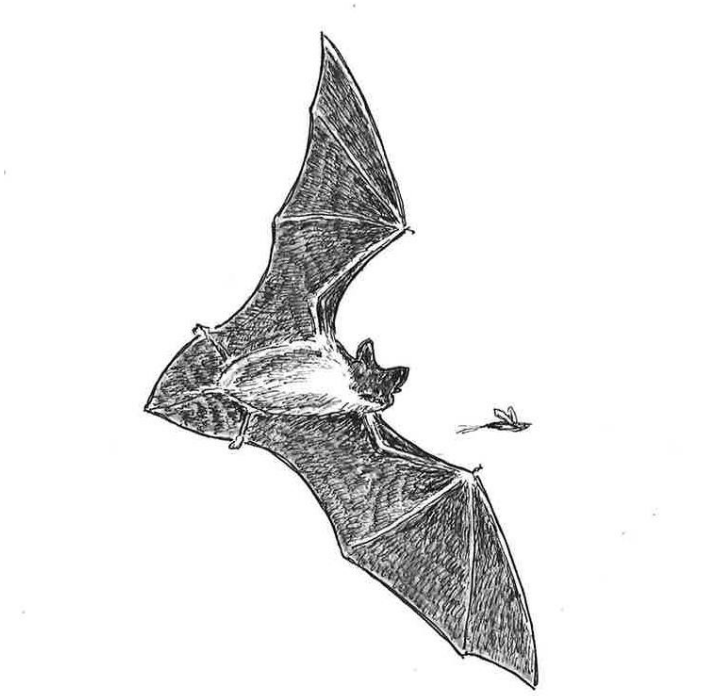
Mississippi Bat Conservation Strategy

Mississippi Bat Working Group



MISSISSIPPI

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RECOMMENDED CITATION

Mississippi Bat Working Group. 2020. Mississippi Bat Conservation Strategy. Mississippi Bat Working Group. Jackson, Mississippi.

DEDICATION—IN MEMORIAM

A champion of bat conservation passed away in Biloxi on July 17, 2019. Kathy Shelton, South Mississippi Conservation Biologist, was a dedicated biologist who made significant contributions to our knowledge of bats in Mississippi. Kathy was originally from Greensboro, North Carolina and received a B.S. in Wildlife Science from North Carolina State University in 1995. She attended graduate school at Mississippi State University and received her M.S. in Wildlife Science in 2000. She began working for the Mississippi Department of Marine Resources soon after graduation, then transferred to Wildlife, Fisheries, and Parks. She spent her first seven years with the Wildlife Bureau, mostly dealing with game management on public lands. Kathy transferred to the Mississippi Museum of Natural Science in 2007 and focused on the conservation and management of nongame species, including amphibians, gopher tortoises, and bats.

Kathy joined the Mississippi Bat Working Group (MBWG) in 2007 and was an avid promoter of bat research, conservation, and management throughout the state. She was active in organizing and conducting mist-net events, including reconnaissance of sites and serving as a team leader. She regularly attended annual meetings of the MBWG and made presentations on the status of bat research and conservation studies throughout the state. Kathy attended several workshops on WNS, acoustic detection methods, and wind energy development to better manage bat populations in the state. Kathy was instrumental in obtaining grants for cave, bridge, and culvert surveys to determine the occurrence of white nose syndrome (WNS) and monitor bat populations. She initiated statewide culvert surveys in 2011 and organized the annual winter "Culvert Blitz." She received widespread acclaim for organizing and implementing the first cave gating in Mississippi at Pitts/Williams Cave in 2018. Another major achievement was the discovery of the first northern yellow bat in Mississippi since 1937.

Kathy gave numerous presentations on Mississippi bats at the annual meetings of the MBWG and the Mississippi Chapter of the Wildlife Society (MS TWS). She also co-authored papers presented at Southeastern Bat Diversity Network and North American Society for Bat Research annual meetings. She co-authored several papers in technical journals and published popular articles on bats in *Mississippi Wildlife* and *Mississippi Outdoors*. Additionally, she gave numerous presentations to schools and community groups. She routinely was a guest on the Mississippi Public radio "Creature Comforts" program.

As a professional wildlife biologist, Kathy received numerous honors throughout her career. In 2008, she was elected President of MS TWS, and in 2008–2009 she served as Program Lead for

Teaming with Wildlife. She was elected Vice-Chair of the MBWG in 2012, and has received the following MBWG awards: Publication Award, Conservation/Research Award (twice), and Chester O. Martin Award. She was elected to the Board of Directors of the Southeastern Bat Diversity Network in 2019. She was also featured for her work gating the first cave in Mississippi in an article in the Clarion Ledger.

She was a major contributor to development of the Mississippi Bat Conservation Strategy.

Kathy made a difference to bat conservation in Mississippi. Mississippi bats and bat biologists owe a lot to Kathy Shelton. Her energy, enthusiasm, and dedication will be thoroughly missed.

AUTHORSHIP AND ACKNOWLEDGEMENTS

We would like to especially recognize Kathy Lunceford who initiated the development of the Mississippi Bat Conservation Strategy, and laid the groundwork for the Mississippi Bat Conservation Strategy. Also integral to the development of this document, we would like to thank Katelin Cross, Chazz Coleman, and Amber Floyd. State occurrence maps were developed by Chazz Coleman, Katelin Cross and Nour Salam, with data provided by the Mississippi Natural Heritage Program.

Cover artwork created by Chester O. Martin

EXECUTIVE SUMMARY

JUSTIFICATION

Declines in bat populations in the eastern United States have led to concern for the future of these species in Mississippi. Reasons for region-wide declines include white-nose syndrome associated with the fungus *Pseudogymnoascus destructans* (Pd), loss or degradation of wintering and maternity hibernacula, forest modifications, human disturbance in roosts and hibernation areas, pesticide use, and wind power development. Although Mississippi provides an abundance of habitats, the potential loss of summer/maternity habitats and winter hibernacula is of great concern.

The purpose of this strategy is to provide processes for Federal, State, municipalities, and private entities to identify, conserve, and recover bat populations in Mississippi. The diversity of bat species, lack of population data, difficulty in identifying and accessing potential habitats, and poor public perception present some of the many challenges to land managers. Federal and state regulations of bat species in Mississippi are insufficient tools to identify and protect most bat populations from direct and indirect impacts. Development of statewide long-term habitat management plans, effective methods for population identification and estimation, and public education could provide a sustainable balance between landscape development and healthy bat populations.

The Mississippi Department of Wildlife, Fisheries, and Parks; U.S. Department of Agriculture; U.S. Fish and Wildlife Service; and U.S. Bureau of Land Management have developed this plan in conjunction with the Mississippi Bat Working Group to promote the conservation of bat species throughout the state of Mississippi.

SCOPE

This plan identifies the bat species found in Mississippi and describes current habitat types used by these species. It also describes past and ongoing monitoring, research, and conservation actions undertaken within the state. In order to adequately address bat conservation needs and efforts in Mississippi, and to identify tools that may reverse downward trends of declining species, this plan outlines specific areas of concern that should be addressed by state and federal resource agencies, Tribes, academia, wildlife managers, forest industry managers, and private land owners.

EVALUATION OF PROGRESS

Due to difficulty in assessing bat populations, it is problematic to set quantifiable goals to measure progress. However, identifiable goals include improved population inventory and monitoring, statewide evaluation of roosting and foraging resources, identification of habitat best management and conservation practices, identification of research needs, creation of landscape-

wide management guidelines, identification of outreach and education needs, and identification of financial resources that will enable management of bat populations within Mississippi.

This strategy is a dynamic document that will be revised as new information is obtained. To keep goals and objectives relevant, this plan should be updated at least every five years.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

List of Abbreviations

BMP	Best Management Practice
CEC	Copperhead Environmental Consulting, Inc.
ESA	Endangered Species Act of 1973
MBWG	Mississippi Bat Working Group
MDOT	Mississippi Department of Transportation
MDWFP	Mississippi Department of Wildlife, Fisheries, and Parks
MNHP	Mississippi Natural Heritage Program
NAS	Naval Air Station
NF	National Forest
NRCS	Natural Resource Conservation Service
NWR	National Wildlife Refuge
USFWS	U.S. Fish and Wildlife Service
NMP	National Military Park
WNS	White-nose syndrome

BATS OF MISSISSIPPI

STATE OF KNOWLEDGE OF BATS IN MISSISSIPPI

Bat conservation and management has become a major concern on state, federal, and private lands throughout the United States. The discovery and subsequent spread of white-nose syndrome (WNS) over the last 15 years have led to increased public support for bats. Bats represent an important component of many ecosystems and contribute significantly to an area's biodiversity. The majority of North American bat species are insectivorous and extremely beneficial because they consume large quantities of moths, flies, mosquitoes, beetles, and other insects. Bats typically consume more than 50 percent of their body weight in insects during each night of active foraging, and nursing females may eat enough insects to equal their body weight (Harvey et al. 1999).

Fifteen species of bats have been documented in Mississippi. Eight of these species are frequently encountered in the state, while the other seven have occasional records. Wolfe (1971) provided historical information on the distribution of Mississippi bats based on literature records and known museum specimens. According to Best and Caesar (2000), little was known of Mississippi's bat fauna at that time, and most information regarding bats in the state had been gleaned from studies conducted in other states. A review of the literature (including abstracts from professional meetings) revealed that few publications prior to 2000 specifically addressed the bat fauna of Mississippi (e.g. White 1961; Crain and Cliburn 1965; LaVal 1967; Wolfe 1971; Kennedy et al. 1974; Carter et al. 1987; Best and Caesar 2000).

The last 15–20 years has seen a tremendous increase in the number of studies conducted on bats in Mississippi. Studies from this time period include articles in scientific journals on species diversity (Trousdale and Beckett 2002; Miller 2003), roost selection (Elmore et al. 2004; Trousdale and Beckett 2004, 2005; Trousdale et al. 2008; Fleming et al. 2013a), and foraging area (Elmore et al. 2005), while numerous technical reports have been produced summarizing survey efforts at various locations (Trousdale and Beckett 2000a, 2000b; Martin et al. 2007, 2008; McCartney 2007a, 2007b, 2010; McCartney and McCartney 2007, 2008; Linehan et al. 2008; Deep South Eco Group [DSEG] 2009, 2016, 2017). Several theses and dissertations completed on bats in Mississippi include: Sherman (2004), Wilf (2004), Linehan (2007), Stevenson (2008), Trousdale (2008), Fleming (2011), Roth (2014), Katzenmeyer (2016), and Veum (2017).

The Mississippi Bat Working Group (MBWG) was established in 2001 with the stated goal of supporting bat research, conservation, education, and management within the state of Mississippi. The annual meeting of the MBWG provides a forum for biologists and members of the general public to present current research and discuss topics of interest. The initiation of the MBWG annual mist net events in 2003 provided a vehicle for increased sampling to gain knowledge of the distribution of bats within the state. The last 10 years have also seen an

increase in the number of individuals trained to capture bats (i.e. mist net, harp net) which has also contributed to the knowledge of species distribution within the state. Much of the focus of the MBWG in recent years has been guided by needs identified by the Mississippi Department of Wildlife, Fisheries, and Parks (MDWFP). To date, there are only seven counties in the state for which there are no bat records (MNHP 2020) (Fig. 1). Maps indicate confirmed total species occurrence by county and do not necessarily depict the true distribution of a species throughout the state of Mississippi. Species may be present in undocumented counties, however records for such occurrences have not been documented to date. This may reflect sampling effort, lack of suitable sampling sites (e.g. limited public lands or too open of habitat), and the inherent difficulty in capturing certain species.

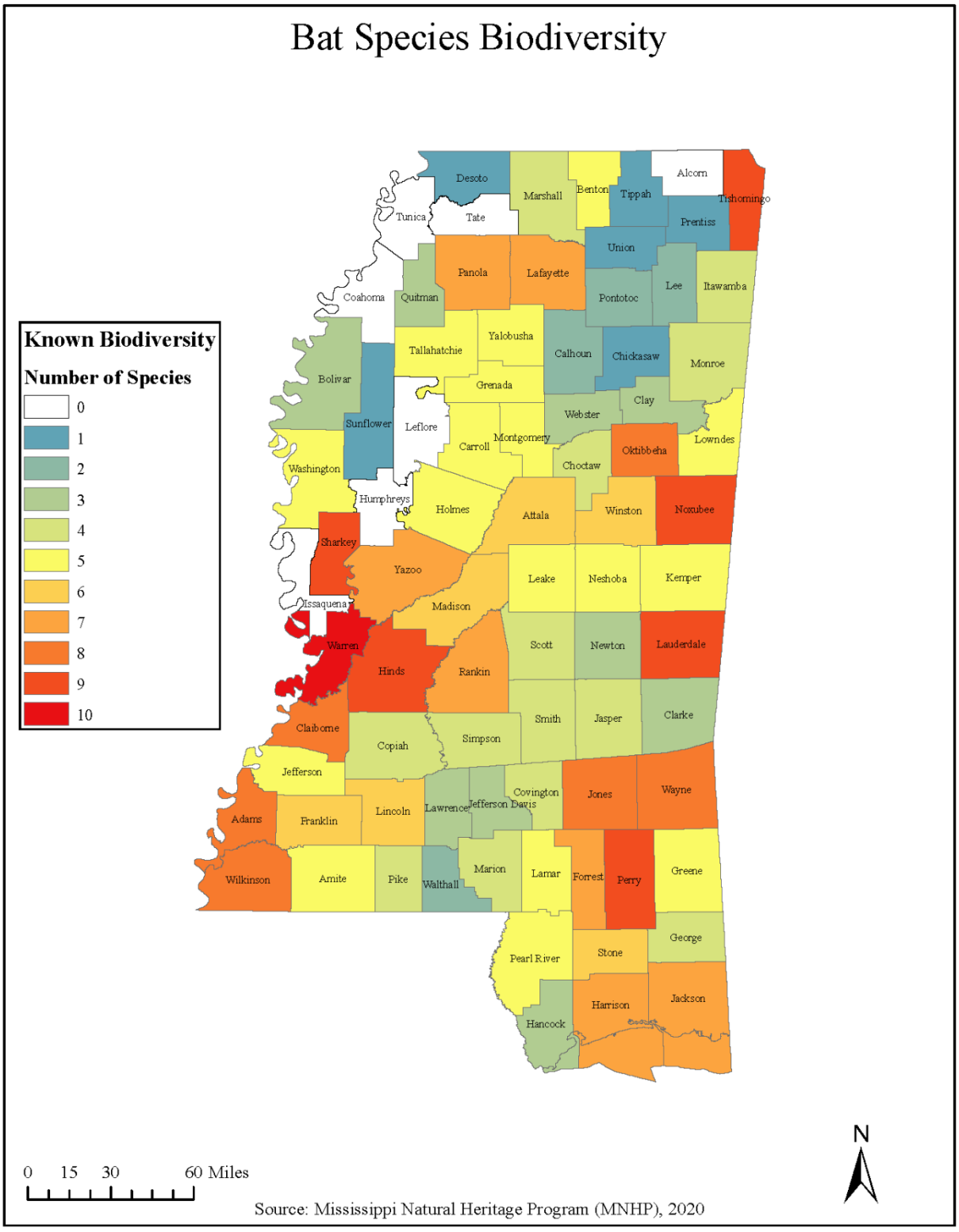

Fig. 1.— Known bat species biodiversity recorded by county in Mississippi.

BAT MANAGEMENT IN MISSISSIPPI

Typically, management for bats focuses on protection of critical habitat—that is, roosting habitat for maternity colonies and hibernacula. Important habitats within Mississippi include the limited cave resources (primarily located in the extreme northeastern and southeastern portions of the state) and forested habitat. The first cave gating in Mississippi was undertaken in 2018 through the efforts of the MDWFP, the U.S. Fish and Wildlife Service (USFWS), the Natural Resource Conservation Service (NRCS), the landowner, and numerous volunteers. This gating protects the largest known maternity colony for southeastern myotis (*Myotis austroriparius*) in the state, estimated at ~9,000 individuals, and is also a significant hibernaculum for tricolored bats (*Perimyotis subflavus*). Caves provide a discrete, easily identified habitat. They present certain challenges, since most caves known to be important for bat populations in Mississippi are in private ownership and many have been degraded by trespassers over time. However, there are resources available for funding cave gates, and landowners can benefit by reducing the potential for trespass injury on their property.

Surveys within the state have also shown that many species of bats will use man-made structures such as abandoned buildings, highway culverts, bridges, and cisterns. Identification of the structures that serve as important maternity roosts or hibernacula is a necessary first step that can then lead to protection of those structures. Now, several of these sites are monitored on a regular basis, but no protection is currently in place.

The majority of bats found in Mississippi use trees for hibernacula, maternity colonies or both. Conservation and management of these roosts and other forest habitat resources present a different challenge. Sixty-three percent of the state's land base is forested (19.4 million acres; Oswalt 2016). Forest managers include federal, State, industry, non-profit, and private entities, each with their own management objectives including commercial production, wildlife conservation, and outdoor recreation. Loblolly pine makes up roughly 40 percent of Mississippi's forests, with hardwoods remaining the dominant forest cover. However, many of these hardwood acres are young stands of reforestation plantings that will take decades to realize their potential to provide cavity roosts. Thus, conservation of mature forests is increasingly critical.

The largest proportion of Mississippi's forestlands lies in private ownership. Traditionally, private forests were managed as a financial investment, with income as the driving management goal. With a depressed pine market, a diversity of conservation cost-share programs, and a growing interest in outdoor recreation, management goals on private lands are shifting. A recent "Southern Wildlife at Risk" survey by the American Forest Foundation (2016) found 87% of southern private landowners cited protection and improvement of wildlife habitat as a key reason they own property. Of those landowners surveyed, 73% want to do more management to benefit wildlife, but identified barriers to managing wildlife on their own lands. Barriers included uncertainty of the right management actions, difficulty in finding support, and the cost of

management. The U.S. Forest Service reports that nationwide, 25% of landowners with 10 or more acres have a formal written management plan, and that 33% of landowners have sought out forest management advice (Butler and Snyder 2017). These studies highlight the importance of providing outreach and support to private landowners, who often lack the resources, even when they have the desire to manage for wildlife.

The American Tree Farm System has 2,719 properties enrolled in their certification program in Mississippi. This equates to 756,652 acres of private forestlands receiving management under a formal forest management plan which has been approved by a registered forester. The average tree farm in Mississippi is 278 acres. These landowners are required to identify threatened and endangered species likely to occur on their property and manage with forestry Best Management Practices (BMPs), which encourage the retention of snags for wildlife and riparian buffers. Communicating the benefits of identifying and leaving snags and cavity trees on the landscape to land managers is an important step in promoting bat management in the state. By following state BMPs, developing forest management guidelines, and partnering with outreach professionals throughout the state, we can help fill this information need. Information regarding organizations providing landowner assistance can be found in Appendices II and III.

Current Research

The focus of recently funded bat projects in Mississippi is to document occurrences of bat populations in the state with special focus on federally protected species. The South Atlantic-Gulf and Mississippi-Basin Interior Regions, Inventory and Monitoring Branch of the USFWS (formally Region 4) assist in coordinating acoustic bat monitoring on 56 National Wildlife Refuges (NWRs) and two Ecological Services Field Offices in 14 states. In Mississippi, 11 of 15 NWRs participate is this program known as the Mobile Acoustical Bat Monitoring project. Survey goals are to establish baseline inventories of bat species at each station and contribute to a landscape-level understanding of bat population trends and habitat associations.

The MDWFP has received grants from the USFWS to conduct roost surveys (primarily of caves, bridges, and culverts) to obtain distributional information and to determine the use of these structures as bat roosting habitats. Surveys are also being conducted to monitor for the potential occurrence of WNS in the state.

Since 2003, the MBWG has hosted an annual mist net event, which surveys a different location throughout the state each year, with the goal of covering as much of the state as possible. Due to the nature of these events, they have been largely restricted to public lands (NWRs, National Forests [NFs], State Parks, Wildlife Management Areas, and the Choctaw Reservation). In recent years, the timing of the events has shifted from summer to fall in an attempt to learn more about seasonal use by bats. Other mist net surveys have been conducted on private, state, and federal lands by state and federal biologists, as well as by contractors and researchers.

Beginning in 2017, the MBWG also coordinates an annual culvert blitz. During the first weekend following January 1, experienced surveyors and volunteers are assigned routes along major roadways throughout the state where they survey culverts for the presence of roosting bats. Routes are repeated annually to assess changes in use over time.

CONSERVATION STATUS OF BATS IN MISSISSIPPI

Table 1.— Conservation status of bat species in Mississippi.

SCIENTIFIC NAME	COMMON NAME	GLOBAL RANK[1]	FEDERAL STATUS[1]	STATE RANK[1]	STATE STATUS[1]
Corynorhinus rafinesquii	Rafinesque's big-eared bat	G3G4	—	S3	—
Eptesicus fuscus	Big brown bat	G5	—	—	—
Lasionycteris noctivagans	Silver-haired bat	G3G4	—	SNA	—
Aeorestes cinereus	Hoary bat	G3G4	—	S2?	—
Dasypterus intermedius	Northern yellow bat	G5	—	SX	—
Lasiurus borealis	Eastern red bat	G3G4	—	—	—
Lasiurus seminolus	Seminole bat	G5	—	—	—
Myotis austroriparius	Southeastern myotis	G4	—	S3S4	—
Myotis grisescens	Gray bat	G4	LE	SH	LE
Myotis lucifugus	Little brown bat	G3	—	SH	—
Myotis septentrionalis	Northern long-eared bat	G1G2	LT	SH	—
Myotis sodalis	Indiana bat	G2	LE	S1B	LE
Nycticeius humeralis	Evening bat	G5	—	—	—
Perimyotis subflavus	Tricolored bat	G2G3	Petitioned	S3S4	—
Tadarida brasiliensis	Brazilian free-tailed bat	G5	—	—	—

[1] Sources for status determination are as follows:

GLOBAL RANK = NatureServe (2019) global conservation status rank. **G1**= critically imperiled; **G2**= imperiled; **G3**= vulnerable; **G4**= apparently secure; **G5**= secure; **G#G#**= range rank, numeric rank used to indicate the range of uncertainty in the status of a species or community.

FEDERAL STATUS = U.S. Fish and Wildlife Service's Endangered Species Act listing. **LE**= listed endangered, **LT**= listed threatened.

STATE RANK = Mississippi National Heritage Program (2018) status ranks for animals of special concern. **S1**= critically imperiled; **S2=** imperiled **S3**= vulnerable; **S4=** apparently secure; **SNA**= not applicable (species is not a suitable target for conservation activities); **SH**= possibly extirpated; **SX**= presumed extirpated; **S#S#**= range rank, numeric rank used to indicate the range of uncertainty about the status of a species or community; **S#B**= breeding status; **S#?**= inexact numeric rank.

STATE STATUS = Protected status according to the Mississippi Nongame and Endangered Species Conservation Act of 1974. **LE**= listed endangered.

Species Accounts

Species State Occurrence Maps

Species occurrence maps included in each species account were developed using the Mississippi Heritage Data Management System, provided by the Mississippi Museum of Natural Science (MMNS). Maps indicate confirmed species occurrence by county and do not necessarily depict the true distribution of the species throughout the state of Mississippi. Species depicted may be present in undocumented counties, however records for such occurrences have not been documented to date.

Species Range Maps

Species range maps were developed using distribution data provided by Patterson et al. (2007).

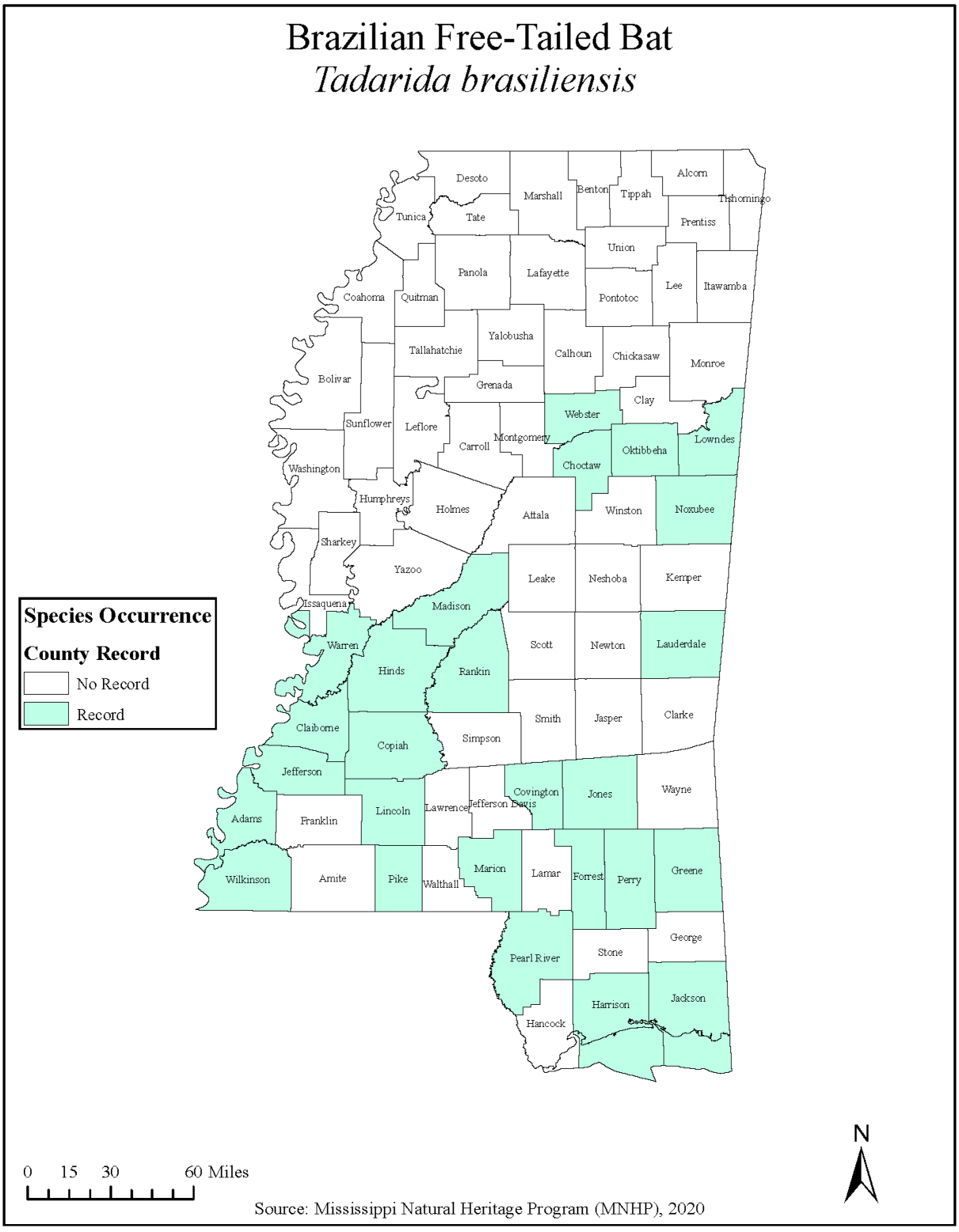

Fig. 2.— Known county occurrence records of Brazilian free-tailed bat (*Tadarida brasiliensis*) in Mississippi.

BRAZILIAN FREE-TAILED BAT – *Tadarida brasiliensis*

Status. – The Brazilian free-tailed bat is considered common throughout its range, and has a global conservation rank of G5, secure (NatureServe 2019; Table 1). Some populations have undergone serious declines in parts of the western United States and Florida (Whitaker and Hamilton 1998). The species is partially protected in Mississippi under Rule M-2.3 Nongame Wildlife in Need of Management (MDWFP 2016).

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Description. – Brazilian free-tailed bats, often referred to as free-tailed bats, are medium in size and have a distinctive tail that is free from the interfemoral membrane. Free-tailed bats have long narrow wings and distinctive vertical wrinkles on the lips along the muzzle (Barbour and Davis 1969; Tuttle and Kennedy 2005). The ears almost meet in the midline but are not joined (Barbour and Davis 1969). The species measures 88–99 mm (3.5–3.8 in) in total length with a wingspan of ranging from 29–36 cm (11.4–14.1 in). Body mass ranges from 8–14 g (0.28–0.49 oz) (Whitaker and Hamilton 1998). LaVal (1973) found that males weighed more than females in early March, but the females weighed more most of the remainder of the year. It was suggested that this was because the females were expending more energy in early March during the early stages of pregnancy (LaVal 1973). Standard measurements include forearm length 41.5–45.5 mm (1.63–1.79 in); hindfoot length 7.4–9.2 mm (0.29–0.36 in); and ear length 19–20 mm (0.75–0.79 in) (Whitaker and Hamilton 1998). The pelage varies from dark brown to dark gray, with the hair nearly uniform in color from base to tip. Scattered white hairs can be found, with very few individuals having large patches of white fur. Hairs as long as the foot extend beyond the toes (Barbour and Davis 1969; Whitaker and Hamilton 1998).

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Distribution –The range of the Brazilian free-tailed bat extends from Oregon, Nevada, Utah, Colorado, Nebraska, Arkansas, Louisiana, Mississippi, Alabama, and North Carolina southward through most of Mexico and Central and South America (Patterson et al. 2007) (Fig. 3). Since 2007, Brazilian free-tailed bats have expanded their range into western North Carolina, eastern Tennessee, and Virginia (McCracken et al. 2018). They hypothesize this is due in part to climate change and the ability of the species to exploit new habitats and use a diversity of roost sites. There are two recognized subspecies of Brazilian free-tailed bats. The western race (*T.b. mexicana*) occurs from central Texas westward, and the eastern race (*T.b. cynocephala*) is found in eastern Texas and throughout the southeastern United States. Although probably more widespread, in Mississippi, Brazilian free-tailed bats have only been documented in 26 of 82 counties (MNHP 2020; Fig. 2).

Fig. 3.— Geographical range of the Brazilian free-tailed bat (*Tadarida brasiliensis*).

Habitat – In the western United States, where the species is migratory, free-tailed bats form huge colonies in caves and under bridges. In the East, there is no evidence this species uses caves, and is generally considered to be non-migratory. Brazilian free-tailed bats in the eastern United States have been documented using stadiums, attics, buildings, bridges, and culverts (Barbour and Davis 1969; Whitaker and Hamilton 1998; Kiser 2000). In Louisiana, Brazilian free-tailed bats have been found roosting with evening bats (*Nycticeius humeralis*) in hollow trees (Jennings 1958; Lowery 1974). Before the arrival of Europeans in North America, and large scale clearing of forests, hollow trees probably served as primary natural roosts for Brazilian free-tailed bats in the eastern United States (Jennings 1958).

