Cooperative White-nose Syndrome Monitoring and Surveillance Plan for Tennessee

12/1/2010

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Cover photo of WNS infected tri-colored bat (Perimyotis subflavus) in Worley's Cave in February of 2010 by Sterling Daniels.

Contents

INTRODUCTION **1**

GOAL AND OBJECTIVES **2**

CAVE VISITATION MANAGEMENT **2**

CAVE CLOSURES ON STATE- AND FEDERALLY-OWNED LANDS 2
MANAGEMENT OF CAVES OPEN TO THE GENERAL PUBLIC 4

PRESENCE/ABSENCE SURVEYS **4**

SUMMER 2010 ..... **5**

BAT COLONIES 5
Reproductive Condition *6*
Thermal Infrared Emergence Counts *7*
MIST NET SURVEYS 8
WING DAMAGE ASSESSMENT 8
BANDING 8
ACOUSTIC SURVEYS 9

WINTER 2010/2011 HIBERNACULA MONITORING **10**

WNS SURVEILLANCE 10
WNS MORTALITY MONITORING 11
BIENNIAL INDIANA BAT CENSUS 12
GRAY BAT CENSUS 18

FEDERAL AND STATE PERMITS **18**

FEDERAL SECTION 10 PERMITS 18
STATE OF TENNESSEE PERMITS 19
Collection of Animal Life on State Forests *19*
TDEC *19*

RESPONSE TO OBSERVATION OF WNS IN CAVES **20**

GENERAL RESPONSE PROCEDURE 20
WNS LABORATORY CONFIRMATION AND DISPOSITION OF SPECIMENS 21
Laboratory Confirmation *21*
Submittal of Other WNS Specimens and Samples *21*

OUTREACH, PUBLIC EDUCATION, AND COOPERATION WITH PARTNERS **22**

RESEARCH **23**

REFERENCES **25**

Tables and Figures

Figure 1. A WNS positive tri-colored bat from Worley's Cave in February 2010 (photo by Sterling Daniels). 1

Figure 2. A cluster of Indiana bats in Hubbards Cave in 2009 (photo by John Lamb) 2

Figure 3. A cluster of gray bats in Hubbards Cave in 2009 (photo by John Lamb) 2

Figure 4. Gray bat migration patterns and WNS positive counties as of summer 2010. 3

Table 1. Bat colonies at which banding and assessment of physical condition are conducted. 6

Table 2. Bat colony annual T3 system counts. 7

Figure 5. Distribution of acoustic survey routes by county in 2009. 9

Figure 6. A tri-colored bat banded in Rice Cave in 2010 (photo by John Lamb) 11

Figure 7. A healthy tri-colored bat in Tobacco Port Cave in 2009 (photo by John Lamb) 11

Figure 8. A healthy N. long-eared bat in Tobacco Port Cave in 2009 (photo by John Lamb) 12

Figure 9. A healthy Indiana bat in Tobacco Port Cave in 2009 (photo by John Lamb) 12

Table 4. Number of bats banded and estimated total number of bats at non gray bat hibernacula in the winter of 2009/2010 (Lamb and Wyckoff 2010) 13

Table 5. WNS Positive caves and species in winter 2009-2010. 13

Table 6. Cave survey schedule for winter 2010/2011. (Note: An "X" denotes presence of a species but no recent survey data. "Tier 2 (B)" denotes that bats will be banded in association with a tier 2 survey. "M" indicates mortality monitoring.) 14

Table 7. SCWDS personnel and contact information. 21

Table 8. Ongoing research related to cave-dwelling bats. 24

Acronyms

AAFB……	Arnold Air Force Base
AMNH…….	American Museum of Natural History
APSU……	Austin Peay State University
FC……...	Fort Campbell
KVRS…….	Knoxville Volunteer Rescue Squad
NMNH……..	Smithsonian Institution National Museum of Natural History
NPS……	National Park Service
NSS……..	National Speleological Society
TDEC…….	Tennessee Department of Environment and Conservation
TVA……	Tennessee Valley Authority
TWRA……	Tennessee Wildlife Resources Agency
TNC……...	The Nature Conservancy
COE……	U.S. Army Corps of Engineers
USFWS……..	U.S. Fish and Wildlife Service
USFS…….	U.S. Forest Service
USGS – NWHC…	U.S. Geological Survey's National Wildlife Health Center
UT…….	University of Tennessee
WNS……..	White-nose syndrome
WMA……	Wildlife Management Area

Introduction

White-nose syndrome (WNS) was first documented in photographs taken on February 16, 2006, at Howe Cave in New York, though this was not reported until 2008. In Tennessee, WNS was confirmed in six caves and three species beginning in February of 2010 (Lamb and Wyckoff 2010; Figure 1 and 4). Considering the number of caves located in Tennessee it is possible that additional occurrences were missed during the 2009/2010 monitoring period.

WNS continues to spread and information is constantly changing or being updated. A description of the disease and its current distribution are, therefore, not included here. The reader is directed to the USFWS WNS website where an up-to-date map of the range as well as current information can be found (http://www.fws.gov/WhiteNoseSyndrome/).

If an individual discovers a dead bat, it should be reported to the local TWRA Regional office. If the bat has a band attached to either forearm (as in Figure 6) this information should be conveyed to TWRA at the time of reporting.

Two species of bats known to occur in Tennessee are listed as Endangered by the United States Fish and Wildlife Service (USFWS). The Indiana bat (*Myotis sodalis*; Figure 2) was listed on 11 March 1967 (USFWS 1999), and the gray bat (*Myotis grisescens*; Figure 3) was listed on 28 April 1976 (USFWS 1982). Gray bat hibernacula censuses were conducted in the winter of 2009/2010 (Samoray 2010). Band recoveries at these caves, in addition to other data, allowed for a better understanding of gray bat migration and possible routes the spread of WNS might take (Lamb and Wyckoff 2010; Figure 4). Censuses at Indiana bat hibernacula will be conducted in the winter of 2010/2011.

This white-nose syndrome surveillance and monitoring plan outlines work to be conducted by the cooperators from summer 2010 through the winter of 2010/2011. It is intended to be renewed annually. Federal, state, non-governmental, and university cooperators developed this plan to:

- Minimize the potential for monitoring and research projects to contribute to the spread of WNS.
- Continue the WNS surveillance began in 2009.
- Document the degree of mortality at WNS infected hibernacula.

Figure 1. A WNS positive tri-colored bat from Worley's Cave in February 2010 (photo by Sterling Daniels).

