White-nose Syndrome
Cooperative Monitoring and Response Plan
for Tennessee

November 24, 2009

Cooperators

Arnold Air Force Base (AAFB)
Austin Peay State University (APSU)
National Park Service (NPS)
Tennessee Department of Environment and Conservation (TDEC)
Tennessee Valley Authority (TVA)
Tennessee Wildlife Resources Agency (TWRA)
The Nature Conservancy (TNC)
U.S. Army Corps of Engineers (COE)
U.S. Fish and Wildlife Service (FWS)
U.S. Forest Service (USFS)
University of Tennessee (UT)

This plan should be cited as: Arnold Air Force Base et al. 2009. White-nose Syndrome Cooperative Monitoring and Response Plan for Tennessee.

Comments and questions regarding this plan should be submitted to:

FWS via email (or phone): *david_pelren@fws.gov* (931/528-6481, ext. 204)

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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 2007, WNS was documented in four additional caves in New York. All five sites were within a ten-mile radius and west of Albany. By March 2008, WNS had spread to hibernacula in three additional states: Vermont, Massachusetts, and Connecticut (Science Strategy Meeting 2008). By May 2009, WNS was confirmed inVirginia (Figure 1). Specimens from a cave in Smyth County were confirmed for WNS in spring 2009 by the National Wildlife Health Center. Therefore, WNS is currently less than 100 miles from one or more major bat

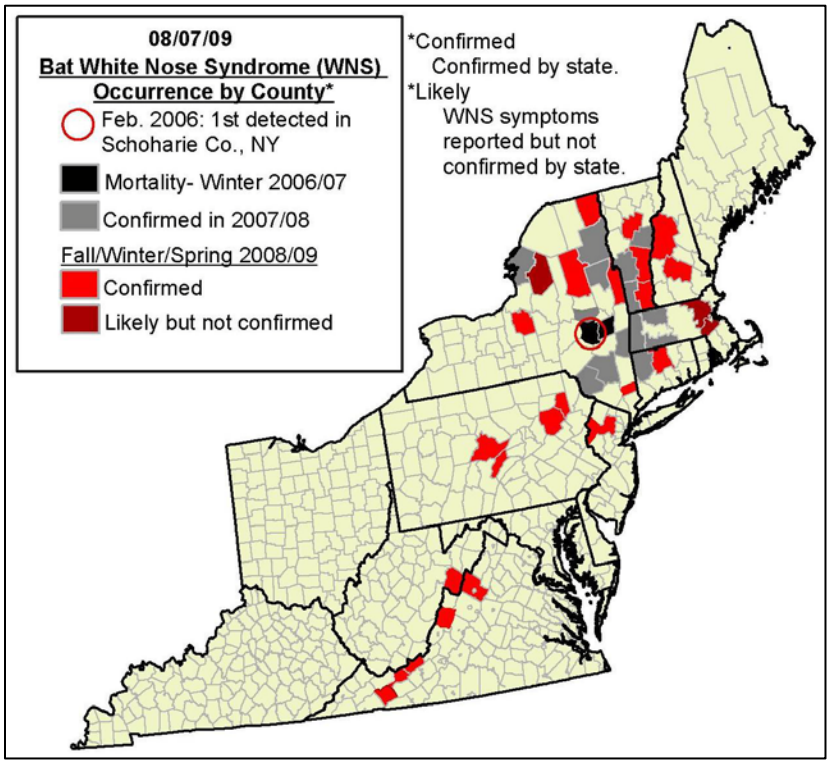

Figure 1. Extent of WNS as of August 7, 2009.

hibernacula in Tennessee (Figure 2). These hibernacula include a gray bat (*Myotis grisescens*) Priority 1 cave (i.e., in Tennessee - a cave used by 50,000 or more gray bats). The gray bat is federally listed as endangered. Based on previously observed patterns and rates of spread, we anticipate that WNS could appear in bat populations in Tennessee as early as winter 2009-2010. Given the long-distance migratory movements of gray bats (Tuttle 1976), movement patterns of gray bats recently banded at AAFB and caves in middle Tennessee (see Figure 3), and the tendency for gray bats to roost in large colonies, this species could potentially serve as a vector for the transmission of WNS throughout the southeastern U.S.

WNS has had a devastating impact on populations of bats in the northeast U.S. (Turner and Reeder 2009). Population declines in excess of 95 percent have been documented in some colonies, occurring over a period of two to three years following initial observation of WNS-related symptoms. Some populations continue to decline 3 to 4 years following initial observations (Britzke pers. comm. 2009, Youngbaer 2009). Bats affected by WNS typically display some or all of the following characteristics: (1) a white fungus that grows on nose, ears, and/or wing membranes; (2) depleted white and brown fat reserves by mid-winter; (3) a reduced capacity to arouse from deep torpor; (4) ulcerated, necrotic and scarred wing membranes; and (5) atypical behavior causing bats to emerge prematurely from hibernacula in mid-winter or to roost in atypical locations within caves (Science Strategy Meeting 2008).