Roosting – Brazilian free-tailed bats are very social with hundreds to thousands of individuals roosting together in tightly packed groups (Whitaker and Hamilton 1998). They roost in a variety of structures, including caves, rock crevices, bridges, culverts, and highway overpasses, and other man-made structures in urban areas (Wilkins 1989, Romano et al. 1999). They have been reported to roost in a variety of buildings throughout the state of Mississippi. In 2007, a large colony was discovered roosting under roof tiles of an apartment complex in Jackson, and other colonies have been excluded from apartments in the vicinity of Hattiesburg (Martin 2007a). A large colony of Brazilian free-tailed bats have been observed roosting in different buildings on the campus of Mississippi State University (N. Hodges, personal communication). In 2006, Brazilian free-tailed bats were observed sharing a roost with evening bats in an abandoned church near Port Gibson (A. S. McCartney and C. O. Martin, unpublished data). Just recently, free-tailed bats were observed roosting with big brown bats in a building in Webster County (N.

Hodges, personal communication). They have also been observed roosting with big brown bats and southeastern myotis under bridges and culverts along several highways in Mississippi (MNHP 2020). In a culvert just north of Natchez, approximately 400–700 Brazilian free-tailed bats were documented using the crevices during the winter (MNHP 2020). During the summer, they have been observed in the expansion joint of a bridge and in bat boxes on the Vicksburg National Military Park (NMP; A. S. McCartney, unpublished data). They have also been documented using several bat boxes installed at Percy Quin State Park (MNHP, unpublished data).

Foraging – Brazilian free-tailed bats have long, narrow wings, which allow them to fly at high speeds for long distances. They tend to feed at high altitudes in habitats that are relatively uncluttered by vegetation. During a single night, individuals fly to foraging sites 50 km (31.1 miles) or more from their roost, often at altitudes above 3,000 m (9,842 ft). The tail membrane, although very short, may be extended and curled down in flight as an aid in catching insects (Whitaker and Hamilton 1998). Moths are their primary food source, but they also eat beetles, flying ants, and a variety of other insects. Lactating females eat an amount equal to more than 50% of their own body mass during a single night's feeding (Wilson and Ruff 1999). Barbour and Davis (1969) stated that bats of this species rarely use night roosts and often appear to feed all night. Harvey et al. (2011) stated that the 20 million free-tailed bats living in Bracken Cave in Texas eat an estimated 182,000 kg (200 tons) of insects nightly. This is a huge contribution to the agriculture industry.

Movement and Migration – T. b. mexicana is typically migratory, spending the winter months in central and South America. *T. b. cynocephala* is considered a non-migratory subspecies (Wilson and Ruff 1999). Tuttle and Kennedy (2005) stated that the eastern race is active year-round and is not known to hibernate. However, Schmidly (1991) reported that southeastern populations underwent periods of torpor in human structures.

Reproduction – Unlike many other bats species, Brazilian free-tailed bats do not store sperm in the uterus for a considerable amount of time before ovulation. It is thought that females spend the winter with males to breed and then return to the maternity roost (Whitaker and Hamilton 1998). Mating occurs from mid-February to late March, and ovulation occurs in late March. Gestation lasts about 77–84 days (Krutzsch 1955). A single pup (rarely two), nearly always produced in the right horn of the uterus, is born from late May to late June. During the day, the adults and the pups roost in separate areas. The young cling together in large masses, and females come to feed them during the day (Whitaker and Hamilton 1998). Despite the substantial number of young that may be present in a colony, females recognize and nurse their own offspring. Young nurse for about 45 days and become volant at 6–7 weeks. Females may become pregnant as yearlings; males become sexually mature at 18–22 months. Maternity colonies initially consist almost entirely of pregnant females. Some colonies in western populations include more than one million individuals. If a nursery falls below about 20,000 females, it is usually abandoned (Caire et al. 1989).

Threats and Management – In Mississippi, free-tailed bats are most commonly found under bridges, in culverts, and in buildings. Most concentrations that have required exclusion in the state have been reported from public school buildings, churches, and university dormitories (Martin 2007a). To manage for this species, coordination with the Mississippi Department of Transportation (MDOT) on the time of year to work on bridges and culverts could be critical. In areas where free-tailed bats are a nuisance, we may need to invest in building large bat condos to help alleviate the problem. In 1991, the University of Florida built bat houses for bats that were inhabiting buildings and the stadium on campus. Bat barns have been added over time, and now these structures have become the world's largest occupied bat houses. This has also become a popular ecotourism opportunity, with many people visiting the University of Florida to view the bat emergence (Marks 2018). It is also advisable to protect uninhabited old buildings/structures that have large colonies and educate the public about how to properly (technique and time of year) exclude bats from their homes. Other threats include predators, such as snakes, raccoons, opossums, skunks, and a variety of raptors, including red-tailed hawks, peregrine falcons, and great-horned owls (Ammerman et al. 2012).

Research Needs– Much research has been conducted on the western subspecies population of free-tailed bats, but much more is needed on the eastern population. Research needs include both roosting and foraging habits, migration, and reproduction. Because of their tendency to forage at high altitudes, free-tailed bats are rarely captured during mist net surveys in Mississippi. Therefore, innovative methods need to be developed to assess their populations and movement patterns. Research should also be conducted to determine what attributes attract these, and other bat species, to culverts and bridges.

In the 1930s, there were about 8.7 million free-tailed bats in Carlsbad Caverns National Park, located in Carlsbad, New Mexico, but this number is now reduced to about a quarter million. Brazilian free-tailed bats have also experienced significant declines in Florida, where they are now considered uncommon (Whitaker and Hamilton 1998). More research is needed to determine the extent and cause of the decline in Brazilian free-tailed bat populations and evaluate the effects of agriculture, home pesticide use, and truck sprayers on bat populations.

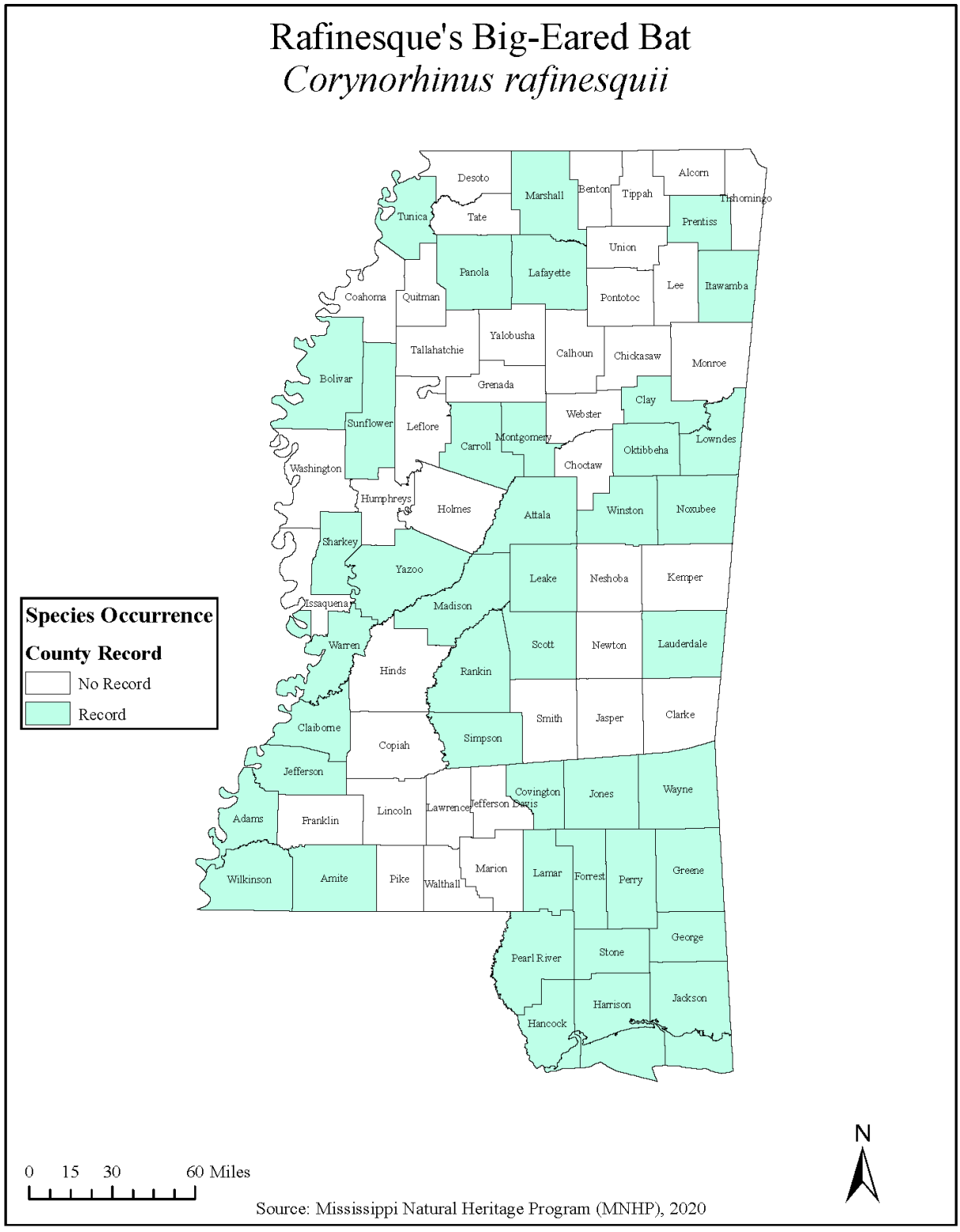

Fig. 4.— Known county occurrence records of Rafinesque's big-eared bat (*Corynorhinus rafinesquii*) in Mississippi.

RAFINESQUE'S BIG-EARED BAT – *Corynorhinus rafinesquii*

Status. – Rafinesque's big-eared bat has a global conservation status rank of G3G4 (vulnerable/apparently secure) and is ranked S3 (vulnerable) in the state of Mississippi (MNHP 2018; NatureServe 2019; Table 1). The Mississippi State Wildlife Action Plan lists the Rafinesque's big-eared bat as a Tier 2 species (in need of timely conservation action) (MMNS 2015). The species is listed as threatened, endangered, or of special concern in 16 of 18 states where it is known to occur (Lacki and Bayless 2013). Although the Rafinesque's big-eared bat is not protected under federal regulation, in Mississippi it is protected under Rule M-2.3 Non-game Wildlife in Need of Management (MDWFP 2016).

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Description. – The Rafinesque's big-eared bat is a medium-sized bat with long, broad ears and large facial glands (pararhinal glands) protruding from each side of its snout (Jones 1977). The species measures 92–106 mm (3.6–4.1 in) in total length with a wingspan ranging from 268–301 mm (10.5–11.8 in). Body mass ranges from 7–13 g (0.25–0.46 oz), where females tend to be slightly heavier than males. Other standard measurements include: forearm length 40–46 mm (1.56–1.79 in); hindfoot length 9–13 mm (0.35–0.51 in); ear length 30–37 mm (1.17–1.49 in); and tragus length 12–16 mm (0.47–0.62 in) (Handley 1959; Barbour and Davis 1969; Jones 1977). The dorsal pelage varies from gray to reddish brown with distinct ventral fur that is black at the base with sharply contrasting white or pale tips (Lacki and Bayless 2013). Long hairs extend beyond the toes. During rest, big-eared bats may coil their ears along the sides of their head like the horns of a ram (Feldhamer et al. 2015).

Distribution – The species occurs throughout the southeastern United States, however populations are disjunct. It occurs from eastern Texas to southern Missouri in the western part of the range; north to southern Illinois, Indiana, and Ohio; and eastward to Florida, North Carolina,

and West Virginia (Jones 1977; Patterson et al. 2007; Harvey et al. 2011; Fig. 5). It is considered uncommon throughout most of its range and is largely absent from the piedmont physiographic province (Lacki and Bayless 2013). Rafinesque's big-eared bats have been documented in 43 of 82 counties in Mississippi (MNHP 2020; Fig. 4). In Mississippi, populations appear to be scattered and are concentrated in the southeastern portion of the state, in the extreme western counties adjacent to the Mississippi River, and in forested regions of north-central Mississippi (McCartney 2007b; Martin et al. 2011; Trousdale 2011). It should be noted the species is difficult to capture using mist nets and increased survey efforts are needed in regions where populations may be present.

Fig. 5.— Geographical range of the Rafinesque's big-eared bat (*Corynorhinus rafinesqu*ii).

Habitat – The Rafinesque's big-eared bat has been found in nearly every habitat type within its range, but denser populations have been recorded in bottomland hardwoods and swamps. They are closely associated with mature hardwood forests along the southeastern coastal plain and Ohio River Valleys. In Mississippi, populations have been found in forested regions of the upper and lower coastal plains, loess hills, interior flatwoods, and the Mississippi Delta.

Roosting – Rafinesque's big-eared bats roost in natural sites and a variety of human-made structures throughout their range (Jones 1977; Clark 1990; Lance et al. 2001; Gooding and Langford 2004; Trousdale and Beckett 2004; Bennett et al. 2008; Trousdale et al. 2008). In Mississippi, big-eared bats have been documented roosting in tree cavities, bridges, culverts, wells, cisterns, abandoned buildings, and specially designed human-made roosts (Wolters and Martin 2000, 2001; Trousdale and Beckett 2002, 2004, 2005; Sherman 2004; Martin et al. 2007, 2008, 2011; McCartney 2007b; Stevenson 2008; Trousdale 2011; Fleming 2011; Fleming et al. 2013a, 2013b). They prefer more open and lighted day roosts than other bat species (Harvey et al. 2011).

Females use hollows of large trees, rock shelters, and cave entrances for maternity roosts but also roost in a variety of human-made structures, including unoccupied buildings, barns, and abandoned wells. Harvey et al. (2011) stated that today maternity colonies are usually found in abandoned buildings and consist of a few to several dozen adults. However, maternity colonies containing up to 200 females and young have been reported in some regions. Abandoned buildings have been documented as significant maternal roost sites on St. Catherine's Creek NWR (Sherman 2004; McCartney 2007b), in an abandoned building in Jefferson County (Martin et al. 2011), and in an abandoned seismograph building in north-central Mississippi. Maternity roosts have been located beneath bridges in Kentucky, Texas (Keely and Tuttle 1999), Louisiana (Lance and Rogowski 1999; Lance et al. 2001), and Mississippi (Wolters and Martin 2000, 2001;

Trousdale and Beckett 2002, 2004; Martin et al. 2011). Highway 315 Bridge (Sardis Bridge), located in the Town of Sardis, supports a maternity colony of approximately 50 individuals. Colonies in Mississippi have also been located in debris deflectors of bridges and culverts throughout the state.

Maternity roosts in hollow trees have been documented on Sam D. Hamilton Noxubee NWR and Tombigbee NF (Stevenson 2008; Fleming 2011, 2013a, 2013b), Delta NF (Wilf 2004), and on DeSoto NF (Trousdale and Beckett 2005; Trousdale et al. 2008). Roost trees reported for Mississippi include black tupelo (*Nyssa sylvatica*), bald cypress (*Taxodim distichum*), American sycamore (*Platanus occidentalis*), sweetgum (*Liquidambar styraciflua*), southern magnolia (*Magnolia grandiflora*), and several species of oaks (*Quercus* sp.) and hickories (*Carya* sp.) (Wilf 2004; Trousdale and Beckett 2005; Stevenson 2008; Fleming 2011; Fleming et al. 2013a, 2013b). Roost trees selected by big-eared bats are typically tall (18–25 m; 59–82 ft), possess large cavities (often with a triangular basal opening), and are often in close proximity to permanent water (Lacki and Bayless 2013). The diameter of roost trees often exceeds 100 cm (39 in). Colonies also select roost trees with both chimney hollows and openings either at the top or upper reaches to facilitate escape from predators and flood events (Gooding and Langford 2004; Rice 2009; Johnson and Lacki 2011). Males and non-reproductive females roost apart from maternity colonies in hollow trees, crevices, buildings, cisterns, culverts, beneath bridges, or under loose bark (Jones 1977). Rafinesque's big-eared bats are known to switch roosts every 2–3 days (Johnson et al. 2012), but they regularly return to previously used roosts (Loeb 2017). Roost switching has been documented for both tree roosts and human-made structures in Mississippi (Trousdale et al. 2008).

Rafinesque's big-eared bats use both natural and human-made structures during the winter (England and Saugey 1999; Stevenson 2008; Fleming 2011; Sasse et al. 2011). Stevenson (2008) reported that old bald cypress trees were used as winter roosts on Sam D. Hamilton Noxubee NWR. Approximately 200 bats were observed roosting in a tree on the refuge in 2009 (Martin et al. 2011). On Desoto NF, several bridges have been documented as winter roost locations for the species (Trousdale 2008). Sardis Bridge also supports a substantial winter population. It is not uncommon to find solitary individuals utilizing culverts during the winter (K. Shelton, personal communication). Several big-eared bats were found hibernating in highway culverts during winter surveys in 2017 and 2018 (Rosamond et al. 2018). Surveys conducted in Claiborne County from November through January 2001–2004, documented clusters of 12–25 individuals roosting in a dilapidated well adjacent to an abandoned house (Martin et al. 2011; M. Wolters, unpublished data). Big-eared bats were also observed in a partially covered well in Winston County during winter surveys. An abandoned seismograph building was used as a hibernaculum as well as a maternity roost site in northcentral Mississippi, and individuals have been observed roosting in abandoned houses on St. Catherine Creek NWR located in southwest Mississippi (Sherman 2004; Martin et al. 2011). Big-eared bats were not observed in any of the ten cisterns surveyed in southwestern Mississippi (McCartney 2007b), however, they have been documented

using cisterns in other states (Harvey and Saugey 2001; Sasse and Saugey 2014) and could potentially utilize these structures in Mississippi.

Foraging – Rafinesque's big-eared bats are agile, highly maneuverable fliers that can glean insects from foliage. They often forage within 1 m (3 ft) of the ground in forested habitats. Their flight patterns are versatile, ranging from direct and swift to slow and highly maneuverable (Barbour and Davis 1969; Whitaker and Hamilton 1998). Bats generally emerge late in the evening to forage and feed primarily on moths, but also consume large numbers of horseflies and craneflies when available (Tuttle and Kennedy 2005; Harvey et al. 2011). In Louisiana, Gregory et al. (2014) determined moths comprised 93.7% of their diet; beetles, true bugs, flies, and ants were also consumed. In a North Carolina study, Ellis (1993) reported horse flies and deer flies comprised nearly a third of the diet of Rafinesque's big-eared bats. Few studies have been conducted relative to foraging areas for the species, but bats have been reported feeding in oak-hickory forests along mid-slopes of ridges, mature bottomland hardwood forests, young pine stands, and deciduous forests on drier soils (Clark et al. 1998; Hurst and Lacki 1999; Medlin and Risch 2008; Lacki and Bayless 2013).

Movement and Migration – Rafinesque's big-eared bats are considered non-migratory, and evidence suggests they are among the most sedentary of North American bat species (Lacki and Bayless 2013). The maximum distances that the species has been recorded away from primary roosting sites are 2.5–2.6 km (1.5–1.6 mi) in upland forests, and 3.1–3.4 km (0.9–2.1 mi) in bottomland forests (England and Saugey 1998; Hurst and Lacki 1999; Lance et al. 2001; Johnson and Lacki 2011). Big-eared bats may hibernate a few months (November–March) in the northern part of their range, but remain active year-round in warmer regions.

Reproduction – Mating occurs in the fall, but ovulation and fertilization are delayed until early spring. Pregnant females segregate from males and non-reproductive females after leaving hibernacula, and give birth to a single pup in late spring. The young become volant in approximately three weeks. Longevity is estimated at around 10 years.

Threats and Management – The greatest threat to the Rafinesque's big-eared bat is habitat loss, especially in forested wetlands. Known and potential roost trees for this species should be protected, and forest management prescriptions should provide for large trees as future habitat, especially along water sources. Loeb (2017) stated that selection of the largest cavities available suggests that maintaining trees with large hollows is critical for the conservation of big-eared bats in bottomland hardwood forests. Furthermore, surplus roosts should be maintained by preserving all potential roost trees and ensuring that new trees are recruited into the pool of potential roosts (Loeb 1017). Since much of the preferred natural habitat in Mississippi has been degraded, survival of the species may well depend on the provision of man-made alternative roost sites until habitat restoration can occur. Thus, roosts located in old buildings, culverts, wells, and bridges should be maintained (Martin et al. 2011). Bridge-roosting populations have

been documented in several regions of Mississippi, but few attempts have been made to protect these sites, except on federal lands. Specially designed man-made roosts have potential and should be considered for placement in appropriate habitat (Bayless 2006; McCartney 2007b). These structures have been used successfully at several sites in southern Mississippi (McCartney 2007b; Martin et al. 2011).

Research needs – Our knowledge and understanding of Rafinesque's big-eared bats in Mississippi has improved substantially due to recent studies. However, there are still many questions regarding habitat requirements, spatial needs, movement patterns, and social interactions of the species. Major roosts have been located and described in several areas, but there have been few long-term commitments to preserve and monitor most of these sites. Seasonal movements, movements among roosts, and use of winter roosts are also in need of study. Additional studies need to be conducted to track big-eared bats to foraging and roost sites using radio telemetry. Long-term studies are necessary to determine use of both natural and man-made roost sites. Specific research needs include: (a) location of significant tree-roosting populations throughout Mississippi; (b) location and assessment of man-made roost sites, including buildings, bridges, wells, bat towers, and culverts; (c) surveys of movement patterns using radio telemetry and visual means; (d) continued monitoring of the status of known populations; (e) studies of foraging habitat (especially in riparian and bottomland areas); and (f) examination of the potential for management on private lands.

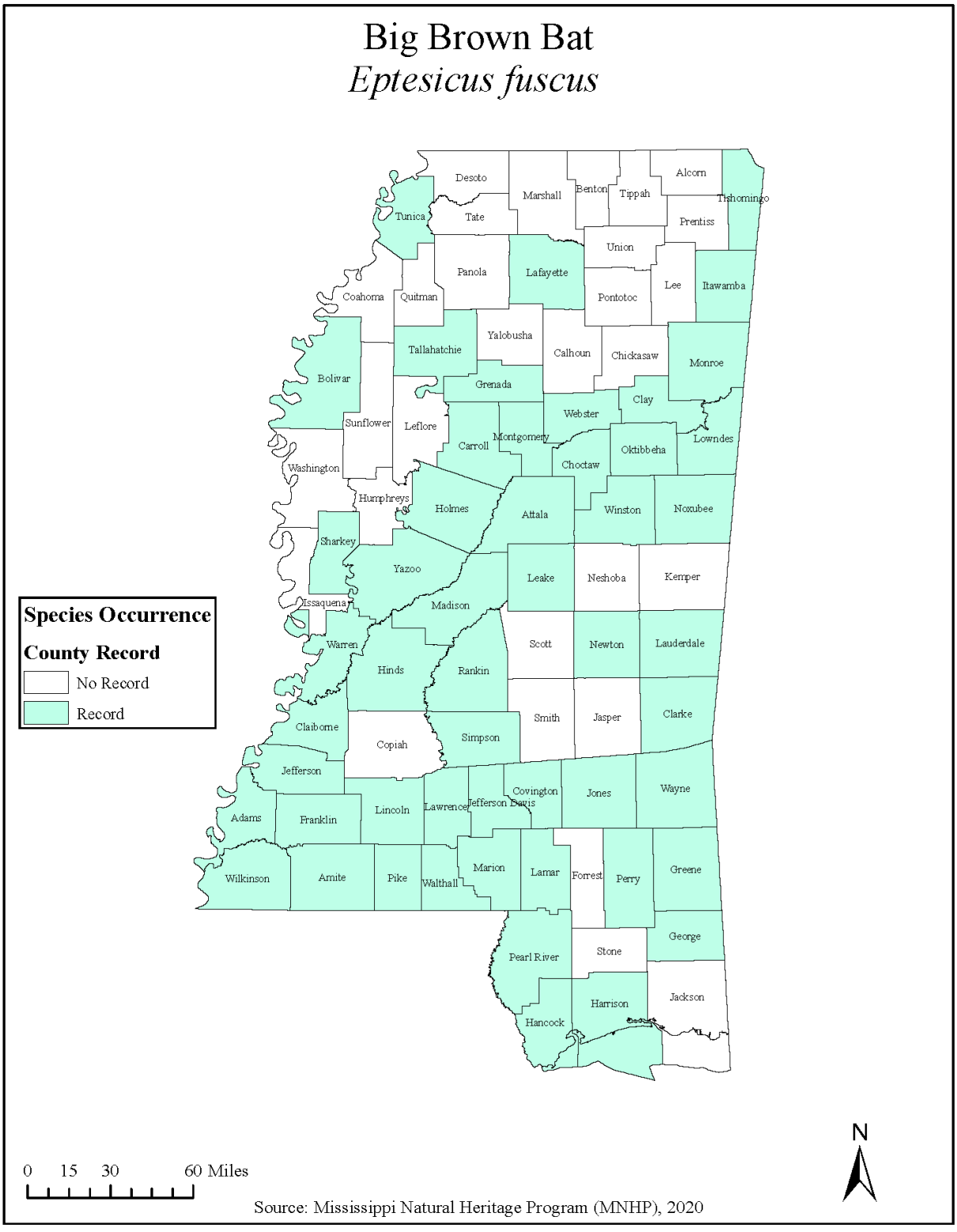

Fig. 6.— Known county occurrence records of big brown bat (*Eptesicus fuscus*) in Mississippi.

BIG BROWN BAT – *Eptesicus fuscus*

Status. – The big brown bat is common throughout most of its range and is not federally protected. The global conservation status rank of this species is G5, secure (NatureServe 2019; Table 1). In Mississippi this species is protected under Rule M-2.3 Nongame Wildlife in Need of Management (MDWFP 2016).

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Description. – The big brown bat is one of the larger North American bats, with a total length of 110–130 mm (4.33–5.12 in) and a wingspan of 32–39 cm (12.60–15.35 in) (Kurta 1995; Harvey et al. 2011). Standard measurements include: body mass 14–21 g (0.49–0.74 oz); forearm length 41–50 mm (1.60–1.95 in); hindfoot length 10–14 mm (0.39–0.55 in); and ear length 16–20 mm (0.62–0.78 in). The species is sexually dimorphic with females being 5% larger than males, on average (Kurta and Baker 1990). The big brown bat has a broad muzzle, fleshy lips, large eyes, and rounded ears (Baker 1983). The tragus is short and rounded. The skin of the face, ears, wings, and tail membrane is black (Kurta and Baker 1990). The dorsal pelage is typically dark brown but ranges from a rich chocolate color to pinkish tan, depending on location, while the ventral pelage varies from pinkish to olive buff. The fur is sometimes described as "oily" in texture. Individuals with albinism are occasionally found, as well as bats with white blotches on the wings (Baker 1983). The only similar species is the evening bat (*Nycticeius humeralis*), which is much smaller with a wingspan of 26–28 cm (10.24–11.02 in). The big brown bat's large size and strong, steady flight distinguish it on the wing. It is very vocal and often produces an audible chatter during flight (Ammerman et al. 2012).

Distribution – The big brown bat is widely distributed from southern Canada southward through the United States, Central America, northwestern South America and many of the Caribbean Islands (Patterson et al. 2007; Harvey et al. 2011; Fig. 7). The species appears to occur at scattered locations throughout Mississippi and is most often encountered in man-made structures. Big brown bats have been documented in 52 of 82 counties in the state (MNHP 2020; Fig. 6).

Fig. 7.— Geographical range of the big brown bat (*Eptesicus fuscus*).

Habitat – Big brown bats are found in a variety of habitats but appear to be most common in

deciduous forested areas in the East. They may also be common in urban/suburban areas and terrain with mixed agricultural use.

Roosting – Historically big brown bats roosted primarily in tree cavities, rock crevices and beneath loose bark. Presently, big brown bats are closely associated with humans, as most summer roosts are in man-made structures, such as attics, barns, underneath buildings, and bat houses where maternity colonies form, ranging from a few to several hundred individuals (Tuttle 1988; French 1999; Harvey et al. 1999). Maternity colonies of 25–75 are most typical, with the largest colonies usually found in buildings (Ammerman et al. 2012). Maternal colonies of big brown bats have been documented at bridge sites in southwestern Mississippi (M. Wolters, unpublished data). Summer roosts are also found in caves, mines, hollow trees, rock crevices, and beneath loose bark (Choate et al. 1994). Big brown bats are also commonly found in bat houses. Roosts of 50 to several hundred individuals have been found in old buildings in Holmes and Webster counties in central Mississippi. Bachelors roost separately in similar, often cooler roosts (Tuttle and Kennedy 2005). Night roosts used intermittently during foraging periods include garages, breezeways, and porches of houses (Harvey et al. 2011).

Big brown bats typically hibernate in underground structures such as caves, mine tunnels, storm sewers, culverts, and buildings (Whitaker and Gummer 1992, 2000; Choate et al. 1994; Harvey et al. 2011). Tree cavities, snags, barns, silos, churches, concrete athletic stadiums, and bridges may also be used (Baker 1983; Tuttle and Kennedy 2005). They have been reported to commonly roost near the entrance of caves and mines, where the air is cooler and drier (Boyles et al. 2009; Feldhamer et al. 2015); this characteristic has also been observed in culvert and bridge sites in Mississippi. The most important feature of a hibernaculum appears to be the maintenance of ambient temperatures above freezing, as it has been documented that bats will rouse and move to a more favorable location if the temperature falls below freezing (Barbour and Davis 1969; Whitaker and Gummer 1992). Torpid bats hang singly or in clusters of up to 100 individuals, where they often wedge themselves into cracks or crevices of the hibernaculum.

In Mississippi, big brown bats have been documented in a variety of man-made structures including buildings, bridges and culverts. They have been found commonly roosting individually and in clusters of up to 15 bats beneath bridges in west-central Mississippi (Wolters and Martin 2000, 2001). In 2004, approximately 150 big brown bats were found roosting in crevices of a concrete bridge in eastern Mississippi (A. McCartney, unpublished data). A population is also known to roost in a monument and surrounding bat houses within the Vicksburg NMP. This species has been documented roosting in highway culverts during the winter in Mississippi; 121 individuals were observed hibernating in interstate highway culverts during the Culvert Blitz surveys conducted in January 2018 (Rosamond et al. 2018). Big brown bats are one of the most common species known to roost in human structures and, thus may require exclusion (Godwin 2014). Houses with hundreds to thousands of big brown bats have been reported by MDWFP (K. Shelton, personal communication).

Big brown bats have also been documented roosting in a variety of deciduous and coniferous trees, and prefer tree roosts that are taller than those in the surrounding area (Kurta 1994; Perry and Thill 2008). They have been reported roosting in pine snags in Arkansas (Perry et al. 2007).