Figure 2. A cluster of Indiana bats in Hubbards Cave in 2009 (photo by John Lamb)

Figure 3. A cluster of gray bats in Hubbards Cave in 2009 (photo by John Lamb)

All biologists conducting bat surveys in Tennessee adhere to guidance presented in the most recent disinfection protocol from the USFWS (http://www.fws.gov/WhiteNoseSyndrome/). Any equipment used in a WNS positive cave is dedicated to use only in WNS caves.

Goal and Objectives

The goal of this plan is to coordinate the conservation community's continued strategy for WNS surveillance and monitoring. The plan describes the cooperators' attempt to achieve the following near-term and longer-term objectives:

- Provide guidance to biologists who conduct presence/absence surveys for bat species as part of biological investigations for project reviews or other purposes.
- Ensure that bat monitoring and research projects in Tennessee adhere to the most recent disinfection protocols provided by U.S. Fish and Wildlife Service.
- Continue surveillance, monitoring, and research programs that will provide information to detect population changes as WNS progresses in Tennessee.
- Coordinate and complete the biennial Indiana bat census.

Cave Visitation Management

Cave Closures on State- and Federally-owned Lands

It has been shown that bat to bat transmission of WNS is possible (USGS– NWHC 2009) and the cooperators recognize that this is the most likely scenario for the spread of WNS. However, the possibility of transmission by humans from cave to cave to bats remains a possibility (USGS–NWHC 2009). In light of this possibility, all publically owned caves in Tennessee were closed in July of 2009 for a period of one year. This closure has now been extended through June 30, 2011 (http://news.tennesseeanytime.org/node/5381).

For management and enforcement purposes the WNS cooperators operatively define a cave as a natural or man-made cavity in bedrock that is at least 50 feet long or deep as measured from the mouth. This cave definition includes abandoned, underground mines because they often contain wildlife.

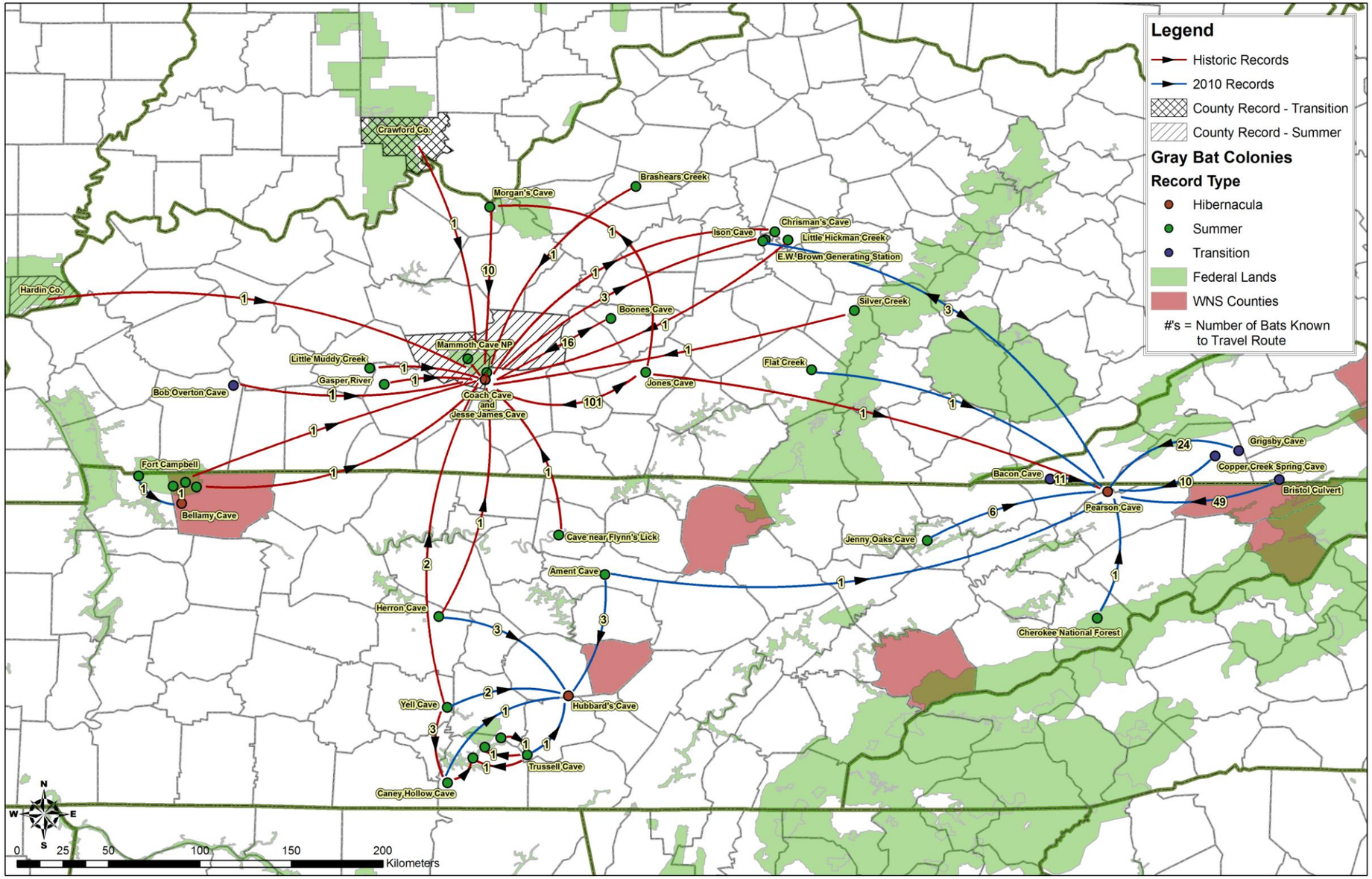

Figure 4. Gray bat migration patterns and WNS positive counties as of summer 2010.
(WNS cooperative partners unpub. data; AAFB unpub. data; Hall and Wilson 1966; Kentucky Department of Fish and Wildlife Services (Traci Hemberger pers. comm. 2010); and Virginia Department of Game and Inland Fisheries (Rick Reynolds pers.comm. 2010).

Management of Caves Open to the General Public

The following caves in Tennessee are expected to remain open to public visitation:

- Appalachian Caverns
- Bristol Caverns
- Cumberland Caverns
- Forbidden Caverns
- Lost Sea
- Raccoon Mountain Caverns
- Ruby Falls
- Tuckaleechee Caverns

Communication with managers of these caves has been initiated by the FWS in an effort to achieve greater consistency in use of measures to minimize the spread of WNS. Discussion will continue regarding use of measures being used at sites such as Mammoth Cave National Park, including: web site notification to potential visitors regarding methods for limiting the spread of WNS, query of visitors regarding recent cave exploration, limitation of gear to specific caves, and decontamination of clothing and gear.