On March 26, 2009, the U.S. Fish and Wildlife Service issued an advisory recommending closure of caves in the affected states and adjoining states to avoid spreading this disease. The FWS (Cookeville Field Office), TWRA, and TNC coordinate with state, federal, and private partners to ensure broad and consistent implementation of this cave closure advisory on public and private lands in Tennessee. Implementing cave closures across Tennessee will minimize the potential for humans to contribute to the spread of WNS by transporting fungal spores among caves in the region.

This white-nose syndrome monitoring and response plan has been developed in response to the recent confirmation of WNS in some bat populations in Virginia. Federal, state, non-governmental, and university cooperators developed this plan to:

(1) coordinate studies that provide valuable baseline data on Tennessee's bat populations,

(2) minimize the potential for monitoring and research projects to contribute to the spread of WNS,

(3) establish a monitoring framework for early detection of WNS in Tennessee populations, beginning during winter of 2009, and

(4) devise a strategy for responding to an outbreak of WNS in Tennessee.

Goals and Objectives

The goals of this plan are to develop the conservation community's strategy for addressing WNS in Tennessee as it relates to monitoring and research, and to describe response measures in preparation for detection of WNS in the state. 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.
- Initiate or continue monitoring and research programs that will provide baseline information used to detect population changes that may indicate an outbreak of WNS.

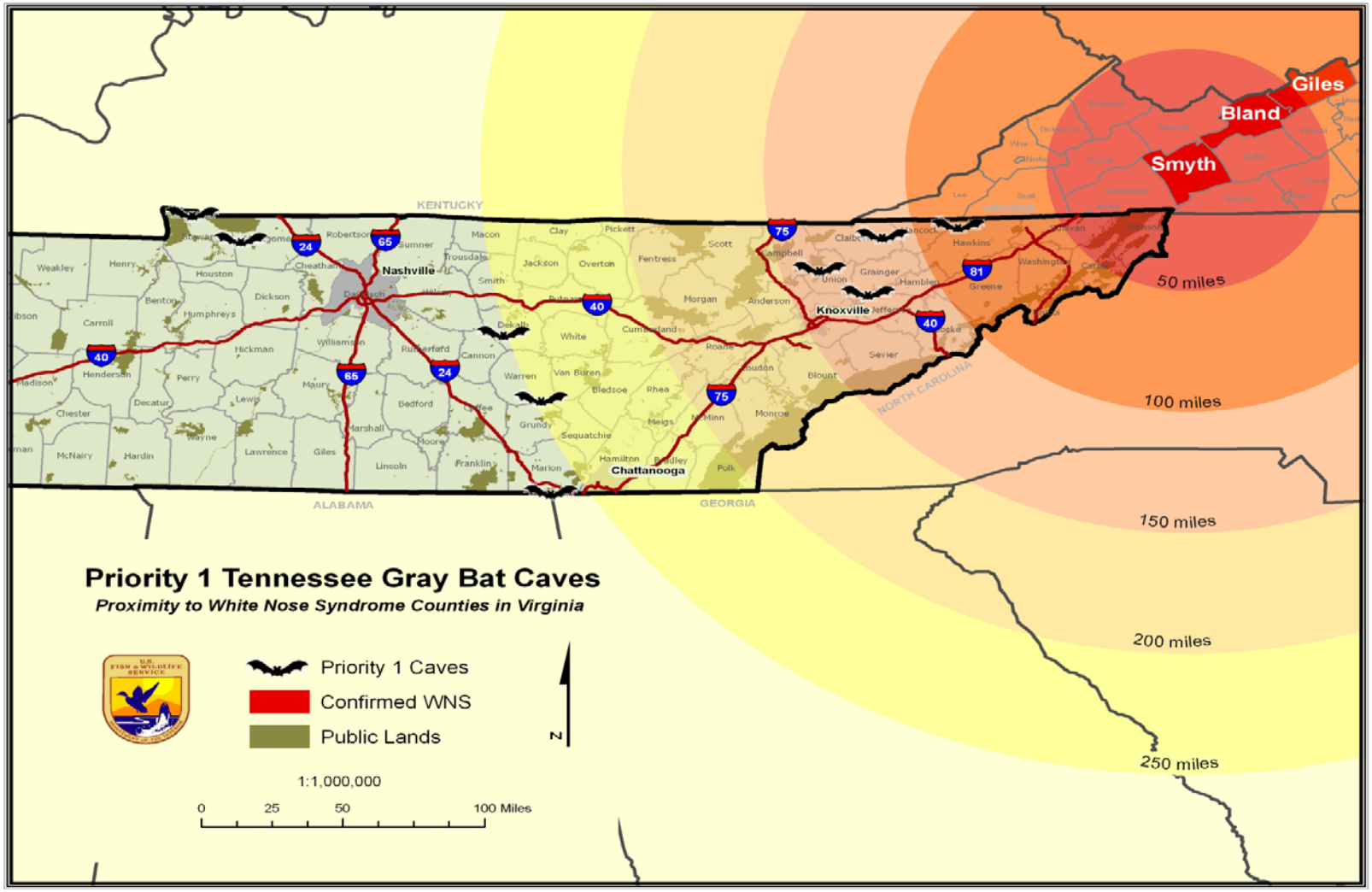

Figure 2. Proximity of Priority 1 gray bat caves in Tennessee to southwest Virginia counties where WNS is confirmed.

