Tennessee Bat Population and White-nose Syndrome

Monitoring Report for 2020-2021

Josh Campbell, Region 2 Wildlife Diversity Coordinator

Tennessee Wildlife Resources Agency

TWRA Wildlife Technical Report 20-6

Acknowledgements

Activities detailed in this report were funded by the Tennessee Wildlife Resources Agency. Contributors, partners and collaborators also provided funding through assistance in conducting surveys.

These surveys could not be conducted with such a high level of effort or as geographically widespread without the assistance of numerous partners and volunteers. Because most caves and winter sites occur on private lands in Tennessee, the number of surveys would be greatly reduced without the support, assistance, and willingness of private landowners. Without the partner, volunteer, and landowner support, we would not be able to understand the distribution of winter bat populations and effects of white-nose syndrome in Tennessee.

Acronyms

AAFB……..……..Arnold Air Force Base

FORT……Fort Campbell Military Installation

MTSU.....Matthew Grisnik and Dr. Donald Walker

NPS……...……..National Park Service

TDEC…….Tennessee Department of Environment and Conservation

TNC…….The Nature Conservancy of Tennessee

TVA……..……Tennessee Valley Authority

TWRA…….….Tennessee Wildlife Resources Agency

UoS..... Sewanee: The University of the South

USFWS……..United States Fish and Wildlife Service

USFS .....United States Forest Service

UTK……University of Tennessee at Knoxville

Species Codes

CORA……... *Corynorhinus rafinesquii*

EPFU…….. *Eptesicus fuscus*

LANO……..… *Lasionycteris noctivagans*

MYAU……...… *Myotis austroriparius*

MYGR…….. *Myotis grisescens*

MYLE……... *Myotis leibii*

MYLU……...…. *Myotis lucifugus*

MYSE……...…. *Myotis septentrionalis*

MYSO…… *Myotis sodalis*

MYsp……...…..Unknown Myotis

PESU……... *Perimyotis subflavus*

Contributors

AAFB.....John Lamb and Shannon Allen

FORT .....Morgan Torres and Gene Zirkle

NPS .....Ryan Williamson and Greg Greico

TDEC ..... …A. Neblett, Jason Miller, Jason Reynolds, and David Withers

TNC.....Cory Holliday

MTSU.....Dr. Donald Walker and Matt Grisnik

TVA .....Liz Hamrick, and Jesse Troxler

TWRA…….……...… Josh Campbell, Rob Colvin, Scott Dykes, Jesse Eaker, Darrell England, Daniel Istvanko, Chris Ogle, Chris Simpson, Mallory Tate, and Dustin Thames

UoS.....Kevin Fouts, Amy Turner, and Nathan Wilson

USFWS……...……...….Dave Pelren

UTK……Ash Cable and Dr. Emma Willcox

Volunteers …… Carlin Frost, Parker Hildreth, Chris Durai, Virginnie Rolland, Amanda Ogle, Kristen Garrison

Executive Summary

During the 2020-2021 monitoring season, field signs of white-nose syndrome (WNS) were observed in 20 of the 110 (18.2%) caves surveyed, but many of the caves surveyed have previously been confirmed WNS positive. Of the 110 caves surveyed, surveys were performed at 70 sites which had not been previously surveyed. No new counties were designated as WNS positive or suspect during the monitoring period. WNS and its causal fungal pathogen *Pd* can now be found in 57 of the 77 (74%) counties containing caves and is considered widespread in Tennessee.

The 2020-2021 winter field season was to be a priority survey year for *Myotis grisescens* (gray bat) and *Myotis sodalis* (Indiana bat) sites. However, all states within the range of these species agreed to delay these surveys until the 2021-2022 field season due to concerns associated with the SARS-CoV-2 pandemic. Concerns included, but were not limited to, the inability to follow social distancing recommendations within caves due to site size, possible human-to-human transmission of SARS-CoV-2 during surveys, and the uncertainty of reverse zoonosis occurring between surveyors and roosting bats.

Observations of *Perimyotis subflavus* (tri-colored bat) decreased 5.51% between the 2019-2020 and 2020-2021 winter field seasons. Since the 2009-2010 winter survey period, observations of *P. subflavus* have declined 49.19%. *Myotis lucifugus* (little brown bat) observations increased 37.08% but does not account for observations at priority *M. sodalis* sites due to the delay of priority surveys. Zero observations of *M. septentrionalis* (Northern long-eared bat) were made during this monitoring period. Winter observations of *M. septentrionalis* have declined 100.0% since 2010.

Despite a decline in big brown bat (*Eptesicus fuscus*) observations during the 2020-2021 field season, observations for the species continue to trend upward since intensive surveys began in 2010. The highest number of observations (876) for *Corynorhinus rafinesquii* (Rafinesque's big-eared bat) were made during this field season. A positive trend for this species is also being observed despite the presence of WNS at multiple sites. Observations of *Myotis leibii* (Eastern small-footed bat) was limited to three individuals across the state, a trend common for this species since intensive surveys began in 2010.

Mist netting data collected since 2005 was utilized to assess summer capture rates and to determine if declines in captures rates were similar to declines being observed during winter cave surveys. Between 2005-2009, TWRA biologists captured 473 bats during nightly netting sessions compared to 1,845 bats between 2010-2020. The average number of captures per year pre-WNS was 94.6 bats and 167.72 bats post-WNS. Based on net hours necessary to capture this species, captures of *M. septentrionalis* during the summer have declined 93.8% post-WNS and are similar to declines associated with winter observations. *P. subflavus* captures during the summer have declined 85.7% when comparing captures per net hour and are almost twice that of declines observed during winter surveys. Based on net hours necessary to capture this species,

captures for *M. lucifugus* during the summer have declined 97.1% post-WNS and these declines are over two times greater than observations observed during the winter.

Table of Contents

List of Figures

List of Tables

Introduction

This report summarizes data collected by all cooperating agencies and partners in Tennessee during the winter of 2020-2021.

Historical survey work within the state of Tennessee was conducted to monitor the success of conservation efforts for endangered bats in Tennessee. This was accomplished by state and federal agencies and non-governmental groups conducting winter bat hibernaculum censuses. This work occurred on a bi-annual basis or staggered every three years depending on the species involved and the availability of personnel. At one-point, selected sites were monitored annually to establish a dataset that would allow trend analysis of populations. These efforts were disbanded in 2015 because of potential negative impacts as the result of repeated visitation. Historical surveys have generally focused on two of three endangered species of bat found in Tennessee, *Myotis sodalis* (Indiana bats) and *M. grisescens* (gray bats). No winter occurrences of the third species of endangered bat, *Corynorhinus townsendii virginianus* (Virginia big-eared bat), are known from Tennessee. A list of all bat species for Tennessee and their regulatory designations can be found in Table 1.

Beginning in 2009 with the concern of bat population declines due to white-nose syndrome (WNS), there was increased awareness to not only continue monitoring the status of endangered species, but to also assess the numbers and health of the common species of cave hibernating bats. Prior to the occurrence of white-nose syndrome (WNS), there was very limited information available on bat hibernacula and winter population trends for once common species of cave hibernating bats, that include: *M. lucifugus*, (little brown bat[1]), *M. septentrionalis* (Northern long-eared bat[2]), *M. leibii* (Eastern small-footed bat), *Eptesicus fuscus* (big brown bat), *Perimyotis subflavus* (tri-colored bat[1]), and *C. rafinesquii* (Rafinesque's big-eared bat). Because of the paucity of data for these species, assessing trends of winter populations of bats and WNS caused mortality has been difficult.

Initially, a tiered monitoring approach was developed and implemented during early monitoring efforts with each tier having varying levels of effort. This approach allowed survey effort to be adjusted to each cave minimizing potential impacts to hibernating bats, while allowing for the objectives of winter monitoring to be met. A description of the tiered monitoring system can be found in Lamb and Wyckoff (2010) and Flock (2014). As the need to gather data for all species increased, complete censuses of bat populations found within all sites surveyed was implemented in lieu of the tiered monitoring approach.

[1] Both *Myotis lucifugus* and *Perimyotis subflavus* were listed as threatened within Tennessee by TWRA in August 2018.

[2] *Myotis septentrionalis* was listed as threatened by the USFWS April 2, 2015 because of severe declines attributed to WNS (USFWS 2015).

Table 1. Conservation status with year of designation and occurrence of WNS for Tennessee bat species (species of greatest conservation need are in bold). D – Deemed in Need of Management; 1 – Global and Subnational Ranks; S – Species in which Pd has been detected, but not WNS confirmed in the state (Bernard et al. 2015); TN – Species that have tested WNS positive in Tennessee (Campbell 2017).