Caves open to the public present unique education opportunities. General WNS information (e.g., a pamphlet developed by the National Speleological Society) is being provided at some commercial caves. We will pursue the enhancement of information flow at caves that are not already distributing educational materials.

Presence/Absence Surveys

On April 2, 2009, the U.S. Fish and Wildlife Service's Southeast Region notified individuals who are authorized, or who have applied for authorization, for recovery-related take of Indiana bats (*Myotis sodalis*), gray bats (*M. grisescens*), Ozark big-eared bats (*Corynorhinus townsendii ingens*), or Virginia big-eared bats (*C. t. virginianus*). Others authorized to work with species in caves where bats hibernate were also contacted. The recipients of this notification were apprised of the Service's March 26, 2009, advisory which recommended closure of caves in WNS affected states and adjoining states to avoid spreading WNS and issued instructions to recipients to restrict access to all caves in Kentucky, Tennessee, and North Carolina. The advisory did allow for cave entry for WNS research and in other circumstances. However, recipients were instructed to coordinate with the FWS contact office on their permit.

All research conducted with federally listed species in caves/mines in Tennessee should therefore be coordinated with the Service's Cookeville Field Office via the following email address: *david_pelren@fws.gov* or by telephone (office): 931/528-6481, ext. 204.

Research conducted with any other species should be coordinated with the Tennessee Wildlife Resources Agency via the following web site: www.state.tn.us/twra or by telephone: 615/781-6610.

When assessing potential summer roosting caves (i.e., gray bats) and/or hibernacula (i.e., Indiana and/or gray bats) to determine presence/absence of federally listed species for regulatory or project review purposes, a Portal Habitat Assessment is still an acceptable first

step in determining the potential use of a cave or mine portal by bats. If this assessment concludes that the cave/mine portal has potential to be used by bats, the consultant should notify the TWRA and FWS – Cookeville Field Office personnel via the email addresses listed above to determine proper methods and obtain site specific guidance for continued investigation. See the March 2006 document "*Coal Mining in Tennessee, Minimum Guidelines for Development of Protection and Enhancement Plans for the Indiana Bat (Myotis sodalis)"* (http://www.fws.gov/cookeville/pdfs/ibatpeptn308.pdf) for guidance on Portal Habitat Assessments. All biologists conducting bat surveys in Tennessee must adhere to guidance presented in the document "Disinfection Protocol for Bat Field Research/Monitoring" (USFWS, June 2009). Updates to these protocols can be found at http://www.fws.gov/northeast/white_nose.html#. In addition to this guidance, the following conditions apply to all bat projects in Tennessee, including surveys, monitoring, and research:

- The date for initiating presence/absence surveys for project review purposes in Tennessee is May 15 as was stipulated in the March 2006 guidelines for bat surveys in the context of coal mining permit reviews.
- In accordance with the section in "Disinfection Protocol for Bat Field Research/ Monitoring" (USFWS, June 2009) concerning notification of signs of WNS, notify TWRA and FWS – Cookeville Field Office at the email addresses provided above if signs of WNS are observed while working with bats.
- Harp trapping and mist-netting during fall will be avoided to the greatest extent feasible in an effort to minimize bat-to-bat transfer of WNS.

Summer 2010

During the summer of 2010, ongoing monitoring and research projects continue to provide data to enable the following:

- Develop baselines at gray bat colonies to assess impacts due to WNS.
- Monitor for signs of previous infection.
- Determine rates of bat return to sites in years following the initial appearance of WNS in an effort to address the potential for development of immunity to WNS.
- Determine potential routes of WNS transmission via bat migration.

These data are generated through a number of approaches including mist netting, monitoring of selected bat colonies using both trapping/direct measurements and thermal-infrared census techniques, monitoring bat communities at the landscape scale using repeated acoustic surveys along selected road routes, and coordinating with parties conducting bat research projects in Tennessee.

Bat Colonies

Bat colony monitoring involves two approaches: 1) banding bats and collecting data on reproductive condition

(Table 1) and 2) conducting emergence counts for selected gray bat colonies (Table 2). Capture methods for banding and reproductive condition assessment differ depending on the type of colony (e.g., cave, man-made structure, etc.), but the information collected is standardized. Subsequent to banding, the following data is collected for each bat:

- Species
- Sex
- Reproductive condition (pregnant, lactating, post lactating, non-reproductive)
- Age (adult or juvenile)
- Wing Damage Index (Reichard and Kunz 2009)
- Weight and/or forearm length (optional)

Table 1. Bat colonies at which banding and assessment of physical condition are conducted.

Cave/Colony	Agency	Species
Ament Cave	USFWS	Gray bat (mixed)
Bellamy Cave	TWRA	Gray bat
Beth Page Bridge	AAFB	Little brown bat, gray bat
Caney Hollow	AAFB	Gray bat (mixed)
Oaks Cave	TWRA	Gray bat
Pearson Cave	TWRA	Gray bat (bachelor)
Trussell Cave	AAFB	Gray bat (bachelor)
White Buis Cave	TWRA	Gray bat (maternity)
Yell Cave	AAFB	Gray bat (maternity)

Reproductive Condition

Some bats exhibiting WNS symptoms survive to emerge from hibernation during spring. These bats exhibit negative effects of WNS, including reduced fat reserves at time of emergence and extensive wing damage that likely reduces flight and foraging efficiency. These and other physiological factors, if not lethal during the summer following hibernation, could nonetheless affect reproductive condition and potentially disrupt delayed implantation or embryo development (Britzke pers. comm.). Therefore, the reproductive condition of all captured female bats is assessed. A reproductive index is calculated as the percent of females classified as reproductive out of the total number of females captured. Continued monitoring of the reproductive index at these caves should detect any dramatic changes over time.

Sampling should be concentrated during the first two weeks of June or the second week of July, in order to minimize disruption of nursing and early volancy of pups (Britzke pers. comm.). The number of bats sampled should be determined according to the number and experience level of persons conducting the sampling. Captured bats will be held no longer than 30 minutes in order to minimize stress as dictated by FWS permits for endangered bat species.

Thermal Infrared Emergence Counts

The COE adapted a Thermal Target Tracker (T3) system to provide a method for conducting emergence counts at gray bat summer colonies, which is now the preferred method of the FWS in Tennessee. The T3 system utilizes thermal infrared video of emergences to track individual bats as they emerge from a roost and counts those bats for a total emergence count. This process minimizes observer bias and simplifies sampling protocols compared to previously used emergence count methods. Staff from AAFB, TNC, and TWRA began monitoring selected summer gray bat colonies using this technology in 2008. Recognizing the importance of acquiring unbiased, repeatable population estimates prior to the potential appearance of WNS in Tennessee, efforts to conduct summer gray bat emergence counts were expanded for a total of 22 caves. Emergence counts should be conducted between the dates of May 15 and June 30 when colonies are stable and before pups are volant.