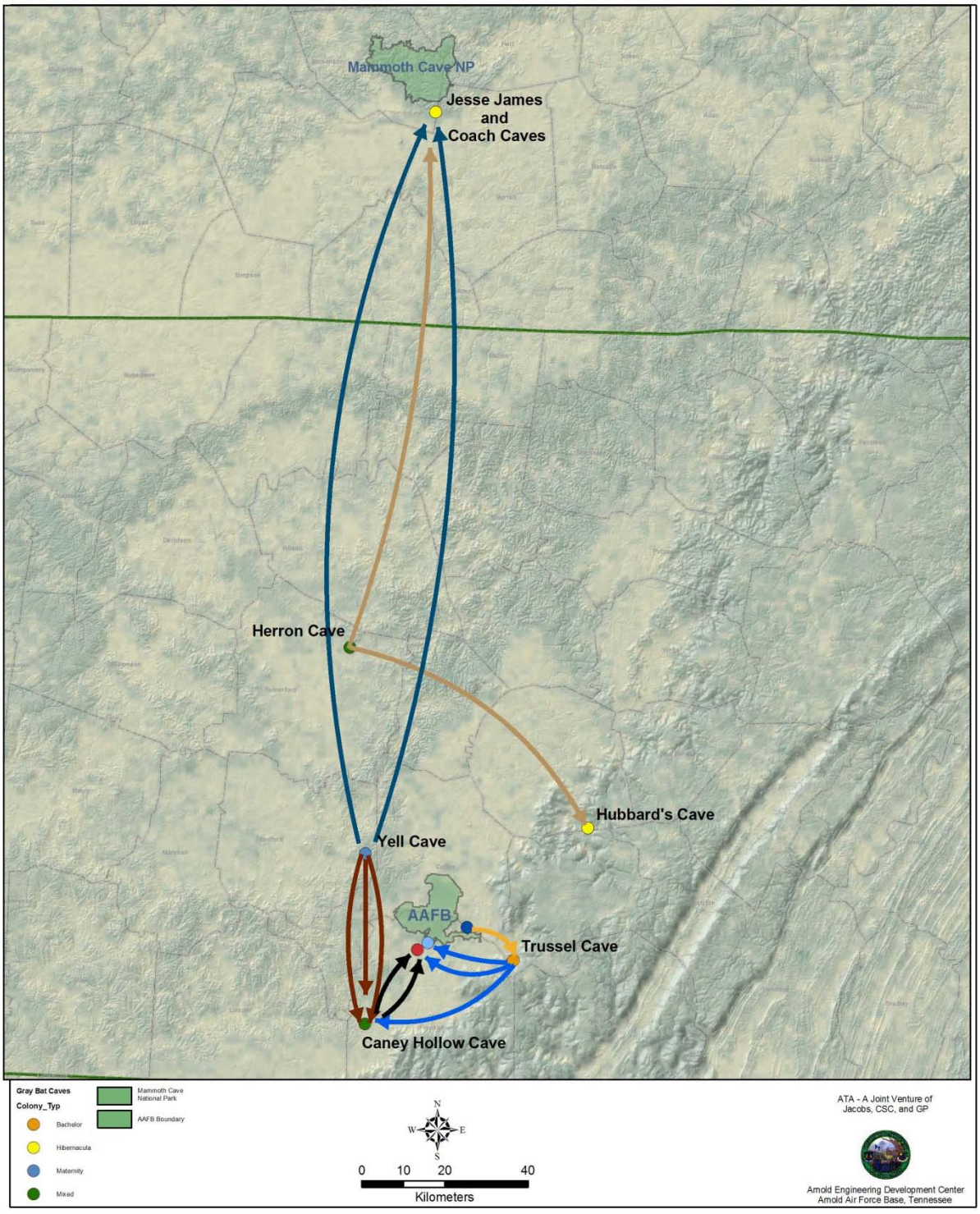

Figure 3. Documented movement of gray bats banded at Arnold Air Force Base and nearby caves in middle Tennessee.

- Identify project reporting protocols and agency contacts.
- Develop a framework for monitoring bat populations during the fall swarming period and after onset of hibernation, in an attempt to detect anticipated occurrence of WNS as early as possible. This will include identification of partners who must be engaged to improve chances for early detection.
- Identify a strategy for responding to reports or direct observations of characteristics described above that are indicative of WNS.

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. Because this advisory allows cave entry for WNS research and in other circumstances, the letter from the Southeast Region instructed recipients to coordinate with the FWS contact office on the 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 email address: *richard.kirk@tn.gov* or by telephone (office): 615/781-6619.