Common Name	Scientific Name	Global Rank[1]	State Rank[1]	Federal Protection	State Protection	WNS Confirmed	*Pd* Positive
Rafinesque's big-eared bat	***Corynorhinus rafinesquii***	G3G4	S3		D[1983]		Yes[S]
Virginia big-eared bat	***Corynorhinus townsendii virginianus***	G3G4T2	SNR	E[1979]	E[1979]		Yes
Big brown bat	*Eptesicus fuscus*	G5	S5			Yes	
Silver-haired bat	*Lasionycteris noctivagans*	G3G4	S4S5				Yes[S]
Eastern red bat	*Lasiurus borealis*	G3G4	S5				Yes[S]
Hoary bat	*Lasiurus cinereus*	G3G4	S5				
Seminole bat	*Lasiurus seminolus*	G5	SNR				
Southeastern bat	***Myotis austroriparius***	G4	S3			Yes	
Gray bat	***Myotis griesecens***	G4	S2	E[1976]	E[1976]	Yes[TN]	
Eastern small-footed bat	***Myotis leibii***	G4	S2S3		D[1983]	Yes	
Little brown bat	***Myotis lucifugus***	G3	S5		T[2018]	Yes[TN]	
Northern long-eared bat	***Myotis septentrionalis***	G1G2	S4	T[2015]	T[2015]	Yes[TN]	
Indiana bat	***Myotis sodalis***	G2G3	S1	E[1967]	E[1967]	Yes	
Evening bat	*Nyctieius numeralis*	G5	S5				
Tri-colored bat	***Perimyotis subflavus***	G2G3	S5		T[2018]	Yes[TN]	
Brazilian free-tailed bat	*Tadarida brasiliensis*	G5	SNR				

D - Deemed in Need of Management

[1] - Global and subnational ranks are obtained from NatureServe.org.

[S] - Species in which *Pd* has been detected in Tennessee, but not WNS confirmed in the state (Bernard et al. 2015)

[TN] - Species that have tested WNS Positive in Tennessee (Campbell 2017)

WNS and its causal fungal pathogen *Pseudogymnoascus destructans* (*Pd*) were first recorded in Tennessee in the winter of 2010 (Figure 1). Since 2010, *Pd* has been histopathological confirmed[3] on bats in 50 counties and genetic material of *Pd* has been located on bats in seven counties in Tennessee (Figure 2). More than seventy-four percent of the counties with caves in Tennessee (77) have been confirmed WNS positive or suspect. Appendix A lists all confirmed or suspect sites and the species from which samples were collected in Tennessee. A list of all species in which *Pd* has been diagnostically confirmed or detected can be found at https://www.whitenosesyndrome.org/about/bats-affected-wns.

Figure 1. Progression of WNS has occurred quickly in Tennessee since being discovered in 2010. No caves were designated as WNS confirmed or suspect during the 2020-2021 monitoring period. The monitoring period includes caves surveyed from December 2020 through March 2021.

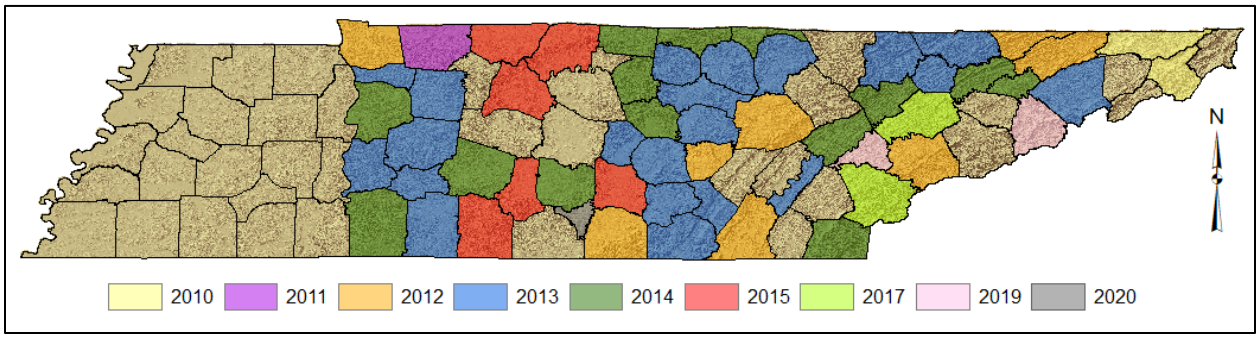
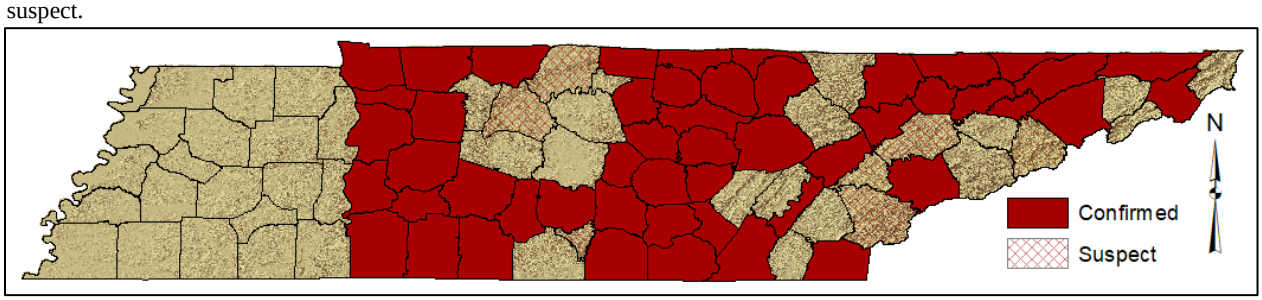


Figure 2. Most cavernous counties in Tennessee have been designated WNS confirmed and currently seven counties are WNS suspect.



With over 10,000 caves in Tennessee and 20% of the known caves in the United States (The Nature Conservancy of Tennessee n.d.), conducting annual surveys of all caves or of all winter bat populations in Tennessee is not a realistic and feasible approach, and not one considered by the WNS Advisory Council of Tennessee. A significant effort is made each year by all state and federal agencies, non-governmental groups and individuals to perform as many winter surveys as possible. Because of the density of caves throughout the state, less than 1% of

[3] During monitoring efforts, a site cannot be confirmed positive for the presence of WNS until histologic investigations reveal *Pd* has infected the tissues of bats. Suspect sites through 2014 are sites which test PCR positive for the presence of *Pd* and this designation is not removed until histology reports reveal tissue infections. Since 2014, the criteria used to classify WNS suspect sites has changed to minimize the need to euthanize bats and can be found at https://www.whitenosesyndrome.org/resource/revised-case-definitions-white-nose-syndrome-11252014.

the caves are visited each year. As a result of this, any conclusions or predictions concerning the spread of WNS across Tennessee and its effect on the bat population should take survey effort into consideration.

In all years, surveys are conducted in a manner allowing strict adherence to the USFWS WNS Decontamination protocols (https://www.whitenosesyndrome.org/static-page/decontamination-information). Decontamination has been a high priority in all years to minimize the potential of surveys aiding the spread of *Pd* across the state. As a result of this priority, the number of caves visited per day is limited based on geography, personnel, and maintaining adequate supplies of decontaminated equipment. Despite the large number of caves in Tennessee and issues surrounding decontamination, efforts have helped to identify new bat hibernacula and to allow changes of winter bat populations to be tracked.

Methods

The 2020-2021 winter cave surveys were conducted between December 2020 and March 2021. As manpower allows, extending the survey effort through April 1st, as this is typically later in the season for winter surveys, allows for further development of WNS symptoms as observed during 2009-2010 surveys (Holliday 2012). Objectives of surveys conducted during the 2020-2021 field season fell into the following three categories with considerable overlap with the last two.

WNS Surveillance

Although a majority of the cavernous counties are WNS confirmed or suspect, surveys are still conducted to determine the presence of WNS at all sites. There are countless caves across the state that still appear to be WNS negative despite county-level WNS designations. Surveys are implemented to gauge the presence of WNS on a site level because of the lack of uniformity of its progression across the state. As a result of this lack in uniformity, monitoring impacts of WNS on winter bat populations on a site by site basis is necessary.

Because of the need to increase knowledge of wintering populations of bat species not listed, complete censuses of all bats observed in caves was implemented. This approach was different from the tiered monitoring approach used in previous years. In the event cooperators deemed presence within the cave was creating unnecessary disturbance to wintering bats, estimates of large clusters of bats were made to decrease the length of time surveyors were in the cave.