Pre- and Post-volancy counts were attempted at five caves in 2009 in order to get a measure of productivity. However, no significant information was gained at the five caves at where this was attempted. Therefore it was recommended that harp trapping be used as the preferred method to determine productivity.

Table 2. Bat colony annual T3 system counts.

Cave	Agency
Ament Cave	FWS
Alexander Cave	TNC
Bat Cave (Lincoln Co.)	AAFB
Bellamy Cave	TWRA
Caney Hollow Cave	AAFB
Duds/Haile Caves	TNC
Featherfoot Cave	TVA
Gallatin Steam Plant	TNC
Herron Cave	TNC
Little Cedar Mountain Cave	TVA
Knowles Ridge Cave	AAFB
Marble Bluff Cave	TVA
Markham Cave	TNC
Nickajack Cave	TVA
Norris Dam Cave	TVA
Oaks Cave	TWRA
Pearson Cave	TWRA
Rose Cave	TWRA
Shipman Creek Cave	AAFB
Tobaccoport Cave	TNC

Cave	Agency
Trussell Cave	AAFB
White Buis Cave	TWRA
Woods Dam*	AAFB
Yell Cave	AAFB

***Standard maternity census – not counted using TIR system.**

Mist net Surveys

Mist net surveys are conducted to capture free flying bats that do not form summer colonies in caves or man-made structures in addition to those captured at colonies. Subsequent to banding, the following data is collected for each bat:

- Species
- Sex
- Reproductive condition (pregnant, lactating, post lactating, non-reproductive)
- Age (adult or juvenile)
- Wing Damage Index (Reichard and Kunz 2009)
- Weight and forearm length

Mist netting will be conducted at AAFB, Catoosa Wildlife Management Area (WMA), Rocky Fork WMA, and North Cumberlands WMA.

Wing Damage Assessment

White-nose syndrome manifests itself visibly on the nose, ears, and flight membranes of bats. It is thought that individuals surviving winter mortality events exhibit some degree of scarring to the flight membranes during the summer period. Reichard and Kunz (2009) developed a Wing Damage Index (WDI) to rank the degree of damage and/or scarring. This methodology is used to assess wing damage levels both at colony monitoring sites and for any other cave bats captured in the normal course of inventory efforts. These data and any documentary photographs will be provided to TWRA in electronic format.

WDI is assessed subsequent to aging while the wing membrane is illuminated. Photographs are used to document bats determined to have a WDI greater than 1. If the number of individuals with WDI greater than 1 is overwhelming, a subsample is photo-documented.

Banding

Bats have been observed in affected caves in years following initial detection of WNS; yet, it is not clear whether any of these bats have survived exposure during the initial mortality event or if all (or many) are new individuals immigrating from elsewhere (Britzke pers.comm.). In an attempt to resolve this uncertainty, all bats captured at colony monitoring sites are banded. Those sites are monitored annually to determine whether previously banded individuals return in years subsequent to initial detection of WNS.

With the exception of *Lasiurus* species, all bats captured in the course of mist netting are also banded. Additionally, other researchers working in Tennessee will be encouraged to band all bats captured in the normal course of inventory efforts. All banding data will be entered into the Southeast Bat Diversity Network Bat Capture Database

(see section on Data Storage and Analysis).

Acoustic Surveys

Diversity and relative abundance are key measurable bat community parameters that may change if WNS significantly impacts bat populations in Tennessee. These parameters are monitored at the landscape scale by conducting road surveys using bat echolocation call recording equipment. Road route surveys are conducted one to three times each year according to guidelines provided by Britzke and Hicks (up-to-date guidelines may be obtained by contacting Dr. Britzke at Eric.R.Britzke@usace.army.mil). The routes are distributed among representative habitats in numerous Tennessee counties. Note that local grottos (i.e., chapters) of the National Speleological Society (NSS) are assisting in this data collection effort. In Tennessee, 31 acoustic routes are run covering 23 counties in 2009 (Figure 5), but this number may vary from year to year based on available personnel.

