233	*Nycticeius humeralis*	M	A	S	36.2	9.3	A	
7/28/2007	2245	*Nycticeius humeralis*	M	A	S	34.5	8.5	A	
7/18/2007	2120	*Nycticeius humeralis*	M	A	S	36.1	10	D	
7/19/2007	2110	*Myotis austroriparius*	F	A	NR	36.7	7.5	A	Red color with small gray patch
7/19/2007		Tagged with transmitter # 123875							
7/19/2007	2120	*Myotis austroriparius*	F	A	NR	38.1	7	A	
7/19/2007		Tagged with transmitter #							
7/19/2007	2140	*Myotis austroriparius*	M	J	NR	36.1	5.7	B	
7/19/2007	2220	*Myotis austroriparius*	F	A	PL	37.3	7.5	A	Found in water
7/19/2007		Tagged with transmitter # 123877							
7/19/2007	2250	*Nycticeius humeralis*	M	A	S	36.2	9	C	
7/19/2007	2250	*Myotis austroriparius*	F	A	NR	37.2	6.5	C	Red color, bald back
7/19/2007	2250	*Myotis austroriparius*	F	A	NR	37.9	6.3	C	
7/19/2007	15	*Myotis austroriparius*	M	J	NR	36.5	6	C	
7/19/2007	15	*Pipistrellus subflavus*	M	A	NR	37.1	7.5	C	
6/12/2007	2100	*Nycticeius humeralis*	M	J	S	33.3	11	B	Small white mites
6/12/2007	2240	*Myotis austroriparius*	F	A	L	38.4	7.8	E	
6/12/2007	2330	*Myotis austroriparius*	F	A	L	38.5	7	A	Net fell in water with bat in

DATE	TIME	SPECIES	SEX	AGE	REPRO. STATUS	FA (MM)	WT (G)	NET	NOTES
6/27/2007	2115	*Nycticeius humeralis*	M	J	Slightly S	35.3	7.5	D	
6/27/2007	2115	*Nycticeius humeralis*	M	J	S	34.8	8.5	A	
6/27/2007	2115	*Nycticeius humeralis*	M	A	S	33.5	8.2	D	
6/27/2007	2115	*Nycticeius humeralis*	M	A	S	34.4	8.5	D	
6/27/2007	2150	*Lasiurus seminolus*	F	J	NR	43.9	8.3	D	
6/27/2007	2150	*Myotis austroriparius*	F	A	NR	37.9	8	D	Bald spots
6/27/2007	2200	*Nycticeius humeralis*	F	A	L	37.2	11	A	Red mite
6/27/2007	2315	*Nycticeius humeralis*	F	J	NR	37.9	9.5	B	
6/27/2007	2350	*Myotis austroriparius*	F	J	NR	38.2	6.2	B	
6/27/2007	2415	*Myotis austroriparius*	F	J	NR	37.2	6	A	
5/21/2007	2050	*Nycticeius humeralis*	M	A	NR	35.79	9.4	F	
5/21/2007	2300	*Nycticeius humeralis*	M	A	NR	35.6	8.4	F	
5/22/2007	2115	*Lasiurus borealis*	M	A	NR	42.42	11	B	
5/22/2007	2215	*Myotis austroriparius*	M	A	NR	37.86	6.2	B	
10/13/2007	1910	*Nycticeius humeralis*	M	A	S	36.2	13.7	C	
10/13/2007	1910	*Nycticeius humeralis*	M	A	S	35.6	15.5	C	
10/13/2007	1916	*Nycticeius humeralis*	M	A	S	34.2	14	A	
10/13/2007	1918	*Nycticeius humeralis*	M	A	S	36.2	12.7	A	
10/13/2007	1918	*Nycticeius humeralis*	F	A	NR	36.6	14.7	A	
10/13/2007	1924	*Nycticeius humeralis*	M	A	S	35.5	12.3	B	
10/13/2007	1927	*Nycticeius humeralis*	F	A	NR	36.3	13.3	C	