WNS Mortality Monitoring

Selected caves previously confirmed or suspected WNS positive were visited to assess the level of mortality that may have occurred since prior visits (Samoray 2011). In order to collect the best data possible under survey conditions, a full census of all bats observed within the caves was conducted. Several of the sites selected for mortality monitoring (Lamb and

Wyckoff 2010) were visited again during the 2019-2020 field season to continue these efforts. Two methods have been used at these sites to assess mortality: repeated, annual visits to count all bats or banding of all bats to assess survivorship at sites previously determined to be WNS positive. It should be noted, of the sites previously selected for these efforts in Lamb and Wyckoff (2010), monitoring efforts have been reduced or not occurred annually as a result of manpower concerns, potential impacts from repeated disturbance, eliminating visitation at sites in which severe declines have occurred to the wintering bat populations, or the bat populations declining to critically low levels or levels too low to make these efforts a viable option.

Bat Population Monitoring

Because historic survey efforts were focused on monitoring endangered *M. sodalis* and *M. grisescens*, there is a paucity of data pertaining to other cave hibernating species in Tennessee. A continued goal of the 2020-2021 surveys was to identify new sites which serve as hibernacula for non-listed, but WNS affected bats. These species include: *P. subflavus*, *M. septentrionalis*, *M. lucifugus*, and *M. leibii*. Several of the sites visited during this period have been visited during previous survey years. Despite these repeated visits, full censuses of bats observed in the caves were performed. Several sites not previously surveyed, were visited during this period and, again, complete surveys of all bats were performed. Methods detailed by Holliday (2012) were used to select these new sites to determine if they harbor cave hibernating bats.

2021 Statewide Results

One hundred ten (110) caves were visited across 28 counties during the winter of 2020-2021. This is the second highest number of caves visited in Tennessee during any WNS monitoring period since surveys began in 2009-2010. Of the 110 caves surveyed, surveys were performed at 70 sites which had not been previously surveyed. WNS field signs were observed in 20 caves. No additional counties were designated as WNS confirmed or suspect during the field season. The results of all caves surveyed can be found in Appendix B.

Almost 2,300 bat observations were made during the surveys. *P. subflavus* constituted over 48% of the observations and this species was observed in 64.5% of all caves surveyed. Despite being commonly observed, *P. subflavus* observations continue to decline throughout the state. *C. rafinesquii* comprised almost 39% of the total bat observations. For the first time since intensive cave surveys began, zero observations of *M. septentrionalis* were made, indicating 100% decline in observations since the discovery of WNS in Tennessee.

The 2020-2021 winter field season was to be a priority survey year for *Myotis grisescens* (gray bat) and *Myotis sodalis* (Indiana bat) sites. During a multi-state meeting in December 2020 with the USFWS, all states within the range of these species agreed to delay surveys until the 2021-2022 field season due to concerns associated with the SARS-CoV-2 pandemic. Concerns included, but were not limited to, the inability to follow social distancing recommendations

within caves due to site size, possible human-to-human transmission of SARS-CoV-2 during surveys, and the uncertainty of reverse zoonosis occurring between surveyors and roosting bats.

Because of the lack of historic data for bat species not typically monitored, the 2009-2010 winter survey period was used as the base for which comparisons of current bat numbers could be made. Although this is not a preferred method for reasons that include equal survey effort between sites and across years, difficulty in observing cryptic species, addition or discovery of significant bat sites, and movement of bats across sites within and between survey years, it is the best dataset to make comparisons for assessing potential declines of these bats as the result of WNS.

Table 2. Percent increase or decrease for species observed between 2010 and 2020.

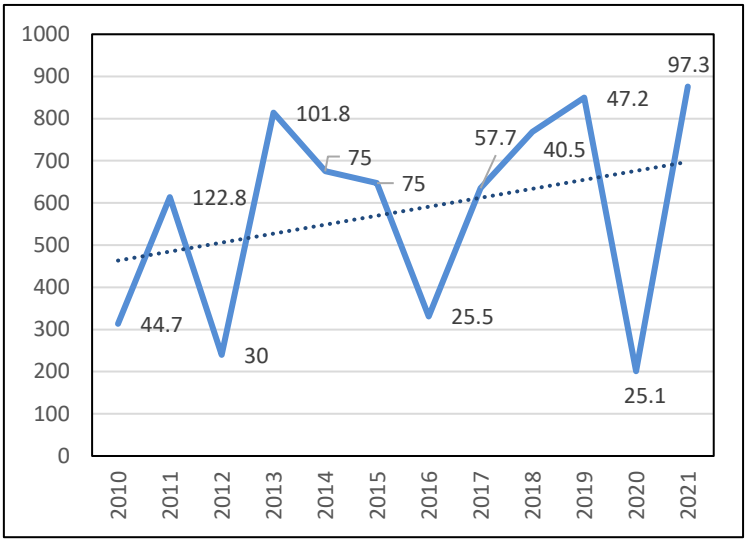
	CORA	EPFU	MYLE	MYLU	MYSE	PESU
2010(n)	313	28	5	2075	292	2159
2021(n)	876	135	3	122*	0	1097
% Decline	**179.87**	**382.14**	**-40.00**	**-94.12**	**-100.00**	**-49.19**

* - Priority sites were not surveyed during the 2020-2021 survey period.

Corynorhinus rafinesquii

Winter populations of *C. rafinesquii* appear stable and continue to show a positive trend despite the presence of WNS at many sites. Presence of *Pd* has been detected on this species using real-time PCR methods at winter sites in Tennessee (Bernard et al. 2015). Observations during the 2020-2021 field season were the highest recorded for the species. Winter counts have exceeded over 600 individuals since 2013 when most priority sites are surveyed. The impact of survey effort has on observations is apparent for this species given the reduced observations made in 2012, 2016, and 2020 when only a portion of priority sites were surveyed (Figure 3). Survey effort for this species has not been equal across all years and this is because of the limited number of sites and the sensitivity of the species to repeated visitation increasing the difficulty in assessing trends for the species.

Figure 3. Total annual observations of *C. rafinesquii* since 2010. Numbers along the graph indicate the average number of observations per cave for each year.

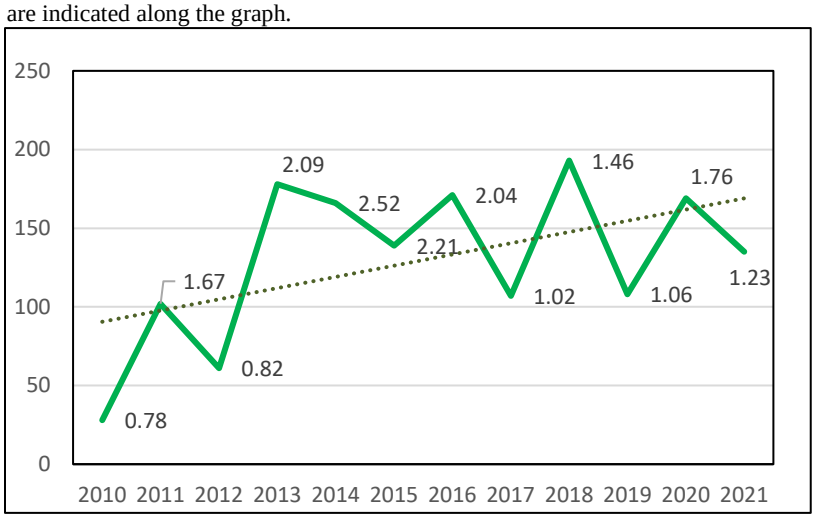


Eptesicus fuscus

The number of *E. fuscus* observed annually has increased since the 2009-2010 winter survey period and this is most likely attributed to increased survey effort. During the 2009-2010 winter monitoring, 36 caves were surveyed compared to the 110 caves surveyed during the 2020-

2021 winter. The average number of individual *E. fuscus* observed during each cave surveyed was 1.23 during 2020-2021 compared to just 0.82 individuals per cave surveyed in 2009-2010 (Figure 4).

Figure 4. Annual total observations statewide of *E. fuscus* during annual cave surveys are represented by the line. Annual average individuals observed per cave are indicated along the graph.



It appears numbers for this species are trending upward during the winter, but due to the low number of observations through the years it is difficult to determine if the trend is statistically significant. Observations for this species may be difficult to make because of roost preferences or selection during the winter. Many of the observations made during the winter are in plain sight or open areas of caves; however, if *E. fuscus* select roosts such as rock crevices, as observed by Neubaum et al. (2006), observations within caves may become problematic. Also, in other portions of the species range, the use of man-made structures during the winter (Whitaker Jr. and Gummer 2000) may indicate winter surveys should include nontraditional sites. Diagnostic symptoms of WNS have been documented in this species (Blehert et al. 2009).