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 was June 1 in 2009, not May 15 as was stipulated in the March 2006 guidelines for bat surveys in the context of coal mining permit reviews. June 1 is also expected to be used as the initiation date in 2010.
- 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 2009

During the summer of 2009, ongoing monitoring and research projects provided a foundation upon which data will be acquired to enable the following: (1) development of baselines to assess impacts to cave-dwelling bat populations that could be affected by WNS in the future, (2) monitoring for signs of previous infection, (3) determining 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, and (4) determining potential routes of WNS transmission via bat migration. These data were generated through a number of approaches, including 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. The most current disinfection protocols issued by FWS were adhered to for all monitoring and research activities conducted in Tennessee (USFWS, June 2009). The following Bat Colony Monitoring section outlines activities that were undertaken at selected colonies of cave-dwelling bats or bats that form colonies in other natural or human-made structures during summer 2009.

Bat Colony Monitoring

White-nose syndrome has not been selective as to which species have been affected in currently impacted caves; therefore, it is desirable to have baseline data for multiple species in order to assess impacts to Tennessee's chiropteran fauna. There is a considerable amount of historic data on many of Tennessee's gray bat colonies, but baseline data generally are lacking for other species that form hibernating colonies and have been affected by WNS in other states. A notable exception to this is APSU's research project examining spatial and temporal patterns of roost use by the tri-color bat (*Perimyotis subflavus*), also known as the eastern pipistrelle, at Dunbar Cave State Park. Therefore, an attempt will be made to obtain baseline information for one or more colonies of several species. WNS has not been documented within the range of gray bats which, unlike the currently affected species, form summer colonies in caves. It is not known whether or how WNS will manifest itself in gray

bat summer colonies. For this reason and to provide data for tracking recovery progress, the number of monitored gray bat colonies was increased.

Bat colony monitoring involves two approaches: banding bats and collecting data on reproductive condition (Table 1) and 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 (Appendix 2)
- 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)
Catoosa checking station	TWRA	Northern long-eared, little brown, &/or big brown bat
Dunbar Cave	APSU	Tricolor bat
Herron Cave	AAFB, TNC, TWRA	Gray bat (maternity)
Little Bat Cave	AAFB, TNC	Rafinesque's big-eared bat
Oaks Cave	TWRA	Gray bat
Trussell Cave	AAFB	Gray bat (bachelor)
Yell Cave	AAFB	Gray bat (maternity)

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 to be monitored annually to determine whether previously banded individuals return in years subsequent to initial detection of WNS. 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.

The only cooperating entity that routinely bands bats in Tennessee is AAFB, which will supply bands to USFWS, TWRA, and TNC for this and other efforts until others acquire bands. Additionally, other researchers working in Tennessee will be encouraged to band all cave bats captured in the normal course of inventory efforts. Contractors or the entity for

which they are working will supply the bands used. All banding data will be entered into the Southeast Bat Diversity Network Bat Capture Database (see section on Data Storage and Analysis).

The gray bat colonies monitored by AAFB are part of a long term banding project. This project has provided useful data indicating potential routes of future spread for WNS (Figure 3). Banding at these sites is conducted after the young are volant to increase capture rates. These sites will therefore be visited twice; once pre-volancy and once post-volancy. We hope that by continuing this project actual routes of spread might be determined.

Reproductive Condition

Some bats have been observed that display WNS symptoms but 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.). While WNS symptoms have not yet been observed in any Tennessee bat colonies, it is possible that maternity colonies here could include individuals that have survived exposure during hibernation in caves further north. Therefore, the reproductive condition of all captured female bats is assessed.

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 45 minutes in order to minimize stress as dictated by FWS permits for endangered bat species.

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 (unpubl.) has developed what he termed 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.

During colony monitoring, 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.

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 FWS. 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 to additional caves for a total of 26 caves. Selected colonies are monitored at least once before and once after the young are volant in an effort to estimate colony productivity. Emergence counts should be conducted between the dates of May 15 and June 30 for those caves where only one count will occur. For caves where measurement of productivity using repeated emergence counts is desired, the pre-volancy count should occur between May 15 and June 15.

As a general rule, the post-volancy count should occur during the period of July 1 to August 15, and preferably July 1 to 31. Gray bats begin to fly approximately three weeks after birth (Harvey et al., 1999). Therefore, if harp trapping can be conducted to more accurately determine the average date of bat births at a maternity colony, post-volancy counts should be conducted no earlier than three weeks after this average date. Assuming that bats may re-locate to other roosts approximately two weeks after young-of-the-year begin to fly, post-volancy counts should be completed within five weeks of the average date of births.

Table 2. Bat colony annual T3 system counts.

Cave	Priority	Agency	Post-volant Census
Ament Cave	2	FWS	Yes
Alexander Cave	2	TNC	Yes
Bat Cave (Lincoln Co.)	2	AAFB	
Bellamy Cave	1	TWRA	Yes
Caney Hollow Cave	2	AAFB	
Duds/Haile Caves	2	TNC	Yes
Featherfoot Cave	2	TVA	
Gallatin Steam Plant	3	TNC	
Herron Cave	2	TNC	Yes
Knowles Ridge Cave	2	AAFB	
Markham Cave	2	TNC	Yes
Nickajack Cave	1	TVA	
Norris Dam Cave	2	TVA	
Oaks Cave	1	TWRA	Yes
Pearson Cave	1	TWRA/TVA	Yes
Rose Cave	2	TWRA	Yes
Shipman Creek Cave	2	AAFB	
Tobaccoport Cave	1	TNC	Yes
Trussell Cave	2	AAFB	

Cave	Priority	Agency	Post-volant Census
White Buis Cave	1	TWRA	Yes
Woods Dam*	2	AAFB	
Yell Cave	2	AAFB	

*Standard maternity census – not counted using TIR system.