Foraging – Big brown bats forage over water, along riparian corridors, and around wooded clearings (Choate et al. 1994; Harvey et al. 2011). They emerge early in the evening and fly a steady, nearly straight course at a height of 6–10 m (20–33 ft) to foraging areas. Bats frequently use the same feeding ground each night and follow identical feeding patterns on different nights. They most frequently prey on beetles but will feed on a variety of medium-sized insects such as ants, flies, mosquitoes, mayflies, stoneflies, moths, froghoppers, caddisflies, crickets, and katydids (Tuttle and Kennedy 2005; Harvey et al. 2011). Big brown bats apparently do not prey on moths to any particular degree (Agosta 2002). A pregnant female can consume its body weight in insects each night, and a colony of 150 big brown bats can consume enough adult cucumber beetles in one summer to prevent the production of 33 million of their root-worm larvae, which are a major corn pest (Whitaker 1995). Big brown bats may become active and feed during warmer periods in winter (Boyles et al. 2009).

Movement and Migration – Big brown bats do not undergo long distance migrations. They sometimes use the same sites for both winter and summer roosts, but have been observed traveling as far as 80 km (50 mi) between winter and summer habitat (Choate et al. 1994).

Reproduction – Mating typically occurs in fall or early winter, and sometimes as late as March, but fertilization is delayed until spring (Tuttle and Kennedy 2005). Gestation is variable, averaging about 60 days. In the eastern United States, females typically give birth to two offspring in late May or early June. Pups become volant in 18–35 days and are nursed for 32–40 days; the young accompany mothers while foraging for up to 17 days (Tuttle and Kennedy 2005). The maximum known longevity in the wild is 19 years, and it is common for this species to live more than 10 years (Feldhamer et al. 2015). Males are known to live longer than females (Kurta 2008). Mortality can be high for pups because many may fall from their roost sites and perish (Feldhamer et al. 2015).

Threats and Management – Predators of big brown bats include barn owls (*Tyto alba*), great horned owls (*Bubo virginianus*), American kestrels (*Falco sparverius*), rat snakes, bull snakes, rattlesnakes, weasels (*Mustela* sp.), rats, and cats (*Felis catus*) (Ammerman et al. 2012; Feldhamer et al. 2015). Although the big brown bat is common over most of its range, protection is warranted given its value to the ecosystem and benefit as a control agent for forest and agricultural pests. A concern in the eastern United States is the loss of roost sites when bats are excluded from older buildings or where buildings are demolished. Maintaining forested habitats with a diversity of mature, broad-leaved trees will provide roosting habitat. Where suitable natural roosts are lacking, installation of bat houses, especially large multi-chambered structures, is recommended (Martin and Staten 2018).

Research Needs – The majority of information provided is obtained from studies in other states. No specific studies have been conducted on big brown bats in Mississippi; thus within-state data are lacking on the species' life history and ecology. Potential research should include an assessment of maternity colonies and winter roosts, including the use of culverts. Additionally, studies are needed on food habits and parasite loading. Also, better information should be provided to the public on proper exclusion methods for homes and other structures.

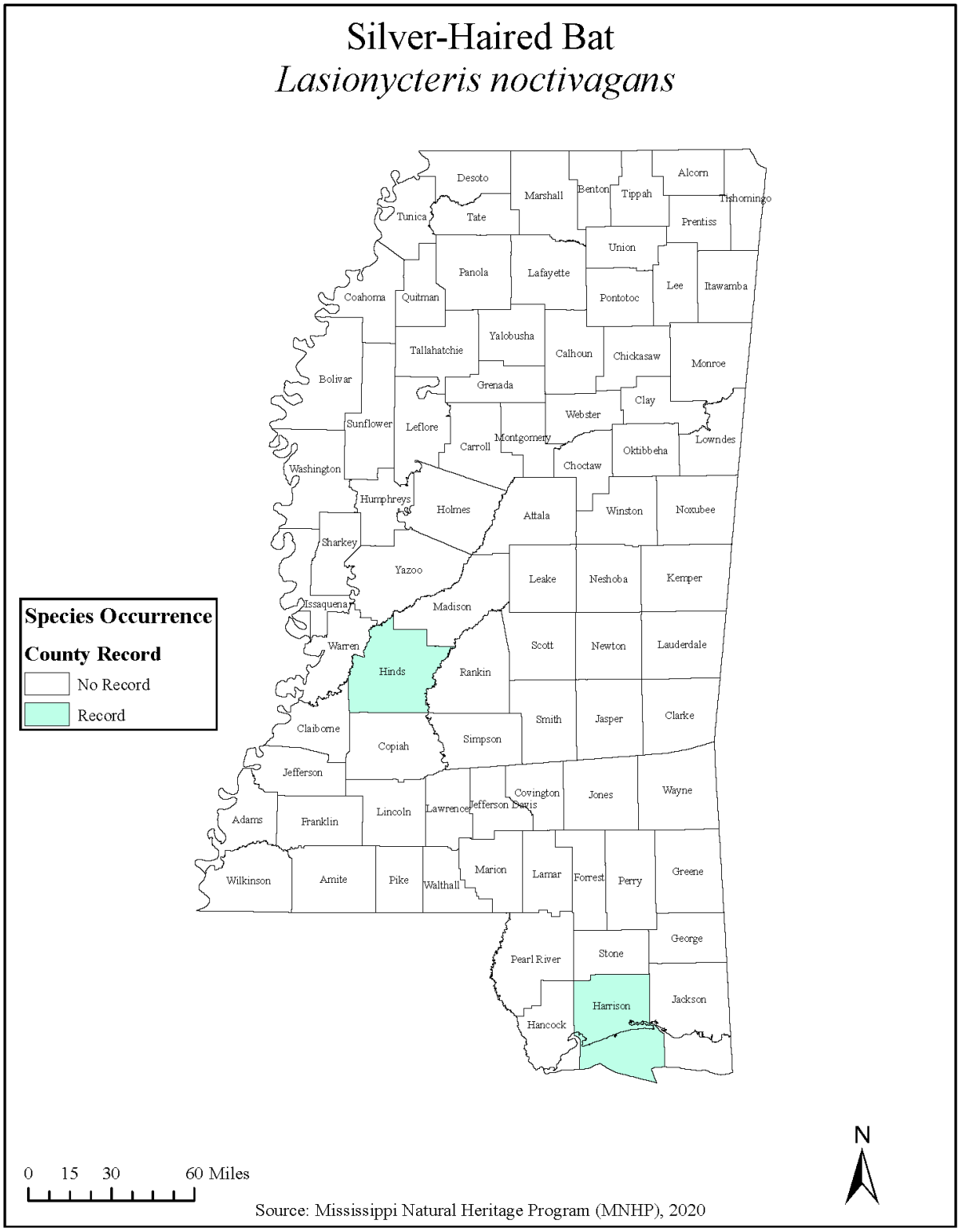

Fig. 8.— Known county occurrence record of silver-haired bat (*Lasionycteris noctivagans*) in Mississippi.

SILVER-HAIRED BAT – *Lasionycteris noctivagans*

Status. – The silver-haired bat is not federally protected, but is considered relatively uncommon throughout much of its range, especially in the southeastern United States (Harvey et al. 2011). As such, the species has a global conservation rank of G3G4, vulnerable/apparently secure (NatureServe 2019; Table 1). In Mississippi, the silver-haired bat has a state rank of SNA, indicating a conservation status rank is not applicable (MNHP 2018; Table 1). Although the silver-haired bat is not protected under federal regulations, in Mississippi it is protected under Rule M-2.3 Nongame Wildlife in Need of Management (MDWFP 2016).

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Description. – The silver-haired bat is a medium-sized bat that is predominately dark brown to black in color with a frosted or silvery appearance resulting from the white tips of individual hairs. Standard measurements include: total length 9–11 cm (3.5–4.2 in); wingspan 27–31 cm (1.1–1.2 in); weight 8.5–12.5 g (0.30–0.44 oz); forearm length 38–43 mm (1.5–1.7 in); hindfoot length 7–10 mm (0.27–0.39 in); and ear length 14–17 mm (0.55–0.67 in; Kunz 1982; Harvey et al. 2011). The ventral fur is pale with a less pronounced silvery wash. The tail membrane is lightly furred dorsally and the ears are short and rounded.

Distribution – The silver-haired bat is a migratory species whose range extends from southern Alaska and central Canada southward through much of the conterminous United States to northeastern Mexico (Kunz 1982; Patterson et al. 2007; Harvey et al. 2011; Fig. 9). Although widespread, this species is relatively uncommon throughout much of its range, especially in the southeastern United States where there are only sporadic records (Golley 1962, 1966; LaVal 1967; Martin 1977; Lance and Rogowski 1999). In Mississippi, this species has been documented only in Harrison and Hinds Counties. A single specimen collected in a residential area of Hinds County in October 1986, and most recently, an individual was collected in Harrison County in March 2020 (Carter et al. 1987; MNHP 2020; Fig. 8). Although undocumented, the species could potentially winter in portions of Mississippi.

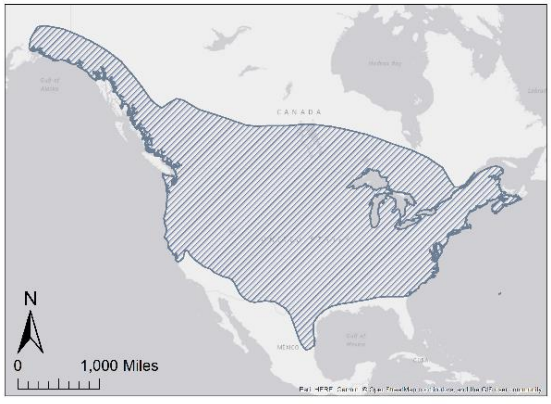

Fig. 9.— Geographical range of the silver-haired bat (*Lasionycteris noctivagans*).

Habitat – Silver-haired bats are primarily tree dwellers, found along forested streams and rivers (Nowak 1999).

Roosting – During warmer months, typical day roosts are under loose tree bark, but they have also been found in woodpecker cavities, bird nests, and buildings (Harvey et al. 2011). During summer residency and migration, female silver-haired bats roost alone or in maternity colonies of up to 55 individuals, whereas males are usually solitary (Barclay et al. 1988; Betts 1998; Perry et al. 2010). Maternity colonies may periodically move among several nearby roost sites, and solitary bats seldom use the same day roost for more than two consecutive days (BCI 2001).

During migration they use a variety of temporary roosts, but prefer more open sites such as sheds, outbuildings, lumber and slab piles, railroad ties, bricks, and fence posts (Kunz 1982). Silver-haired bats use a variety of trees throughout their autumn-winter range, but few species have been identified in the literature. Perry et al. (2010) examined winter roost selection in Arkansas and found that they preferred roosting in pine-hardwood stands >50 years old. Ninety percent of roost sites were in trees, 55% of which were under the loose bark of shortleaf pines (*Pinus echinata*). Other roost trees used were blackgum (*Nyssa sylvatica*), northern red oak (*Quercus rubra*), white oak (*Q. alba*), and under the roots of red maple (*Acer rubrum*). Winter roosts have also been documented in buildings, caves, mines, crevices, and even wooden structures on ships (Clark 1993; Cryan and Veilleux 2007; Perry et al. 2010).

Foraging – Silver-haired bats leave day roosts at dusk and forage over ponds and streams at heights up to 8 m (25 ft). They emerge earlier than most bat species and can be recognized by their slow flight and repetition of flight patterns; they sometimes fly repeatedly over the same circuit during the evening (Harvey et al. 2011). They have hunting territories as large as 100 m (300 ft) in diameter that may be located as far as 2–50 km (1.25–31 mi) from day roosts (BCI 2001). Their diet consists of a wide variety of insects, including flies, midges, leafhoppers, moths, mosquitoes, termites, true bugs, beetles and ants (BCI 2001; Harvey et al. 2011). They appear to select mostly small, soft-bodied insects, especially those that swarm in groups. Silver-haired bats may rouse in winter and leave their roosts to forage when evening temperatures are >10°C (50°F).

Movement and Migration – Silver-haired bats migrate from northern states to warmer wintering sites in late August and September, and return to cooler summer regions in late May. Spring migration lasts for about two weeks, but fall migration is spread over a longer period of time (Harvey et al. 2011). During winter, silver-haired bats migrate to the southern United States and usually reside south of a line from Pennsylvania to Missouri, to southern Arizona and California (Izor 1979; Perry et al. 2010). Harvey and Saugey (2001) found abundance of the species increased during a two week spring migration period in Kentucky and Tennessee.

Reproduction – Mating occurs primarily in the fall prior to migration. Ovulation and fertilization are delayed until late April or May, and gestation lasts approximately 50–60 days. Young are

raised in the northern portion of their range in the United States and northward into Canada. Most females give birth to twins (occasionally only one) in June or early July (Harvey et al. 2011). The young become volant at approximately three weeks of age. Expected longevity in the wild is seven years, although dental records have shown silver-haired bats can live as long as 12 years (Kunz 1982).

Threats and Management – The silver-haired bat is potentially affected by wind-energy facilities because it is a long-distant migrant. In Mississippi, there are no large-scale wind farms, and the only suitable locations for wind farms currently would be off-shore or in the Delta region of the state (WINDExchange 2018). This should be monitored as changes in technology could make Mississippi more appealing for wind energy development. To effectively manage for the silver-haired bat, additional research is needed regarding roosting behavior and habitat requirements in eastern forested habitats. Perry et al. (2010) found silver-haired bats selected shortleaf pine trees as roost sites in Arkansas, thus conservation and management efforts should preserve these pine stands in Mississippi. However, silver-haired bats utilize several other tree species during winter in the Southeast. Recruitment and retention of snags, along with the maintenance of structural complexity in upland forests and riparian areas are important for the conservation of bat species, including silver-haired bats (Campbell et al. 1996).

Research Needs – The fact that only a single silver-haired bat has been reported in Mississippi makes it difficult to devise a reasonable conservation and management strategy for the species. We suggest that additional efforts be undertaken to locate migrating and wintering bats, particularly in the northernmost counties of the state where larger populations occur in surrounding states such as Tennessee and Arkansas.

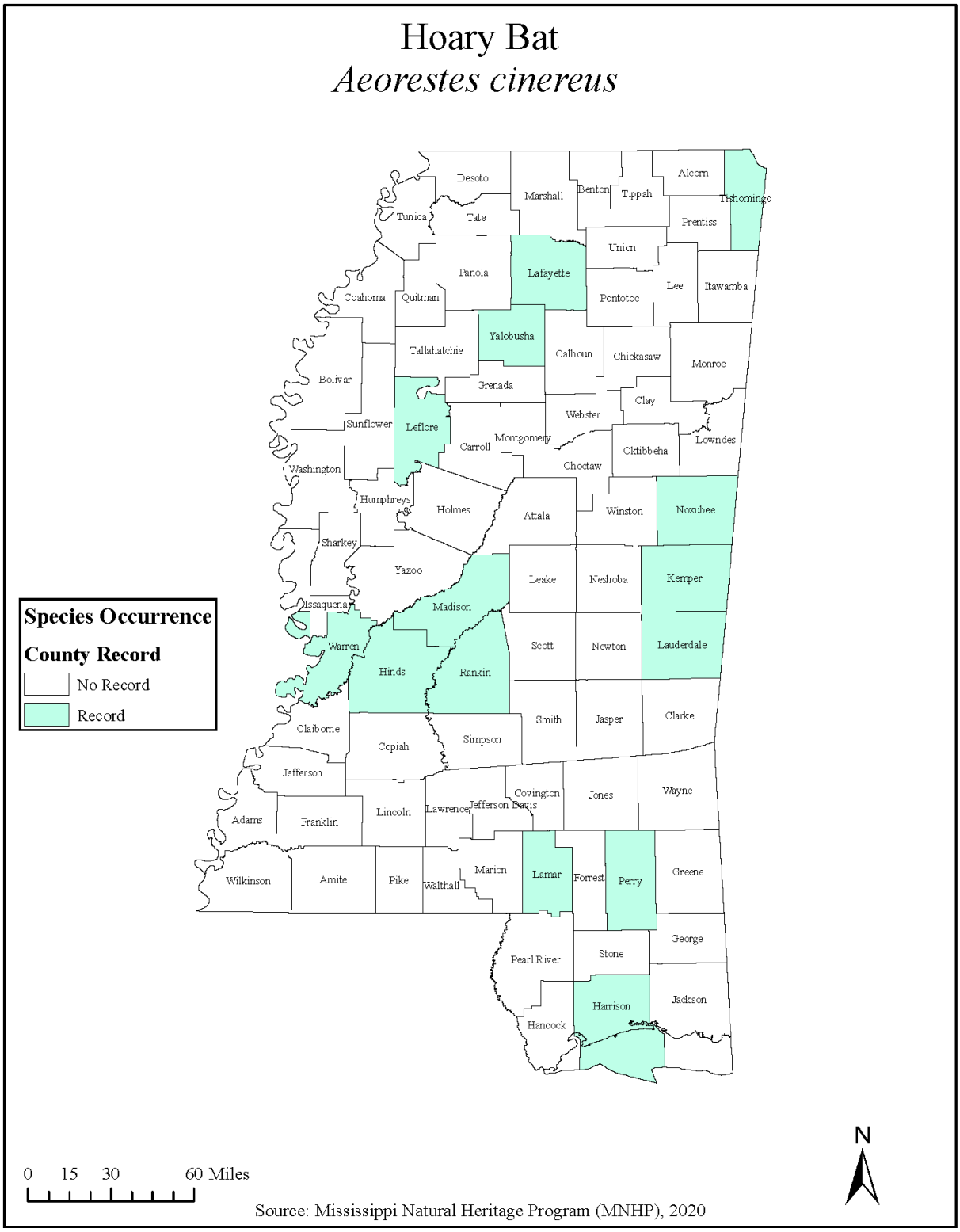

Fig. 10.— Known county occurrence records of hoary bat (*Aeorestes cinereus*) in Mississippi.

HOARY BAT – *Aeorestes cinereus* (syn. *Lasiurus cinereus*)

Status. – The hoary bat is not federally protected, but is considered vulnerable/apparently secure (G3G4) globally (NatureServe 2019; Table 1). In Mississippi, the hoary bat is considered imperiled and has a state rank of S2? (MNHP 2018; Table 1). The hoary bat was previously classified as a *Lasiurus* species, however recent genetic work conducted by Baird et al. (2015) concluded it should be considered a separate genera. The Hawaiian hoary bat (*Aeorestes semotus*), formerly recognized as a subspecies of *A. cinereus*, is now considered a separate species and is federally listed as endangered by the USFWS. Although *A. cinereus* is not protected under federal regulation, in Mississippi it is protected under Rule M-2.3 Nongame Wildlife in Need of Management (MDWFP 2016).

Description. – The hoary bat is a large, strikingly colored bat with a heavily furred tail membrane. Standard measurements are as follows: total length 13–15 cm (5.2–5.9 in); wingspan 34–41 cm (13–16 in); body mass 25–30 g (0.9–1.1 oz); forearm length 52–58 mm (2.0–2.3 in); ear length 18–20 mm (0.7–0.8 in); and tragus length 0.9 mm (0.04 in). Pregnant females may weigh over 30 g (1.05 oz). The dorsal pelage is dark mahogany brown, and the hair tips are white, resulting in a heavily frosted appearance. The individual hairs are dark at the base, yellowish in the middle, and black at the ends with white tips. The underside of the abdomen is not heavily frosted and is usually yellow to yellowish brown (Shump and Shump 1982b). The ears are furred and rimmed with black. Fur on the throat and face is yellowish, and the dorsal surface of the interfemoral membrane is densely furred. Yellowish fur extends onto the ventral wing membrane from body to wrist. The forearms appear pinkish (Ammerman et al. 2012).

Distribution – The hoary bat is the most widespread North American bat, occurring in most of southern Canada, throughout the United States, and southward through much of South America (Patterson et al. 2007; Harvey et al. 2011; Fig. 11). During the summer, males are mainly distributed in western North America, whereas females are more abundant in eastern regions (Findley

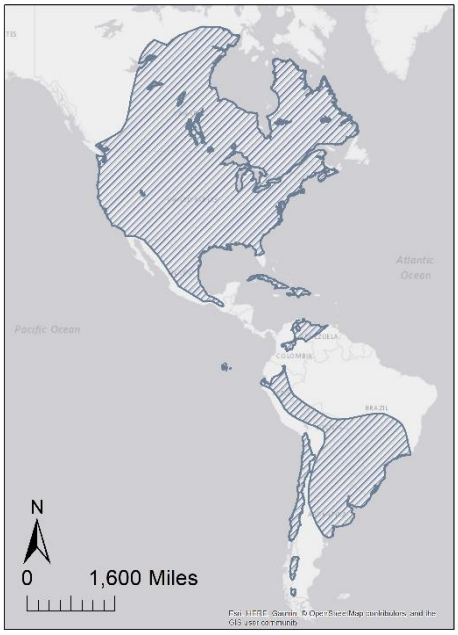

Fig. 11.— Geographical range of the hoary bat (*Aeorestes cinereus*).

and Jones 1964; Cryan 2003). Hoary bats have been documented in 14 of 82 counties in Mississippi, although they are probably more widespread throughout the state (MNHP 2020; Fig. 10).

Habitat – Hoary bats are found in a wide variety of geographic habitats from lowland deserts, to tropical rain forests, and northern tundra (Tuttle 1995). They occur in pine-hardwood forests in the eastern United States, and in arid deserts and ponderosa pine (*Pinus ponderosa*) forests in the West. Hoary bats are abundant on the edges of croplands and deciduous forests of the plains states, and in coniferous forest of the Pacific Northwest. In Canada, hoary bats are abundant in deciduous forests along ridges surrounded by wet meadows, marshes, and bays.

Roosting – Often referred to as tree or foliage bats, hoary bats are solitary, roosting primarily among foliage in deciduous or coniferous trees. In the summer they roost in foliage that is well covered from above, but open from beneath so that bats can drop down easily to initiate flight. Roosts have been documented from 3–19 m (10–62 ft) above the ground, and are usually found at the edge of a clearing (Constantine 1966; Gruver 2003; Perry and Thill 2007). Hoary bats prefer trees that are taller and larger in diameter and tend to roost in stands dominated by mature trees (Jung et al. 1999; Perry and Thill 2007). However, they have been found roosting in open wooded glades, in fencerows between crops, and along urban streets in city parks. Females and young usually roost higher than solitary adults (BCI 2001). Hoary bats generally show low roost-site fidelity, but Perry and Thill (2007) documented females using the same roost for 23–26 consecutive days during the maternity season. Unusual roost sites have included a squirrel's nest, the side of a building, underneath driftwood, a woodpecker hole, under a bridge, and inside a cave (Neill 1952; Carter and Menzel 2007; Ammerman et al. 2012).

Foraging – Hoary bats leave their roosts soon after dusk, foraging early in the evening and again an hour before sunrise (BCI 2001). They forage over meadows, streams, rivers, and stands of trees at canopy level and may select a mosaic of forest and vegetation types that include small openings and edges. Hoary bats exhibit high foraging site fidelity, choosing sites that they return to on successive nights. Females may travel as far as 19 km (12 mi) to forage (Tuttle 1995). Hoary bats are insectivorous and hunt relatively large prey. Moths often make up the bulk of their diet (90%), but other prey items include beetles, flies, wasps, grasshoppers, crickets, termites, dragonflies, true bugs, and occasionally mosquitoes (Warner 1985; Harvey et al. 2011; Ammerman et al. 2012). Valdez and Cryan (2009) found in New Mexico the diet of hoary bats shifted more to beetles during spring migration.

Movement and Migration – Northern populations of hoary bats make long migrations to and from warmer winter habitats (Harvey et al. 2011). Although solitary in summer and winter, they congregate for migration in the fall, which consists of hundreds of individuals from both sexes traveling from August–October. The sexes are segregated throughout most of the summer range, where males remain in the western states, generally in montane areas (Cryan 2003), and females move to the northern, eastern, and central states to give birth (Ammerman et al. 2012). Most

hoary bats in the eastern United States overwinter along the Atlantic Coast from South Carolina to central Florida, along the Gulf Coastal states from Florida to Texas, and westward through Texas and south through northern Mexico. During spring migration, pregnant females precede males and reach their northern summer territories in mid-May (BCI 2001). Hoary bats are reported to fly at elevations as high as 2,440 m (8,000 ft) (Harvey et al. 2011).

Reproduction – Mating begins in early September and may continue throughout the winter and into spring. Parturition appears to range from mid-May to early July. Litters may be composed of 1–4 pups, but the typical litter size is two (Shump and Shump 1982b; Willis and Brigham 2005). Pregnant individuals have been captured in May and June in New Mexico and Arkansas (Bogan 1972; Gardner and McDaniel 1978; Saugey et al. 1989; Ammerman et al. 2012), and females with young have been reported in roosts in mid-June in Arkansas (Perry and Thill 2007). The young are not weaned until approximately seven weeks of age; approximately three weeks after becoming volant. The growth rate of juvenile hoary bats is less than that documented for most other species breeding in temperate North America (Koehler and Barclay 2000).

Threats and Management – No major predators are known for hoary bats, but they have been reported to be eaten by American kestrels and rat snakes, and hawks and owls are likely to prey on them from time to time (Barbour and Davis 1969; Shump and Shump 1982b). Habitat loss may be affecting some populations regionally, with evidence of declines in Indiana (Whitaker et al. 2006) and Arizona (Morrell et al. 1999). Aircraft may occasionally strike hoary bats. Martin et al. (2008) reported a dead specimen found on a runway at Naval Air Station (NAS) Meridian in June 2007. Currently the primary threat to the species is the impact of wind-energy facilities. In 2005, hoary bats represented the highest proportion of bat mortality at these facilities throughout the United States (Kunz et al. 2007). Most were adult males killed in late summer and fall during their seasonal migrations (Arnett et al. 2008). In Mississippi, there are no large-scale wind farms, and currently the only suitable locations for wind farms are offshore or in the Delta region of the state (WINDExchange 2018).

Management for hoary bats should generally include maintaining diverse deciduous and coniferous forest habitats and retaining an abundance of mature trees. Maintaining forests with large trees and small openings are beneficial to hoary bat populations, therefore, land managers should seek to retain large trees along forest edges and corridors (BCI 2001). Habitat along crop borders and forest edges should be protected or restored for foraging. As with other forest bat species, most researchers agree that a good management strategy includes maintaining a variety of age classes within a mature forest landscape. Where possible, the use of pesticides for insect control should be limited in forested areas.

Research Needs – Little is known about the biology and ecological preferences of hoary bats in Mississippi. Additional acoustic and mist net surveys should be conducted in forested areas throughout the state.

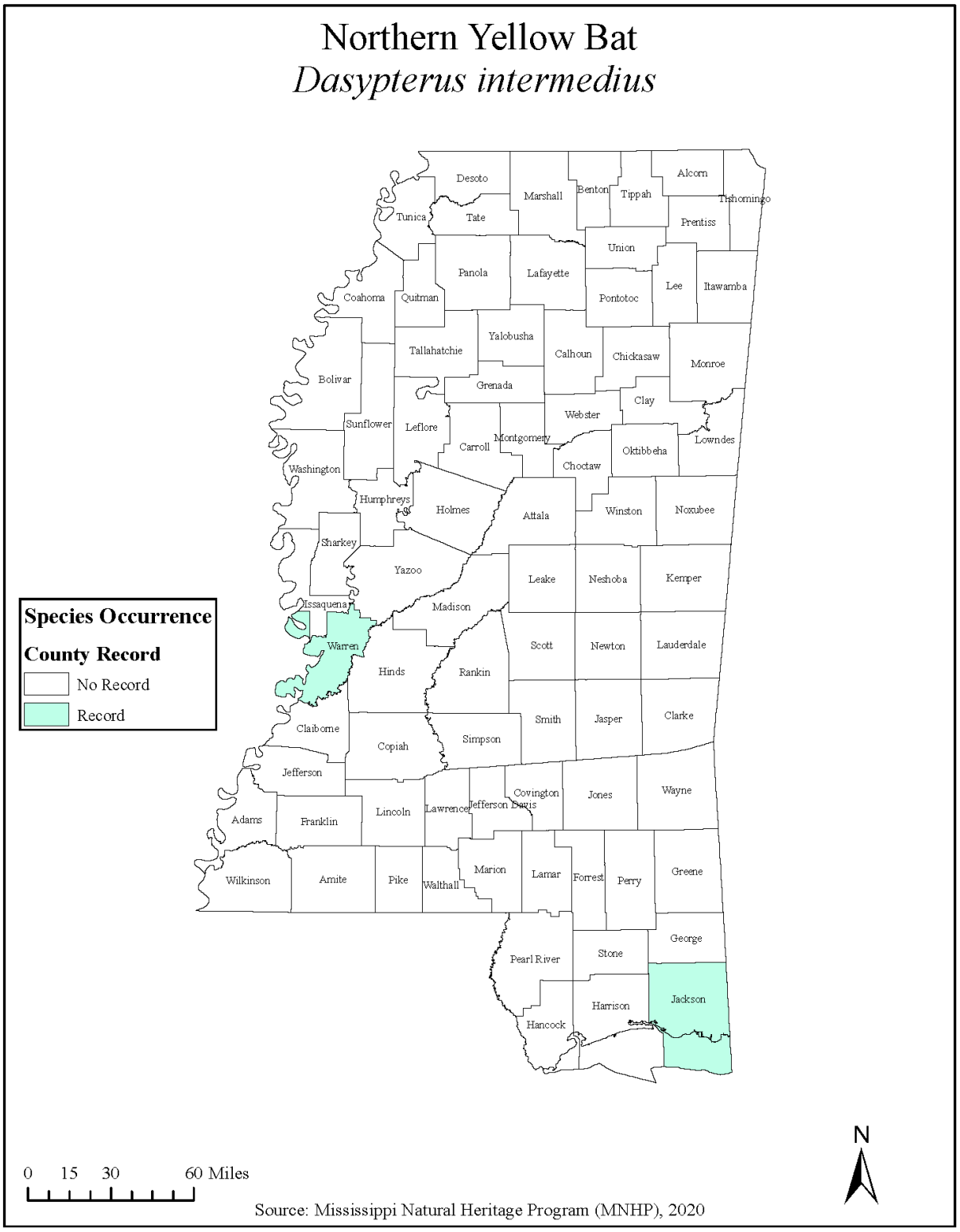

Fig. 12.— Known county occurrence records of northern yellow bat (*Dasypterus intermedius*) in Mississippi.

NORTHERN YELLOW BAT – *Dasypterus intermedius* (syn. *Lasiurus intermedius*)

Status. – The northern yellow bat is considered uncommon to locally common throughout its range, and has a global conservation rank of G5, secure (NatureServe 2019; Table 1). Once considered extirpated in Mississippi, this species was recently documented in the state in 2018 (MNHP 2020). Since the recent discovery, the state rank designation has not been updated and the species is currently listed as SX, presumed extirpated (MNHP 2018). Although the northern yellow bat is not protected under federal regulations, in Mississippi this species is protected under Rule M-2.3 Nongame Wildlife in Need of Management (MDWFP 2016).