10/13/2007	1927	*Nycticeius humeralis*	M	A	S	35.3	14.7	C	
10/13/2007	1934	*Nycticeius humeralis*	F	A	NR	36.7	12.7	A	
10/13/2007	1951	*Nycticeius humeralis*	M	A	S	35.3	14	A	
10/13/2007	2055	*Myotis austroriparius*	F	A	NR	37.7	7.5	A	Red in color
10/19/2007	1910	*Nycticeius humeralis*	M	A	S	34.1	13.5	B	
10/19/2007	1915	*Nycticeius humeralis*	F	A	NR	39	12.7	A	
10/19/2007	1915	*Nycticeius humeralis*	M	A	S	35.5	13	A	
10/19/2007	1915	*Nycticeius humeralis*	M	A	S	35	13	A	
10/19/2007	1915	*Nycticeius humeralis*	F	A	NR	37.6	14	A	
10/19/2007	1922	*Nycticeius humeralis*	M	A	S	36.1	14	B	
10/19/2007	1924	*Nycticeius humeralis*	M	A	S	35.8	12.5	A	
10/19/2007	1926	*Nycticeius humeralis*	M	A	S	35.4	13.5	A	Bald spot on back
10/19/2007	1930	*Myotis austroriparius*	F	A	NR	35.8	6.3	B	Red in color
10/19/2007	1931	*Nycticeius humeralis*	M	A	S	35.6	15.5	A	2 white spots on fur
10/19/2007	1933	*Nycticeius humeralis*	F	A	NR	37.7	12.5	A	Old wound on forearm
10/19/2007	1934	*Nycticeius humeralis*	F	A	NR	38.8	13.5	A	
10/19/2007	1940	*Nycticeius humeralis*	M	A	S	34.6	14.7	A	
10/19/2007	1941	*Nycticeius humeralis*	M	A	S	35.5	15.5	B	
10/19/2007	1941	*Nycticeius humeralis*	M	A	S	36.5	14.5	C	
10/19/2007	1941	*Nycticeius humeralis*	M	A	NR	37	16	C	
10/19/2007	1942	*Nycticeius humeralis*						B	Escaped prior to processing
10/19/2007	1950	*Nycticeius humeralis*	F	A	NR	37	15	A	
10/19/2007	1950	*Nycticeius humeralis*	M	A	S	37.1	16	A	
10/19/2007	1957	*Nycticeius humeralis*	F	A	NR	37.8	15	C	
10/19/2007	1959	*Myotis austroriparius*	M	A	NR	36.3	7.3	C	
10/19/2007	2002	*Nycticeius humeralis*	M	A	S	35.1	15	B	
10/19/2007	2006	*Myotis austroriparius*	M	A	S	38	6.3	B	Red in color
10/19/2007	2007	Escaped						A	Escaped prior to ID
10/19/2007	2040	*Nycticeius humeralis*	M	A	S	35	14.5	B	
10/19/2007	2040	*Nycticeius humeralis*						A	Escaped prior to processing
9/6/2007	2040	*Nycticeius humeralis*	M	A	S	33.8	12	B	
9/6/2007	2040	*Nycticeius humeralis*	F	A	NR	36.5	15	B	
9/6/2007	2040	*Nycticeius humeralis*	M	A	S	34	10	A	
9/6/2007	2040	*Nycticeius humeralis*	M	A	S	35.3	14	B	
9/6/2007	2040	*Nycticeius humeralis*	F	A	NR	34	12	C	
9/6/2007	2045	*Nycticeius humeralis*	M	A	S	36	11.3	B	
9/6/2007	2053	*Nycticeius humeralis*	F	A	NR	36	12.5	A	

DATE	TIME	SPECIES	SEX	AGE	REPRO. STATUS	FA (MM)	WT (G)	NET	NOTES
9/6/2007	2053	*Nycticeius humeralis*	M	A	S	36.1	12.7	B	
9/6/2007	2055	*Nycticeius humeralis*	F	A	NR	37.2	11.7	A	