Myotis leibii

Observations of this species are extremely limited and have never exceeded 24 in any given year since 2009. The most sites this species has been observed at in any year was 8 (2019), making it difficult to ascertain whether populations of this species are stable, increasing or declining. Similar to *E. fuscus*, it is likely the roosting preferences of this species lead it to be under surveyed annually. In contrast with other cave-roosting bats, *M. leibii* chooses roosts on the cave floor, under talus, or in cracks or crevices within the substrate (Erdle and Hobson 2001). Admittedly, these roosts are under surveyed during the winter, as assessing these areas would increase the time of surveys, visitation, and increase disturbance to other roosting bats. Despite the lack of survey effort for this species, there is still concern WNS may impact this species given diagnostic symptoms have been observed in *M. leibii* (https://www.whitenosesyndrome.org/about/bats-affected-wns).

Myotis lucifugus

Numbers of *M. lucifugus* have mirrored the cyclical surveys conducted for *M. sodalis*, as these two species are often observed within the same hibernacula; however, there are sites within

the state where the two species do not occur together. Only 122 total individuals were observed during cave surveys for this monitoring period, but this was not a priority count year.

Despite this species once occurring in large numbers at winter sites in northern portions of its range (Davis and Hitchcock 1965) and populations in Tennessee constituting a small portion of the overall population (Kunz and Reichard 2010), the decline of *M. lucifugus* within the state resemble those modeled by Frick et al. (2010), in which a 99% chance of regional extinction of the species was possible. Conservation and recovery efforts for *M. lucifugus* will prove both challenging and difficult given the declines observed in Tennessee.

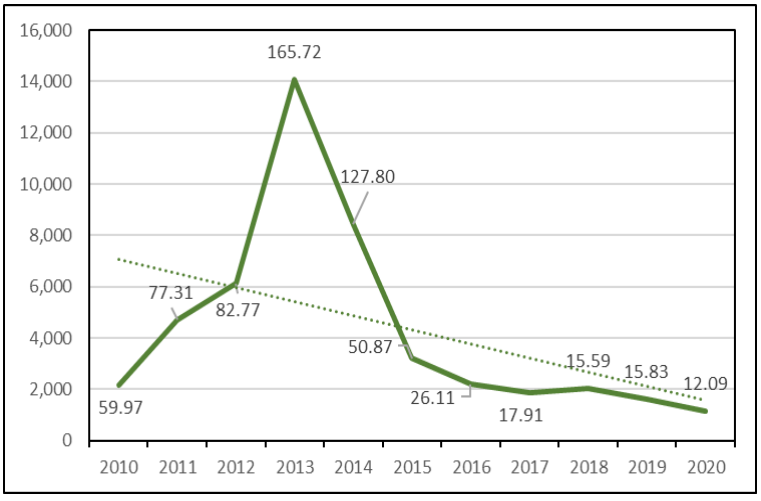
Myotis septentrionalis

Historically, observations of *M. septentrionalis* have been low as it was recorded anecdotally while conducting surveys for species with more significant designations. During 2009-2010, surveyors collected data with increased emphasis on this species. *M. septentrionalis* displays roost preferences similar to those of *E. fuscus* and *M. leibii*, roosting in cracks and crevices of the cave substrate likely leading to it being under surveyed across all years. Since 2012, winter populations of *M. septentrionalis* have declined precipitously. No observations were made during the 2020-2021 cave survey period (Table 2). The decline in total observations for this species has now reached 100% but may not indicate complete extirpation as many of the sites surveyed had not been previously surveyed and not all caves in the state were surveyed. Although the lack of observations can be attributed to roosting preferences of the species, such a drastic decline in the number of observations across multiple winters indicates WNS is having detrimental impacts to *M. septentrionalis*. Given the lack of observations and known WNS impacts, there is high cause of concern for this species in the state.

Perimyotis subflavus

P. subflavus was one of the most commonly encountered solitary roosters within caves during the winter, being observed in 80% or more caves surveyed annually. Sadly, this species is no longer observed at historic densities and its numbers at sites have declined significantly over the past three years. As with other species, numbers peaked in 2013, but have declined at an alarming rate since. Observations decreased 5.51% from 1,161 (2019-2020) to 1,097 (2020-

Figure 5. Annual total observations statewide of *P. subflavus* during annual cave surveys are represented by the line. Annual average individuals observed per cave are indicated along the graph.



2021). Along with the decrease in total in observations, the number of *P. subflavus* observed during each cave survey has declined significantly since the 2009-2010 monitoring period. During 2009-2010, the average number of *P. subflavus* observed per cave survey was 59.97, however, the average number of individuals observed during 2020-2021 cave surveys was 9.97.

WNS Mortality / Bat Population Monitoring

Numerous sites across the state have been visited annually or multiple times since the widespread, multi-species focused survey efforts began in 2009-2010. Since the effort and ability of surveyors was different in 2020-2021, due to manpower availability and concerns associated with SARS-CoV-2, the majority of sites visited and not been previously surveyed. Only 25.4% of caves surveyed during the field season had been previously surveyed. The number of surveys performed at these sites since the 2009-2010 field season averaged 5 surveys (range 2-11) and the number of years between surveys averaged 3 (1-11). Table 3 illustrates the observed declines at sites between the last survey and 2020-2021 surveys and the first survey and 2020-2021 surveys. While there were some sites in which increases for *P. subflavus* were observed, observations for this species at most sites continue to decline. Surprisingly, sites with large declines in observations for *P. subflavus* (Whiteside Cave) had larger increases in observations of the species in 2020-2021. Although roost switching occurs by bats throughout the winter, it is evident WNS is greatly impacting winter bats in Tennessee, especially *M. lucifugus*, *M. septentrionalis*, and *P. subflavus*. Some bat researchers and biologists believe WNS has caused and is leading to extirpation of species from sites.

Table 3. The percent change in observations of 4 species of bats in Tennessee. Percentages in red indicate declines at sites between 2020-2021 and first and last surveys conducted for each site.

				Last Survey to 2021				First Survey to 2021			
Cave Name	**County**	**Number of Surveys**	**Years Between Surveys**	**PESU**	**MYLU**	**EPFU**	**MYSE**	**PESU**	**MYLU**	**EPFU**	**MYSE**
Blackmans Cave	Knox	5	1	**-16.67**				**-50.00**			
Buis Saltpeter Cave	Claiborne	2	8	**-75.53**	**-92.31**	20.00		**-75.53**	**-92.31**	20.00	
Bunkum Cave	Pickett	6	1	27.42				**-46.26**			
Capshaw Cave	Putnam	2	5	**NC**				NC			
Carlton Cave	Franklin	7	3	**-9.26**				**-75.50**			
Coleman Cave	Montgomery	7	2	**NC**	**-100.00**	200.00	**NC**	**-95.00**	0.00	200.00	**-100.00**
Cooper Creek Cave	Montgomery	10	2	**-83.33**	**NC**	100.00	**NC**	**-99.08**	**-99.22**	**-52.94**	**-100.00**
Cripps Mill Cave	DeKalb	5	2	**-23.81**				**-68.25**			
Grassy Cove Saltpeter	Cumberland	7	2	**-40.00**	25.00	**NC**	**NC**	**-90.63**	**-85.65**	**NC**	**-100.00**
Great Expectations Cave	White	9	2	**-49.56**				**-71.50**			
Gregory Cave	Blount	7	2	**NC**	**NC**			**-98.80**	**-100.00**		
Haile Cave	Jackson	2	3	120.00		125.00		120.00		125.00	
Hazel Ward Cave	Warren	4	1	**-69.05**				**-69.05**			
Indian Cave	Franklin	2	2	275.00				275.00			
Jaco Spring Cave	Warren	5	1	40.00				**-36.36**			
Mill Hole Cave	White	4	1	**-58.14**				50.00			
Oaks Cave	Union	7	2	**-15.38**				**-81.67**			
Poga Road Cave	Carter	2	11	**-100.00**				**-100.00**			
Pygmalion	Fentress	2	3	8.20				8.20			
Roberson Cave	Franklin	2	3	**-83.33**				**-83.33**			
Sculpture Cave	Carter	6	1	**-26.32**				16.67			
Sour Kraut Cave	Claiborne	2	8	**-85.71**				**-85.71**			
Stark Cave	Robertson	4	2	**-64.00**				**-93.43**			
Summer Sump Cave	Dekalb	3	3	200.00				**-25.00**			
Valley Cave	Wilson	2	4	26.67				26.67			
Wet Cave	Franklin	4	1	175.00				**-91.27**			
Whiteside Cave	Marion	11	2	61.82				**-72.78**			
Winter Cave	Dekalb	4	2	**-100.00**		**-100.00**		**-100.00**		**-100.00**	

Use of Summer Mist Netting Data to Determine Declines in Capture Rates Associated with WNS

Declines associated with white-nose syndrome have been documented during the winter since the discovery of the fungal pathogen in Tennessee during the winter of 2010. To assess potential declines associated with WNS during the summer, we utilized differences in catch per unit effort associated with summer mist net data collected by TWRA. Levels of effort were assessed from 2005-2009 (Pre-WNS) and 2010-2020 (Post-WNS) to determine differences in level of effort necessary to capture bats during the summer.