Description. – The northern yellow bat is a large bat with a yellow to tan coloration. Along with the hoary bat, this is one of the largest bat species found in Mississippi. Standard measurements include: total length 12–13 cm (4.8–5.2 in.); wingspan 35.5–40.6 cm (14–16 in); weight 14.2–19.8 g (0.5–0.7 oz); forearm length 45–56 mm (1.75–2.18 in). From limited samples, Kern (1992) lists the following measurements for males: tail length 51–60 mm (2.0–2.4 in) and hindfoot length 8–11 mm (0.3–0.4 in); and females: tail length 45–49 mm (1.8–1.9 in) and hindfoot length 12 mm (0.5 in). The northern yellow bat has an overall yellowish hue, although the tips may be gray or brown. The tail is furred only on the basal half (closest to the body), and there are no white shoulder patches, unlike other *Lasiurus* species. Ears are more distinctly pointed than other tree bats and the calcar is slightly keeled. There is no difference in color between sexes, but females tend to be larger than males.

Distribution – The distribution of the northern yellow bat is closely tied to the range of Spanish moss (*Tillandsia usneoides*). This species is primarily found in coastal regions of the southeastern United States, from Virginia into Texas, coastal Mexico and into Central America (Webster et al. 1980; Patterson et al. 2007; Fig. 13). There are a few scattered records from Virginia, North Carolina, and Pennsylvania. Although they seem to be common in Florida, there are only two records of this species in Alabama, and two records from Mississippi (MNHP 2020; Fig. 12). Until recently, the northern yellow bat was considered extirpated from Mississippi with only one documented historic record from Warren County in 1937. However, in October 2018, a bat was captured on a

Fig. 13.— Geographical range of the northern yellow bat (*Dasypterus intermedius*).

crane at Ingalls Shipbuilding in Jackson County and transported to a bat rehabilitator. The individual was later identified as a northern yellow bat and represents the first record of this species in the state in 81 years (K. Shelton, personal communication).

Habitat – Northern yellow bats occupy a variety of woodland habitats in close proximity to permanent water. Commonly found roosting in trees, this species forages primarily in open areas.

Roosting – The most common roost documented for northern yellow bats is in Spanish moss, an epiphytic plant found in the United States along the Atlantic and Gulf Coasts, primarily in hardwood trees (Menzel et al. 1999; Hutchinson 2006; Coleman et al. 2012). Hutchinson (2006) noted that the Spanish moss appeared to offer shelter from intense rainfall, as well as concealment from predators. It has been noted on several occasions that bats use Spanish moss suspended below branches with no clutter underneath, providing a clear flight path (Hutchinson 2006; Coleman et al. 2012). In Texas, Jimenez (2016) tracked northern and southern yellow bats (*Dasypterus ega*) to the dried fronds of Sabal palms (*Sabal palmetto*). In South Carolina, Socci et al. (2017) also tracked several northern yellow bats to Sabal palms. They also use ornamental palms such as the Washington fan palm (*Washingtonia robusta*) and banana trees (*Musa* sp.) in Texas (Mirowsky 1997). Although occasionally found in pine forests, roosts are commonly in hardwood forests, but it is unclear whether that is related to the trees themselves or the fact that Spanish moss is more common in hardwoods (Coleman et al. 2012).

The northern yellow bat is typically solitary, but females may form small maternity colonies in the summer. While they may all roost in the same tree, a mother and her pups will usually hang alone. Males may be nearby, but rarely found roosting with females (BCI 2001).

Foraging – Northern yellow bats will feed 5–6 m (16–19 ft) above open areas, among scattered trees, forest edges, dunes, grasslands (pasture, open fields beside airports, golf courses, or edges of lakes), and open water. Large feeding aggregations may occur in ideal habitats when young begin to fly (BCI 2001). Males are rarely a part of these aggregations (Barbour and Davis 1969; Harvey et al. 2011). They feed on a wide variety of insects including dragonflies, damselflies, beetles, flying ants, grasshoppers, and mosquitoes (BCI 2001; Harvey et al. 2011). In comparison to some other bats species, the foraging and feeding habits of the northern yellow bat is poorly known.

Movement and Migration – Northern yellow bats are considered non- migratory. They are typically active throughout the year, but may become torpid in cooler months (NPS 2017).

Reproduction – Breeding occurs during flight in the fall and possibly winter and early spring (Kern 1992; Marks and Marks 2006). Females form small maternity colonies, sometimes including up to at least 45 individuals (Baker and Dickerman 1956). Gestation will last two to three months and a litter of three or four pups is born in late May or June. Unlike other tree bat species, yellow bats only have two nipples, so more than two pups rarely survive (NPS 2017). Young are usually volant within one month (NatureServe 2019).

Threats and Management – Because of the lack of information on the northern yellow bat in Mississippi, threats to and management of the species must be based on information from other states or other similar species. As with many bat species, loss of habitat represents one of the greatest threats (Bunch et al. 2005). While yellow bats are associated with Spanish moss, they are known to use multiple tree species including palm (*Sabal* sp.), live oak (*Quercus virgiana*), and loblolly pine (*P. taeda*). Management should prioritize and promote the retention of mature forests and Spanish moss to benefit the species (Coleman et al. 2012; Socci et al. 2017).

In addition to Spanish moss, yellow bats are often found roosting in dried palm fronds. While there are no known native populations of Sabal palms in Mississippi, it is occasionally found in small patches, thought to have washed ashore from storms (H. Sullivan, personal communication). Palms are often used in landscaping in coastal areas and yellow bats have been found in proximity to development, suggesting that the bats will make use of urban areas. Encouraging land managers to avoid trimming old palm fronds from these decorative palms could benefit the yellow bat in Mississippi (BCI 2001; Socci et al. 2017). Additionally commercial moss collection should also be limited where the yellow bat is of management concern.

As with other tree bat species, the practice of prescribed burning may have positive and negative impacts to northern yellow bats. Throughout the southeast, prescribed fire is regularly used as a forest management tool. These fires can effect bats both directly and indirectly. The use of fire has the ability to increase the amount and quality of available habitat for bats, and improve foraging quality and insect abundance (Carter et al. 2002). While summer, or growing season, burns can result in the death of tree roosting bats, their solitary nature makes it rare that a large number of individuals would be killed in a single event. During this time yellow bats are typically in the tree canopy when rearing young and will be further from the flames and more able to move to a new roost during burns. Winter, or dormant season, prescribed burns are more likely to negatively impact yellow bats as individuals must arouse from torpor to escape approaching fires. . In Missouri, Layne (2009) found that bats responded quicker to fire stimuli (smoke, fire noise) when temperatures were above approximately 10°C (50°F). Effects of dormant season burns on Lasiurine bats can be reduced if burns are avoided on the coldest days of the year.

Research Needs – Information on northern yellow bats in Mississippi is extremely limited. Important initial research should include identifying priority areas and increasing surveys in areas with Spanish moss and palms to help establish the distribution of the species in the state. Conducting year-round surveys can help establish summer and winter roost site and habitat requirements.

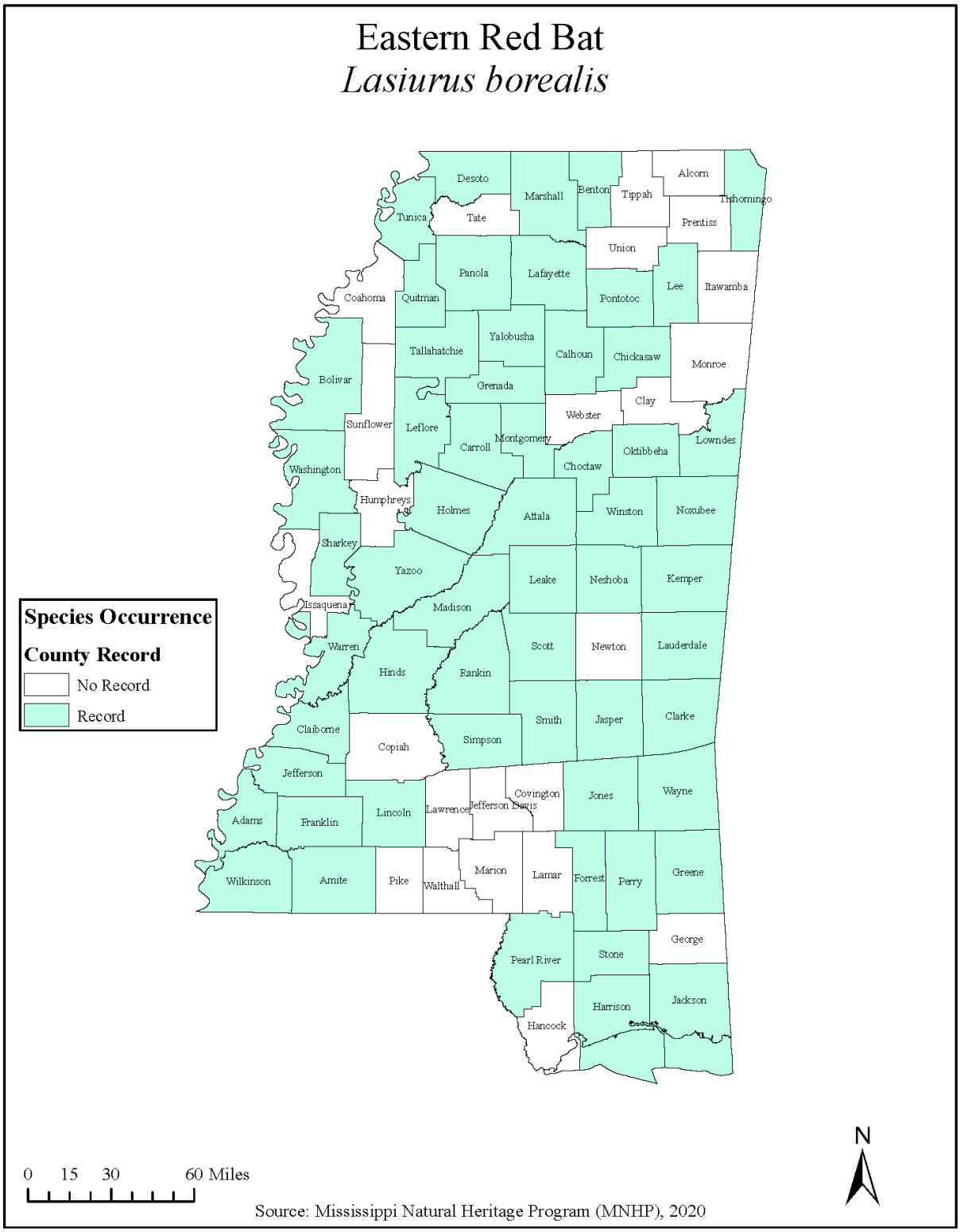

Fig. 14.— Known county occurrence records of eastern red bat (*Lasiurus borealis*) in Mississippi.

EASTERN RED BAT – *Lasiurus borealis*

Status. – The eastern red bat is considered common throughout its range (Shump and Shump 1982a; Harvey et al. 2011). While this species has a global conservation rank of G3G4 (vulnerable/apparently secure), it is not listed as a species of concern by any state in the eastern United States (NatureServe 2019; Table 1). On the extreme western edge of the species range in Colorado and Montana, the eastern red bat is listed as S2B, imperiled during breeding season, or S2S3, imperiled or vulnerable (IUCN 2017). Although the eastern red bat is not protected under federal regulations, it is protected in Mississippi under Rule M-2.3 Nongame Wildlife in Need of Management (MDWFP 2016).

Description. – The eastern red bat is a medium-sized, reddish-colored bat with relatively long, pointed wings (Shump and Shump 1982a). Standard measurements include: total length 9–13 mm (3.66–5.12 in); wingspan 28–33 cm (11.02–13.0 in); weight 6–14 g (0.21–0.49 oz); forearm length 36–46 mm (1.42–1.81 in); tail length 45–60 mm (1.77–2.36 in); and hindfoot length 6–11 mm (0.24–0.43 in). The dorsal pelage varies from brick red to chestnut, and individual hairs are tipped with white, which gives this bat a frosted appearance. The frosting is more prominent on females, thus males usually have a brighter red color than females. The ventral fur is paler, or more yellow than the dorsum. The wing membranes are dark brown and the shoulder and wrist have conspicuous white patches. The ears are short, rounded, and furred on the outside, and the uropatagium, or tail membrane, is thickly furred on the dorsal side.

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Distribution – The eastern red bat occurs from the eastern edge of the Rocky Mountains, across southern Canada, and south through the United States to Florida, western Texas, southern New Mexico, and northeastern Mexico (Patterson et al. 2007; Fig. 15).

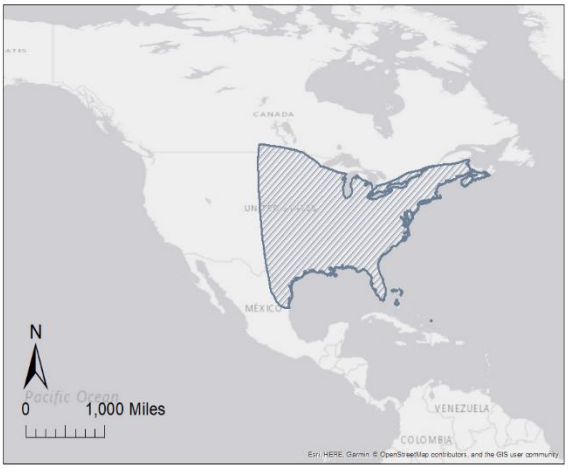

Fig. 15.— Geographical range of the eastern red bat (*Lasiurus borealis*).

The range of the species covers the entire state of Mississippi and they have been documented

in 58 of 82 counties in the state (MNHP 2020; Fig. 14). Counties lacking eastern red bat data are probably due to lack of survey efforts, rather than the species not being present.

Habitat – Eastern red bats and other members of the genus *Lasiurus* are commonly referred to as tree or foliage bats because they often roost in tree foliage during warm months. Red bats are most common in forested areas throughout their range and are primarily solitary, interacting only during the fall breeding season and migration.

Roosting – Red bats are often called foliage roosters due to their habit of hanging from twigs, leaf petioles, and small limbs during the day, giving them the appearance of dead leaves. Red bats will use several roost trees, sometimes switching as frequently as every two or three days (Hutchinson and Lacki 2000). In general, roosting preferences of eastern red bats include the following features: a) dense vegetation above; b) unobstructed space below, allowing bats to drop to initiate flight; c) no potential perches beneath the roost that could increase their vulnerability to predators; d) dark colored ground cover that minimizes reflected sunlight; e) sufficient surrounding vegetation to protect from wind and enhance heat and humidity retention; and f) southern exposure where heat gain is greatest and vegetation is most dense (BCI 2001).

Hibernating eastern red bats use a variety of roosts, including tree hollows, exposed tree trunks, and leaf litter. Mormann and Robbins (2007) found individual roost tree characteristics appeared more important than stand-level characteristics during the winter. In the Southeast, red bats roost in tree canopies during relatively warm winter days and drop into leaf litter on the forest floor during cold periods (Saugey et al. 1998; Moorman et al. 1999; Boyles et al. 2003; Dunbar and Tomasi 2006). Leaf litter may be beneficial for energy conservation because it provides a relatively stable microclimate (Hutchinson and Lacki 2001; Mager and Nelson 2001).

Red bats primarily use large overstory hardwoods, even in areas where pines are abundant, typically roosting close to open areas (Menzel et al. 1998; Mager and Nelson 2001; Perry et al. 2007; O'Keefe et al. 2009, 2013). They are fast fliers and foraging occurs mostly from the treetop level to within just a few inches of the ground (Barbour and Davis 1969; Sealander and Heidt 1990; Elmore et al. 2005). They select a wide variety of deciduous tree species for roost sites including maples (*Acer* sp.), elms (*Ulmas* sp.), and evergreens such as loblolly pine and eastern red cedar (*Juniperus virginiana*) (Elmore et al. 2004; Mormann and Robbins 2007). Red bats frequently use clumps of Spanish moss in the South (Shump and Shump 1982a). In eastern Kentucky, red bats selected roosts in mature, contiguous forests and showed a preference for tall, large diameter (average 41 cm; 16 in), deciduous trees as day roosts (Hutchinson and Lacki 2000). Bats roosted in the outer foliage of the canopy at 16.5 m (54 ft) above ground. Day roosts were around 275 m (900 ft) from the forest edge and no roosts were located <50 m (165 ft) from any edge. A study in eastern Maryland found bats roosted in plots with a higher basal area, greater canopy coverage, and less ground cover than random plots (Limpert et al. 2007). Their

results suggested that red bats in their study area selected roosts in mature riparian forests near trails, open water, and wetlands.

In contrast to other studies, Elmore et al. (2004) found that red bats in an intensively managed pine forest in eastern Mississippi roosted in loblolly pines and in midstory hardwood trees. Bats used 16 species of hardwoods (70%) and loblolly pine (30%) as day roosts. Within thinned pine stands, red bats tended to select roost trees with a denser subcanopy and higher basal area compared to random sites. They concluded day roost requirements of eastern red bats may exhibit greater plasticity than previously thought.

Foraging – Eastern red bats are often the first bats to emerge from day roosts to forage at dusk, flying high at first and eventually coming within 2–4 m (7–13 ft) of the ground as darkness approaches (BCI 2001). Red bats are fast fliers and concentrate foraging activity from tree top level down to only inches above the ground, predisposing them to forage over uncluttered habitat such as clear-cuts and thinned stands (Hart et al.1993; Jung et al. 1999; Elmore et al. 2004). Forest structure could be an important factor determining foraging habitat use (Loeb and O'Keefe 2006a).

A reliable water source may be an important habitat factor for drinking and as use as a travel corridor for eastern red bats (i.e. streams). Elmore et al. (2004) found all foraging areas studied in Mississippi contained a water source, with bats flying low over water to drink and to capture insects. A Kentucky study conducted by Hutchinson and Lacki (1999) showed that red bats selected foraging areas with water in a higher percentage than was found on the landscape.

Red bats feed most actively during the first several hours after sunset, but nursing females may feed all night. They may travel 600–1000 m (2000–3300 ft) from day roosts to feeding sites. Red bats forage in a variety of habitats, mostly along the edges of pastures, croplands, and other openings with large deciduous trees interspersed throughout (Martin et al. 2008). They also feed around forest edges and beneath streetlights (Hickey et al. 1996). An Indiana study found red bats foraged in woodlands and over recently planted forest stands, open water, parks, and pasturelands and avoided urban areas such as commercial lands, gravel pits and transportation corridors (Walters et al. 2007).

Insects comprising their diet include moths, crickets, flies, mosquitoes, true bugs, beetles, and cicadas (Harvey et al. 2011). Insects consumed around streetlights are predominately moths (BCI 2001). Prey species consumed typically vary throughout the season and seem to be more predicated on insect abundance (Carter et al. 2004). Foraging location is also an important component of prey availability.

Movement and Migration – Eastern red bats are considered highly migratory, arriving at summer roosts between March and April and departing to wintering sites in late October and November (Shump and Shump 1982a). While red bats winter throughout the southeastern United States and

northeastern Mexico, concentrations are highest along the Atlantic and Gulf Coastal Plain (Cryan 2003). During the winter males tend to be more common in northern regions, with southern areas having higher concentrations of females (Davis and Lidicker 1956; LaVal and LaVal 1979; Padgett and Rose 1991; Cryan 2003). During the spring and summer, the range of the eastern red bat expands to the Great Lakes and Great Plains regions, where there are no clear differences in the distribution of males and females (Baker 1978; Whitaker and Hamilton 1998; Cryan 2003). Although generally solitary, red bats migrate in groups and forage in close proximity to one another in the summer (LaVal and LaVal 1979).

Reproduction – Mating occurs in August and September, often while red bats are in flight, but fertilization is delayed until spring (BCI 2001). Females typically roost alone when rearing young. Females give birth in early summer with a peak in mid-June. LaVal and LaVal (1979) reported the first pregnant red bat captures in Louisiana on May 4, and the first lactating females observed June 1. Litter size ranges from one to five pups, with an average of three. Young red bats cling to the fur of their mother with their teeth and thumbs, as well as their hindfeet (Jackson 1961). As they get older, the young will cling to a leaf or twig during the day and mothers will leave the young at the roost during foraging events (Johnson 1932). It is not uncommon to see an adult flying, or attempting to fly, with her young, to move to a new roost (Barbour and Davis 1969). Offspring become volant in approximately four weeks and are weaned within two weeks of becoming volant.

Threats and Management – The solitary nature of the eastern red bat makes it difficult to determine population status. While there is a substantial population, it is thought to be declining (NatureServe 2019). This inability to measure the population is the greatest limitation to effective management and measuring how that management affects bats (Brigham 2007). Historically, loss of habitat has likely played a part in this decline historically, but a new threat emerged with the advent of wind energy and the development of large, expansive wind farms. The red bat is one of the most commonly killed species at wind energy facilities, with the majority of fatalities occurring during fall migration (Cryan and Veilleux 2007). While Mississippi is not currently considered highly suitable for wind energy development, the situation should be monitored as advances in wind turbine technology are developed.

Most researchers agree that a good management strategy for the conservation of bats should include the conservation and management of forest stands with a diversity of forest structure and age classes to provide roosting and foraging habitat. Low clutter foraging habitat, such as linear openings and early successional habitat should also be maintained to make forests more suitable for bats. To benefit bat species, Amelon et al. (2014) suggest management in highly fragmented landscapes should prioritize increasing the extent of deciduous forests, and in highly forested landscapes, management should focus on creating gaps and openings in order to provide edge habitat and link non-forest and watering sites. If stand-level habitat features are a management objective for red bats, O'Keefe et al. (2009) recommend leaving a minimum basal area of 3.6

m^2/ha (15.7 ft^2/ac) of hardwoods >10 cm (4 in) in diameter. No recommendations could be found to address basal area and red bat habitat use in Mississippi.

Throughout the southeast, prescribed fire is commonly used as a forest management tool. The use of prescribed fire has the ability to increase the amount and quality of available foraging habitat, including increased insect abundance (Carter et al. 2002). While prescribed fire has the potential to cause mortality in tree roosting bats, the solitary nature of this species reduces the threat that a large number of individuals would be killed in a single event. During the spring and summer (growing season), red bats are typically in the tree canopy rearing young and will be further from the flames, giving them the ability to move to a new roost during burns. Winter, or dormant season, prescribed burns are more likely to negatively affect red bats. During winter, when most red bats are in torpor, it can take up to 30 minutes to arouse enough to escape the flames. During a prescribed fire in Arkansas, red bats were observed on the ground attempting to crawl or fly away while still in a state of near torpor (Saugey et al. 1989). They have also been observed flying from fires in Missouri, West Virginia, and South Carolina (Moorman et al. 1999; Rodrigue et al. 2001; Mormann 2005). In Missouri, Layne (2009) found bats responded more rapidly to fire stimuli (smoke, fire noise) when temperatures were above approximately 10°C (50°F). Effects of dormant season burns on red bats can be reduced if burns are avoided on the coldest days of the year.

Research Needs – Although red bats are commonly captured during summer mist net surveys in Mississippi, little information exists about their winter habits in the state. Studies identifying preferred winter roost habitat should be conducted to help better advise forest management practices that take place in the winter. Their habit of utilizing more exposed roosts makes them more vulnerable to disturbance during a time when they are less able to respond. Their solitary nature makes it hard to monitor populations for increases or declines. An adequate monitoring protocol should be developed and implemented.

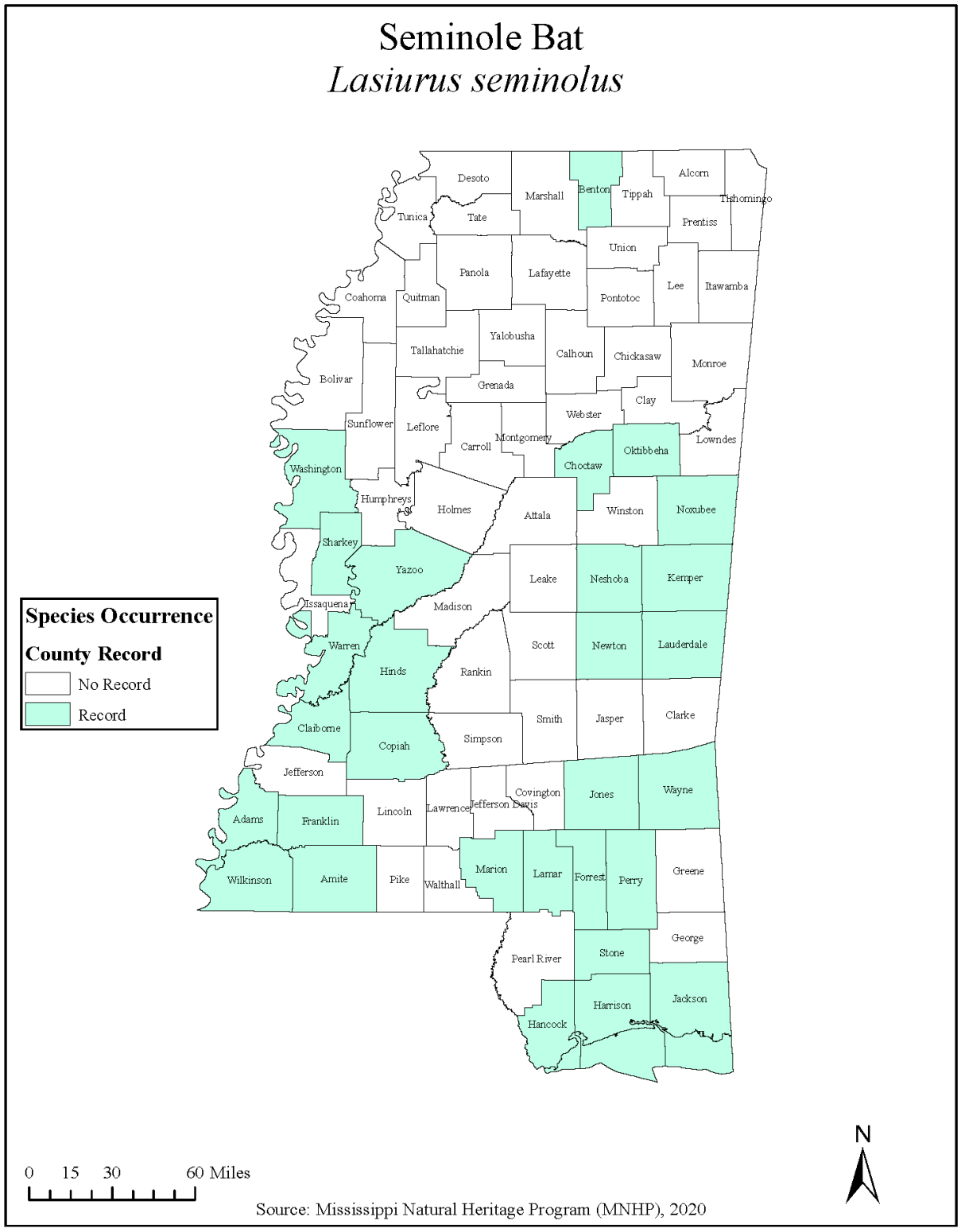

Fig. 16.— Known county occurrence records of Seminole bat (*Lasiurus seminolus*) in Mississippi.

SEMINOLE BAT – *Lasiurus seminolus*

Status. – The Seminole bat is endemic to the southeastern United States and has a global conservation rank of G5, secure (NatureServe 2019; Table 1). It is not protected under federal regulations, but is protected in Mississippi under Rule M-2.3 Nongame Wildlife in Need of Management (MDWFP 2016). Status and population trends are generally unknown for the Seminole bat, except for several recent studies in South Carolina, Georgia, and Arkansas. Little information is available on the species in Mississippi, but they appear to be fairly common, especially in southern counties. They have been collected with red bats at many forested sites but are generally fewer in number (Martin et al. 2008).

Description. – The Seminole bat has deep mahogany fur that is frosted at the tips, giving it a reddish-maroon hue. Measurements include: total length 9–11 cm (3.5–4.3 in); wingspan 29–32 cm (11–12 in); body mass 9–14 g (0.3–0.5 oz); tail length 35–50 mm (2.4–1.9 in); forearm length 35–45 mm (1.3–1.7 in); and hindfoot length 8–10 mm (0.3–0.4 in). As with the eastern red bat, Seminole bats have white patches on the shoulders and wrist, the tail membrane is fully furred, and the ears are short and rounded. The pale venter is reddish orange posteriorly (Wilkins 1987). Seminole bats and female red bats are very similar and can be confused in the field.

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Distribution – Seminole bats occur throughout the southeastern United States from Florida to eastern North Carolina, and westward through the Gulf Coast states to southeast Texas, northeastern Oklahoma, and southern Arkansas (Wilkins 1987; Patterson et al. 2007; Harvey et al. 2011; Fig. 17). Perry (2018) reported recent observations indicate Seminole bats may be expanding their range in North America. Their data indicates a recent and rapid shift northward, likely attributed to climate change, and an expansion westward, potentially due to a shift in vegetation communities in grassland regions. In Mississippi, Seminole bats have been documented in 29 of 82 counties (MNHP 2020; Fig. 16). Historically this species was thought to occur primarily in the southern half of the state, however, in July 2019, a Seminole bat was captured in Holly Springs NF in

Fig. 17.— Geographical range of the Seminole bat (*Lasiurus seminolus*).

Benton County, indicating their distribution in Mississippi is more widespread than previously thought.

Habitat – Seminole bats inhabit bottomland forest stands consisting of both deciduous and coniferous trees (Wilkins 1987). As with other *Lasiurus* species, they are commonly referred to as tree or foliage bats. The distribution of Seminole bats was historically thought to coincide with that of Spanish moss, however, several recent studies indicate seasonal differences in the selection of roost sites by the species. Literature suggests Seminole bats occupy tree roosts in the summer and use Spanish moss only during the winter months (Carter and Menzel 2007). In Mississippi, they have been documented in several locations where Spanish moss does not occur.

Roosting –

During the summer, Seminole bats tend to roost in pine dominated stands and select tall, large-diameter trees, predominately pine, as day roosts (Menzel et al. 1998, 1999; Perry and Thill 2007; Hein 2008b). The Seminole bat is a common foliage-roosting species, frequently found roosting in clumps of needles on smaller branches of pine trees, especially slash pine (*Pinus elliottii*) and loblolly pine (Menzel et al. 1998, 2000; Hein et al. 2005, 2008b). Summer roosts are usually occupied by a single bat or a female with young (Ammerman et al. 2012). Seminole bats switch roosts frequently but tend to stay in the same general area,, rarely using the same roost for more than one or two days (Menzel et al. 2000; Peter and Thill 2007; Hein et al. 2008b). This roost switching behavior suggests stand and landscape features may be more influential to roost-site selection than tree and plot characteristics (Cryan et al. 2001; Elmore et al. 2004; Hein et al. 2008b). Seminole bats were the dominant species captured (9 of 12 specimens) in thinned longleaf pine (*Pinus palustris*) habitat during a survey in late April in Harrison County, Mississippi within the DeSoto NF (MBWG 2019, unpublished data). Spanish moss was not present in the survey area.