9/6/2007	2105	*Nycticeius humeralis*	F	A	NR	38	12	A	
9/6/2007	2131	*Nycticeius humeralis*	F	A	NR	37.5	13.7	B	
9/6/2007	2133	*Nycticeius humeralis*	F	A	NR	38.7	13.5	A	
9/6/2007	2210	*Nycticeius humeralis*	M	A	S	35.8	11.3	B	
9/6/2007	2212	*Nycticeius humeralis*	M	A	S	34.7	11.3	A	
9/6/2007	2212	*Nycticeius humeralis*	M	A	S	36.1	10.7	A	Red mites
9/6/2007	2305	*Nycticeius humeralis*	F	A	NR	37.8	14	B	
9/6/2007	2345	*Nycticeius humeralis*	F	A	NR	36.5	12	A	
9/7/2007	2010	*Myotis austroriparius*	M	A	NR	36.1	6	B	
9/7/2007	2042	*Nycticeius humeralis*	F	A	NR	39.1	12.7	A	
9/7/2007	2044	*Nycticeius humeralis*	M	A	S	35.6	12	B	
9/20/2007	2013	*Nycticeius humeralis*	F	A	NR	36.7	14.3	C	
9/20/2007	2042	*Nycticeius humeralis*	M	A	S	33.8	11.5	B	
9/20/2007	2046	*Nycticeius humeralis*	M	A	S	34.6	13.5	C	
9/20/2007	2051	*Myotis austroriparius*	F	A	NR	37.9	7.7	D	Tagged with transmitter # 198
9/20/2007	2051	*Myotis austroriparius*	F	A	NR	38.5	7.7	D	Tagged with transmitter # 217
9/20/2007	2051	*Nycticeius humeralis*	M	A	S	36.4	13.3	D	
9/21/2007	2004	*Nycticeius humeralis*	M	A	S	36.4	14.5	A	
9/21/2007	2015	*Nycticeius humeralis*	M	A	S	35.1	12.3	A	
9/21/2007	2029	*Nycticeius humeralis*	F	A	NR	36.8	14.5	A	
9/21/2007	2034	*Nycticeius humeralis*	F	A	NR	37.6	16.7	B	
9/21/2007	2034	*Nycticeius humeralis*	F	A	NR	35.7	13	B	
9/21/2007	2034	*Nycticeius humeralis*	F	A	NR	36	15	C	
9/21/2007	2034	*Nycticeius humeralis*	M	A	S	35.8	12.5	C	
9/21/2007	2035	*Nycticeius humeralis*	M	A	S	34.8	14	B	
9/21/2007	2036	*Nycticeius humeralis*	M	A	S	34.8	14	A	
9/21/2007	2040	*Nycticeius humeralis*	F	A	NR	38	14.7	A	
9/21/2007	2042	*Nycticeius humeralis*	M	A	S	35.6	13.2	B	
9/21/2007	2042	*Nycticeius humeralis*	F	A	NR	38.2	14.7	C	
9/21/2007	2043	*Nycticeius humeralis*	F	A	NR	36.4	16	A	
9/21/2007	2044	*Nycticeius humeralis*	F	A	NR	36.7	14	A	
9/21/2007	2045	*Lasiurus borealis*	F	A	NR	38.1	8.5	B	
9/21/2007	2046	*Nycticeius humeralis*	M	A	S	34.3	12.5	A	
9/21/2007	2047	*Nycticeius humeralis*	M	A	S	35.7	14.7	B	
9/21/2007	2101	*Nycticeius humeralis*	M	A	NR	34	14.5	A	
9/21/2007	2111	*Nycticeius humeralis*	F	A	NR	36.3	16.5	B	
9/21/2007	2111	*Myotis austroriparius*	F	A	NR	38.1	8	B	Tagged with transmitter # 280
9/21/2007	2131	*Myotis austroriparius*	M	A	NR	38.6	7	C	Tagged with transmitter # 258
9/21/2007	2249	*Nycticeius humeralis*	F	A	NR	35.3	12.7	B	
9/21/2007	2250	*Myotis austroriparius*	M	A	NR	37.3	7	B	Tagged with transmitter # 320