Catch per Unit Effort (CPUE) was calculated three different ways based on differing calculations utilized by bat biologists. The TWRA method standardizes effort based on the size of the net used during surveys. In this method, the 12m net is the standard net size calculations are based on and a single high 12m net opened for one hour equals one hour of netting effort. The level of hourly effort for nets smaller than 12m is determined by dividing the net size by 12m. A 9m net opened for one hour equals 0.75 hours of netting effort (9/12=0.75). This same approach is utilized to determine hourly efforts for nets larger than 12m as well. A 18m net opened for one hour equals 1.5 hours of netting effort for each hour opened (18/12=1.5). The hourly netting effort for each size is then multiplied by the total hours each net is opened to determine the total net hours. This method accounts for double- and triple-high net sets utilized by all bat biologists.

The second CPUE method utilized was to standardized effort to the net itself. Each net opened, regardless of size, equals a single night of effort. This method appears standard among bat biologists and consultants but fails to capture the difference in net sizes and times nets are opened during nightly netting sessions. CPUE for this method is simply expressed as total net nights. The sizes of each net array, i.e. double- and triple-high net sets, is not accounted for using this method.

Recently, the USFWS has collected data pertaining to the number of square meters of mist net utilized during each netting session. Assuming this data is being utilized to determine CPUE, we calculated effort by dividing the total square meter of net used by the total number of bats captured. This method takes the various net sizes into account but does not account for differences in times nets are opened. Net area is determined by multiplying the width of each net by the height of each net. All nets have a standard height of 2.6m and area is determined by simply multiplying the width and height of each net utilized. This method also accounts for double- and triple-high net sets utilized by all bat biologists.

Results

Between 2005-2009, TWRA biologists captured 473 bats during nightly netting sessions compared to 1,845 bats between 2010-2020. The average number of captures per year pre-WNS was 94.6 bats and 167.72 bats post-WNS. The level of mist netting effort was almost eight times

higher post-WNS compared to pre-WNS (TWRA CPUE – 3,949.66 net hours to 515.93 net hours; USFWS CPUE – 32,684.60m^2 to 4,797.00m^2). Total net nights using the single net CPUE method was almost three times higher post-WNS compared to pre-WNS (721 net nights to 250 net nights).

Declines have been observed for multiple species in the state since the discovery of WNS. We summarized results for *M. spetentrionalis*, *P. subflavus*, and *M. lucifugus*. Results for the *M. sodalis* were omitted because captures were limited and associated with projects specific to the species. Table 4 summarizes the levels of effort to capture individual bat species pre- and post-WNS based on the differing CPUE methodologies. CPUE for each method is summarized for each species pre- and post- WNS following Table 1.

M. septentrionalis

Declines for *M. septentrionalis* bat has exceeded 99% in the state during the winter and summer declines have appeared to follow these same trends. Once commonly captured throughout much of the state, captures for this species during the summer have declined significantly. Pre-WNS, *M. spetentrionalis* were captured every 4.56 mist net hours or every 2.21 mist net nights or took 76.92m^2 of net array (the equivalent of roughly a triple high 9m net set). One hundred net hours would produce approximately 21 captures of the species pre-WNS.

Post-WNS, captures have significantly declined for the species. *M. spetentrionalis* are now captured every 76.92 mist net hours or every 13.89 mist net nights or take 250 m^2 of net array (the equivalent of two 12m triple high net sets and one 9m triple net set). One hundred net hours would produce approximately 1.3 captures of the species post-WNS. Based on net hours necessary to capture this species, captures for *M. septentrionalis* during the summer have declined 93.8% post-WNS and are similar to declines associated with winter observations.

P. subflavus

A similar pattern unfolds for *P. subflavus* in Tennessee when assessing summer captures in the state. Observations during the winter vary between years and the decline observed since 2010 exceeds 46%. Pre-WNS, *P. subflavus* were captured every 7.09 mist net hours or every 3.42 mist net nights or took 66.67m^2 of net array (the equivalent of roughly a double high 12m net set). One hundred hours produced approximately 14 tricolored bat captures.

Captures of *P. subflavus* have declined significantly post-WNS. *P. subflavus* are now captured every 43.48 mist net hours or 8 net nights or 333.33 m^2 for net array (the equivalent of roughly three 12m triple high net sets and one 9m triple high net set). One hundred net hours would produce approximately 2 *P. subflavus* captures. *P. subflavus* captures during the summer have declined 85.7% when comparing captures per net hour and are almost twice that of declines observed during winter surveys.

M. lucifugus

Winter observations of *M. lucifugus* have declined 44.92% since the discovery of WN in the state, but slight increases in these observations have occurred in recent years. Pre-WNS, *M. lucifugus* were captured every 34.48 mist net hours or 16.67 mist net nights or 333.33m^2 for net array (the equivalent of roughly three 12m triple high net sets and one 9m triple high net set). One hundred net hours produced approximately 3 *M. lucifugus* captures.

While the number of captures between the two periods was the same (15), the level of effort now required to capture this species on the summer landscape has increased. *M. lucifugus* are now captured every 250 mist net hours or 47.62 net nights or 2,000m^2 for net array (the equivalent of almost twenty-one 12m triple net sets). Over one hundred-fifty net hours are needed to capture one *M. lucifugus*. Based on net hours necessary to capture this species, captures for *M. lucifugus* during the summer have declined 97.1% post-WNS and these declines are over two times greater than observations observed during the winter.

Table 4. Differences in the level of effort necessary to capture individual bat species pre- and post-WNS based on the three CPUE methodologies.

	Pre-WNS (2005-2009)			Post-WNS (2010-2020)		
	TWRA CPUE	**Single Net CPUE**	**USFWS CPUE**	**TWRA CPUE**	**Single Net CPUE**	**USFWS CPUE**
Species	**Net Hours Necessary to Capture one Bat**	**Net Nights Necessary to Capture one Bat**	**Net Area Necessary to Capture One Bat**	**Net Hours Necessary to Capture one Bat**	**Net Nights Necessary to Capture one Bat**	**Net Area Necessary to Capture One Bat**
CORA	500	250	5,000	33.33	5.68	250
EPFU	22.22	10.87	200	13.7	2.49	111.11
LABO	3.36	1.62	31.25	4.65	0.85	38.46
LACI	83.33	41.67	1,000	250	47.62	2,000
LANO	250	125	2,500	333.33	55.56	2,500
MYAU	62.5	31.25	500	1,000	27.78	1,000
MYGR	17.85	8.62	167	142.85	3.92	166.67
MYLE	17.24	8.33	167	21.27	34.48	1,000
MYLU	34.48	16.67	333	250	47.62	2,000
MYSE	4.56	2.21	42	76.92	13.89	500
NYHU	34.48	16.67	333	27.03	4.98	250
PESU	7.09	3.42	67	43.48	8	333.33

Pre-WNS (Between 2005-2009)

TWRA Method

Total Net Hours	Total Bats Captured	Total Bats per Net Hour	CORA	COTO	EPFU	LABO	LACI	LANO	LASE	MYAU	MYGR	MYLE	MYLU	MYSE	MYSO	NYHU	PESU	TABR
515.93	473	0.917	0.002	0.000	0.045	0.298	0.012	0.004	0.000	0.016	0.056	0.058	0.029	0.219	0.000	0.029	0.141	0.000

Net Hours Necessary to Capture a Single Bat of Each Species
CORA: 500, EPFU: 22.22, LABO: 3.36, LACI: 83.33, LANO: 250, MYAU: 62.5, MYGR: 17.85, MYLE: 17.24, MYLU: 34.48, MYSE: 4.56, NYHU:34.48, PESU:7.09

Single Net Method

Total Open Net Nights	Total Bats Captured	Total Bats per Net Night	CORA	COTO	EPFU	LABO	LACI	LANO	LASE	MYAU	MYGR	MYLE	MYLU	MYSE	MYSO	NYHU	PESU	TABR
250.00	473	1.892	0.004	0.000	0.092	0.616	0.024	0.008	0.000	0.032	0.116	0.120	0.060	0.452	0.000	0.060	0.292	0.000

Net Nights Necessary to Capture a Single Bat of Each Species
CORA: 250, EPFU: 10.87, LABO: 1.62, LACI: 41.67, LANO: 125, MYAU: 31.25, MYGR: 8.62, MYLE: 8.33, MYLU: 16.67, MYSE: 2.21, NYHU: 16.67, PESU: 3.42