Seminole bat summer roosts are typically found in pine trees. They rarely roosted in deciduous trees, even when these trees were more abundant than pines (Menzel et al. 1998; Hein et al. 2005; Perry and Thill 2007). However, recent range expansions include forests dominated by oak-hickory or other hardwood forest types. Multiple male and female Seminole bats have been documented in the oak-hickory dominated forests in Kentucky during the summer reproductive season. Thus, Seminole bats may be adapting to roost in other forest types or they are more plastic in their roosting habits than previously believed, and additional research in these non-pine ecosystems is warranted. Large-scale restoration of open woodland forests throughout states such as Missouri, Kentucky, and Tennessee (e.g. Nigh 2007) also may be providing habitat in areas that until recently contained dense, closed-canopy forests not usually preferred by Seminole bats (e.g. Perry and Thill 2007; Perry et al. 2007).

During the winter, Seminole bats are solitary and use a wide variety of roosting sites, including Spanish moss, the canopy of overstory trees, hanging vines, pine needle clusters, shrubs, and leaf

litter on the forest floor (Hein et al. 2005, 2008a; Ammerman et al. 2012). Compared to the summer, Seminole bats tend to select winter roosts that provide additional shelter and increased thermoregulatory conditions. During colder temperatures (≤4°C; 39°F), they often roost beneath leaf litter on the forest floor, or within pine needle clusters suspended close to or on the forest floor (2008a). Hein et al. (2008a) reported Seminole bats generally roost on the southeast side of trees during the winter, likely to optimize sun exposure and radiant heating. During warmer winter temperatures (≥4°C; 39°F), roost selection is similar to that of summer roosts, with most roosts located within the canopy of overstory trees (2008a). Roosting home range sizes are generally larger in winter and encompass several stand types of varying age classes, compared to summer roosts that are typically within the same forest stand (Menzel et al. 1998; Hein et al. 2008a, 2008b). This is presumably driven by resource and temperature fluctuations as various stand types and age classes likely offer a suite of microclimate conditions for roosting bats (Matlack 1993). Seminole bats frequently switch roosts during warmer temperatures in the winter, but do so less frequently during colder temperatures (Hein et al. 2008a).

Foraging – Seminole bats emerge from daytime roosts early in the evening and forage at treetop level in forested areas, over water, and along forest edges (Wilkins 1987; Carter et al. 1998, 2004). Bats typically forage in open areas with less clutter that could impede maneuverability. They capture prey with a swift, direct flight, but may also glean insects off of vegetation (BCI 2001). Seminole bats forage in a variety of habitats including pine stands, bottomland and upland hardwood forests, wetlands and even in urban areas (Chapman et al. 2000; Carter et al. 2004; Ammerman et al. 2012). In urban areas they will frequent streetlights to capture insects (Ammerman et al. 2012). The broad diversity of foraging habitat types indicate Seminole bats may select foraging habitat and prey based on habitat structure and prey availability. Their diet includes true bugs, flies, mosquitoes, beetles, flying ants, moths, crickets, and other insects which are usually captured in and around tree canopies (Harvey and Saugey 2001; Harvey et al. 2011). During early summer, prey items are mostly Hymenoptera (ants, wasps, and bees), while later in the summer Coleoptera (beetles) make up the majority of their diet. While bats may be selecting certain prey items, density also influences food selection (Carter et al. 2004).

Movement and Migration – Seminole bats are considered a regional migrant (migrate 100–500 km; 62–311 mi) (Barkalow 1948; Fleming and Eby 2003; Perry 2018). Bats winter along the Gulf Coast, Carolinas and southern Arkansas, and can migrate as far north as Missouri and Kentucky during the summer maternity season (Perry 2018). Seminole bats wander extensively after the young are weaned, which is indicated by late summer occurrences outside their breeding range (Barbour and Davis 1969; Harvey and Saugey 2001; Harvey et al. 2011; Perry et al. 2018). Autumn records have been reported for the Caribbean, Mexico, Oklahoma, Texas, Wisconsin, Arkansas, New York, and Pennsylvania, (Brant and Dowler 2000; Ammerman et al. 2012; Perry et al. 2018). Miller (2003) reported high variation in captures of Seminole bats from

year to year in eastern Mississippi and speculated differences in weather patterns may influence distribution of the species on the landscape.

Reproduction – Mating occurs in late fall or winter, possibly in flight (BCI 2001). Females give birth to one to four pups in late May or early June, and rear the young in tree foliage. The young mature quickly and become volant in three to four weeks. Barbour and Davis (1969) reported sex ratios were nearly equal in younger age classes but skewed toward females in older age classes, suggesting this was due to higher mortality in males. However, in eastern Mississippi, Miller (2003) found juvenile and adult bats had similar sex ratios, both of which were highly skewed toward females. Martin et al. (2005) recorded 10 males and three females captured in 2004, and nine males and nine females captured in 2005 at Camp Shelby; sex ratios were equal in juveniles. No records of longevity are known.

Management – As with most other forest bat species, a diverse forest of coniferous and hardwood species with varying age classes is beneficial in providing adequate roosting habitat. Perry et al. (2007) demonstrated the importance of relatively open forest stands to many species, including the Seminole bat. Hein et al. (2005, 2008a, 2008b) stressed the need for forest managers to consider seasonal differences in roosting behavior of Seminole bats when implementing management activities. Hein et al. (2008b) found that corridors may represent a feasible approach to maintaining suitable roosting habitat, as mature pine and mixed pine-hardwood corridors provided suitable roosting habitat in their study. Maintaining larger trees along forest edges is also beneficial. The Seminole bat's use of understory trees and leaf litter during the winter suggests that prescribed burns conducted in the cooler months may adversely affect bat populations. When bats are disturbed by fire and forced to expend energy during winter, they expend critical fat stores and may become more vulnerable to predators. Winter burns also may result in direct mortality to torpid bats roosting on or near the ground (Hein et al. 2008a). Commercial moss collection should also be limited where the Seminole bat is a management concern. Also, in some areas of the Southeast, large amounts of pine straw are harvested annually from the forest floor to provide mulch for commercial garden and nursery dealers. This activity should be strictly regulated on public lands where it might affect winter populations of Seminole bats.

Research Needs – The Seminole bat is considered relatively common in Mississippi, although this is largely limited to anecdotal information and capture records are lacking. Little information is available on the life history and ecology of the Seminole bat in Mississippi. Additional information is needed on all aspects of this species' life history, particularly winter movements and roosting habitat.

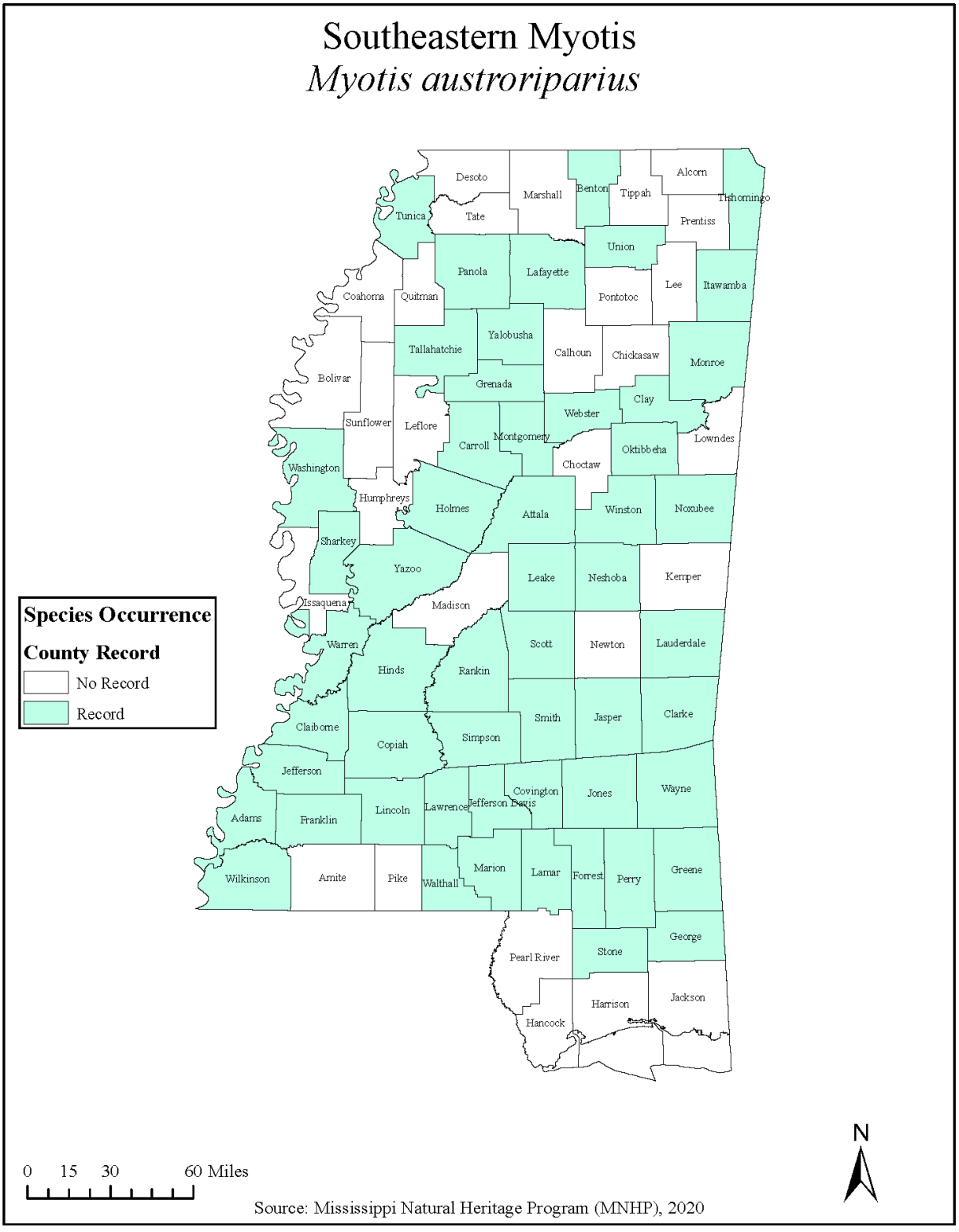

Fig. 18.— Known county occurrence records of southeastern myotis (*Myotis austroriparius*) in Mississippi.

SOUTHEASTERN MYOTIS – *Myotis austroriparius*

Status. – The southeastern myotis has a global conservation status rank of G4, apparently secure (NatureServe 2019; Table 1). In Mississippi, this species was historically considered extremely rare and was assigned an S1S2 species rating (critically imperiled/imperiled) by the Mississippi Natural Heritage Program (MNHP 2004). However, recent surveys indicate it is more common than previously thought, leading to a change in designation to S3S4, vulnerable/apparently secure (MNHP 2018). Additionally, the MNHP downgraded the southeastern myotis from a Tier 1 species (species in need of immediate conservation action) to a Tier 2 species (in need of timely conservation action) in the most recent revision of the Mississippi State Wildlife Action Plan (MMNS 2015). The southeastern myotis continues to be a species of concern throughout its range except in Louisiana (Lacki and Bayless 2013). This species is not protected under federal regulations, but is protected in Mississippi under Rule M-2.3 Nongame Wildlife in Need of Management (MDWFP 2016).

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Description. – The southeastern myotis is a medium-sized *Myotis* species with a total body length of 78–92 mm (3.04–3.59 in) and a wingspan of 24–29 cm (9.46–11.43 in; Lacki and Bayless 2013). Other standard measurements include: body mass 4–9 g (0.14–0.32 oz); forearm length 31–41 mm (1.21–1.60 in); ear length 12–15 mm (0.47–0.59 in); hindfoot length 8–11 mm (0.31–0.43 in); and tail length 34–42 mm (1.33–1.64 in; Schmidly 1991; Choate et al. 1994; Mirowsky and Horner 1997). Adult females are usually larger than males. Color is highly variable with the dorsal fur ranging from dull gray to gray-brown to bright orange-brown, and the ventral fur varying from tan to white (LaVal 1970; Gardner et al. 1992; Humphrey and Gore 1992). The facial skin is pinkish brown. The wing membrane attaches at the base of the toe, no keel is present on the calcar, and toe hairs extend to or beyond the tip of the claws (Barbour and Davis 1969; Humphrey and Gore 1992).

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Distribution – The southeastern myotis occurs throughout much of the southeastern United States except for the Appalachian and Smoky Mountain regions, however data on the species' range is lacking or scarce in many areas (Whitaker and Hamilton 1998; Lacki and Bayless 2013). Its range extends from southeastern North Carolina to peninsular Florida, across the southern states to eastern Texas and Oklahoma, and northward in the Mississippi Valley to western Kentucky, southern Illinois, and southern Indiana (Barbour and Davis 1969; Jones and Manning 1989; Patterson et al. 2007; Lacki and Bayless 2013; Fig. 19). Southeastern myotis were previously considered extremely rare in Mississippi and were only known from six counties prior to the year 2000. However, recent surveys have documented their occurrence in 54 of 82 counties throughout the state (MNHP 2020; Fig. 18).

Fig. 19.— Geographical range of the southeastern myotis (*Myotis austroriparius*).

Habitat – Southeastern myotis occur in or near habitats associated with permanent water (Jones and Manning 1989). Bottomland hardwood forests are usually preferred foraging and roosting habitat, especially during the summer season.

Roosting – Southeastern myotis roost in a variety of natural and man-made structures. During the maternity season, adult males and nonbreeding juveniles roost separately in bachelor colonies. These roosts are located in caves, tree cavities, culverts and buildings. In cavernous regions of the Southeast, the availability of caves appears to be the essential criterion for roost-site selection as the vast majority of young are born and reared in cave habitats (Gore and Hovis 1994; Humphrey and Gore 1992). Mississippi has several caves that support maternity colonies of southeastern myotis. Surveys of Waddell Cave, located in Smith County, Mississippi, have recorded 1,500–2,500 southeastern myotis, and it is a confirmed maternity colony (Beckett and Trousdale 2000; Roth 2014). Williams Cave (formerly Pitts Cave), located in Wayne County, Mississippi contains an estimated 9,000 southeastern myotis during the summer (Roth 2014; MNHP unpublished data). Eucutta Cave, located about 15 km (9 mi) northwest of Williams Cave, supports a small maternity colony of around 400 individuals (MNHP, unpublished data).

Characteristics of non-cave habitats are not well known but maternity colonies have been reported in chimneys (Foster et al. 1978), concrete culverts (Bain 1981; Martin et al. 2005, 2008; Rosamond et al. 2018), buildings (Kern et al. 1996; Trousdale and Beckett 2000c), beneath bridges (Trousdale and Beckett 2000c; Lance et al. 2001; Wolters and Martin 2001), in cisterns (Sherman 2004; McCartney 2007b), and in hollow trees (Horner and Mirowsky 1996; Mirowsky and Horner 1997; Cochran 1999; Hoffmann 1999; Wilf 2004; Stevenson 2008; Rice 2009; Fleming 2011; Fleming et al. 2013a). In eastern Mississippi, runway culverts at NAS Meridian

are regularly used as maternal roost sites by large numbers of southeastern myotis (Martin et al. 2008). Maternal colonies have also been reported in culverts under Highway 61 in Warren and Claiborne Counties (MNHP, unpublished data). Three cisterns on private lands near St. Catherine's Creek NWR were used as maternal roosts by large numbers of southeastern myotis; emergence counts included 5,479 and 6,486 in August 2004, and 5,691 in May 2004 (Sherman 2004; McCartney 2007b). A bridge located near Sardis Lake in north-central Mississippi supports a maternal colony of 1,500–2,000 bats. A bridge crossing Okatoma Creek in south-central Mississippi supports about 200-500 individuals in the summer (MNHP, unpublished data).

Tree species identified as providing roost sites in Mississippi include black tupelo, bald cypress, American sycamore, sweetgum, water hickory (*Carya aquatic*), pignut hickory (*C. glabra*), nuttall oak (*Q. nuttalii*), water oak (*Q. nigra*), swamp chestnut oak (*Q. michauxii*), and overcup oak (*Q. lyrata*; Wilf 2004; Stevenson 2008; Fleming 2011; Fleming et al. 2013a, 2013b). Southeastern myotis roost in a variety of tree species, suggesting other features such as cavity presence and size may be of greater importance (Fleming et al. 2003). While several studies have addressed roost site selection in bats using trees, selection for microclimate is commonly considered the most plausible (Barclay and Kurta 2007; Boyles 2007).

Harvey and Saugey (2001) reported after leaving the maternity roost southeastern myotis take up residence in small groups at outdoor sites. At NAS Meridian in eastern Mississippi, maternal roosts in runway culverts begin to dissipate in October, and only small numbers roost individually or in clusters in culverts during the fall and winter months (Martin et al. 2008). However, the MNHP database (2019) shows many runway culverts with small numbers of southeastern myotis and several with >50 individuals during winter. Recent winter surveys of highway culverts revealed 2,009 southeastern myotis hibernating in a series of culverts in west-central Mississippi, just south of Vicksburg (Rosamond et al. 2018). Also, in southwestern Mississippi, over 2,000 southeastern myotis were counted emerging from a cistern in December 2003, indicating that these structures also serve as winter roosts (Sherman 2004). Eucutta, Waddell, and Williams caves contain southeastern myotis in the winter but numbers vary greatly from year to year.

Foraging – Southeastern myotis are usually associated with water bodies, which they use as foraging habitat. Bats usually forage low, close to the water surface (Harvey et al. 2011). Few studies have addressed specific food items but they are known to eat mosquitoes, crane flies, small beetles, and moths (Zinn and Humphrey 1981). Prey selection is probably variable throughout the species range (Lacki and Bayless 2013).

Movement and Migration – Little information is available on seasonal movements of southeastern myotis, and there are no records of long-distance migration (Lacki and Bayless 2013). Although winter hibernacula and summer maternity sites are often in different locations,

summer and winter ranges are presumed to be identical (Barbour and Davis 1969; Lacki and Bayless 2013). Bats may hibernate up to seven months in the northern part of their range (Barbour and Davis 1969; Gardner et al. 1992), but they may remain active for much of the winter in the lower coastal plain (Lowery 1974). Southeastern myotis experience brief periods of hibernation, or at least torpor, during colder periods in Florida (Humphrey and Gore 1992). Frequent roost switching has been reported in hollow tree-roosting bats after young are reared in South Carolina (Clark et al. 1997) and Texas (Mirowsky 1998). It was also documented in Arkansas, where bats used solitary roosts in mines, bridges, and small cavities of hollow trees (Reed 2004).

Reproduction – Mating time for southeastern myotis is unknown (Harvey et al. 2011), but copulation is believed to occur in autumn (Rice 1957). In Florida, pregnant females begin to congregate at maternity roosts by mid-March, and the young are born in late April to mid-May. Martin et al. (2008) observed maternity colonies at NAS Meridian forming in early May, but there was no documentation as to when pups were born. The southeastern myotis is unique in the genus *Myotis* in that females usually give birth to twins. The young remain in the maternity roost while females forage, and the older pups form clusters when the females are away (Rice 1957). The young become volant at five to six weeks of age, usually between early June and early July.

Threats and Management – Destruction of prime maternity and winter habitat poses the greatest threat to southeastern myotis. Harvey et al. (2011) stated that the destruction of roost sites and killing of bats by humans are major threats. Loss, fragmentation, and degradation of bottomland hardwood forests are among the most significant threats to populations of the species (Lacki and Bayless 2013). Bottomland hardwood forests continue to be fragmented due to conversion to agriculture, urbanization, drainage, levee construction, reservoir creation, and road construction (Wilson et al. 2007; Lacki and Bayless 2013). Of particular concern is the loss of mature trees with basal cavities in managed forests. Degradation of aquatic ecosystems (especially stream systems) and riparian buffer zones is detrimental to foraging habitat. Land use change and altered hydrology in bottomland areas can result in sedimentation and water pollution that can affect water quality and prey availability. Natural predators include owls, raccoons (*Procyon lotor*), rat snakes, and opossums (*Didelphis virginiana*). Mumford and Whitaker (1982) reported screech owls taking southeastern myotis in flight, and Bergstrom and Smith (2017) found that they were a major food item of barred owls during the nesting period.

Except for maternity caves and tree roosts, little guidance is available for managing southeastern myotis and their habitats. However, known or potential maternity sites should be identified and protected from timber harvest and other human disturbances. The areas around a roost entrance should be kept clear to permit unobstructed passage for bats. Consideration should be given to developing and maintaining buffer zones around roost sites. Maintaining adequate stands of mature forest, especially older trees with basal cavities, near water sources is recommended for providing a supply of natural roost sites. Managers should also identify and protect alternate

roost sites such as old structures, culverts, bridges, and cisterns. Primary roost sites should also be monitored on a routine basis to evaluate their continued use and to prevent vandalism (Martin et al. 2008).

Research Needs – Our knowledge of southeastern myotis in Mississippi has improved in recent years, but there is still much to be learned concerning the complexity of the species in relation to habitat needs. We know bats are making extensive use of man-made structures as roost sites, but we don't know if this indicates preference or the lack of available natural roosts. There are also many areas of the state where roost tree availability has not been assessed. Movements among roosts and characteristics of winter roosts are also in need of study. Research is also needed on foraging behavior, diet, parasites and diseases. Updates to previously conducted surveys will be required to gauge the status of southeastern myotis, and additional surveys are needed in bottomland habitats that were not previously examined. Specific research needs include: (a) location of prime tree-roosting populations throughout Mississippi; (b) location of prime man-made roosting structures throughout Mississippi (including culverts, bridges, cisterns, wells, and buildings); (c) continued assessment and monitoring of cave use; and (d) monitoring of populations at both natural and man-made roost sites.

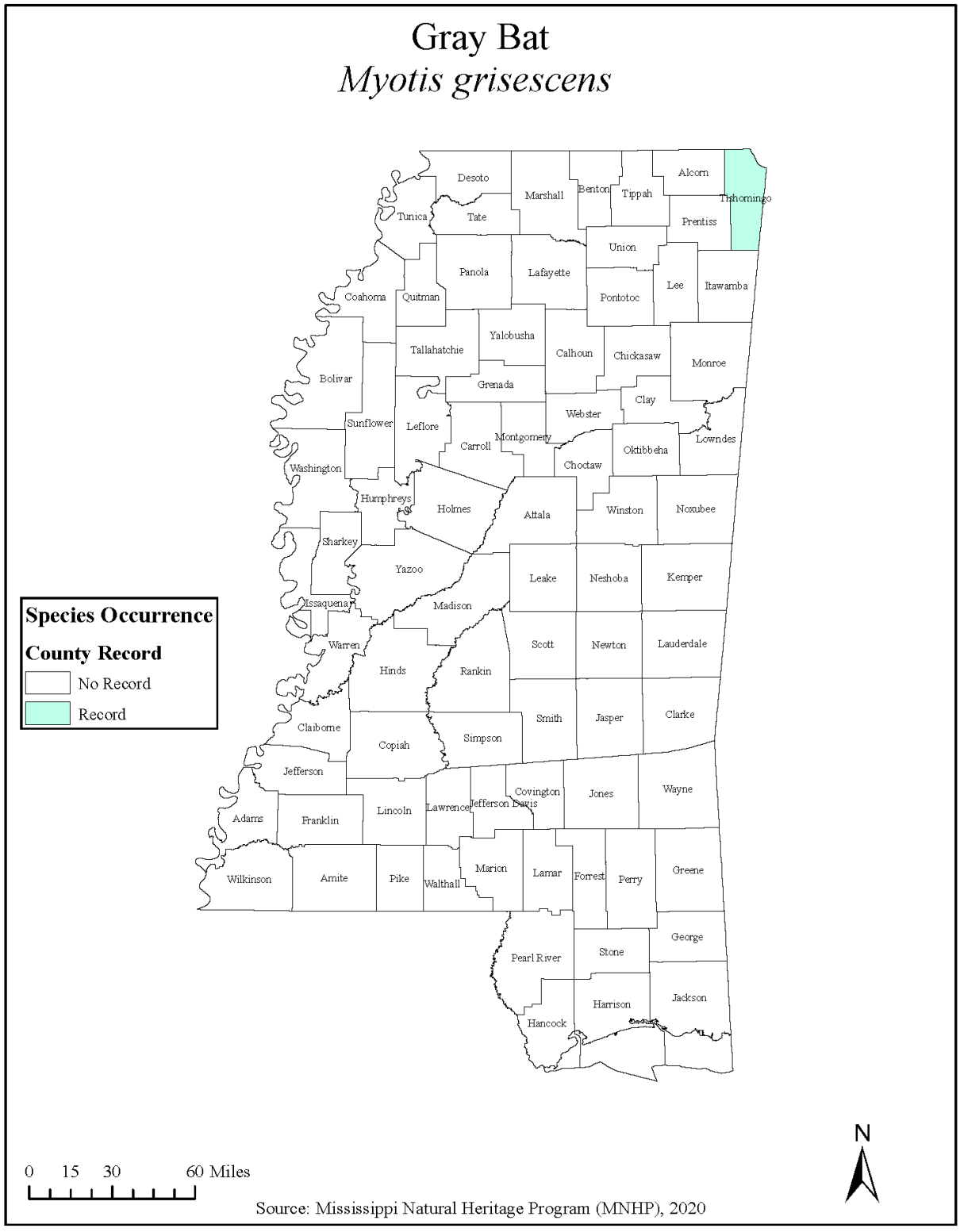

Fig. 20.— Known county occurrence record of gray bat (*Myotis grisescens*) in Mississippi.

GRAY BAT – *Myotis grisescens*

Status. – The gray bat was federally listed as endangered under the Endangered Species Act of 1973 (ESA) in April 1976 due to declining population numbers (Table 1). In 2005, the population was estimated at 2.5 million with approximately 95% of the population hibernating in only 17 caves in the following states: Tennessee (5 caves), Missouri (4), Arkansas (5), Kentucky (2), and Alabama (1) (Harvey et al. 2005). A multi-agency survey of hibernacula conducted from 2005 to 2007 estimated the range-wide population to be approximately 3.4 million bats, indicating stable to increasing population levels across the species' range (Martin 2007b). While listed with a global rank of G4, apparently secure, the state rank for the gray bat throughout most of its range is S2, imperiled, or S1, critically imperiled (NatureServe 2019; Table 1). Prior to 2004, the last observation of the gray bat in Mississippi occurred in 1966. As a result, the gray bat has a state rank of SH, possibly extirpated, and is state listed as endangered (MNHP 2018; Table 1).

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Description. – The gray bat is a medium-sized *Myotis* with the following measurements: total length 80–105 mm (3.15–4.13 in); wingspan 27.5–30.0 cm (8.9–10.2 in); body mass 7–16 g (0.2–0.6 oz); and forearm length 40–46 mm (1.3–1.5 in) (Barbour and Davis 1969). The fur is uniformly gray. The primary identifying characteristics for this species is the wing membrane is attached to the foot at the ankle, and by a distinct notch on the inside curve of each hindfoot claw (Barbour and Davis 1969; Harvey et al. 1981; Decher and Choate 1995; Tuttle and Kennedy 2005).

Distribution – The range of the gray bat spans 14 states from Kansas and Oklahoma to the west, Indiana and Illinois to the north, Virginia to the east, and Florida to the south (Patterson et al. 2007; Fig. 21). In Mississippi, gray bats have only been documented in Tishomingo County at Tripoli Chalk Mine, located in the northeast corner of the state (White 1961; LaVal 1967; Kennedy et al. 1974; MNHP 2020; Fig. 20). Two gray bats were captured in mist nets outside of the mine in 1966 (LaVal 1967), and Jones and Carter (1989) stated that gray bats were known only from the vicinity

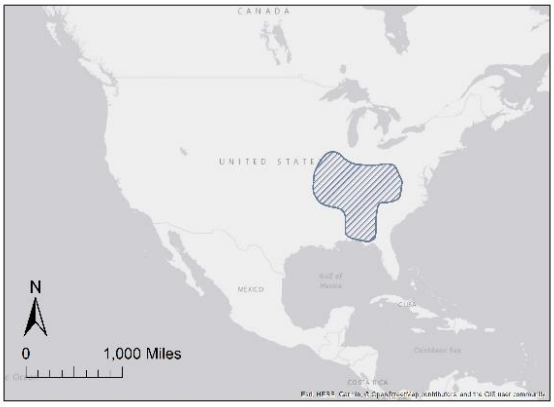

Fig. 21.— Geographical range of the gray bat (*Myotis grisescens*).

of this site in Mississippi. During 1990–1991, Best and Caesar (2000) conducted seasonal surveys of 11 caves and mines in Tishomingo and Union Counties, but no gray bats were observed. They noted evidence of extensive human disturbance to Tripoli Chalk Mine, including the presence of graffiti, trash, and smoke, which is thought to have affected its use by bats (Best and Caesar 2000). Extensive cave surveys in the state have also been conducted by MDWFP from 2004 to present with no gray bats observed (K. Shelton, personal communication).

Tripoli Chalk Mine is located approximately 6.4 km (3.9 mi) east of Iuka, Mississippi (Best and Caesar 2000) and 1.6 km (1 mi) west of the Mississippi-Alabama border. The mine is situated in a bottomland hardwood forest and is approximately 32 by 137 m (105 by 449 ft) and 4 m (13 ft) high with domed ceilings and vertical passages that connect different chambers of the mine (DSEG 2016). The mine was opened prior to 1893 and closed in the early 1900s.

On September 20, 2004, a male gray bat was found dead on private property in Belmont, located in southern Tishomingo County (Sherman and Martin 2006). The specimen was donated to the MMNS, where identification was confirmed on October 8, 2004. The bat was an adult, non-reproductive male, with a forearm length of 43.88 mm (1.73 in). The specimen was retained as MMNS Registration #6132 and deposited in the mammal collection at the museum (Sherman and Martin 2006). The collection site in Belmont is approximately 42 km (26 mi) south of Tripoli Chalk Mine and 7.7 km (4.8 mi) from the Alabama border. It is approximately 90 km (56 mi) southwest of the closest known gray bat maternal colony, located at Blowing Springs Cave, Alabama. The property consists of an upland mixed forest along the top of a ridge, with a small pond and creek located approximately 0.4 km (0.2 mi) from where the bat was found. The bat was found during fall migration, therefore, it is possible this individual was migrating through Mississippi from a summer roost to a winter hibernacula.