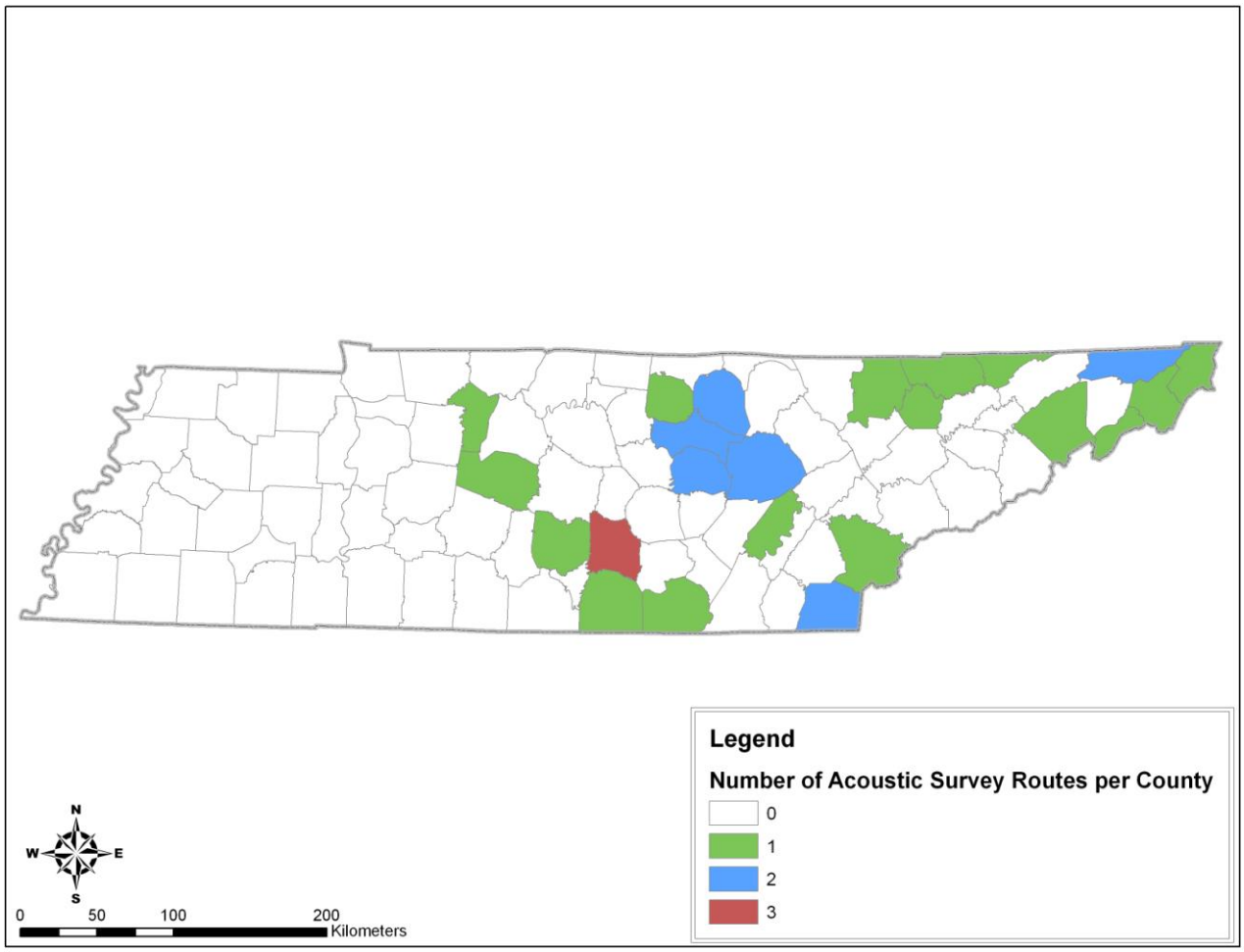

Figure 5. Distribution of acoustic survey routes by county in 2009.

Winter 2010/2011 Hibernacula Monitoring

Hibernacula monitoring this winter will be broken into four categories (Table 6):

- WNS Surveillance
- WNS Mortality Monitoring
- Biennial Indiana Bat Census
- A single Gray Bat Census

Criteria used in the selection of caves included species diversity and population size. Attempts will also be made to obtain bat population data for other previously lesser-known hibernacula.

Surveys are scheduled based upon a number of factors: 1) geographic location a) in relation to known WNS positive caves and b)even distribution across middle and east Tennessee, 2) species present, 3) survey intensity (tiers), and 4) the need to document mortality in known WNS positive caves. When possible, geographic clusters of caves were identified where surveys could be temporally spread out among the caves within a cluster. This allows us to reduce disturbance to bats within any single cave while being able to monitor a geographic area for the appearance of WNS. Hibernacula of all cave-dwelling bats are included in the surveys. Big brown bats (*Eptesicus fuscus*) will be documented opportunistically as encountered in surveys of other species, but will not be targeted specifically due to typically low hibernation densities.

WNS Surveillance

A two tiered approach will be used to monitor caves for the appearance of WNS and, in some cases, to track trends in bat populations. Tiers are based on the intensity and frequency of the survey methods (Table 3).

Table 3. Description of tiered bat monitoring strategy for Tiers 1 and 2.

	Methods
1	Full Hibernacula Count – full survey of hibernating bats, visual examination of bats for signs of WNS, band recovery
2	Rapid Survey – cursory population estimate, examination of roosting bats for signs of WNS, band recovery

Tiered monitoring allows the intensity of surveys to be modified based upon the need to survey caves while balancing the need to reduce disturbance to hibernating bats. The survey effort may vary within a cave by species. For example, a cave with a large number of Indiana bats and a few little brown bats may be surveyed at the tier 1 level for Indiana bats and the tier 2 level for little brown bats. These varying tiers are based upon the different survey needs for each species and the inevitable disturbance. Detailed tier and sampling methodologies are described below. Surveyors are expected to sketch a map of caves, indicating locations of bats. In addition, high-resolution digital photography will be used as possible during tier 1 and tier 2 surveys to document apparent presence of WNS, numbers of bats, and species.

At caves where WNS has yet to be documented, Tier 2 surveys will be conducted. Caves will be entered to document any significant changes in populations. These surveys will be performed by individuals familiar with historical populations when possible. Because population data on non-listed species is minimal, initial surveys will be

used as the baseline when necessary. Hibernating bats will be visually examined for WNS external symptoms. Bats exhibiting potential but inconclusive symptoms may be handled for closer examination. Bats with previously-applied bands will be handled to retrieve band numbers, provided the researcher can retrieve them safely. If not, color(s) of band(s) and the forearm to which it attached (i.e. left and/or right) will be noted. Additionally, the surface temperature of the cave wall near the roost will be recorded.

Tier 2 surveys and banding will continue just prior to emergence in caves where this effort was initiated in the winter of 2009/2010 (Table 4; Figure 6). Banding will aid in documenting the return of individuals to the same cave or movement to other caves.

Information gained in this effort is expected to be used as a basis for management decisions in the future. Additional information regarding other hibernacula and for additional species is needed to increase this effort and obtain a larger data set.

In addition, the appropriate agency and individuals will respond to any reports from the public of WNS symptoms in caves or the surrounding landscape to assess the reported situation.

Figure 6. A tri-colored bat banded in Rice Cave in 2010 (photo by John Lamb)

WNS Mortality Monitoring

WNS was confirmed in six caves (Table 5, Figure 4) and three species (Figures 7-9) beginning in February of 2010. These caves will be monitored to document the level of mortality in the winter of 2010/2011 (Table 6).

Figure 7. A healthy tri-colored bat in Tobacco Port Cave in 2009 (photo by John Lamb)

Figure 8. A healthy N. long-eared bat in Tobacco Port Cave in 2009 (photo by John Lamb)

Figure 9. A healthy Indiana bat in Tobacco Port Cave in 2009 (photo by John Lamb)

WNS-infected and non-infected bats will be banded at these caves and any other newly documented occurrences. Observation of banded bats in years following initial mortality events, combined with additional banding in late spring once a site is found to be affected, could provide conclusive evidence whether some individuals are able to survive exposure to an environment shared with other WNS affected individuals. Additionally, the surface temperature of the cave wall near the roost will be recorded.

Biennial Indiana Bat Census

These counts follow the standard method for monitoring hibernating Indiana bats (USFWS 2007). All Tier 1 surveys being conducted as a continuation of ongoing survey efforts at significant hibernacula will occur between January 15 and February 15, the time period during which hibernacula monitoring for gray and Indiana bats has historically occurred. However, to reduce disturbance, only the four caves (White Oak Blowhole, Bull, Kelly Ridge, and Wolf River caves; Table 6) identified in the previous census as containing the majority of Indiana bats will receive full counts. Census at these caves will capture approximately 92% of those counted in 2009 (Andrew King pers. comm.).