USFWS Using Net Area

Total Net Area	Total Bats Captured	Total Bats per Net Area	CORA	COTO	EPFU	LABO	LACI	LANO	LASE	MYAU	MYGR	MYLE	MYLU	MYSE	MYSO	NYHU	PESU	TABR
4,797.00	473	0.0986	0.0002	0.000	0.005	0.032	0.001	0.0004	0.000	0.002	0.006	0.006	0.003	0.024	0.000	0.003	0.015	0.000

Square Meters Necessary to Capture a Single Bat of Each Species
CORA: 5,000, EPFU: 200, LABO: 31.25, LACI: 1,000, LANO: 2,500, MYAU: 500, MYGR: 166.67, MYLE: 166.67, MYLU: 333.33, MYSE: 41.67, NYHU: 333.33, PESU: 66.67

Post-WNS (Between 2010-2020)

TWRA Method

Total Net Hours	Total Bats Captured	Total Bats per Net Hour	CORA	COTO	EPFU	LABO	LACI	LANO	LASE	MYAU	MYGR	MYLE	MYLU	MYSE	MYSO	NYHU	PESU	TABR
3,949.66	1,845	0.467	0.032	0.000	0.073	0.215	0.004	0.003	0.001	0.007	0.047	0.005	0.004	0.013	0.004	0.037	0.023	0.000

Net Hours Necessary to Capture a Single Bat of Each Species

CORA: 33.33, EPFU: 13.70, LABO: 4.65, LACI: 250, LANO: 333.33, LASE: 1,000, MYAU: 142.85, MYGR: 21.27, MYLU: 250, MYSE: 76.92, NYHU: 27.03, PESU: 43.48

Single Net Equals a Single Net Night

Total Open Net Nights	Total Bats Captured	Total Bats per Net Night	CORA	COTO	EPFU	LABO	LACI	LANO	LASE	MYAU	MYGR	MYLE	MYLU	MYSE	MYSO	NYHU	PESU	TABR
721	1,845	2.559	0.176	0.000	0.402	1.180	0.021	0.018	0.003	0.036	0.255	0.029	0.021	0.072	0.019	0.201	0.125	0.000

Net Nights Necessary to Capture a Single Bat of Each Species

CORA: 5.68, EPFU: 2.49, LABO: 0.85, LACI:47.62, LANO: 55.56, LASE: 333.33, MYAU: 27.78, MYGR: 3.92, MYLE: 34.48, MYLU: 47.62, MYSE: 13.89, NYHU: 4.98, PESU: 8

USFWS Using Net Area

Total Net Area	Total Bats Captured	Total Bats per Net Area	CORA	COTO	EPFU	LABO	LACI	LANO	LASE	MYAU	MYGR	MYLE	MYLU	MYSE	MYSO	NYHU	PESU	TABR
32,684.60	1,848	0.0565	0.004	0.000	0.009	0.026	0.0005	0.0004	0.000	0.001	0.006	0.001	0.0005	0.002	0.000	0.004	0.003	0.000

Square Meters Necessary to Capture a Single Bat of Each Species

CORA: 250, EPFU: 111.11, LABO: 38.46, LACI: 2,000, LANO: 2,500, MYAU: 1,000, MYGR: 166.67, MYLU: 2,000, MYLE: 1,000, MYSE: 500, NYHU: 250, PESU: 333.33

Conclusions

With each year of survey effort, the impact of WNS to winter bats in Tennessee becomes clearer. During the past three years, large declines of *M. lucifugus*, *M. septentrionalis*, and *P. subflavus* have been made, and these declines are even more apparent when assessing WNS impacts at individual winter sites. Unfortunately, the declines are magnified by the increased effort it now takes researchers, biologists and consultants to captures these species on the landscape during summer months and indicate the impacts of WNS on the summer landscape. Despite the widespread declines being observed at many winter sites, there are winter bat populations stable or trending upward at some sites. Biologists are cautiously optimistic populations at these sites will maintain as such given similar increases have been observed at sites prior to declines.

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Appendix A

- A list of all WNS confirmed, suspect, or negative counties in Tennessee based on diagnostic reports.

[1]Tapelift sample taken and the bat was not euthanized; [2]Bat submitted was found dead at site; [C]WNS confirmed; [S]WNS suspect; [N]WNS Negative [SW]Only a swab sample was taken from the bat tested and was not euthanized; [N/A]Report not available.

Cave Name or Structure	County	Year	WNS Status	Species	Diagnostic Report Number
Camps Gulf Cave	Van Buren	2010	Suspect	PESU[S], MYSO[1,N]	NWHC-22984
Dunbar Cave	Montgomery	2010	Suspect	MYSE[S]	NWHC Event 15950
East Fork SLP Cave	Fentress	2010	Suspect	MYLU, MYSE[S]	NWHC Event 15979
Grindstaff Cave	Carter	2010	Confirmed	MYSE[C], PESU[C]	NWHC
Hubbards Cave	Warren	2010	Negative	MYGR[N]	NWHC
White Oak Blowhole	Blount	2010	Suspect	N/A	N/A
Worleys Cave	Sullivan	2010	Confirmed	MYSE, PESU	NWHC Event 15948
Bellamy Cave	Montgomery	2011	Negative	MYGR[N]	NWHC-23532
Camps Gulf Cave	Van Buren	2011	Suspect	PESU[S]	NWHC-23481
Cooper Creek Cave	Montgomery	2011	Confirmed	MYLU[C], MYSE[C], PESU[C]	NWHC-23444
East Fork SLP Cave	Fentress	2011	Suspect	MYLU[S]	NWHC-23482
Under a House	Polk	2011	Negative	MYGR[2]	SCWDS CC11-188
White Oak Blowhole	Blount	2011	Suspect	MYLU[N]	NWHC-23466
Austin Peay State University	Montgomery	2012	Suspect	MYLU[S]	SCWDS CC12-235
Bellamy Cave	Montgomery	2012	Confirmed	MYGR, PESU[C]	SCWDS WNS12-54, WNS12-55
Bull Cave	Blount	2012	Negative	PESU[N]	SCWDS WNS12-50
Camps Gulf Cave	Van Buren	2012	Confirmed	N/A	N/A
Cantwell Valley Cave	Hancock	2012	Confirmed	N/A	N/A

[1]Tapelift sample taken and the bat was not euthanized; [2]Bat submitted was found dead at site; [C]WNS confirmed; [S]WNS suspect; [N]WNS Negative [SW]Only a swab sample was taken from the bat tested and was not euthanized; [N/A]Report not available.

Cave Name or Structure	County	Year	WNS Status	Species	Diagnostic Report Number
Carlton Cave	Franklin	2012	Confirmed	PESU[C]	SCWDS WNS12-56
Fort Campbell Nerd Hole	Stewart	2012	Confirmed	PESU[C]	NWHC-23846
Grassy Cove SLP Cave	Cumberland	2012	Confirmed	MYLU[C]	SCWDS WNS12-064 A-B
Gregory Cave	Blount	2012	Negative	PESU[N]	SCWDS WNS12-50
Hubbards Cave	Warren	2012	Negative	MYGR[N]	SCWDS WNS12-067
Hurricane Creek Cave	Humphreys	2012	Negative	PESU[N], MYSO[N]	NWHC-23848
Lookout Mtn. Battlefield Pit #1	Hamilton	2012	Confirmed	PESU[C]	SCWDS WNS12-86
Lost Creek Cave	White	2012	Negative	MYGR[N,SW], MYLU[N, SW], PESU[N,SW]	SCWDS WNS12-41, WNS12-42, WNS12-43
New Mammoth Cave	Campbell	2012	Negative	MYLU[N]	SCWDS WNS12-068
Pearsons Cave	Hawkins	2012	Confirmed	MYGR[C]	SCWDS WNS12-70
Rainbow Cave	Blount	2012	Negative	PESU[N]	SCWDS WNS12-50
Upstream Cave	Hancock	2012	Confirmed	PESU[C]	SCWDS WNS12-072
White Oak Blowhole	Blount	2012	Confirmed	MYLU[C], PESU[C]	SCWDS WNS12-061, WNS12-062
Afton Cave	Greene	2013	Confirmed	PESU[C]	SCWDS WNS13-72 A-C
Big Mouth Cave	Grundy	2013	Confirmed	MYLU[C]	SCWDS WNS13-56

[1]Tapelift sample taken and the bat was not euthanized; [2]Bat submitted was found dead at site; [C]WNS confirmed; [S]WNS suspect; [N]WNS Negative [SW]Only a swab sample was taken from the bat tested and was not euthanized; [N/A]Report not available.