Habitat – Gray bats are year-round cave residents, occupying cold hibernation caves or mines in the winter and warmer caves during the summer (Tuttle 1976; Gore 1992).

Roosting – Both male and female gray bats utilize the same hibernation sites. They are extremely loyal to specific caves or mines (or to small groups of caves or mines in close proximity) to which they return each winter (Tuttle 2003). Suitable winter hibernacula are typically deep and vertical (USFWS 1982), with multiple entrances, good airflow, and temperatures ranging from 5–11°C (41–51°F) (Harvey et al. 2011).

In early spring, members within a hibernation colony disperse in groups to several different cave sites for the summer, with only females and their young occupying maternity caves and males and non-reproductive females using peripheral caves (Tuttle 1976). Colonies select summer caves with temperatures that range from 14–25°C (57–77°F) (USFWS 1982). Maternity caves are usually the warmest caves in the summer range because they contain structural heat traps, which capture the metabolic heat from clustered individuals (Tuttle 1976). Gray bats may also occasionally roost at man-made sites that simulate summer caves, such as storm drains (Hays

and Bingham 1964; Elder and Gunier 1978). In Missouri, Gunier and Elder (1971) reported an unusual occurrence of gray bats roosting in a barn. Lamb (2000) described a maternity colony using a gate-room at Woods Reservoir Dam on Arnold Air Force Base, Tennessee. This site was listed as a Priority Two maternity colony in the Gray Bat Recovery Plan (USFWS 1982). Another gate-room of the dam was used by a bachelor colony (Lamb 2000, 2005).

Foraging – Gray bats forage primarily over water where flying insects are abundant (Tuttle 1976, 1979; LaVal et al. 1977). In the early evening, gray bats emerge from summer roosts and fly to foraging sites associated with water or wetland vegetation (Brack 1985). Martin (2007b) described summer colonies utilizing areas where open water (including streams, lakes, and reservoirs) is within foraging distance of caves and other roosting sites suitable for rearing young. They usually fly a direct route to feeding areas (Tuttle 1976), but may fly over land to reach the river channel or tributary systems that lead to open water foraging sites (Thomas 1994; Best and Hudson 1996). Summer colonies, especially maternity colonies, prefer caves that are within 1 km (0.6 mi) of a major river or lake and are rarely found in caves located at distances greater than 4 km (2.5 mi) (Tuttle 1976). Factors closely correlated with distance traveled to feeding areas include growth rate and survival, condition of young bats, and adult mortality. Tuttle (1979) postulated that forested areas surrounding caves or located between caves and foraging habitat are important for gray bat survival. These areas serve as travel corridors and as protective cover during feeding for newly volant young (USFWS 1982). In Tennessee, results of surveys conducted at Arnold AFB indicate wetland depressions are also important foraging sites for gray bats (Lamb 2000). Thomas and Best (2000) reported gray bats from a northern Alabama cave foraged over areas of approximately 9,700 ha (24,320 ac).

Movement and Migration – Gray bats emerge from hibernation in the spring and move to their summer range where colony members disperse among hundreds of caves in separate bachelor and maternity colonies (Decher and Choate 1995). Adult females migrate to the breeding range in late March or early April, and most adult males and juveniles migrate between mid-April and mid-May. For the summer range, thousands to tens of thousands of reproductive females congregate in a preferred maternity cave to bear and rear young, while adult males and yearlings of both sexes form bachelor groups and occupy other caves (Harvey 1992). After young become volant, gray bats become more transient within their home range and frequently use alternate roost sites (Thomas 1994). Fall migration occurs in approximately the same order as spring emergence, with adult females leaving early September and juveniles departing last, usually mid-October (Tuttle 1976). Due to limited suitable hibernacula, gray bats migrate to common hibernation sites across a broad area (Hall and Wilson 1966). Tuttle (1976) found that one-way distances regularly traveled during migration ranged from 17–37 km (11–23 mi), and bats may migrate as far as 500 km (310 mi) from Florida to hibernacula in Tennessee and northern Alabama. Gray bats demonstrate strong philopatry (loyalty) to both summer and winter ranges. They may use as many as six different caves in the summer range but show no significant movement within the winter range after hibernation begins (Tuttle 1976).

Reproduction – Gray bats require two years to reach sexual maturity (Tuttle 1976). Copulation occurs upon arrival at winter caves, and supplemental copulation may also occur during the period of hibernation (Guthrie 1933; Saugey 1978). Females store sperm in the uteri but do not ovulate until they have emerged from hibernation (Guthrie 1933). Gestation lasts for 60–70 days (Saugey 1978), and parturition occurs in late May and early June (Tuttle 1976). The single, naked young pups cling to adult females for about a week, and remain in the nursery caves while females forage. Most young become volant by four weeks of age, usually late June to mid-July (Saugey 1978). For newly volant young, growth rates and survival depend on commuting distances between roosts and foraging areas (Tuttle 1976). Although juvenile mortality is low (Saugey 1978) and potential longevity is high (up to 17 years), survival to maturity is only about 50% (USFWS 1982). Therefore, approximately five years are required for a female gray bat to produce two surviving offspring.

Threats and Management – Range-wide primary threats to this species include disturbance at hibernation and maternity sites, destruction or modification of habitat near cave entrances and between caves and rivers or reservoirs, WNS, and contaminants. Impacts caused by human environmental alterations include deforestation and chemical contamination. Mortality and probable population declines in gray bats have been linked to pesticide use (Clark et al. 1978; Martin 2007b). Sasse (2005) analyzed contaminants detected in gray bat caves in Arkansas and found gray bats are continuing to be exposed to pesticide residues that are potentially fatal.

The largest threat to this species is disturbance at hibernation and maternity sites. Disturbance at a hibernacula can cause bats to arouse at least partially from hibernation and use energy reserves that cannot be replenished until spring (Tuttle 1976). Disturbance at maternity caves is most harmful from late May through mid-July when non-volant young are in the roost. It is estimated thousands of bats may die from a single disturbance (USFWS 1982). Bat friendly gates have been installed at most large hibernation and maternity sites to protect bats from disturbance. Gating can also help to reduce the spread of WNS. White-nose syndrome has the potential to cause large declines for this species, however, as of 2015, no significant impacts to the gray bat from WNS have been observed.

Research Needs –Extensive mist net, bridge, culvert, and cave surveys are conducted annually by MDWFP and the MBWG, along with the help of volunteers from multiple state and federal agencies with no gray bats observed. This work should be continued to obtain additional information regarding presence of this species in Mississippi. An emphasis for survey efforts should be placed on northern Mississippi, particularly the northeast corner of the state, with surveys concentrated during spring or fall migration periods. It is recommended that wing tissue samples be collected and genetically analyzed, if possible, from any *Myotis* species captured in the state to ensure accurate identification.

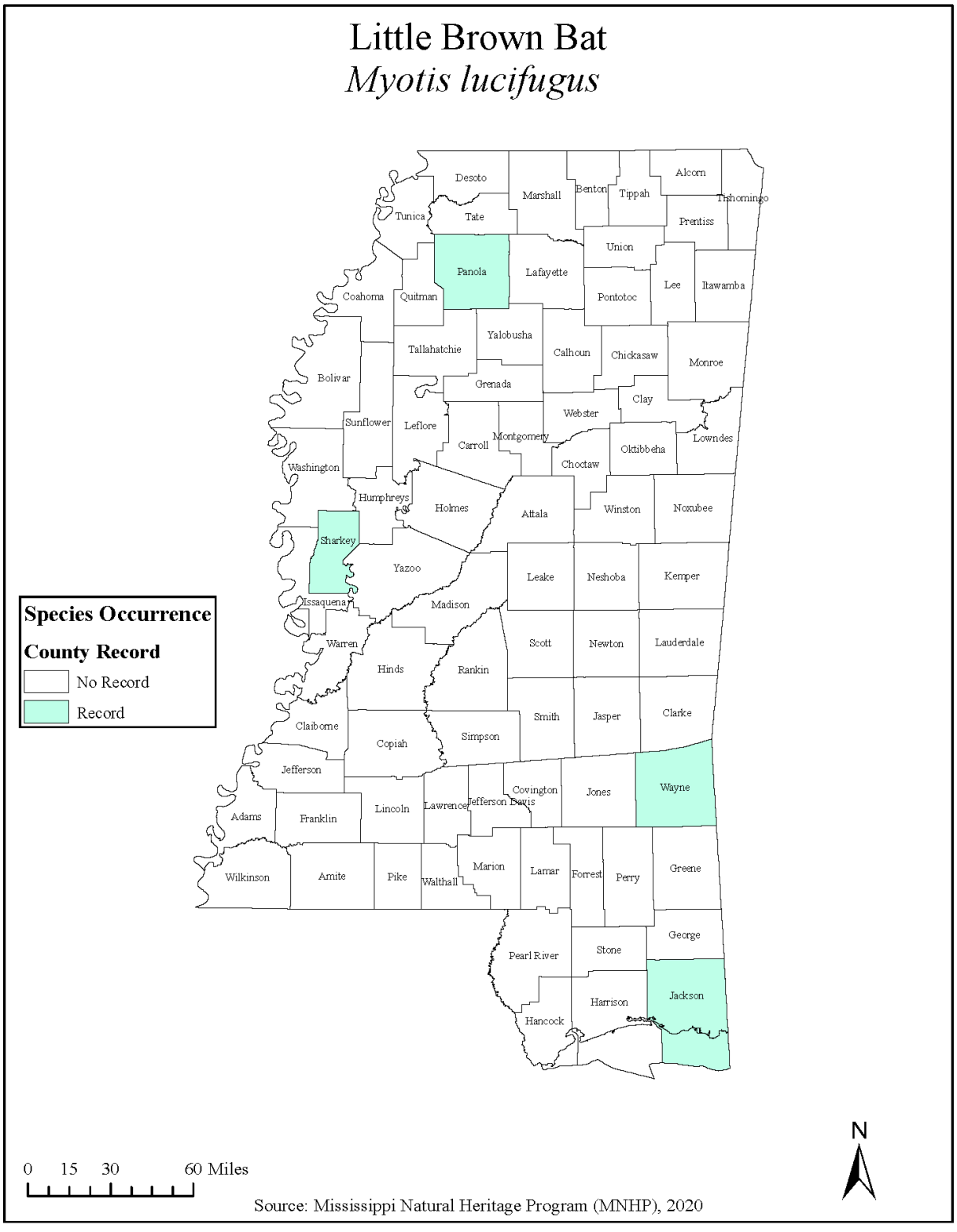

Fig. 22.— Known county occurrence records of little brown bat (*Myotis lucifugus*) in Mississippi.

LITTLE BROWN BAT – *Myotis lucifugus*

Status. – Prior to 2006, the little brown bat was considered one of the most abundant bat species in the United States (Barbour and Davis 1969). However, severe declines in population numbers have occurred since 2006 due to WNS. Populations of little brown bats have declined by 94% in Canada and the northeastern United States, with several local populations extirpated. Frick et al. (2010) predicts that regional and possibly range-wide extinction of this species could occur by 2026 due to WNS. This species has a global conservation status rank of G3, vulnerable, and in Mississippi has a state rank of SH, indicating the species is possibly extirpated (MNHP 2018; NatureServe 2019; Table 1). This species is not protected under federal regulations, but is protected in Mississippi under Rule M-2.3 Nongame Wildlife in Need of Management (MDWFP 2016).

Description. – The little brown bat is a medium-sized *Myotis* with sleek, glossy, brown fur. It is similar in appearance to the Indiana bat (*M. sodalis*), however, it does not have a keeled calcar and has long hairs on the toes that extend past the claws. This species has a total length of 41–54 mm (1.6–2.1 in) and body mass of 7–9 g (0.25–0.32 oz) (Barbour and Davis 1969; Kunz and Reichard 2010). Forearm length is 33–41 mm (1.3–1.6 in) and ear length is 11–15.5 mm (0.4–0.6 in) (Barbour and Davis 1969; Hall 1981).

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Distribution – The range of the little brown bat spans from central Alaska and southern Canada and into the southeastern and southwestern United States (Patterson et al. 2007; Fig. 23). In Mississippi, it has been documented in four counties (Panola, Jackson, Sharkey and Wayne), with the last occurrence in the state documented in 1952 (MNHP 2020; Fig. 22).

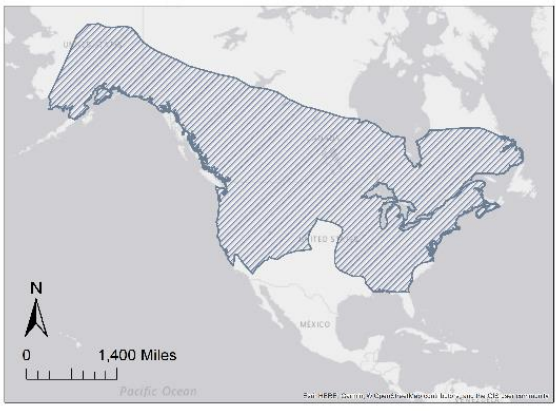

Fig. 23.— Geographical range of little brown bat (*Myotis lucifugus*).

In 1937, one little brown bat was captured at the Tallahatchie River in Panola County and submitted as a voucher specimen to the MMNS. In 1944, one little brown bat was captured on Horn Island, located in Jackson County (Richmond 1962). In 1952, one little brown bat was captured from a cave located in Wayne County, and the voucher specimen was deposited in the Louisiana State University Museum of Zoology (LaVal 1967).

Between 1999–2001, Wilf (2004) captured and identified 14 little brown bats in Delta NF, located in Sharkey County, however, no vouchers were collected.

Habitat – The little brown bat utilizes caves and mines as swarming sites from August to October (during the mating period and pre-hibernation fattening period), and as hibernation sites during the winter (Kunz et al. 1998; McGuire et al. 2009). In the spring and summer this species is considered a habitat generalist and can be found in a wide variety of habitat types including karst regions, forested habitats, grasslands, old fields, and urban environments.

Roosting – Winter hibernation sites for the little brown bat include caves, abandoned mines, tunnels, and similar sites with relatively stable, cool temperatures of 2–12°C (36–54°F) and high humidity (Fenton 1969; Kunz and Reichard 2010). Little brown bats show high fidelity to hibernation sites and often return to the same site each winter (Humphrey and Cope 1976). Hibernation sites are usually occupied from October–March.

In April, reproductive females will form maternal colonies consisting of ten to potentially a few thousand individuals (Kunz and Reichard 2010). Summer maternal sites include caves, hollow trees, attics, and other man-made structures. Little brown bats seem to prefer dark and warm sites as maternal roosts (Crampton and Barclay 1998). Roost fidelity is high for maternal sites as well, with females commonly returning to their natal roost yearly (Frick et al. 2010). Non-reproductive females and males will roost separately from maternal colonies and will roost individually or in small groups in a wide variety of roost types including man-made structures and tree cavities. This species is considered opportunistic and will utilize many habitat and roost types (Fenton and Barclay 1980).

The only documented roost site for this species in Mississippi is from Williams Cave (formerly Pitts Cave), located in Wayne County, the largest known cave in the state. An individual was captured on November 22, 1952 and it is assumed that it was utilizing the cave as a hibernation site. Graduate students at the University of Southern Mississippi and conservation biologists with MDWFP have conducted surveys of this cave regularly since 1999. However, this species has not been observed at this site since 1952, and it is currently being utilized by southeastern myotis and tricolored bats.

Foraging – This species is considered an opportunist and habitat generalist, foraging in a wide range of habitat types including riparian areas, floodplains, upland forests, ponds, and fields. Foraging range can exceed 30 ha (70 ac) (Henry et al. 2002). Diet of the little brown bat consists of aerial insects including flies, moths, beetles, caddisflies, mayflies and lacewings (Anthony and Kunz 1977). Foraging usually occurs over open water or in forested buffer areas surrounding water (Anthony and Kunz 1977; Barclay 1991). Little brown bats usually have two to three active feeding bouts per night, utilizing night roosts to rest in between feeding sessions (Kunz 1988). Pregnant and lactating females can consume 2.5–3.7 g (0.09–0.13 oz) of insects in one

night, with some lactating females consuming the equivalent of their body mass in a single night (7 g; 0.25 oz; Kunz 1988).

Movement and Migration – Little brown bats may migrate hundreds of kilometers from winter to summer roosts in the northeast. In the west, it is likely bats hibernate near their summer range (Schmidly 1991). Studies have documented movements between different hibernacula (from a few kilometers to 805 km for a single bat; Fenton 1969), between summer roosts and hibernacula (2–241 km; Davis and Hitchcock 1965), and between swarms and both summer roosts and hibernacula (119–805 km, Fenton 1969; 10–455 km, Humphrey and Cope 1976).

Reproduction – Breeding begins in August at swarming sites that also serve as hibernacula (Davis 1964; Fenton 1969; Kunz et al. 1998). Delayed ovulation and fertilization occur with pregnancy beginning in spring and gestation lasting 50–60 days (Barbour and Davis 1969). Females form maternal colonies in early spring and remain until August. Maternal colonies can contain from 50–2,500 individuals (Mumford and Cope 1964). Each reproductive female gives birth to a single pup.

Threats and Management – The primary threat to the little brown bat is WNS which has caused substantial declines for the species. Research conducted by Frick et al. (2010) predicts that regional and possibly range-wide extinction of this species could occur by 2026 due to WNS. Wind farms and disturbance at hibernacula and maternal sites are also considered threats to this species. Research regarding WNS and bat mortality at wind farms are high research priorities among the bat scientific community. The USFWS provides over a million dollars in grant money annually to researchers to further our understanding of WNS and its effects.

Research Needs – It is likely that the little brown bat no longer occurs in Mississippi, however, it is recommended that wing tissue samples be taken and genetically analyzed from any *Myotis* species captured in the state to ensure accurate identification.

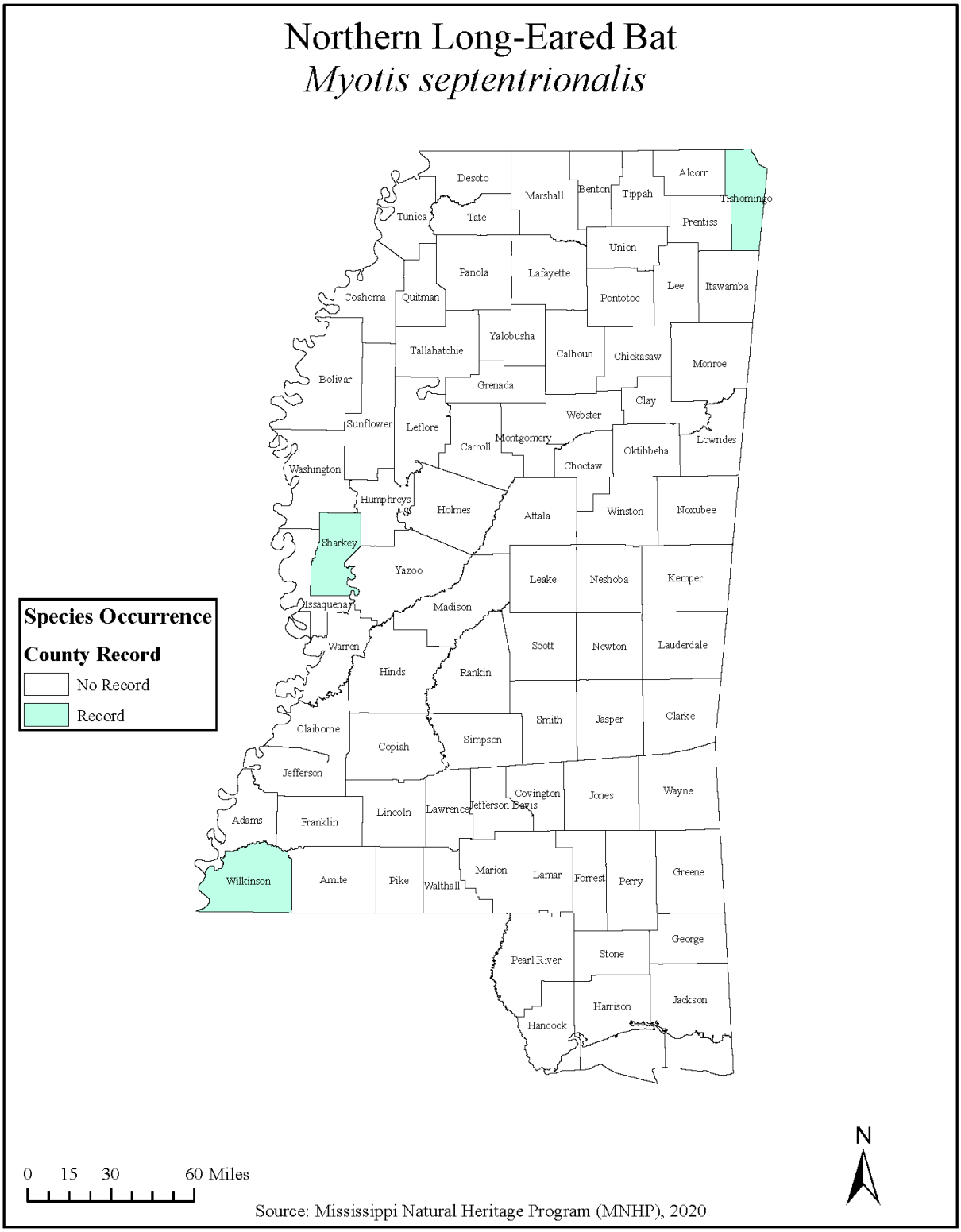

Fig. 24.— Known county occurrence records of northern long-eared bat (*Myotis septentrionalis*) in Mississippi.

NORTHERN LONG-EARED BAT – *Myotis septentrionalis*

Status. – The northern long-eared bat is widespread in the eastern United States, although it is patchy in distribution and rarely found in large numbers (Barbour and Davis 1969). Due to declining population numbers, primarily caused by WNS, this species was federally listed under the ESA as threatened in May 2015 (Table 1). At roost sites in states where WNS has been detected, many populations of northern long-eared bats have declined by 99% (USFWS 2015). For states that have not been affected by WNS, populations of this species appear relatively stable. As a result, conservation status ranges from secure in some states, to critically imperiled in others. The northern long-eared bat has a global conservation status rank of G1G2, critically imperiled/imperiled (NatureServe 2019; Table 1). Although Mississippi has not been affected by WNS, the northern long-eared bat has a state rank of SH, indicating it is possibly extirpated in the state (MNHP 2018; Table 1). This species is partially protected in Mississippi under Rule M-2.3 Nongame Wildlife in Need of Management (MDWFP 2016).

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Description. – The northern long-eared bat is a medium-sized *Myotis* with a total body length of 77–95 mm (3.0– 3.7 in) and mass of 5–8 g (0.2–0.3 oz; Barbour and Davis 1969; Caceres and Barclay 2000). Other standard measurements include: wingspan 23–26 cm (8.9–10.2 in); forearm length 34–38 mm (1.3–1.5 in); and tail length 35–42 mm (1.3–1.6 in; Barbour and Davis 1969; Caceres and Pybus 1997; Caceres and Barclay 2000). Females tend to be larger than males (Caceres and Pybus 1997). The fur is medium to dark brown on the back and tawny to pale-brown on the ventral side (Nagorsen and Brigham 1993; Whitaker and Mumford 2009). The primary identifying characteristic for this species is the relatively long ears, particularly compared to other *Myotis* species. When laid forward the ears will extend up to 5 mm (0.2 in) beyond the nose (Caceres and Barclay 2000; Whitaker and Mumford 2009).

Distribution – The range of the northern long-eared bat includes southern Canada and central and eastern portions of the United States (Nagorsen and Brigham 1993; Patterson et al. 2007; Fig. 25).

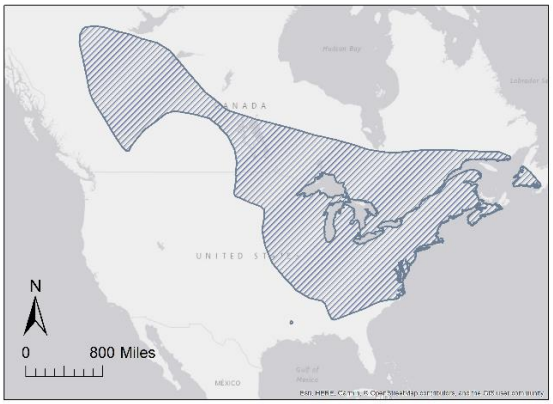

Fig. 25.— Geographical range of the northern long-eared bat (*Myotis septentrionalis*).

There are four historic records for this species in Mississippi. One individual was collected on August 10, 1937, one on July 16, 1939, and two on August 5, 1979. All were captured in Tripoli Chalk Mine located in Tishomingo County, in the northeast corner of the state, with specimens deposited at the MMNS. There are four current records documented for this species in Mississippi, located in Tishomingo, Sharkey, and Wilkinson Counties (MNHP 2020; Fig. 24). Wilf (2004) reported capturing two individuals at the same location in Delta NF located in Sharkey County; a male was captured on July 19, 2000, and a female was captured June 3, 2001. Although no vouchers were collected, one of the bats was photographed. Deep South Eco Group (DSEG 2006) observed one individual on October 24, 2004 at Tripoli Chalk Mine (Sherman and Martin 2005; Sherman 2006). Additional surveys have been conducted at the chalk mine from 2004 to present with no northern long-eared bats observed (DSEG 2006; K. Shelton, personal communication).

Most notable among the current observations is an individual captured by conservation biologists with MDWFP on April 27, 2017, in Wilkinson County (MNHP 2020). This is the southernmost known occurrence of the species in the state, and is currently outside of the known range of the species (USFWS 2019b). The individual was captured by mist net and was identified as a southeastern Myotis during field observations (measurements: forearm 33.1 mm [1.3 in]; mass 8 g [0.28 oz]; ear length 14.2 mm [0.56 in]). Note ear length for northern long-eared bat is documented as 17–19 mm (0.67–0.75 in) and southeastern Myotis is 15 mm (0.59 in; Barbour and Davis 1969). The individual was a non-reproductive adult male. Wing punch samples were taken at the time of capture and sent to the National Wildlife Health Center in 2020, who later identified the individual as a northern long-eared bat.

Habitat – Suitable habitat for the northern long-eared bat includes a variety of forested habitats. Research has shown that presence and activity of this species is highest in old growth forests with late-successional characteristics (Matteson 2010). Late-successional forest characteristics important to this species include a high percentage of old trees (>100 years), uneven forest structure, single and multiple tree fall gaps, standing snags, and woody debris (Krusic et al. 1996). These characteristics provide an abundance of dead or decaying trees that can be used for breeding, day roosting, and foraging.

Roosting – Hibernation sites for the northern long-eared bat are commonly in caves and abandoned mines, which can vary substantially in size and shape. Hibernacula typically have relatively constant cooler temperatures (0–9°C; 32–48°F) with little airflow and high humidity (Fitch and Shump 1979; Caceres and Pybus 1997; Brack 2007). In caves and abandoned mines, northern long-eared bats are most commonly found roosting in cracks and crevices in the wall or ceiling (Barbour and David 1969; Whitaker and Mumford 2009). Additional cave or mine-like structures have also been documented as hibernation sites for this species, including abandoned railroad tunnels (USFWS 2015), a hydroelectric dam facility (Kurta et al. 1997), and a dry well (Griffin 1945). Over 1,100 hibernacula sites have been documented in 29 of the 37 states within the range of this species, although, some of these sites contain only 1–3 individuals (Whitaker and Hamilton 1998; USFWS 2015).

Summer sites for this species are most commonly found under bark or in cavities of live or dead trees. Studies conducted by Foster and Kurta (1999) have documented that maternal tree roosts for this species in the eastern United States include American beech (*Fagus grandifolia*), silver maple (*Acer saccharinum*), red maple, black cherry (*Prunus serotina*), green ash (*Fraxinus pennsylvanica*), and black locust (*Robinia pseudoacacia*). Studies conducted by Perry and Thill (2007) in the Ouachita Mountains of central Arkansas, found shortleaf pine was the most utilized tree species. Additionally, pine snags were more commonly used by this species than hardwood snags during the study. Some studies propose that tree characteristics such as cavities and loose bark are more important to roost suitability for this species than the tree species itself (Foster and Kurta 1999; Carter and Feldhamer 2005). Maternal colonies have also been documented in man-made structures including barns, buildings, utility poles, under bridges, and in artificial roosts (Barbour and Davis 1969; Nixon and Leberg 2009). In addition to tree roosts and man-made structures, males and non-reproductive females will also utilize caves and mines in the summer.

In Mississippi, the only known historic summer site for this species is in Tripoli Chalk Mine. Records are not available to determine if this was a maternity site for this species, or if the voucher specimens collected were the only individuals present. Currently, the abandoned mine is visited frequently by local residents, as apparent by heavy vandalism including graffiti and evidence of camp fires.

Foraging – Foraging habitat for the northern long-eared bat includes forested hillsides and ridges, and to a lesser degree small forest clearings, above water and along transportation corridors (LaVal 1967; Brack and Whitaker 2001). They have also been documented foraging along forest trails and small roads (Loeb and O'Keefe 2006b). Feeding on a variety of insect species, bats forage primarily above the understory, but under the canopy in forested habitats (Nagorsen and Brigham 1993). The northern long-eared bat feeds primarily on moths and beetles, but has also been documented foraging on flies, leafhoppers and caddisflies (Brack and Whitaker 2001; Feldhamer et al. 2009). In addition to capturing prey midair, they can also glean insects perched on surfaces. This foraging ability, combined with agile flight capabilities, enables the species to forage in forests with dense understory (Foster and Kurta 1999).

Movement and Migration – Migration for the northern long-eared bat is typically brief, seasonal, and regional. Spring migration generally occurs from mid-March to mid-May when moving from winter hibernacula to summer maternity roosts. Fall migration typically occurs from mid-August to mid-October when moving from maternity sites to hibernacula, also known as the swarming season. Heightened activity has been documented at caves during the swarming period, as transient bats will use these sites as a stopover along migration routes or as copulation sites (Kurta et al. 1997).

Reproduction – In the northern portion of its range, mating typically occurs in late July and in the southern regions in early October (Whitaker and Hamilton 1998). Females delay fertilization by storing sperm during hibernation, with ovulation and fertilization occurring toward the end of hibernation (Caceres and Pybus 1997). Gestation is likely 60 days. Pregnant females form maternity colonies with an average of 30–60 individuals per colony (Barbour and Davis 1969; Caceres and Barclay 2000). A single pup is born in late May to early June (Caire et al. 1989), becoming volant by 21 days.

Threats and Management – Range-wide primary threats to this species include WNS, the destruction or modification of habitat (which includes modification of hibernacula, including mine or cave entrance closures or gating which could affect air flow and temperatures, disturbance at hibernacula, conversion of forests for agricultural, urban or mineral development purposes, and forest management including timber harvest), wind energy development, and contaminants.