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 (Appendix 1). 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. Approximately 27 routes were completed during summer 2009 (Table 3), and data from these routes are being gathered and compiled in fall/winter 2009. A small number of routes may be added in 2010.

Table 3. Distribution of acoustic survey routes by county.

County	Number of Routes	Organization	Specific routes
Bedford/Coffee	1	AAFB	Normandy and Bedford Lakes
Carter/Unicoi	1	USFS	Rock Creek to Little Doe River
Cheatham	1	TWRA	Cheatham Wildlife Management Area
Clay/Jackson	1	NSS	Brimstone Creek to Zion Road (Maberry H & C)
Cocke/Greene	1	USFS	Paint Creek to Meadow Creek Mountain
Coffee/Franklin	2	AAFB	AAFB properties
Cumberland	1	NSS	Grassy Cove/Crab Orchard area
Cumberland/Morgan	1	TWRA	Catoosa Wildlife Management Area
Cumberland/White	1	TWRA	Bridgestone/Firestone Wildlife Management Area
Franklin/Grundy	1	AAFB	Sewanee to Pelham Valley
Franklin/Lincoln/Moore	1	AAFB	Elk River
Jackson	1	TNC	Flynns Lick area
Jackson/Overton	1	FWS	Livingston to Mount Union
Marion	1	TWRA	Prentice Cooper Wildlife Management Area
Maury/Williamson	1	TWRA	Natchez Trace Parkway – Hwy. 96 to Hwy. 7
Monroe	1	USFS	Oosterneck Creek to Tellico River/Ballplay
Monroe/Polk	1	USFS	Reliance to Tellico Plains
Overton	1	FWS	Alpine Mountain to Monterey
Polk	1	USFS	Sina Branch to Ocoee Powerhouse No. 3
Putnam	1	NSS	Cookeville/Brotherton Mountain loop
Putnam	1	TTU	Buck Mountain area
Putnam/White	1	NSS	Lost Creek to State Highway 70
Rhea	1	TWRA	Yuchi Wildlife Management Area
Stewart	2	APSU	Land Between the Lakes
Sullivan	1	USFS	Keenburg to Sowbed Gap

Fall 2009

The TWRA is cooperating with Dr. Eric Britzke on a project to examine migratory patterns of Indiana bats based on stable isotope signatures measured in hair of female bats. Analysis of stable isotope signatures in hair samples makes it possible to estimate the latitudinal range within which individual bats spend their summer months, corresponding to the time for establishing maternity colonies for birthing and rearing of pups. This project was initiated to determine whether a portion of bats found in these Tennessee hibernacula might establish maternity colonies in the Cumberland Plateau and Mountains. Because samples were collected from Wolf River and Cornstarch Caves during fall 2007 and fall 2008, a baseline is available for investigating whether changes in migratory patterns occur in response to WNS or other factors.

Based on analysis of stable isotope signatures between the two sampling periods, the proportion of bats in these hibernacula that spent their summers in more northern areas decreased relative to the proportion that summered in more southern latitudes. This project will continue at least through November 2009, when samples were collected from Wolf River Cave. The bats involved in the isotope analysis are banded, weighed, and assessed for wing damage.

Winter 2009/2010 Hibernacula Monitoring

Tiered Monitoring

A tiered approach will be used to monitor caves for the appearance of WNS and, in some caves, to track trends in bat populations. Tiers are based on the intensity and frequency of the survey methods (Table 4). 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 gray bats and a few little brown bats may be surveyed at the tier 1 level for gray 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.

Table 4. Description of tiered bat monitoring strategy for Tiers 1, 2, and 3.

	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
3	Entrance survey - survey of entrance for roosting bats

Tier 1 is the most intensive survey method, in which a full hibernation count will be performed. These counts have been the standard method for monitoring hibernating Indiana and gray bats. 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. 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.

Tier 2 surveys include a cursory population estimate to evaluate dramatic population fluctuations and an evaluation of roosting bats for signs of WNS. 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, colors of bands will be noted. In addition, WNS-infected and non-infected bats will be banded during the period immediately prior to spring emergence (Table 5). 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.

Tier 3 surveys will involve examination of cave entrances for the presence of bats. Movements of bats to cave entrances and to areas outside caves prior to the usual hibernation emergence period has been observed in WNS infected populations of the northeastern U.S. Therefore, this behavior may provide a simple means of detecting WNS infected populations in Tennessee. A specific list of caves to be surveyed under tier 3 has not been developed, but opportunistic surveys might be conducted as time permits. Caves in close proximity to those monitored under tiers 1 and 2 are most likely to be surveyed under tier 3. Volunteers (e.g., members of National Speleological Society grottos) will assist in this effort where feasible. Caves will not be entered beyond drip lines during tier 3 surveys, and any bats visible inside cave entrances will be handled only by wildlife professionals.