Cave Name or Structure	County	Year	WNS Status	Species	Diagnostic Report Number
Blowing Cave	Hickman	2013	Confirmed	MYLU[C], MYSE[C], PESU[C]	SCWDS WNS13-38, WNS13-39, WNS13-40
Buggytop Cave	Franklin	2013	Confirmed	PESU[C]	SCWDS WNS13-103
Buis SLP Cave	Claiborne	2013	Confirmed	MYLU[C]	SCWDS WNS13-74 A-B
Cornstarch Cave	Fentress	2013	Confirmed	MYLU[C], PESU[C]	SCWDS WNS13-10, WNS13-11
Depriest Branch Cave	Lewis	2013	Confirmed	MYLU[C], MYSE[C], PESU[C]	SCWDS WNS13-46, WNS13-47, WNS48
Dunbar Cave	Montgomery	2013	Confirmed	PESU[C]	SCWDS WNS13-98, WNS13-101
East Fork SLP Cave	Fentress	2013	Confirmed	MYLU[C]	SCWDS WNS13-12
Espey Cave	Cannon	2013	Confirmed	PESU[C]	SCWDS WNS13-95
Eve's cave	Meigs	2013	Confirmed	PESU[C]	SCWDS WNS13-76
Gunter's Cave	Cannon	2013	Negative	PESU[N]	SCWDS WNS13-91
Herd O' Coons Cave	Union	2013	Confirmed	MYLU[C], PESU[C]	SCWDS WNS13-70 A-B, WNS13-71
Hubbards Cave	Warren	2013	Confirmed	PESU[C]	SCWDS WNS13-13
Hunt Cave	Dickson	2013	Confirmed	PESU[C]	SCWDS WNS13-49 A-C
Jaybird Cave	Perry	2013	Confirmed	MYLU[C]	SCWDS WNS13-44
Knob Creek Cave	Lawrence	2013	Confirmed	PESU[C]	SCWDS WNS13-54

[1]Tapelift sample taken and the bat was not euthanized; [2]Bat submitted was found dead at site; [C]WNS confirmed; [S]WNS suspect; [N]WNS Negative [SW]Only a swab sample was taken from the bat tested and was not euthanized; [N/A]Report not available.

Cave Name or Structure	County	Year	WNS Status	Species	Diagnostic Report Number
Lost Creek Cave	White	2013	Confirmed	PESU[C]	SCWDS WNS13-53 A-B
New Mammoth Cave	Campbell	2013	Confirmed	MYSE[C], MYLU[C]	SCWDS WNS13-25 A-B, WNS13-26
North Spivey Cave	Jackson	2013	Confirmed	MYLU[C]	SCWDS WNS13-94
Private Residence	Sequatchie	2013	Confirmed	PESU[C]	SCWDS WNS13-99
Pearsons Cave	Hawkins	2013	Confirmed	MYGR[2,N]	SCWDS WNS13-45
Richardson Cave	Houston	2013	Confirmed	MYLU[C]	SCWDS WNS13-02
Rose Cave	White	2013	Suspect	MYLU[S]	SCWDS WNS13-14
Sour Kraut Cave	Claiborne	2013	Confirmed	PESU[C]	SCWDS WNS13-75
Three Forks Cave	Overton	2013	Confirmed	PESU[C]	SCWDS WNS13-90
Trussell Cave	Grundy	2013	Confirmed	PESU[C]	SCWDS WNS13-55 A-C
Trussell Downstream Cave	Grundy	2013	Confirmed	PESU[C]	SCWDS WNS13-55 A-C
Virgin Falls Cave	White	2013	Confirmed	PESU[C]	SCWDS WNS13-50
Welch-Blowing Cave	Putnam	2013	Confirmed	PESU[C]	SCWDS WNS13-64
Whiteside Cave	Marion	2013	Confirmed	PESU[C]	SCWDS WNS13-63
Wolf River Cave	Fentress	2013	Confirmed	MYLU[C]	SCWDS WNS13-9
Zarathustrus Cave	Fentress	2013	Confirmed	PESU[C]	SCWDS WNS13-27
Aunt Beck Simmons Cave	Macon	2014	Confirmed	N/A	N/A
Biffle Cave	Wayne	2014	Confirmed	PESU[C]	SCWDS WNS14-10 A-C

[1]Tapelift sample taken and the bat was not euthanized; [2]Bat submitted was found dead at site; [C]WNS confirmed; [S]WNS suspect; [N]WNS Negative [SW]Only a swab sample was taken from the bat tested and was not euthanized; [N/A]Report not available.

Cave Name or Structure	County	Year	WNS Status	Species	Diagnostic Report Number
Big Jordan Cave	Pickett	2014	Confirmed	PESU[C], MYLU[C]	SCWDS WNS14-32, WNS14-33
Bridgewater Cave	Smith	2014	Confirmed	PESU[C]	SCWDS WNS14-20 A-B
Cave Creek Cave	Roane	2014	Confirmed	PESU[C]	SCWDS WNS14-31 A-B
Corner Store Cave	Hamblen	2014	Confirmed	PESU[C], MYLU[C]	SCWDS WNS14-29, WNS 14-30
Cripps Mill Cave	Dekalb	2014	Confirmed	PESU[C]	SCWDS WNS14-9
Dunbar Cave area	Montgomery	2014	Confirmed	PESU[C]	SCWDS WNS14-13, WNS14-14, WNS14-16, WNS14-16
Gee Cave	Polk	2014	Confirmed	PESU[C]	SCWDS WNS14-53
Hubbards Cave	Warren	2014	Confirmed	MYGR[2,N]	SCWDS WNS14-7
Hurricane Creek Cave	Humphreys	2014	Confirmed	PESU[C]	SCWDS WNS14-12
Indian Cave	Grainger	2014	Confirmed	PESU[C]	SCWDS WNS14-128, WNS14-129
Leonard Cave	Clay	2014	Confirmed	PESU[C]	SCWDS WNS14-130, WNS14-131, WNS14-132
Mason Cave	Sumner	2014	Suspect	PESU[S]	SCWDS WNS14-52 A-B
Rummage Cave	Maury	2014	Confirmed	PESU[C]	SCWDS WNS14-11 A-C
Springhill SLP Cave	Anderson	2014	Confirmed	MYLU[C]	SCWDS WNS14-8 A
Ward Cave	Bedford	2014	Confirmed	PESU[C]	SCWDS WNS14-51 A-C

[1]Tapelift sample taken and the bat was not euthanized; [2]Bat submitted was found dead at site; [C]WNS confirmed; [S]WNS suspect; [N]WNS Negative [SW]Only a swab sample was taken from the bat tested and was not euthanized; [N/A]Report not available.

Cave Name	County	Year	WNS Status	Species	Diagnostic Report Number
Crumpton Creek SLP Cave	Coffee	2015	Confirmed	PESU[C]	SCWDS CC15-124
Hardin's Junkyard Cave	Davidson	2015	Suspect	MYLU[S]	Field Signs Observed, UV positive, Photos Taken
Magnussen Cave	Giles	2015	Confirmed	PESU[C]	SCWDS CC15-26
Mason Cave	Sumner	2015	Suspect	N/A	Field Signs Observed, UV positive
Petty Cave	Marshall	2015	Confirmed	PESU[C]	SCWDS CC15-123 A-C
Silvertooth Cave	Moore	2015	Suspect	PESU[N]	SCWDS CC15-125
Stark Cave	Robertson	2015	Confirmed	PESU[C]	SCWDS CC15-127
Civil War Bunker	Tipton	2016	Negative	EPFU[N], PESU[N]	SCWDS 16-92 A-B
Ball Play Cave	Monroe	2017	Suspect	PESU[SW]	CCB137
Blackmans Cave	Knox	2017	Suspect	PESU[SW]	CCB332
Ghost Cave	Loudon	2019	Suspect	PESU[SW]	CCB786, CCB787, CCB788, CCB789, CCB790, CCB791, CCB792, CCB793, CCB794
Williams Mine	Cocke	2019	Suspect	PESU[SW]	CCB1160, CCB1162