In order to safeguard this species from additional declines, many state and federal agencies are installing bat friendly gates at hibernation sites to help reduce the spread of WNS and to protect bats from disturbance during hibernation. To protect summer roosting habitat, several conservation measures have been established by USFWS that include: a) prohibiting habitat destruction within 0.25 mile of a known, occupied hibernacula; b) cutting or destroying known occupied roost trees during the pup season (June 1–July 31) and; c) clearcutting within 0.25 mile of known occupied roost trees during the pup rearing season.

Research Needs – Extensive mist net surveys have been conducted throughout the state of Mississippi yielding no captures of the northern long-eared bat (DSEG 2017). Mist net, bridge, culvert, and cave surveys are conducted annually by MDWFP and the MBWG, along with the help of volunteers from multiple state and federal agencies. The northern long-eared bat has not been documented during these survey efforts. This work should continue in order to obtain additional information regarding the presence of this species in Mississippi. Recent research has shown the use of acoustic lures can increase probability of capturing northern long-eared bats (P. Roby, personal communication). In the future, this technique should be used when surveying within the range of this species in Mississippi. If northern long-eared bats are found during mist net surveys, efforts should be made to locate a roost site. Having proper tracking equipment

available for use by surveyors should be a priority. It is also recommended that genetic samples be obtained from any captured *Myotis* sp. and tested, if possible, to confirm proper identification.

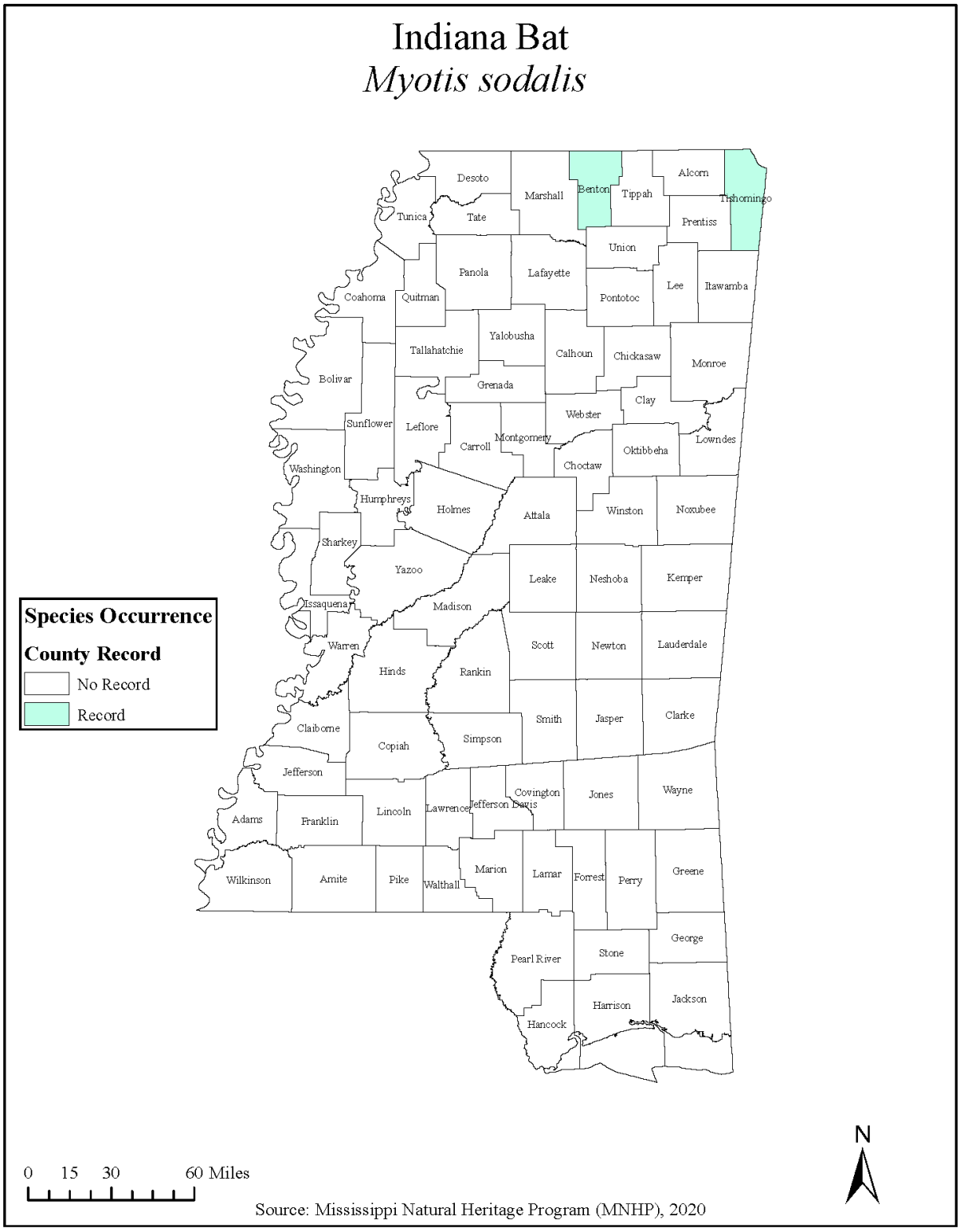

Fig. 26.— Known county occurrence records of Indiana bat (*Myotis sodalis*) in Mississippi.

INDIANA BAT – *Myotis sodalis*

Status. – The Indiana bat was federally listed as endangered in 1967 under the Endangered Species Preservation Act of 1966 due to declining population numbers, and is currently listed as endangered under the ESA of 1973, as amended (Table 1). At the time of listing, the population was estimated at 880,000 individuals (Clawson 2002). While the Indiana bat population saw an upward trend from 2003–2007, likely attributed to conservation efforts at hibernacula and summer habitats, estimates have continued to decline since 2009, due to significant declines from WNS in the Northeast, Appalachia and Midwest (USFWS 2009). In 2019, the USFWS (2019) estimated the range-wide Indiana bat population was approximately 537,297 bats, with 71% of the population hibernating at sites located in Missouri (36.3%) and Indiana (34.4%). This represents an additional 4% decline from 2017, and an overall decline of 19% since the discovery of WNS in 2007 (USFWS 2017, 2019). It is presumed that the majority of the population, historically and currently, hibernates in relatively few caves, making this species particularly vulnerable to population declines. White-nose syndrome and the fungus that causes it, *Pd*, has spread across the entire range of the Indiana bat and has been documented in all known hibernacula sites as of 2017 (USFWS, unpublished data). It is predicted that WNS has and will continue to cause significant declines for bat species. Thogmartin et al. (2013) estimates that WNS will cause a severe population decline for the Indiana bat by greater than 86% within the next decade.

The Indiana bat is globally and state listed as imperiled (G2 and S1, respectively) throughout most of its range (NatureServe 2019; Table 1). Prior to 2013, the last observation of the Indiana bat in Mississippi occurred in 1939. As a result, it was given a state rank of possibly extirpated (SH) by the MNHP (2004). Due to recent observations of the Indiana bat, documented in 2013 and 2015, the state rank in Mississippi is currently S1B, indicating the species is critically imperiled and thought to be only present during the summer maternal season (MNHP 2018; Table 1). Additionally, the Indiana bat is state listed as endangered.

Description. – The Indiana bat is a medium-sized *Myotis* with the following measurements: total length 41–49 mm (1.6–1.9 in); body mass 5–11 g (0.2–0.4 oz); forearm length 36–41 mm (1.4–1.6 in); hindfoot 8–10 mm (0.3–0.4 in); and ear height 12–15 mm (0.5–0.6 in; Barbour and Davis 1969; University of Wisconsin 2018). The fur is a dull (not glossy) grayish chestnut, usually nearly black but sometimes brownish. The underside is pinkish to cinnamon. Two identifying

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characteristics for this species are a distinctly keeled calcar and foot hairs that do not extend beyond the claw (Barbour and Davis 1969).

Distribution – The range of the Indiana bat includes most of the eastern United States (23 states), with Oklahoma and Iowa located on the western edge of the range, Wisconsin and Michigan located on the northern edge, New York and New Jersey on the northeastern edge and Alabama and Arkansas on the southern edge (Patterson et al. 2007; Fig. 27). In Mississippi, this species has only been documented in Tishomingo and Benton Counties (MNHP 2020; Fig. 26). Twelve Indiana bat voucher specimens were collected in 1937 and six were collected in 1939 at Tripoli Chalk Mine, in Tishomingo County. This species has not been documented at the mine since 1939 although numerous surveys have been conducted from 2004–present (K. Shelton, personal communication).

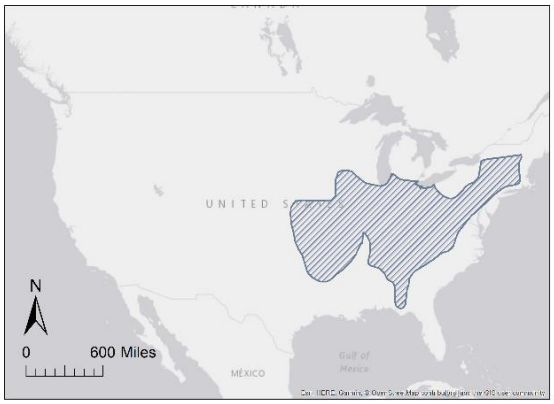

Fig. 27.— Geographical range of the Indiana bat (*Myotis sodalis*).

In April 2013, aerial telemetry surveys conducted by Copperhead Environmental Consulting, Inc. (CEC) radio-tracked a female Indiana bat from Rose Cave in White County, Tennessee, 511 km (317.5 mi) to a small beaver pond at Holly Springs NF in Benton County, located in north Mississippi (Roby et al. 2019). Since this observation occurred during spring migration, it is likely the tracked individual was migrating from a winter hibernaculum to a summer maternal roost. This is the first record for the Indiana bat in Mississippi since 1939. During the telemetry study, radio-tagged Indiana bat individuals from Rose Cave were also tracked to Georgia, creating a new state record for the species. In April 2015, Roby et al. (2019) radio-tagging 44 Indiana bats from Hubbards Cave in Warren County, Tennessee and 35 individuals from Rose Cave. During the study, one female Indiana bat was tracked from Rose Cave to a loblolly pine tree located on a ridge above the same beaver pond area at Holly Springs NF as in 2013. Although aerial migration surveys were also conducted in 2016 and 2017, no Indiana bats were tracked to Mississippi.

Habitat – The Indiana bat is most commonly associated with mixed hardwood forests and mixed hardwood-pine forests. In the late fall through early spring, the Indiana bat is typically associated with karst regions since it hibernates in caves. In the summer, habitat consists of wooded or semi-wooded areas, often along streams. Foraging habitat includes forested areas, particularly near water (USFWS 2007).

Roosting – Indiana bats hibernate in caves and abandoned mines where temperatures are relatively stable below 10°C (50°F) and usually above freezing (Hall 1962). Hibernation sites

often have large rooms with vertical passages that provide a range of roost sites with varying temperatures (USFWS 2007). Individuals form large, tightly packed clusters which can average 300 individuals per square foot (LaVal and LaVal 1980). Clusters will often occur in the same area of a particular cave each year (Hall 1962). Heavy concentrations of individuals at only a few hibernacula sites make this species particularly vulnerable to potential threats. In 2019, the USFWS (2019) reported approximately 49.8% of the Indiana bat population hibernated in man-made structures (267,260 bats in 19 mines, 20 bats in 1 dam, and 6 bats in 1 tunnel) and 50.2% (269,991 bats) hibernated in natural caves.

In the spring, reproductive females will migrate to maternity sites in forested areas and typically roost behind loose or peeling bark of dead or dying trees (particularly under large slabs of bark), or in tree cavities (Carter 2003). Roost trees are often within forest canopy gaps, along fence lines or wooded edges, and will usually receive direct sunlight for more than half the day (USFWS 2007). Habitats where maternity roosts occur include bottomland hardwood forests, floodplains, wooded wetlands, riparian zones, and upland communities. The most common roost tree species include elm (*Ulmus* sp.), oak, hickory, ash (*Fraxinus* sp.), maple, and poplar (*Populus* sp.), especially trees with exfoliating bark (USFWS 2007). In the spring, males and non-reproductive females will either stay near the hibernacula or move to wooded areas. Maternity colonies are widely dispersed and often difficult to locate, therefore the locations of a vast majority of Indiana bat maternity colonies are unknown throughout their range (USFWS 2019a).

The only known historical summer roost for this species in Mississippi is in Tripoli Chalk Mine. It is likely that the mine was a maternal site due to the number of individuals captured on two separate occasions, however, MMNS records do not specify. This mine is 32 by 137 m (105 by 449 ft) and 4 m (13 ft) high with domed ceilings and vertical passages that connect different chambers of the mine (DSEG 2016). This abandoned mine is currently visited frequently by local residents as apparent by heavy vandalism, including graffiti and evidence of campfires. Public visitation is quite possibly the reason it was abandoned after the late 1930s.

Currently, the only maternal/summer roost site documented for this species in Mississippi is within and surrounding a beaver pond at Holly Springs NF (Roby et al. 2019). In 2013, the exact tree roost within the beaver pond could not be located during surveys conducted by CEC. The beaver pond is surrounded by a bottomland hardwood forest dominated by white oak, sweetgum, and red maple. In 2015, a radio-tagged Indiana bat was tracked to a loblolly pine tree located in an upland area just above the beaver pond.

Foraging –Foraging by Indiana bats occurs in a wide range of habitats dependent upon availability, including riparian areas, floodplains, upland forests, ponds, and fields (USFWS 2007). Semi-open forested habitats and forest edges seem to be common foraging areas for this species (Humphrey et al. 1977). Studies have shown that floodplain forest was the most preferred

habitat in Illinois (Garner and Gardner 1992) and woodlands were the most preferred foraging habitat in Indiana (Sparks 2003). The diet of the Indiana bat consists of flies, moths, beetles, and caddisflies (Kurta and Whitaker 1998).

Movement and Migration – In the late fall, northern populations of Indiana bats migrate south to Alabama, Tennessee, Kentucky, Indiana, Missouri, and West Virginia where they hibernate for the winter (USFWS 2013). Bats typically leave their hibernacula in late March and April and migrate north for the maternal season. Migration surveys conducted by CEC have documented several Indiana bats in Tennessee remain in the state for the maternal season after leaving their hibernacula, although they move to a different site. Still, some individuals travel long distances to maternal sites, many of which are south of Tennessee (Roby et al. 2019). During the 2014 aerial telemetry project conducted by CEC, radio transmitters were placed on two female Indiana bats captured at Blowing Cave (Sevier County, Tennessee) and 51 females at Rose Cave (White County, Tennessee). Many of the tracked individuals remained within Tennessee, however one individual traveled 241 km (150 miles) from Blowing Cave to an area west of Owensboro, Kentucky, near Sloughs Wildlife Management Area. Several other individuals were tracked 225 km (140 miles) from Rose Cave to Talladega NF, east of Anniston, Alabama. The results from this study indicate that Indiana bats are migrating further south in the summer than researchers previously thought.

Reproduction – Mating usually occurs surrounding the entrance of caves from late August to early October, with males arriving first. Ovulation and delayed fertilization (from sperm stored from fall mating) occurs in the spring. Maternity colonies of pregnant females form in late spring, usually in May. Since maternal sites are often located under loose bark or in tree cavities, population estimates at maternal sites are usually made using emergence counts. It is estimated most maternal colonies contain less than 100 individuals (Harvey 2002). Maternal colonies or individuals in maternal colonies will switch roost sites during the summer. Maternal colonies will often use 10–20 trees each year, with only a few of these trees being used as a primary roost site during the breeding season. One offspring is born in June or July and is volant within four to five weeks (Humphrey et al. 1977).

Threats and Management – The primary threats to the Indiana bat include habitat loss and degradation, forest fragmentation, winter disturbance, environmental contaminants, WNS, non-native invasive species, climate change, and wind turbines (USFWS 2019a). Eleven caves and two mines in the eastern United States are designated as critical habitat for the Indiana bat and are currently protected under the ESA. By 2001, over 35 hibernacula in caves and mines were acquired and protected (Currie 2002). Primary management strategies for this species, as outlined in The Indiana Bat Recovery Strategy (USFWS 2007), include range wide population monitoring at hibernacula, conservation and management of hibernacula and surrounding habitat, further research into requirements of and threats to the species including WNS research, and public education and outreach.

Research Needs – In Mississippi, studies should be focused on locating maternity roosts, with an emphasis on Holly Spring NF and the surrounding area. Artificial roosts should be installed in this area to provide additional roosting opportunities. Additional acoustic monitoring should be conducted utilizing USFWS Range-wide Indiana Bat Survey Guidelines to determine mist net survey locations (USFWS 2020).

The 2013 and 2015 records of the Indiana bat on Holly Springs NF are significant records given that they are the first records of this species in Mississippi in 74 years. Intensive mist net surveys have been conducted in the northern half of the state targeting the Indiana bat, with no captures obtained for this species (DSEG 2016; B. Rosamond, personal communication; S. Whittington, personal communication). Additional work focused on obtaining capture records on the Holly Springs NF and surrounding counties is needed to determine relative abundance estimates of the Indiana bat. Studies of habitat and roost selection in Mississippi are also research priorities. The continuation of migration surveys utilizing aerial telemetry will also provide valuable information regarding migration habits for this species in addition to documenting new maternal roost sites.

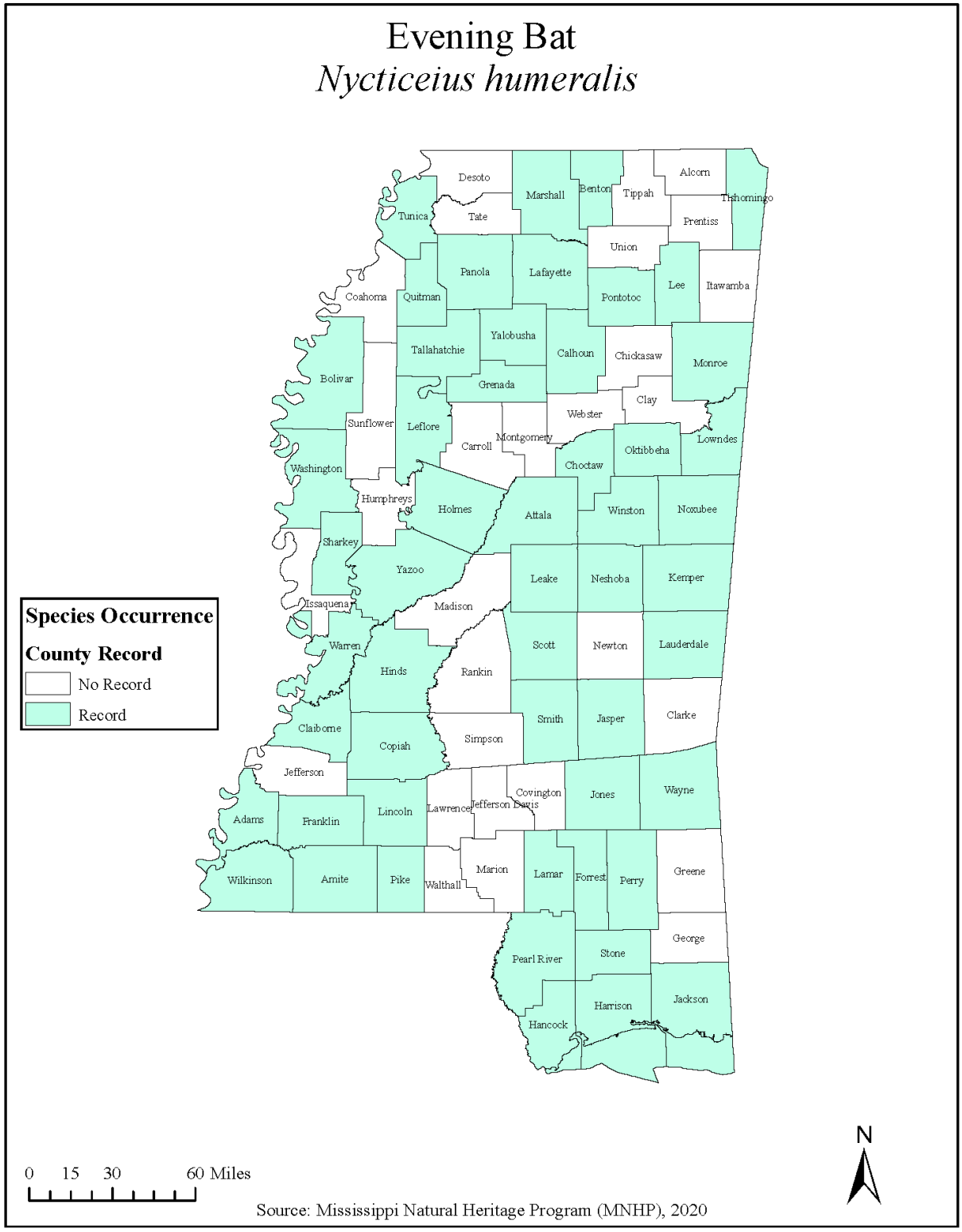

Fig. 28.— Known county occurrence records of evening bat (*Nycticeius humeralis*) in Mississippi.

EVENING BAT – *Nycticeius humeralis*

Status. – The evening bat is common throughout most of its range, and the population seems to be relatively stable in Mississippi. This species has a global conservation status rank of G5, secure (NatureServe 2019). Although evening bats are not protected under federal regulations, in Mississippi they are partially protected under Rule M-2.3 Nongame Wildlife in Need of Management (MDWFP 2016).

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Description– Evening bats are small, dark brown bats, with a total length of 92.7 mm (3.65 in; Whitaker and Hamilton 1998). The fur is dull brown above, with dull gray bases and lighter brown below (Whitaker and Hamilton 1998; Wilson and Ruff 1999). The tail is furred only at the base of the dorsal side (Martin et al. 2008). Evening bats are similar in appearance to big brown bats. They can be distinguished by smaller size, a shorter forearm (36 mm; 1.4 in) and a single upper incisor (Whitaker and Hamilton 1998). They differ from *Myotis* species by their short, rounded tragus and the short, sparse, dull-brown fur. Bats of this species are also distinguishable by their unique musky odor.

Standard measurements include: wingspan 26–28 cm (10.24–11 in); body mass 5–14 g (0.17–0.49 oz); forearm length 35.6 mm (1.4 in); hindfoot length 7.1 mm (0.28 in); and ear length 14–15 mm (0.55–0.59 in; Whitaker and Hamilton 1998).

Distribution – Evening bats range from Pennsylvania to Florida, extending westward to parts of Texas, northward to Nebraska, central Iowa, and southern Michigan (Barbour and Davis 1969, Wilson and Ruff 1999; Patterson et al. 2007; Fig. 29). Evening bats have been documented in 53 of 82 counties in Mississippi (MNHP 2020; Fig. 28). They were the most common species captured during multi-year studies at Camp Shelby and NAS Meridian (Martin et al. 2007, 2008).

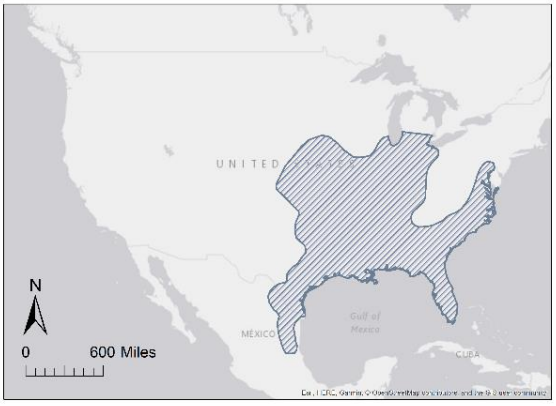

Fig. 29.— Geographical range of the evening bat (*Nycticeius humeralis*).

Habitat – Evening bats are a forest-dwelling species that roost in tree crevices, cavities and behind loose bark, as well as in buildings. This species rarely enters caves but does participate in swarming activities at some cave entrances in late summer (TPWD 2018).

Roosting – Evening bats use a large variety of roosts in both upland and riparian habitats, as well as man-made structures. Natural roosts include hollow trees, behind loose bark of dead pine trees, in woodpecker cavities, in leaf litter, between rocks, and even in underground burrows (Barbour and Davis 1969; Ammerman et al. 2012; Schmidly and Bradley 2017). This species is a true forest bat and is almost never encountered in caves (TPWD 2018).

With the loss of natural habitat, evening bats have adapted to roosting in buildings (Barbour and Davis 1969; Whitaker and Hamilton 1998; Wilson and Ruff 1999; TPWD 2018). Maternity colonies have been detected in attics, lofts of old barns, cisterns, and hollow cypress trees (Wilson and Ruff 1999; Martin et al. 2008) and may contain from a few to almost 1,000 individuals. They are the one of the most common species in Mississippi to use man-made bat boxes. Adult males are solitary and little is known about their habits. Evening bats change roosts often, apparently due to microclimate fluctuations and the need to maintain a certain temperature regime (BCI 2001). In the Southeast, they sometimes roost communally with Brazilian free-tailed bats (Harvey and Saugey 2001; Harvey et al. 2011). A large colony of evening bats and free-tailed bats were discovered roosting in an abandoned church in west-central Mississippi (A. S. McCartney and C. O. Martin, unpublished data).

Little is known about the winter habits of evening bats. Boyles and Robbins (2006) found evening bats in Missouri selected a higher proportion of live trees in the winter months, as opposed to the summer months where they selected trees in the late stages of decay. They noted habitat characteristics were more important than tree characteristics in explaining this variation between seasons. Winter roost trees were situated in areas with high tree density and lower average tree height.

Foraging – Evening bats become active shortly after sunset and feed primarily over clearings, farm ponds, and canopy openings along watercourses (Choate et al. 1994; Wilson and Ruff 1999; BCI 2001). Schmidly and Bradley (2017) found evening bats have two preferred times of foraging, one in the early evening hours and then again just before dawn.

As a relatively slow and deliberate flier, evening bats forage primarily on beetles, moths, and leaf hoppers, although true bugs including small flies, caddisflies, and flying ants are sometimes consumed. The most important insect consumed from an agricultural perspective is the spotted cucumber beetle (adult form of the southern corn rootworm) (Wilson and Ruff 1999; BCI 2001). Feldhamer et al. (1995) found cucumber beetles comprised almost one-fourth of the evening bats' diet. Evening bats that roost together seem to share information about the location of rich foraging patches (Wilson and Ruff 1999).

Movement and Migration – The evening bat is considered migratory in the northern parts of its range (Humphrey and Cope 1968; Watkins 1972; Geluso et al. 2008). In Mississippi, this species is thought to move from a summer roost to a winter roost, but are not thought to migrate long distances. Although evening bats are capable of entering torpor, the extent to which they hibernate is unknown (Wilson and Ruff 1999). Very little is known about this species' migration or winter habitat requirements.

Reproduction – Copulation takes place in the fall, which is noted by the enlargement of testes in males (Wilson and Ruff 1999; BCI 2001; Martin et al. 2008; Schmidly and Bradley 2017). Two young are born to the female in late May to early June (Schmidly and Bradley 2017).

Nursery colonies may contain several hundred individuals and are usually segregated by sex, with adult males rarely encountered in the nursery colonies. The young, at least on occasion, accompany their mother, attached to her breast (Schmidly and Bradley 2017). Young evening bats grow rapidly and begin to feed on insects at 24 days of age, and are weaned by four weeks (Wilson and Ruff 1999). They are volant at approximately 20 days of age and are nearly adult size by one month of age (Schmidly and Bradley 2017).

Threats and Management – Effective management should ensure availability of snags and live cavity trees, especially along forest edges. Miles et al. (2006) determined the availability of roost structures across the landscape appears to be an important factor influencing roost-site selection by evening bats. Results of their study indicate land management on pine-dominated landscapes in the Southeast should promote the availability of large trees, retention of snags, and an open understory to provide abundant roost structures for evening bats. Roost sites may also be provided by allowing maturation and senescence of trees in streamside management zones to promote snag and cavity formation (Miles et al. 2006). Loss of old-growth forest has deprived this species of its original roosts, and further losses result when wooden barns and other old buildings are replaced by structures that bats cannot use. Buildings that serve as known roosts should be maintained, and artificial roosts should be provided when bats must be excluded. Upon exclusion, evening bats will readily use bat houses if properly built and located near the former roost (Acker 1999). Evening bats are highly beneficial consumers of insect pests, and they coexist well with humans. Public education and artificial roosts could greatly aid in the conservation of this species (TPWD 2018). Because evening bats rarely use caves, they have a decreased risk of contracting WNS (TPWD 2018).

Research Needs – Very little is known about the biology and ecological preferences of evening bats in Mississippi, especially regarding migration or winter habitat requirements. Additional surveys should be conducted in forested areas throughout the state using acoustic bat detectors and mist-netting at various times of the year.

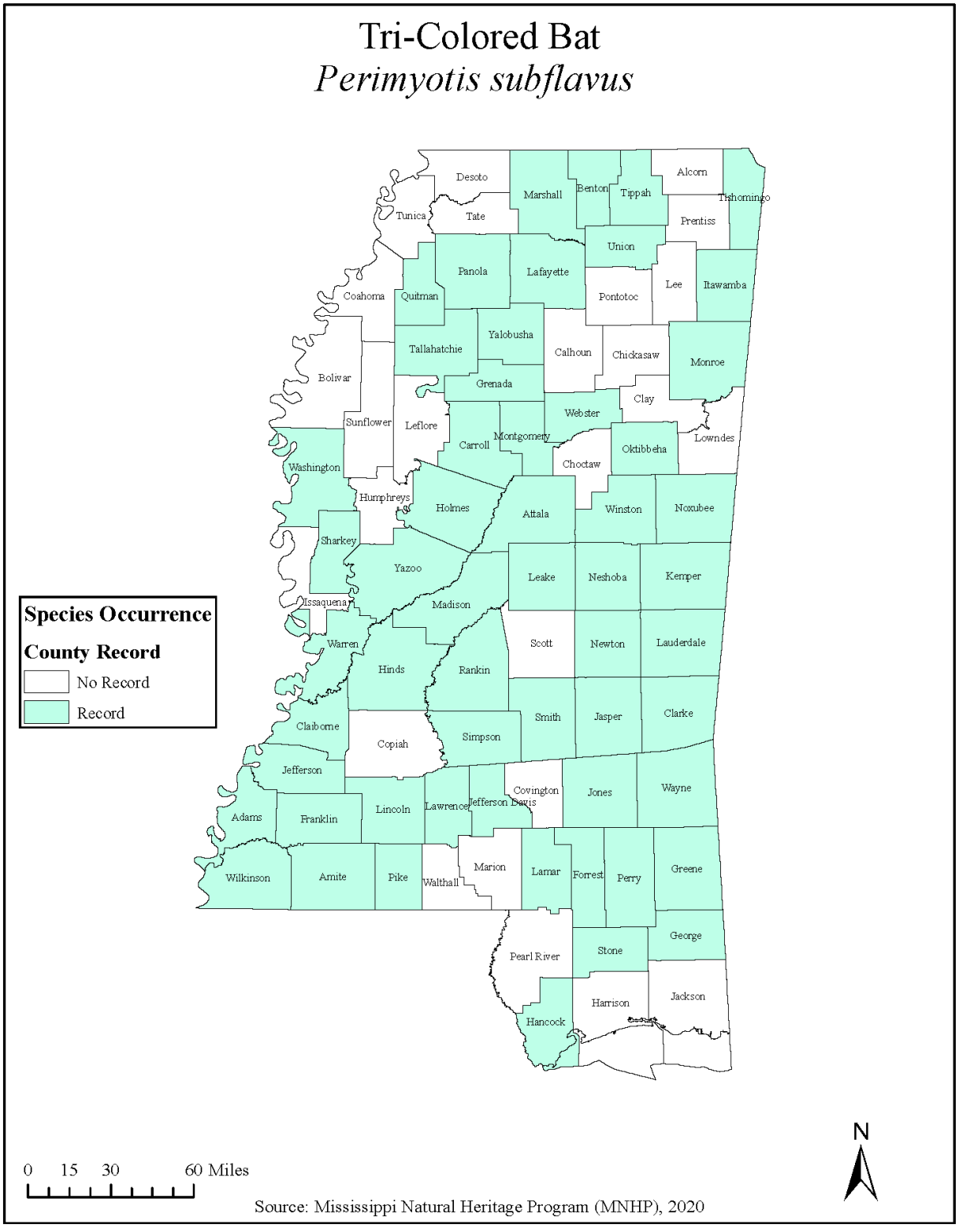

Fig. 30.— Known county occurrence records of tricolored bat (*Perimyotis subflavis*) in Mississippi.