Site Selection and Schedule

Caves were selected based upon available species occurrence data for hibernacula in Tennessee. The cooperators will survey, at a minimum, the caves listed in Table 5. Attempts will also be made to obtain bat population data for other previously lesser-known hibernacula.

Caves were selected to sample as many species as possible and in significant numbers. Surveys are scheduled based upon a number of factors: 1) geographic location, 2) species present, 3) survey intensity (tiers), and 4) potential for management actions in response to findings of WNS-affected bats. 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.

Remote Sensing

Remote sensing techniques may be used during winter 2009/2010 in Tennessee. These techniques would hopefully provide information regarding bat activity that exceeds the known or assumed baseline level. Bat Conservation International (BCI) is evaluating several sites in the Southeast and Midwest for the use of instrumentation that involves a beam-breaking technique. This could provide quantitative and directional information relative to bat movements at one or two sites in Tennessee. If this technology is implemented prior to occurrence of WNS in Tennessee, we could establish baseline bat movement level as a point of reference for future monitoring. Information gained through use of beam-break technology would be used to determine if bat activity (i.e., behavior consistent with WNS) occurs within hibernacula during periods when surveyors are not present. Beam-break monitoring could also be used to determine dates that bats emerge from hibernation. BCI is currently coordinating with entities in several states, and deployment of beam-break equipment at or near the entrances of several caves is anticipated for winter 2009/2010. This equipment would be attached to existing cave gates or to a temporary frame. The availability of resources and ability to address technical issues will dictate if beam-break technology will be implemented this winter.

The use of Anabat instrumentation to detect bat activity during the hibernation period is also being considered. Although this technique would not be expected to provide quantitative data, detection of bat disturbance relative to pre-WNS levels may be feasible. This information would be used to determine if bat behavior consistent with WNS occurs during periods when surveyors are not present. Anabat recorders may be used in conjunction with long-term power sources at one or more sites in Tennessee during winter 2009/2010, and microphones could possibly be placed near roosting sites within caves. This will occur as resources (i.e., time and funding) allow.

Table 5. Cave survey schedule for winter 2009/2010. (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.)

Cave Name	County	Agency/Org	Jan 15 - Feb 15	Feb 15 - Apr 15	Species Count/Estimate During Most Recent Survey							
					CORA	EPFU	MYGR	MYLE	MYLU	MYSE	MYSO	PISU
Bull Cave	Blount	NPS		Tier 2					236	12	2,097	25
Gregory's Cave	Blount	NPS		Tier 2	4							
Kelley Ridge Cave	Blount	NSS		Tier 2	350	1		1	996		904	149
Scott Gap Cave	Blount	NPS		Tier 2					165	11	40	383
White Oak Blowhole Cave	Blount	NPS, FWS		Tier 2					766	12	7,983	
New Mammoth Cave	Campbell	TNC,FWS		Tier 2		3		3	282	7	88	
Rattling Pit Cave	Cocke	NPS, NSS, BCI, TWRA	Tier 1	Tier 3			16,200					
Hardin (Junkyard) Cave	Davidson	TWRA, SCCi		Tier 2					X			
Cornstarch Cave	Fentress	COE,FWS,TWRA,TNC		Tier 2 (B)					210		188	
East Fork Saltpeter Cave	Fentress	FWS, TNC		Tier 2					395		115	
Little Jack Creek Cave	Fentress	TWRA,FWS,TNC		Tier 2							10	
Redbud Cave	Fentress	TWRA,FWS,TNC		Tier 2					12		5	
Wolf River Cave	Fentress	COE, FWS,TWRA,TNC		Tier 2 (B)			10		754		762	
Yggdrasil Cave	Fentress	FWS, TWRA		Tier 1							10	
Zarathustras Cave	Fentress	TWRA, FWS		Tier 2 (B)							100	
Hasson Cave	Hawkins	TNC		Tier 2			X					
Pearson Cave	Hawkins	BCI, TNC, FWS, TWRA	Tier 1	Tier 2			278,357				500	
Bellamy Cave	Montgomery	BCI, TNC, FWS, TWRA	Tier 1	Tier 2			139,364					
Cooper Creek Cave	Montgomery	TWRA,TDEC		Tier 2 (B)							X	
Dunbar Cave	Montgomery	APSU, TWRA,TDEC		Tier 2 (B)					X			X
Alexander Cave	Perry	TNC		Tier 2							6	
Tobaccoport Saltpeter Cave	Stewart	BCI, TNC, FWS, TWRA	Tier 1	Tier 3		34	15		207	2	82	39
Cagle Saltpeter Cave	VanBuren	TWRA, FWS, AEDC, TDEC		Tier 2							2	
Camps Gulf Cave	VanBuren	TDEC, AAFB		Tier 2							X	
Foxhole Cave	VanBuren	FWS,TWRA		Tier 2				X	X			
Rice Cave	VanBuren	TWRA, FWS		Tier 2							20	
Rose Cave	VanBuren	TWRA,FWS		Tier 2 (B)			503		540		40	
Hubbard's Cave	Warren	TNC,TDEC,AAFB,FWS, TWRA	Tier 1	Tier 2			520,326				500	
Little Bat Cave	Warren	AAFB,TDEC		Tier 2 (B)	X							
Lost Creek Cave	White	FWS,TWRA		Tier 2							35	
Measles Gulf Cave	White	TNC,FWS, AAFB		Tier 2 (B)	100							
Whiteside Cave	White	TNC,FWS, AAFB		Tier 2 (B)								X