Appendix B

- 2019-2020 Winter Survey Results

County	Cave Name	Survey Date	CORA	EPFU	LANO	MYAU	MYGR	MYLE	MYLU	MYSE	MYSO	SP?	PESU	Total Bats	Surveyors
Blount	Calderwood Bluff Cave	1/19/2021											1	1	TWRA
Blount	Calderwood Cave	1/19/2021											18	18	TWRA
Blount	Calderwood Cobble Cave	1/19/2021												0	TWRA
Blount	Calderwood Roadside Cave	1/19/2021												0	TWRA
Blount	Gregory Cave	2/1/2021											15	15	NPS
Blount	Old Calderwood School Basement	1/19/2021	40											40	TWRA
Blount	Past the Gate Cave	1/19/2021											3	3	TWRA
Campbell	Big Beech Cave	1/6/2021												0	TWRA
Carter	Elk Mills Cave	2/24/2021											4	4	TWRA
Carter	Little Elk Mills Cave	2/24/2021												0	TWRA
Carter	McKeehan Cave	2/24/2021		2									6	8	TWRA
Carter	Poga Cave	2/24/2021						1	1				8	10	TWRA
Carter	Poga Road Cave	2/24/2021												0	TWRA
Carter	Sculpture Cave	1/26/2021		3									14	17	TWRA
Claiborne	Buis Saltpeter	2/23/2021		6					2				23	31	TWRA, UTK
Claiborne	Sour Kraut Cave	2/23/2021		4									2	6	TWRA, UTK
Claiborne	White Buis/Upper Coonsie Creek Cave	1/7/2021					1						11	12	TWRA
Cumberland	Grassy Cove SLP	1/13/2021		1					60		2		3	66	TWRA
Dekalb	Cripps Mill Cave	1/14/2021		9							2		69	80	TWRA, TNC
Dekalb	Overall Cave	2/1/2021											3	3	TWRA, TNC
Dekalb	Summer Sump Cave	1/26/2021											3	3	TWRA
Dekalb	Winter Cave	1/26/2021												0	TWRA
Fentress	Big Indian Creek Cave	12/30/2020												0	TWRA
Fentress	Little Sweet Cave	12/30/2020												0	TWRA
Fentress	Matt Batt Pit	2/12/2021	475											475	TWRA
Fentress	Millard Fillmore Cave	2/12/2021												0	TWRA
Fentress	MLK Day Cave	3/8/2021		2									6	8	TWRA, TNC
Fentress	Mossy Crack Cave	3/8/2021	3										-	3	TWRA, TNC
Fentress	Pygmalion	12/14/2020	6						53		2		66	127	TWRA
Fentress	Rattlesnake Nest Cave	3/8/2021											3	3	TWRA, TNC
Fentress	Scooped Day Cave	2/12/2021											-	0	TWRA
Fentress	Sweet Gum Cove Cave	12/30/2020	1										-	1	TWRA

County	Cave Name	Survey Date	CORA	EPFU	LANO	MYAU	MYGR	MYLE	MYLU	MYSE	MYSO	SP?	PESU	Total Bats	Surveyors
Franklin	Caroline's Head Cave	2/4/2021											6	6	TWRA
Franklin	Cave Cove Cave	3/11/2021		3									31	34	TWRA
Franklin	Floorless Hole Cave (E2)	2/22/2021											26	26	TWRA
Franklin	Indian Cave	3/3/2021	34										15	49	TWRA, TDEC
Franklin	Roberson Cave	2/4/2021		1									1	2	TWRA
Franklin	Robinson Cave	2/4/2021											11	11	TWRA
Franklin	Wet Cave	2/26/2021											11		AAFB
Franklin	Wolf Cove Cave	3/11/2021		2							1		20	23	TWRA
Franklin	Carlton Cave	3/10/2021											49	49	TWRA
Greene	Dolomitic Dud	2/16/2021												N/A	TWRA
Greene	My So Called Cave	2/16/2021											1	1	TWRA
Greene	Mary Marie Cave	2/16/2021												N/A	TWRA
Hamblen	Panther Creek Park Cave	1/26/2021											3	3	TWRA
Hamblen	Staircase Cave	1/26/2021											0	0	TWRA
Jackson	Duds / Haile Caves	1/7/2021		9			1						11	21	TNC, TWRA
Jackson	Flynn Creek Cave	1/7/2021		9									3	12	TWRA, TNC
Jackson	Haile Cave	1/7/2021		9			1						11	21	TWRA, TNC
Jackson	Jennings Creek Rift	3/15/2021											9	0	TWRA
Knox	Blackmans Cave	1/18/2021											10	10	TWRA
Knox	Cruze Cave	1/18/2021											2	2	TWRA
Lewis	Abandoned mine	12/20/2020		6									3	9	TWRA
Marion	Circle Cave	2/23/2021											18	18	TWRA
Marion	Whiteside Cave	1/5/2021											89	89	TWRA
Montgomery	Coleman Cave	1/22/2021		3					1				2	**6**	TNC, TWRA
Montgomery	Cooper Creek Cave	1/22/2021		8					1				2	**11**	TNC, TWRA, TDEC
Pickett	Bunkum Cave	1/11/2021		7									79	86	TWRA
Pickett	Little Fork Karst Feature	1/20/2021												**0**	TNC
Pickett	Little Fork SLP Cave	1/20/2021							1				20	21	TWRA, TNC
Pickett	Phillip's Cave	2/2/2021												0	TWRA, TNC
Pickett	Pratt Cave	2/2/2021	2								1		11	14	TWRA, TNC
Putnam	Capshaw Cave	2/4/2021											2	2	TWRA, TNC
Robertson	Christian Cave	2/9/2021											4	**4**	TNC, TWRA

County	Cave Name	Survey Date	CORA	EPFU	LANO	MYAU	MYGR	MYLE	MYLU	MYSE	MYSO	SP?	PESU	Total Bats	Surveyors
Robertson	Fish Pond Bluff Cave	2/9/2021		1									2	**3**	TNC, TWRA
Robertson	Stark Cave	2/9/2021		9									9	**18**	TNC, TWRA
Sevier	East Fork River Cave	2/19/2021		4									4	8	TWR
Sevier	Stupkas Cave	2/1/2021											23	23	NPS
Smith	Beasley's Bend Cave	2/2/2021		1									3	4	TWRA
Smith	New Piper Cave	2/8/2021											15	**15**	TNC, TWRA
Smith	Piper Cave	2/8/2021	1	26			4	1					13	**45**	TNC, TWRA
Sullivan	3 C's Railroad Culvert #2	2/22/2021												0	TWRA
Sullivan	3 C's Railroad Culvert #3	2/22/2021												N/A	TWRA
Sullivan	Cedar Branch Cave	2/22/2021												N/A	TWRA
Sullivan	Dragons Nostril Cave	2/22/2021		1										1	TWRA
Sullivan	Hemlock Bridge Cave	2/22/2021												0	TWRA
Sullivan	Yonce Cave	2/22/2021												N/A	TWRA
Sullivan	3 C's Railroad Culvert #1	2/22/2021												0	TWRA
Unicoi	Bumpus Cove Cave	2/17/2021											1	1	TWRA
Union	Big Cave	1/11/2021		2									2	4	TWRA, UTK
Union	Big Coon Caverns	1/11/2021												0	TWRA, UTK
Union	Deep Sink Cave	1/27/2021											0	0	TWRA, UTK
Union	Ellison Hollow Cave	2/23/2021		1										1	TWRA, UTK
Union	Little Coon Caverns	1/11/2021												0	TWRA, UTK
Union	Mouse River Cave	1/6/2021											1	1	TWRA
Union	Panther Cave A	1/6/2021		3									1	4	TWRA
Union	Rocky Hollow Cave	1/11/2021		1									2	3	TWRA, UTK
Union	Unexpected Cave	1/27/2021											5	5	TWRA, UTK
Union	Oaks Cave	1/27/2021									3		11	14	TWRA, UTK
Van Buren	Dry Fork Sump Cave	3/16/2021												0	TWRA
Van Buren	Oglethorpe Cave	3/16/2021												0	TWRA
Van Buren	Pumice Hole	3/16/2021												0	TWRA
Van Buren	Rumbling Falls - Blasted Goat Ent.	2/24/2021											117	117	TNC, TWRA
Van Buren	Suzie Hole	3/16/2021											1	1	TWRA
Warren	Hazel Ward	1/12/2021											13	13	TWRA
Warren	Jaco Spring Cave	1/12/2021		1			5						28	34	TWRA

County	Cave Name	Survey Date	CORA	EPFU	LANO	MYAU	MYGR	MYLE	MYLU	MYSE	MYSO	SP?	PESU	Total Bats	Surveyors
Warren	King Cave	2/3/2021					1				1		35	37	TWRA, TNC
Washington	Cavern Chasm	2/17/2021												0	TWRA
Washington	Epic Epikarst Cave	2/17/2021												0	TWRA
Washington	Epikarst Arch Cave	2/17/2021												0	TWRA
White	Ghost River Cave	12/15/2020											1	1	TWRA
White	Great Expectations	1/8/2021	314	1					3		23		57	395	TWRA
White	Mill Hole Cave	1/6/2021						1					18	19	TWRA
Wilson	Alexandras Pit	12/17/2020											-	0	TWRA
Wilson	Deloric Well	12/17/2020											4	4	TWRA
Wilson	Dons Flowstone Hole	12/17/2020											3	3	TWRA
Wilson	Koeser Pit	12/17/2020											-	0	TWRA
Wilson	Mother's Day Cave	12/17/2020											1	1	TWRA
Wilson	Valley Cave	3/5/2021											19	19	TWRA
Wilson	Denny Cave	3/5/2021												0	TNC, TWRA