TRICOLORED BAT – *Perimyotis subflavus*

Status. – The tricolored bat does not currently have federal protection but is considered a candidate species for listing under the ESA by the USFWS. On June 14, 2016, the Center for Biological Diversity and Defenders of Wildlife filed a petition for listing the tricolored bat as either threatened or endangered due to population declines throughout parts of its range. On December 20, 2017, the USFWS published their finding that listing may be warranted and is currently conducting a status review of the species. Tricolored bats were once considered common throughout much of their range, but have experienced precipitous declines in some areas due largely in part to WNS (Harvey et al. 2011). The global conservation status rank of this species is G2G3, imperiled/vulnerable (NatureServe 2019). In Mississippi, tricolored bats have a state rank of S3S4, vulnerable/apparently secure (MNHP 2018). Tricolored bats are also protected under Rule M-2.3 Nongame Wildlife in Need of Management in the state of Mississippi (MDWFP 2016).

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Description. – The tricolored bat is one of the smallest species of bats in North America and is named for their tricolored dorsal hairs. Standard measurements include: total length 75–95 mm (2.95–3.74 in); wingspan 21–26 cm (8.27–10.24 in); weight 3–8 g (0.11–0.28 oz); forearm length 31–35 mm (1.22–1.38 in); hindfoot length 7–10 mm (0.28–0.39 in); and ear length 12–14 mm (0.47–0.55 in). The tragus is blunt, straight, and less than one-half the ear length (Kunz 1982; Choate et al. 1994; Harvey et al. 2011). The dorsal pelage varies from reddish-brown through yellowish-to grayish-brown, while the venter is paler. The dorsal hairs are tricolored, being darkest at the base, yellowish-brown in the middle, and dark at the tip; the long guard hairs are completely reddish-brown. The forearms are distinctly reddish, contrasting with the dark wings. The interfemoral membrane is lightly furred on the dorsal side. The ears are longer than they are broad and taper to a narrowly rounded tip.

Distribution – This species was once common throughout its range, which extends from eastern Canada southward through most of the eastern United States to eastern Mexico and Central America, and westward to Nebraska, Kansas, southeastern Colorado, and eastern New Mexico

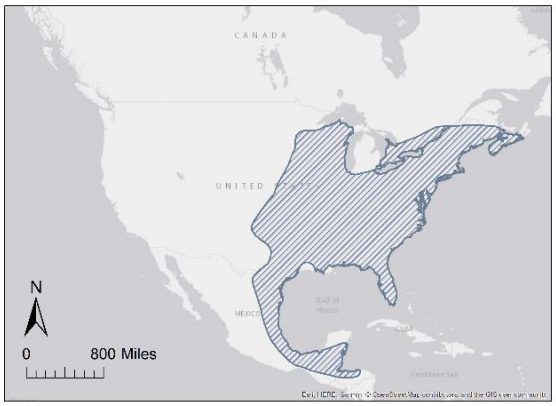

Fig. 31.— Geographical range of the tricolored bat (*Perimyotis subflavus*).

(Patterson et al. 2007; Harvey et al. 2011; Fig. 31). Since the 1980s, the range of the tricolored bat has expanded significantly to the west into New Mexico, Colorado, Wyoming, and South Dakota (Geluso et al. 2005) and to the north into the Great Lakes basin (Kurta et al. 2007; Slider and Kurta 2011). In Mississippi, tricolored bats have been documented in 56 of 82 counties in the state (MNHP 2020; Fig. 30). Many of these records are winter roosts.

Habitat – Tricolored bats are generally found in forested areas that are partly open, and contain large trees with plentiful woodland edges (Amelon 2006).

Roosting – The tricolored bat is one of the first bats to enter hibernation and is typically found in hibernacula from October–March in Mississippi (MDWFP, unpublished data). Winter roost sites include caves, abandoned mines, rock crevices and other man-made structures. Tricolored bats have the longest hibernation period of any bat species in their range. In the northern portion of their range they may hibernate as long as nine months (BCI 2001). Individuals exhibit hibernaculum site fidelity, returning to the same cave or mine every winter, where they hang singly on cave walls and ceilings (BCI 2001). A bat may have several places where it roosts within the hibernacula, shifting from one to the other at times of brief arousal (Harvey et al. 2011). In the southern portion of their range, tricolored bats often arouse from torpor to feed (Carter and Menzel 2007). Roth (2014) looked at arousal patterns in tricolored bats from a cave in south Mississippi and found mean duration between arousal bouts was 14–21 days.

Both microclimate and landscape-scale features are important factors influencing winter roost preference for tricolored bats. Roost sites in the hibernacula are usually located where there is minimal airflow and climate conditions are relatively stable. This species will hibernate in caves or mines at ambient temperatures of 8–13°C (46–55°F) (BCI 2001). In Arkansas, Briggler and Prather (2003) found tricolored bats were more abundant in caves with a wide range of temperatures within a season, but had little variation between seasons. Bats were also more commonly found where cave openings had an east-facing aspect. Briggler and Prather (2003) suggest this may be a result of structural differences given these caves were frequently longer and more thermally stable than caves facing other directions. In Texas, Sandel et al. (2001) determined minimum temperature was the only significant microclimate predictor of tricolored bat abundance and seasonal use of box culverts for winter hibernacula. They suggested culvert use as hibernacula may be a result of opportunity rather than a response to selection criteria. The culverts with high densities of bats appear to be associated with habitat corridors linking hibernacula with suitable forest habitat used during periods of non-hibernation.

Culverts have been documented as roost sites in eastern Texas (Walker et al. 1996; Sandel et al. 2001), Georgia (Lutsch 2019), Missouri (Missouri Department of Transportation, unpublished data), and throughout Mississippi (Martin et al. 2005, 2007; MBWG, unpublished data). In eastern Texas, tricolored bats were the most common species roosting in box culverts. They were observed roosting separately and in clusters, with most bats either on the culvert ceiling or in the

angle between the wall and ceiling (Walker et al. 1996). The culverts served primarily as winter roosts, as most specimens examined from January–March were in torpor, and bats were absent from early April through the first week in September.

In Mississippi, individuals have been documented during winter in caves and mines in northeastern counties (e.g. Best and Caesar 2000), beneath bridges in southern and west-central counties (Wolters and Martin 2000, 2001; Sherman 2004; Katzenmeyer 2016; C.O. Martin, unpublished data), and in culverts throughout the state (Martin et al. 2005; Katzenmeyer 2016). Although tricolored bats use culverts throughout the state, use tends to decrease in northern parts of Mississippi (MBWG, unpublished data). Tricolored bats account for 32–64% of all bats found in culverts during early January culvert surveys (Rosamond et al. 2018).

Female tricolored bats emerge from the hibernacula in April, but males usually do not emerge until May (Fujita and Kunz 1984). Some bats continue to occupy winter retreats in summer, but most roost in trees and occasionally in buildings (Fujita and Kunz 1984; Whitaker 1998). Tricolored bats are most often observed in bottomland, deciduous forests or over rivers or lakes, but are also found over high, forested ridges (Tuttle and Kennedy 2005). Males are often solitary, while females form small maternity colonies of $\leq$35 individuals (Whitaker and Hamilton 1998; BCI 2001). Typical summer roosts are high in the tree foliage, and maternity colonies may also be found in buildings (Fujita and Kunz 1984; Whitaker 1998). Tricolored bats in Florida have been found roosting in Spanish moss of understory trees on exposed high-marsh hammocks (Menzel et al. 1999). Perry et al. (2007) found in central Arkansas most tricolored summer roosts (57.1%) were in hardwoods or mixed pine-hardwood stands 50–90 years old. Veilleux and Veilleux (2004) found female tricolored bats show site fidelity to summer roosting areas between years as well as individual roosts within a year. Some females changed roost locations every night, while others spent nine or more days in the same tree.

In Mississippi, tricolored bats have been documented during the summer in caves (Trousdale and Beckett 2002), an abandoned chalk mine (Best and Caesar 2000), under bridges (Trousdale and Beckett 2002), and in pine dominated forests (Trousdale and Beckett 2002; Miller 2003), and bottomland hardwood forests (Stevenson 2008).

Foraging – Tricolored bats forage along forest edges and over ponds and waterways for small insects such as leaf hoppers, ground beetles, true bugs, ants, flies, and small moths (Whitaker 2004). They emerge early in the evening and forage twice each night, just after sunset and again around midnight. The flight is erratic and the foraging area is small (Harvey and Saugey 2001). Foraging areas are typically located within 4.3 km (2.7 miles) of the roost (Veilleux et al. 2003).

Movement and Migration – Tricolored bats are not considered a migratory species (Fujita and Kunz 1984). However, a recent isotope study suggests that some tricolored bats in northern populations will undergo a southern fall migration (Fraser et al. 2012). Males are more likely to

move south than females. Migrations between hibernacula and summer nursery sites usually do not exceed 80 km (50 miles) and average ≤50 km (31 mi) (BCI 2001).

Reproduction – Breeding occurs as tricolored bats swarm in autumn, but ovulation and implantation are delayed until females emerge from hibernation. Forced copulation during hibernation has been observed (K. Shelton, personal communication). Females usually give birth to twins in late spring or early summer. Pups are born hairless and pink with eyes closed, but grow rapidly and become volant in one month (Harvey and Saugey 2001; Harvey et al. 2011). At weaning, the body mass of pups was nearly 80% that of adult post-partum body mass, and the forearm length was over 90% that of adult female size (Hoying and Kunz 1998).

Threats and Management – Once considered common, tricolored bats have become increasingly rare in some parts of their range, particularly in the northeast. This is believed to be, at least in part, due to WNS. However, Ingersoll et al. (2013) found that even prior to WNS, tricolored bats were experiencing a slight decline. This is believed to be due to threats such as loss and disturbance of critical roosting areas, toxicity from pesticides, and increased mortality due to collisions with vehicles, buildings, and wind turbines. In some areas, tricolored bats may account for up to 25% of the total bat mortality at wind turbines, with adult males experiencing higher mortality rates than any other group (Arnett et al. 2008).

Due to their summer roosting habits, the best way to monitor tricolored bats in Mississippi is through hibernacula surveys. Currently, MDWFP conducts winter hibernacula monitoring in caves and culverts known to house a significant number of tricolored bats and periodically swabs individual bats and substrates for the presence of the fungus *Pd*. To date, while the fungus has been detected, no bats exhibiting signs of WNS have been found. Additionally, the MBWG coordinates an annual culvert blitz, targeting culverts throughout the state and visiting as many as possible during a 3-day period in early January. These monitoring efforts should continue and may provide insight into the impacts of WNS on tricolored bats in the Southeast.

Research Needs –Little research has been conducted on the species in Mississippi, particularly in regards to maternal roosts and summer habits. Increased research on the summer ecology of tricolored bats in Mississippi is needed. Additionally, continued monitoring of winter populations is important to determine the impacts of WNS on tricolored bats in Mississippi.

GOALS AND PRIORITY OBJECTIVES

OVERVIEW

To advance conservation of bats in Mississippi, we have developed goals and priority actions that address four overarching categories: 1) Research; 2) Inventory and Monitoring; 3) Management; and 4) Education and Outreach. Within each category, we have outlined primary goals and associated priority actions to help direct the activities of scientists and land managers involved with bat conservation in Mississippi. Beneath each priority action, we list suggested projects/tasks that will help to accomplish stated goals. This should not be viewed as an exhaustive list of priority conservation actions regarding bats in Mississippi. Additional goals and priority actions will likely be identified as the strategy is implemented, and as we gain a greater understanding of bat ecology in Mississippi. It should be noted that the goals and priority actions are considered equal in significance and are not presented in order of importance.

RESEARCH

Although the number of bat research projects has increased substantially in Mississippi in the last fifteen years, additional research is needed to increase our knowledge regarding species diversity, distribution, relative abundance, and habitat use.

Goal 1: Conduct research to determine resource requirements and limiting factors for bat populations in Mississippi.

Throughout Mississippi, limited information is available relative to the life history of resident and migratory species. To more adequately manage for bat species throughout the state, we must develop a better understanding of the basic resource requirements and limiting factors of each species.

Priority actions

1. Identify factors influencing maternity and hibernation roosts for individual species.
    a. Evaluate phenology of roost habitat use (culverts, caves, houses, man-made structures, etc.).
    b. Evaluate and expand research on the use of man-made structures (i.e. bridges, debris deflectors, culverts, etc.).
        i. Expand culvert surveys to the summer months and evaluate their use as roosting habitat.
        ii. Expand bridge surveys to the winter months and evaluate their use as hibernacula.
    c. Investigate hibernacula and winter habitat requirements for priority species.
        i. Evaluate wintering habitat/hibernacula use of all bat species found in Mississippi.

ii. Evaluate the use of forest floor features (i.e. leaf litter) by all tree bat species found in Mississippi.

d. Investigate maternity roost and summer habitat requirements for priority species.

2. Identify factors influencing reproduction and foraging habitat for individual species.
   a. Evaluate effects of temperature, rainfall, food availability, and habitat quality on bat populations.
   b. Develop food availability studies for bats, with emphasis on threatened, endangered and species of concern.
      i. Assess food availability relative to foraging area and habitat type for priority species.
      ii. Assess phenology of food availability and changes in climate patterns.

Goal 2: Evaluate migration and movement patterns of bats in Mississippi.

Migration is a complex behavior that involves certain genetically acquired and/or learned behaviors. Limited information is available pertaining to bat migration relative to their energetic requirements, departure locality, timing of migration, or the routes and navigational landmarks that they utilize.

Priority actions

1. Evaluate migration patterns of bats in Mississippi within and between seasons.
   a. Evaluate bat migration and movement patterns through band recovery work.
      i. Conduct research in conjunction with banding and recovery work to determine impacts of banding on bat health and survival.
      ii. Incorporate cavity tree searches into band recovery work.
   b. Evaluate bat migration and movement patterns, including roost switching through radio telemetry studies.
   c. Develop long-term studies of year-to-year roost site fidelity, especially use of culverts and caves.
   d. Collaborate with other state and federal agencies utilizing radio telemetry work conducted in neighboring states to look at inter-state migration.

2. Evaluate migratory and seasonal needs of bat species in Mississippi.
   a. Identify migratory or travel routes, associated hazards, and requirements for roosts and foraging habitat.
   b. Evaluate key landscape features and migration routes to determine where to best allocate management activities.

Goal 3: Evaluate genetics of *Myotis* species in Mississippi.

Preliminary genetic research being conducted through the Louisiana Heritage Program suggests misidentification of northern long-eared bat and southeastern myotis while using morphological characteristics alone. Given geographic proximity, studies should be conducted in Mississippi to determine if these species are also being misidentified in the state. More broadly, genetic studies should be conducted on all *Myotis* species within the state, especially given similar morphological characteristics, as well as comparable auditory calls that are difficult to differentiate using acoustic monitoring software alone.

Priority actions

1. Evaluate genetic structure of *Myotis* populations and the genetic basis of species designations.
    a. Prioritize listed species such as Indiana bat, northern long-eared bat and gray bat.

Goal 4: Evaluate historic changes to habitat and current land management practices.

Historic changes to the landscape and current land management practices in Mississippi and throughout the Southeast have had a major impact on bat populations. Currently, very few land management plans provide specific guidelines to promote bat conservation throughout the state. Further research is needed to provide state and federal agencies as well as private landowners' guidelines to promote bat conservation throughout the state.

Priority actions

1. Evaluate the use of land management activities on bat populations such as timber harvesting, fire suppression, prescribed burning, mining, grazing, and agriculture.

2. Evaluate landscape composition and potential impacts to species and populations.
    a. Evaluate snag availability to advise management recommendations.
        i. How many cavity trees per acre should be retained/maintained to support bat populations? Which tree species make the best snags? What are the senescence rates of these species?
    b. Determine what features best predict cavity tree selection in bat species, specifically Rafinesque's big-eared bat, southeastern myotis, and tricolored bat.
    c. Quantify important characteristics of riparian habitats to develop management recommendations.
    d. Evaluate seasonal influence of landscape composition, such as roads and other corridor features, on species and populations.
    e. Evaluate impacts of light pollution on bat species.

INVENTORY AND MONITORING

Long-term studies evaluating population trends, ecosystem functions, and habitat requirements of bat species are an essential component to promoting bat conservation. Such studies are imperative to inform management decisions throughout the state. This section highlights inventory and monitoring needs to assess population baselines, species distributions, and habitat requirements necessary to inform management decisions and to evaluate effectiveness of conservation efforts for bat species in Mississippi.

Goal 1: Collect baseline inventory data and monitor bat populations to assess trends.

Baseline information on population size and distribution is needed for all bat species in Mississippi to determine population changes over time, assess conservation status, appraise threats, and track responses to conservation actions. At present, quantitative data on abundance and trends of different bat species in the state are limited and sporadic.

Priority actions

1. Develop long-term studies to inform management decisions, with an emphasis on federally listed species and state species of conservation concern.
    a. Formulate means of marking individuals (tattooing or other qualified method) to strengthen population estimates and demographic data.
    b. Initiate band recovery studies of known priority roost locations including caves, abandoned mines, bridges and culverts.
    c. Promote the use of mist-netting and acoustic software to help establish baseline distribution data.

2. Inventory and monitor natural and artificial roosts and habitats that support, or once supported, or may support priority bat colonies and populations in Mississippi.
    a. Develop standardized monitoring protocols for: 1) surveying priority maternal colonies; and 2) seasonal surveys of man-made roost structures.
    b. Continue annual cave surveys, monitor ownership and maintain relationships with landowners.
    c. Continue and expand seasonal surveys of natural and man-made roost structures (e.g. bridges, culverts, cisterns, abandoned buildings, bat houses) utilizing standardized protocols.
    d. Develop a system to locate and survey bat houses throughout Mississippi. This could develop into citizen science surveys that can be submitted online to the MBWG.

3. Continue and expand mist-netting efforts, targeting data gaps and species of concern.

4. Continue and expand acoustic monitoring efforts.

a. Adopt North American Bat Monitoring Program (NABat) survey protocols to standardize data collection among resource managers.
b. Compile and store raw acoustic monitoring data in a repository for future use as software capabilities improve.

5. Implement band recovery with inventory and monitoring.
   a. Develop a standardized banding datasheet to streamline data entry.
   b. Develop a database where band identification can be reported to the MBWG.

Goal 2: Develop a statewide centralized repository for bat data and encourage interagency cooperation and collaboration on inventory and monitoring.

A major impediment to inventory and monitoring bat populations throughout the state is the lack of a centralized database/repository that can be utilized across state, federal and educational institutions.

Priority actions

1. Develop a protected standardized database for all survey and research data collected throughout the state.
   a. Assign a database manager to develop and maintain database.
   b. Work with state and federal permitting agencies to require all applicants to report all collected data to the database manager.
   c. Work to incorporate all historical data into the new database.

MANAGEMENT

Approximately 17 million acres or 72% of the total forested areas within Mississippi are in private ownership/management. Therefore, bat population sustainability and habitat management is highly dependent on actions taken by non-government land managers. To advance bat conservation in Mississippi, state and federal conservation agencies must work together in partnership with private landowners to achieve conservation goals throughout the state.

Priority actions

Goal 1: Develop land management guidelines and recommendations for public and private landowners to support bat populations throughout the state.

Currently, bat species in Mississippi are rarely included in existing wildlife management plans that direct habitat and species management activities for priority wildlife species. Given several species with protected status occur in Mississippi, it is imperative bat species are included when developing wildlife management plans at all levels.

1. Develop land management standards and guidelines for bats that can be incorporated into federal, provincial, tribal, private land and state land management and wildlife conservation plans.
    a. Work with the USFWS to develop an interagency 7(a)(1) program for listed bat species to identify conservation efforts to promote proactive recovery of listed species throughout the state of Mississippi.
    b. Develop companion documents providing detailed habitat management recommendations and best management practices for public and private landowners, to include potential sources of financial assistance.

2. Work with federal and State public land managers to implement and evaluate effectiveness of management recommendations.
    a. Establish demonstration areas on public lands to promote bat conservation.

3. Provide recommendations to MDOT and other related agencies (i.e. Tennessee Valley Authority) concerning the timing of maintenance, repairs, and replacements to minimize impacts to bat species.

4. Prioritize management of riparian, wetland and open area foraging sites. Efforts should be made to improve availability and quality of wetland and riparian foraging areas.
    a. Incorporate bat conservation measures into riparian management practices and programs (i.e. NRCS, U.S. Army Corps of Engineers, Department of Defense).
    b. Work with MDOT to minimize use of riprap and encourage restoration of wetland vegetation at stream crossings.

5. Prioritize conservation of mature bald cypress/tupelo stands and other sensitive habitats, as they are disappearing from the landscape in Mississippi. Work with state and federal agencies to protect these stands from logging, road construction, and other disturbances on public lands.

6. Identify and protect caves and man-made roost sites. The use of man-made structures such as bridges, culverts, cisterns, and abandoned buildings as roosting habitat has been well documented for Mississippi. Key structures and caves should be identified and protected from disturbance and vandalism.
    a. Develop recommendations and resources available for cave gating.
    b. Facilitate the development of land protection programs on lands surrounding known priority roost sites and caves in Mississippi.

EDUCATION AND OUTREACH

Education, along with public support for conservation efforts, is essential to safeguarding bat populations. Informing the public about the ecological benefits of bat species helps to dispel false narratives concerning bats. Through education and outreach programs, wildlife agencies are able to create conservation stewards that are vital to the conservation of bats species in Mississippi.

Goal 1: Continue and expand educational outreach within local communities and organizations.

Educational outreach is essential for promoting public awareness of the benefits of bat species to Mississippi's ecosystems. Outreach events should continue and expand across the state to promote awareness and help forward the conservation of these species.

Priority actions

1. Continue and expand educational outreach
    a. Develop educational materials for Mississippi State University Extension Service for outreach to the general public.
    b. Continue bat presentations made to school, scout, and private groups through the development of specialized programs.
    c. Continue to provide educational outreach on Mississippi Public Broadcasting's "Creature Comforts."
    d. Continue to include bat programs at state wildlife festivals and other outreach opportunities.
    e. Coordinate and increase participation for the annual Culvert Blitz and MBWG Mist Net Event.

Goal 2: Develop educational outreach materials for public and private land managers.

Educational materials highlight the ecological role of bats, the benefits of bats to human welfare and the economy, and the conservation and management requirements of bats throughout the state.

1. Produce educational materials.
    a. Create "Bats of Mississippi" posters and pamphlets.
    b. Develop "Bats of Mississippi" interactive species profiles on the MBWG website.

2. Develop and distribute bat house designs and installation recommendations to post on the MBWG website.

3. Develop companion documents providing detailed habitat management recommendations for public and private land managers.

4. Increase publication of semi-popular articles in non-traditional magazines and journals.

5. Increase publication of manuscripts in professional journals.

6. Identify and seek out funding to assist with educational outreach opportunities.

Goal 3: Maintain current partnerships and foster new relationships.

Broad collaboration among various conservation agencies allows groups with overlapping interests to better allocate limited resources to accomplish common goals. Developing and fostering partnerships across multiple agencies allows for the exchange of information, resources and technologies helping to promote bat conservation.

Priority actions

1. Maintain coordination with bat biology and conservation organizations (e.g. Southeastern Bat Diversity Network, North American Society for Bat Research, Bat Conservation International).
    a. Mississippi bat biologists should continue to support these organizations by being represented at annual meetings and providing results of ongoing studies and activities through poster and paper sessions.

2. Establish points-of-contact for agencies, organizations, universities, museums/nature centers, and private individuals interested in the conservation and management of bats.
    a. Maintain a contacts database where any events or updates can be advertised through electronic mail.
    b. Develop a list of media contact to distribute articles regarding bat conservation throughout the state.

3. Develop bat management workshops for state, federal, and local agencies and private consultants.

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APPENDIX I — BIBLIOGRAPHY OF BAT RESEARCH CONDUCTED IN MISSISSIPPI.

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APPENDIX II- HABITAT MANAGEMENT ASSISTANCE FOR PRIVATE LANDOWNERS

Agency or Group	Assistance Provided	Contact
USDA Natural Resources Conservation Service (NRCS)	Technical, financial and educational assistance. Provided directly to landowners at the local level. Help plan, apply and maintain conservation systems that are site-specific and environmentally and economically sound.	Local county office
USDA Farm Services Agency (FSA)	Financial assistance provided directly to landowners at the local level. Technical assistance is provided through NRCS	Local county office
USDA Cooperative State Research, Education and Extension Service	Information and educational materials on forest and wildlife management	Regional, state or county office; Partner universities
US Fish and Wildlife Service	Technical, educational, and in some cases financial assistance for habitat restoration and management	State or local office
US Forest Service or Mississippi Forestry Commission	Technical, educational, and in some cases financial assistance for local land managers with forests, wildlife and other natural resources	Regional, state or county office
Mississippi Dept. of Wildlife, Fisheries, and Parks	Educational materials, technical guidance, and cost-sharing of habitat management in some cases	Regional, state or county office
Mississippi State University Extension Service	Information and educational materials, continuing education programs and workshops, and technical assistance	Msucares.edu, county extension agent, or regional wildlife extension specialist
Private, Nongovernmental, and Nonprofit Conservation Organizations	A variety of conservation organizations provide technical, educational, and in some cases financial assistance for habitat restoration and management (e.g. The Nature Conservancy, Wildlife Mississippi, Audubon Society)	State or local contacts

APPENDIX III- MAJOR FARM BILL CONSERVATION PROGRAMS TO PROMOTE BAT HABITAT ON WORKING LANDS

Program	Purpose	Land eligibility	Type of assistance
Conservation Reserve Enhancement Program (CREP)	Land retirement program that helps agricultural producers protect environmentally sensitive land, decrease erosion, restore wildlife habitat, and safeguard ground and surface water. CREP emphasizes partnerships among State, Tribal, or local governments, private groups, and the USDA.	Lands that address an agriculture-related environmental issue of State or National significance such as impacts to water supplies, loss of critical habitat for threatened and endangered wildlife species, and soil erosion. Enrollment in a State is limited to specific geographic areas and practices.	Annual payment plus cost-share of up to 50% of the eligible costs to install the practice. CREP contracts require a 10- to 15-year commitment to keep lands out of agricultural production. CREP is administered by FSA; NRCS provides technical assistance. Contact NRCS or Farm Services Agency (FSA) State or local office.
Conservation Reserve Program (CRP)	Land retirement program encourages farmers to convert highly erodible cropland or other environmentally sensitive acreage to vegetative cover such as tame or native grasses, wildlife plantings, trees, filter strips, or riparian buffers. Addresses issues raised by State, regional, and National conservation initiatives.	Highly erodible land, wetland, streamside areas in pasture land, certain other lands. Eligible wetlands must have been cropped 3 of 10 previous years, highly erodible cropland 4 of 6 previous years.	50% cost-share for establishing permanent cover and conservation practices, and annual rental payments for land enrolled in 10- to 15-year contracts. Additional financial incentives are available for some practices. CRP is administered by FSA; NRCS provides technical assistance. Contact NRCS or FSA State or local office.
Conservation Stewardship Program (CSP)	Addresses resource concerns comprehensively by 1) undertaking additional conservation activities; and 2) improving, maintaining, and managing existing conservation activities. The CSP encourages farmers to broadly improve their conservation effort to protect water and air quality, improve soil quality, store carbon in soils, add wildlife habitat, conserve water, and save energy.	Private and Tribal agricultural land, and forested land incidental to agriculture. Land converted to cropland since 2008 is not eligible.	Annual payments based on expenses, foregone income, and environmental benefits; 5-year contracts renewable for another 5 years. Contact NRCS State or local office.
Environmental Quality Incentives Program (EQIP)	Promotes agricultural production and environmental quality as compatible National goals by helping eligible participants install or implement structural and management practices to protect water and air quality, improve soil quality, store carbon in soils, create or enhance wildlife habitat, conserve water, and save energy.	Private land on which agricultural commodities, livestock, or forest-related products are produced.	Up to 75% cost-share for installed conservation practices or 100% of foregone income; contracts run 1 year past last practice installation, up to 10 years. Up to 3 years of incentive payments for certain management practices. Special payment consideration for practices that promote pollinator habitat. Contact NRCS State or local office.
Agricultural Conservation Easement Program (ACEP) / Wetland Reserve Easements (WRE)	Land retirement program to restore, protect, or enhance wetlands on private or Tribal lands.	Farmed wetland or wetland converted to agriculture before 1985, together with functionally dependent adjacent land, or cropland or grassland that was used for agricultural production prior to natural flooding.	Private lands: 1) Permanent easement payment equal to forgone value plus 100% of restoration costs; or 2) 30-year easement payment (75% of forgone value) plus 75% of restoration costs. Tribal lands: restored through any combination of 2 and 3. Contact NRCS State or local office.

*All programs are voluntary. Please see the NRCS website for more information (http://www.nrcs.usda.gov/programs/), and visit the USDA Service Center Locator to find USDA offices that administer these programs (http://offices.sc.egov.usda.gov/locator/app)