Bats will be visually examined for external signs of WNS while the survey is conducted. Banded bats will be handled to collect band information, provided the researcher can retrieve it safely. If not, the color of the band will be noted. Additionally, the surface temperature of the cave wall near the roost will be recorded.

Table 4. Number of bats banded and estimated total number of bats at non gray bat hibernacula in the winter of 2009/2010 (Lamb and Wyckoff 2010)

Cave	Little brown bat		Indiana bat		Tri-colored bat		Rafinesque's big-eared bat	
	Banded	Total# bats	Banded	Total# bats	Banded	Total# bats	Banded	Total# bats
Whiteside Cave	0	0	0	0	44	327	0	0
Rice Cave	3	6	16	32	8	167	0	0
Zarathustra Cave	2	8	37	51	0	15	0	0
Little Bat Cave	0	0	0	0	0	2	15	63
Measles Gulf Cave	0	0	0	0	0	12	52	156
Rose Cave			29	50				
Total	**5**	**14**	**82**	**133**	**52**	**523**	**67**	**219**

Table 5. WNS Positive caves and species in winter 2009-2010.

(Showed symptoms, but not collected for analysis)*

County	Cave	Date	Species
Sullivan	Worley (aka Morril's) Cave	2/8/2010	Tri-colored bat (*Perimyotis subflavus*)
Montgomery	Dunbar Cave	3/5/2010	N. long-eared bat (*Myotis septentrionalis*)
Carter	Grindstaff Cave	3/8/2010	N. long-eared bat (*Myotis septentrionalis*) Tri-colored bat (*Perimyotis subflavus*)
Van Buren	Camps Gulf Cave	3/23/2010	Tri-colored bat (*Perimyotis subflavus*)
Blount	White Oak Blowhole Cave	3/30/2010	Little brown bat (*Myotis lucifugus*) Indiana bat (*Myotis sodalis*)*
Fentress	East Fork Saltpeter Cave	4/5/2010	N. long-eared bat (*Myotis septentrionalis*)

Table 6. Cave survey schedule for winter 2010/2011. (Note: An "X" denotes presence of a species but no recent survey data. "Tier 2 (B)" denotes that bats will be banded in association with a tier 2 survey. "M" indicates mortality monitoring.)

						Species Count/Estimate During Most Recent Survey							
Cave Name	WNS (Yes/No)	County	People	Jan 15 - Feb 15	Feb 15 - Apr 15	COR A	EPFU	MYGR	MYLE	MYLU	MYSE	MYSO	PISU
Bull Cave		Blount	USFWS/NPS/KVRS	Tier 1						236	12	2,097	25
Gregory's Cave		Blount	USFWS		Tier 2	4							
Kelley Ridge Cave		Blount	USFWS/KVRS	Tier 1		350	1		1	996		904	149
Scott Gap Cave		Blount	USFWS		Tier 2					165	11	40	383
White Oak Blowhole Cave	Yes	Blount	USFWS/NPS/UTK	Tier 1 (M,B)						766	12	7,983	
New Mammoth Cave		Campbell	TNC/TWRA/USFWS		Tier 2(B)		3		3	282	7	88	
Norris Dam Cave		Campbell	TVA		Tier 2								42
Carter Saltpeter Cave		Carter	TNC/TWRA		Tier 2								
Poga Road Cave		Carter	TNC/TWRA		Tier 2								
White Buis Cave		Claiborne	TWRA		Tier 2								
Rattling Pit Cave		Cocke	USFWS/KVRS	Tier 1				16,200					

				Species Count/Estimate During Most Recent Survey									
Cave Name	WNS (Yes/No)	County	People	Jan 15 - Feb 15	Feb 15 - Apr 15	CORA	EPFU	MYGR	MYLE	MYLU	MYSE	MYSO	PISU
Grindstaff Cave	Yes	Carter	TNC/TWRA		Tier 2 (M)						X		X
Hardin (Junkyard) Cave		Davidson	TWRA		Tier 2					X			
Coriolis Cave		Fentress	TNC		Tier 2 (B)								
Cornstarch Cave		Fentress	TNC/TWRA		Tier 2 (B)					210		188	
East Fork Saltpeter Cave	Yes	Fentress	TNC/TWRA/USFWS		Tier 2 (B/M)					395		115	
Little Jack Creek Cave		Fentress	TNC/TWRA		Tier 2(B)							10	
Redbud Cave		Fentress	TNC/TWRA		Tier 2(B)					12		5	
Wolf River Cave		Fentress	USFWS/TWRA/TNC/COE	Tier 1				10		754		762	
Zarathustras Cave		Fentress	USFWS/AAFB		Tier 2 (B)					8		51	15
Signature Cave		Franklin	TWRA/AAFB		Tier 2 (B)								
Carlton Cave		Franklin	TWRA/AAFB		Tier 2 (B)								
Pearson Cave		Hawkins	TNC/TWRA		Tier 2			208,191				500	

						Species Count/Estimate During Most Recent Survey							
Cave Name	WNS (Yes/No)	County	People	Jan 15 - Feb 15	Feb 15 - Apr 15	COR A	EPFU	MYGR	MYLE	MYLU	MYSE	MYSO	PISU
Whiteside Cave		Marion	TWRA/AAFB		Tier 2 (B)								327
Bellamy Cave		Montgomery	TWRA/FC		Tier 2(A)			152,159					
Coleman Cave		Montgomery	TNC/TWRA/FC		Tier 2								
Cooper Creek Cave		Montgomery	TNC/TDEC /Amie		Tier 2 (B)							X	
Dunbar Cave	Yes	Montgomery	TWRA/TDEC		Tier 2 (B?/M)								X
Alexander Cave		Perry	TNC/TWRA		Tier 2							6	
Marble Bluff Cave		Roane	TVA		Tier 2								92
Tobaccoport Saltpeter Cave		Stewart	TNC/TWRA/FC		Tier 2 (B)		34	54		207	2	82	39
Worley (aka Morril's) Cave	Yes	Sullivan	TNC/TWRA		Tier 2 (M)								X
Oaks Cave		Union	TWRA		Tier 2 (B)								
Cagle Saltpeter Cave		VanBuren	TDEC/AAFB		Tier 2							2	
Camps Gulf Cave	Yes	VanBuren	TDEC/AAFB		Tier 2 (B/M)							X	

						Species Count/Estimate During Most Recent Survey							
Cave Name	WNS (Yes/No)	County	People	Jan 15 - Feb 15	Feb 15 - Apr 15	COR A	EPFU	MYGR	MYLE	MYLU	MYSE	MYSO	PISU
Rice Cave		VanBuren	TDEC/AAFB		Tier 2					6		32	167
Rose Cave		VanBuren	TWRA/AAFB/USFWS		Tier 2 (B)			503		540		50	
Hubbard's Cave		Warren	TNC/AAFB		Tier 2			513,084				500	
Little Bat Cave		Warren	TNC/AAFB		Tier 2 (B)	63							2
Lost Creek Cave		White	TNC/TWRA/USFWS		Tier 2(B)							35	
Measles Gulf Cave		White	TNC/AAFB		Tier 2 (B)	156							12

Gray Bat Census

Censuses of the majority of the high priority gray bat hibernacula in Tennessee were conducted in 2010 (Samoray 2010). The single exception is Rattling Pitt Cave in Cocke County (Table 6), which will be accomplished this winter subject to landowner permission.