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 prior to the appearance of WNS in Tennessee will provide a baseline that will be useful for evaluating effects of WNS on bat populations if it appears 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 and the potential use of measures in direct attempts to control WNS in bats (e.g., via euthanasia and use of fungicides), several other activities may result in the take of bats - lethal or otherwise. In order to minimize disturbance of bats, most of these actions would most likely be performed during late fall activities at Wolf River Cave (the only cave being sampled in the fall) or immediately prior to/during spring emergence from hibernacula. Activities 14, 15, and 16, listed below, are not expected to be conducted during winter 2009/2010. Because two federally listed species will likely be affected, authorization to conduct the following WNS-related activities must be 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. transfer of bats from caves to captive populations and return to caves

13. 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
14. euthanizing bats for the purpose of reducing rates of spread of white-nose syndrome
15. application of chemicals for purpose of controlling white-nose syndrome fungal infections
16. blocking bat egress/ingress at cave entrances with mesh netting or other appropriate materials for the purpose of reducing rates of transmission among colonies

In order to expedite authorization of these activities, the Service's Cookeville Field Office will apply for Subpermittee Authorization under the recovery permit held by the Assistant Regional Director, Ecological Services, for the Southeast Region. This permit will name the Cookeville Field Office Supervisor as a subpermittee and authorize designation of biologists from the Service and other cooperating entities as additional subpermittees. However, all designated subpermittees from organizations other than the Service will be required to submit applications for individual authorization to the Service's Southeast Region Office prior to being designated a subpermittee by the Cookeville Field Office Supervisor.

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:

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

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.

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 and 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 7 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). Note that the "Guidelines for Post-Emergence Bat Submission, Summer 2009 (June-October)" document is expected to be revised during fall 2009.

SCWDS has processed samples from West Virginia and Virginia and is prepared to process Tennessee samples. Whole bats should be submitted for necropsy. They should be stored in two or more sealable bags and immediately placed on ice. A blue ice container is preferred; do not use wet ice. Because the appearance of the fungus can change during shipment, the SCWDS contact also requested that bats be photographed as they are collected. These photos should be sent to the lab as well. The submission form (Appendix 2) should be filled out and included in the package. The Chief veterinarian (Kevin Keel) and staff should be notified that samples are being sent. Notifying all staff listed in the table below would ensure that someone on duty is expecting a shipment. In the event that the sample is collected and sent by a cooperator other than TWRA (the contract holder); Richard Kirk, Mark Thurman, or another member of the TWRA staff should be notified when the sample is shipped. SCWDS will be notified that the TWRA is aware of the submission. SCWDS is currently evaluating the process for diagnosing WNS, and all parties will be notified of any changes in the current process.

Table 6. 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

Upon confirmation of 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.

Submittal of Other WNS Specimens and Samples

Whole or partial specimens 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. Specimens should be sent frozen as directed in the instructions in Appendix 3. 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 along with the forms in Appendix 4. Biopsy protocols are also provided in Appendix 5. Scissors or other appropriate implements may be used to remove a 3-millimeter diameter section of material from wings of deceased bats, but the sterilization procedures described in Appendix 5 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.

Disposal of Other Bat Carcasses

Bat carcasses will be removed from caves and properly disposed of. Dead bats should be placed in a sealed plastic bag and placed inside a second bag or container, which is to be handled only with clean gloves. This outer packaging layer is considered clean, uncontaminated, and safe to transport inside a vehicle (preferably contained within a clean cooler). If removal of bats from a particular cave would be overwhelming because of the number of carcasses, then they will remain in the cave.

Experimental Control Measures

WNS is generally expected to be documented within Tennessee during winter 2009/2010 or 2010/2011. Based on trends observed in the northeastern U.S., bat mortality rates of 95 percent or greater could occur at affected roost sites within two years of the documentation of WNS. Faced with many unanswered questions and little time or manpower, resource agencies are scrambling to prepare for and prevent the spread of WNS into and throughout their state(s). To provide guidance to wildlife managers preparing response plans, the US Fish and Wildlife Service convened a structured decision making (SDM) process with selected state wildlife agencies' participation to address the question: What management measures should be taken this year within a given area to control the spread and minimize the effects of white-nose syndrome on hibernating bats at the individual and population levels? The draft guidelines developed in response to this question focused on the area encompassing sites that are greater than 250 miles from the nearest site of infection, which effectively excluded nearly half of Tennessee. **However, the draft guidance recommended that no experimental control measures be implemented in the area analyzed, at least during winter 2009/2010, and in following this recommendation we are implementing no experimental control measures in Tennessee during this period.**

Despite this, below we describe experimental control measures that have been considered by the cooperators who prepared this plan. These include treatment of bats with chemical compounds to control *G. destructans*, culling of WNS-affected individuals from the hibernating colonies, and blockage of bat movements into or out of affected hibernacula. However, none will be implemented until such time as an addendum to this plan is prepared that provides: justification for doing so, methods, and the experimental framework for applying treatments. This addendum would also address site selection factors, including: potential for enacting various control treatments at the site, ability to treat all bats affected by WNS within a hibernaculum, number of bats exhibiting WNS symptoms, timing of the detection of WNS, size of the roosting bat colony, geographic area (especially relative to the

leading edge of WNS-affected sites), proximity to other bat hibernacula, presence of endangered species, biological diversity of the cave, and potential for human disturbance.