Data Storage and Analysis

The need for a central database for bat data has long been recognized by most bat biologists. Estimates of population trends, banding records, and other data are essential to the response to and monitoring of WNS in Tennessee. Absent such a database, biologists are forced to seek out and compile data, published and unpublished, from individual studies in order to answer questions that require data from a large geographic region – e.g., across an entire species' range. To facilitate data use, we will contribute data gathered during the monitoring projects described in this response plan to the Southeast Bat Diversity Network / Northeast Bat Working Group (SBDN/NEBWG) database. Individuals will be responsible for entering all bat data they collect into the SBDN/NEBWG database (http://www.sbdn.org/Bat_DB 2006.html). However, surveyors may take advantage of a recent offer from personnel of the University of Tennessee to provide data entry and management services. Data collected in Tennessee will provide a means for evaluating effects of WNS on bat populations now that it has appeared in the state. Historical data will be entered into the database as time allows.

Federal and State Permits

Federal Section 10 Permits

In addition to the monitoring of bat health, several other activities may result in the take of bats - lethal or otherwise. Because two federally listed species will likely be affected, authorization to conduct the following WNS-related activities has been permitted through an Endangered Species Act section 10(a) (1) (A) recovery permit:

1. hair clipping
2. banding
3. harp trapping and mist netting during non-hibernation seasons
4. attachment of radio transmitters to bats
5. attachment of light tags to bats
6. collection of fecal material
7. collection of wing punches for genetics studies and other analyses
8. salvage of dead bats for submittal (a) to labs for white-nose syndrome testing, (b) to researchers conducting white-nose syndrome related research, or (c) to museums seeking specimens or tissues of gray and Indiana bats
9. entry of caves and man-made structures harboring endangered species for monitoring, surveillance, and research
10. installation of remote bat detection equipment
11. use of acoustic monitoring systems to record bat vocalizations
12. euthanizing bats with advanced symptoms of white-nose syndrome for the purpose of laboratory examination for white-nose syndrome or other testing/research – no more than two bats per species per cave

State of Tennessee Permits

Use of Tennessee's Wildlife for Scientific Purposes

Tennessee Code Annotated 70-2-213, requires persons wanting to take, capture, and transport Tennessee's wildlife for scientific purposes to have a Scientific Collection Permit. Application for the free permit can be made electronically through the Tennessee Wildlife Resources Agency's website at http://www.state.tn.us/twra/. The applicant's name, address, and affiliated organization must be completed on the application. The applicant must also specify the number of any species to be taken under the permit along with an explanation of the need. Explanation of the need to use Tennessee's wildlife for scientific purposes must be reasonable and valid. The permit is valid for a one-year period and requires the applicant to coordinate collections with the appropriate TWRA Regional Office. An annual report must be submitted on or prior to the expiration date. It must include the number and dispositions of collections made under the permit.

Collection of Animal Life on State Forests

Tennessee State Rule 0080-07-1 prevents the abuse and misuse of the natural resources found on state forests. Section .03 allows persons officially representing a reputable scientific or educational institution(s), federal or state agencies to be permitted for such collecting by the District Forester. Activities to be conducted and appropriate justification must be submitted to the appropriate District Forester's Office. The Forestry Division is divided into four Administrative Districts as shown on the map below:

Approvals may also be required as provided by law, rule or regulation to collect or take wildlife by the Tennessee Wildlife Resources Commission (T.C.A 70-2-213 above) or TDEC (see below). Coordination by the applicant with the appropriate agencies would facilitate issuance of a dual permit as needed.

TDEC

Possession of a TDEC permit is required by surveyors in addition to FWS & TWRA permits for any bat-related work to be conducted on lands owned or managed by TDEC. An "Application for Scientific Research and Collecting Permit" may be submitted by an individual or organization. The application is located online at http://www.tennessee.gov/environment/permits/parkcoll.shtml. The application should include a description of all potential activities, a list of parks or natural areas involved, names of individuals to be covered by the permit, and approximate dates of the proposed surveys or other action. The application should also include the specification that the WNS cooperators will coordinate directly with personnel of each park or natural area.

East Tennessee District Thomas E. Dailey, District Forester P.O. Box 2666 Knoxville, TN 37901-2666 Voice: (865) 594-6432, Fax: (865) 594-8907	**Cumberland District** Richard Merinar, District Forester 390 South Lowe, Suite 10 Cookeville, TN 38501-4702 Voice: (931) 526-9502, Fax: (931) 526-2279
Highland Rim District Gerald Eaton, District Forester 3497 Church Street Burns, TN 37029 Voice: (615) 797-3117, Fax: (615) 797-3113	**West Tennessee District** Roy Ward, District Forester P.O. Box 438 Lexington, TN 38351 Voice: (731) 968-6676, Fax: (731) 968-5356

Response to Observation of WNS in Caves

General Response Procedure

Upon determination that bats within a particular hibernaculum appear to be affected by WNS (i.e., exhibiting WNS symptoms such as characteristic white muzzles), the following actions will be taken:

- Bats that appear to be affected will be photographed if possible.
- Estimate:
    - the current number of roosting bats by species
    - the number of infected bats, also by species if possible.
- Collect and process any bats for testing, carcasses, and wing material for submittal to researchers.
- Disinfect all clothing and gear in accordance with "Disinfection Protocol for Bat Field Research/ Monitoring" (USFWS, June 2009) and dedicate gear to future surveys as specified in the protocol.

In accordance with the section in the FWS disinfection protocol concerning notification of signs of WNS, notify TWRA and FWS–Cookeville Field Office at the email addresses provided on page i of this plan.

WNS Laboratory Confirmation and Disposition of Specimens

Laboratory Confirmation

Upon determination that bats within a particular hibernaculum appear to be affected by WNS, two bat carcasses per cave will be submitted (if available) to the Southeastern Cooperative Wildlife Disease Study for analysis and laboratory confirmation of WNS. Samples may also be sent to the U.S. Geological Survey's National Wildlife Health Center if necessary (USGS – NWHC, 2008; USGS – NWHC, 2009).

Upon confirmation of *Geomyces destructans* and/or WNS, the cooperators will be notified, and public notices will be placed on the web sites of TWRA and the FWS. In addition, new records will be forwarded as appropriate to facilitate updates of the national WNS occurrence map. Cal Butchkoski (Pennsylvania Game Commission) currently updates the map.

Table 7. SCWDS personnel and contact information.

Name	Position	E-mail
Dr. Justin Brown	Wildlife Disease Diagnostician and Postdoctoral Associate	jubrown1@uga.edu
Dr. John Bryan	Postdoctoral Associate	Jabryan@uga.edu
Dr. Sonia M. Hernandez-Divers	Assistant Professor	sdivers@warnell.uga.edu
Dr. M. Kevin Keel	Assistant Research Scientist	mkkeel@uga.edu
Dr. Mark Ruder	Vet Med Graduate Assistant	mgruder@uga.edu

Submittal of Other WNS Specimens and Samples

Whole or partial specimens from deceased bats are needed from differing areas and species as investigations into the cause(s) of WNS continue. This material can be used in studies of WNS, genetics, and other aspects of bats. At least two museums are currently serving as warehouses to supply researchers with samples – the American Museum of Natural History (AMNH) and Smithsonian Institution National Museum of Natural History (NMNH). Both of these have agreed to accept samples from Tennessee. Although efforts to limit the duration of cave visits in order to minimize bat disturbance may affect our

ability to collect material to some extent, the cooperators will attempt to collect the number of specimens and samples described below.

The primary point of contact for the Smithsonian Institution National Museum of Natural History (NMNH) is Dr. Suzanne Peurach (PEURACHS@si.edu). The NMNH has requested that at least 25 – 30 specimens of each species appearing to be infected by WNS be submitted annually. If available, 30 specimens of each species will be submitted from Tennessee. Bats will be retained in freezers of individual researchers and gathered for batch submittal at the end of the hibernation season by the FWS Cookeville Field Office.

The primary contact for submission to the American Museum of Natural History (AMNH) is Dr. Nancy Simmons (simmons@amnh.org). The AMNH has requested that wing biopsies of any bats found (i.e., those infected by WNS in addition to non-infected bats) be submitted. Scissors or other appropriate implements may be used to remove a 3-millimeter diameter section of material from wings of deceased bats, but sterilization procedures must be followed. Additional information regarding submissions to the AMNH can be found at http://research.amnh.org/mammalogy/batgenetics/.

Biopsies are to be submitted in sample tubes (containing ethanol) supplied by the AMNH, which will also cover all shipping costs. In addition to the specimen forms, copies of permits documenting that the bats were collected legally are also required. The AMNH has requested that a maximum of 20 specimens per year per species be submitted to allow population-level comparisons. The FWS's Cookeville Field Office will request and distribute the sample tubes needed; and the FWS will collect and submit the samples at the end of the winter sampling season.

Outreach, Public Education, and Cooperation with Partners

Public education has been initiated through several media. This effort will be expanded, including coordination with professionals that work with bats or in/near their habitats. The following methods are being pursued:

- WNS talking points – State and federal agencies and non-governmental organization partners will coordinate during fall 2010 to update talking points (including reports of unusual bat sightings to TWRA and/or FWS) for the news media and other interested groups in Tennessee. The FWS will lead this effort.

- Meetings with NSS grottos – TNC, TWRA, and FWS have participated in WNS discussions at meetings of the East Tennessee Grotto, Nashville Grotto, and Upper Cumberland Grotto. The status of WNS, cave closure advisories, and development of this plan have been discussed at the meetings.

- State and county health departments – The director of the rabies program has been contacted by TWRA and advised that the county health departments may receive reports of dead bats from the public. The WNS fact sheet and a contact list will be provided to the state

health department for circulation among the county offices.

- Wildlife nuisance control personnel – The WNS fact sheet will be provided to permittees by TWRA.

- Wildlife rehabilitation specialists – Although it is illegal to rehabilitate bats in TN, the WNS fact sheet will be provided to permittees by TWRA.

- Archaeological study permits – The FWS's "Disinfection Protocol for Bat Field Research/Monitoring" will be provided via the state archaeologist to entities permitted to conduct archaeological studies at cave sites.

- TWRA hunting guide – Hunters are asked to report unusual bat sightings to TWRA or FWS personnel.

- Tennessee Bat Working Group website – Educational material will be provided in fall/winter 2010, including information regarding methods for reporting unusual bat sightings.

- Web site reporting – Recent press releases requested that the public report unusual bat sightings to the FWS. During July 2009, the FWS received three of these reports for sites in Tennessee. Reporting to TWRA and the local FWS office will be requested in the future.

- Reporting mechanism for state – TWRA will provide information for reporting on its website.

- Other opportunities for notification of the public and partners will be pursued as they become available.

Research

The Service's March 2009 advisory recommended that all non-WNS related research conducted in caves and mines should be coordinated with federal and state conservation agencies, who should weigh potential benefits of research projects involving entry into caves against the risk posed to bats. The advisory acknowledged that much of the research currently under way in bat hibernacula is related to WNS and/or monitoring, and continued research is essential to advancing our understanding of WNS. In Tennessee, several research projects are underway or are planned that specifically address WNS or will otherwise provide valuable information about cave-dwelling bats (Table 8).

Table 8. Ongoing research related to cave-dwelling bats.

Subject	Principal Investigators	Relevant Data
Effects of prescribed fire on roosting habitat of the endangered Indiana bat, *Myotis sodalis* **Location: Cherokee and Nantahala National Forests, Great Smoky Mountains National Park**	• Susan Loeb • Joy O'Keefe	• Banding bats captured during sampling • Assessing damage of captured bats' wings • Conducting telemetry study to locate specific roost trees for 6-8 adult females • Developing logistic regression models related to (1) roost tree and plot characteristics, and (2) stand and landscape traits of roost sites
Dunbar Cave surveys and bat monitoring **Austin Peay "Bat Project"**	Andrew N. Barrass	• Mapping of cave use by tricolor bat and other species-using Microscale GIS- photographing wings and banding • "Bat Project" web page for community education regarding WNS-University sponsored • Harp trapping and mist netting at Dunbar cave, early emergence (spring) - photographing wings and banding • Acoustic Monitoring of bats along 3, 30-mile transects and at 5 site locations in the U.S. Forest Service's , Land Between the Lakes National Recreation Area (Summer and Fall)

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