Treatment with Chemical Compounds

Several chemical compounds have been initially screened for their effectiveness in killing a surrogate to *Geomyces destructans* by Dr. Hazel Barton (University of Northern Kentucky) and her colleagues. One potentially promising biodegradable compound has been identified and is being tested by Dr. Kevin Keels (Southeastern Cooperative Wildlife Disease Study - SCWDS) on *G. destructans*. Additionally, current research is being conducted to determine the efficacy of other compounds.

Contact with Dr. Barton will be maintained on a regular basis to determine the appropriate chemical to be used during treatment efforts. Appropriate methods for application of the chemical/s will also be discussed. Methods may include direct spraying of a compound onto bats or an area of cave or placement of open containers within a portion of a cave to allow for volatilization throughout a localized area. The cooperators will coordinate with our colleagues conducting analogous efforts in Kentucky, and this research will serve as a field test of chemical compounds in reducing transmission rates of WNS in newly-affected sites.

Attempts will be made to treat all bats within a hibernaculum that exhibit WNS symptoms such as characteristic white muzzles. The treatment will be applied approximately once per two to four week period, averaging once per three week period, until the hibernation season is complete. The most appropriate chemical dilution and application method is being developed. At this time, the best application method involves use of a spray bottle (possibly a scent mister) to deliver a slow, continuous mist over the bats. This requires use of eye protection and gloves. Chemical compounds will not be used in situations where flowing water would transport materials outside of the area of treatment.

Culling Treatment

A minimal number of bats that exhibit white muzzles that are characteristic of WNS will be euthanized ("culled") in attempt to minimize the spread of *G. destructans* within roosting bat colonies. Bats would be euthanized with the use of isofluorene, an anesthetic commonly used by veterinarians, or by similar appropriate means. Liquid isofluorene would be used to saturate a cotton ball, which is placed in a sealed plastic bag with a bat for 30 minutes. The bats can be sent to laboratories and used in testing of other compounds and exposure methods.

Blockage of Bat Movements

Some hibernacula may also provide scenarios that are conducive to blockage of bat ingress or egress. This option is being considered. Bats in the northeastern portion of the country have exited caves prior to the standard hibernation emergence period, only to perish in sub-freezing temperatures. However, it has been suggested that some of these individuals could reach and infect nearby caves. Transmission of WNS to unaffected roosting bats in other caves is of concern in these situations. Therefore, blockage of an entire cave or portions of a cave may result in minimization of the spread of WNS.

However, bats in Tennessee may be able to feed during invertebrate emergences in late winter. Thus, the possibility for improved body condition and subsequently greater survival rates could potentially be increased. Although speculative, winter air temperatures in the southern U.S. lend greater potential for this scenario. It is anticipated that blockage of bat movements into and out of caves will remain a point of discussion during winter 2009/2010.

Cave Visitation Management

Cave Closures on State- and Federally-owned Lands

On March 26, 2009, the Service released a cave advisory due to the spread of WNS in bats in the northeast. The advisory recommended voluntary measures designed to limit the role of humans as a potential vector for spreading WNS within the northeast and to other regions. One of the recommended measures was a voluntary moratorium, effective immediately, on all caving activity in states known to have hibernacula affected by WNS, and all adjoining states, unless conducted as part of an agency-sanctioned research or monitoring project. In response to this recommendation the following cave restrictions have been instituted in Tennessee:

- The Great Smoky Mountains National Park closed its caves to public access on April 3, 2009. This closure will continue for an unspecified period.
- The Cherokee National Forest closed its caves and mines on May 21, 2009 for a period of one year.
- Beginning July 1, 2009, state agencies closed all caves on publicly-accessed property through May 2010, and The Nature Conservancy concurrently closed all caves located on its properties. The state closures restrict public access to all caves and abandoned mines on land managed by the TWRA, TDEC, and the Tennessee Department of Agriculture's Division of Forestry. These lands include state parks, natural areas, forests, and wildlife management areas. The sole exception to this closure is Dunbar Cave State Park, at which Tennessee State Parks provides tours for the public.

Personnel of the Corps of Engineers also intend to close caves on their properties. The FWS is coordinating with the COE to accomplish this. Signs are being provided by the FWS in November 2009, and they are expected to be posted this fall.

Management of Caves Open to the General Public

The following caves in Tennessee are expected to remain open to public visitation for an unspecified period:

- Dunbar Cave State Park
- 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.

Some caves offer extra opportunities for exploration or overnight excursions (i.e., Appalachian Caverns, Cumberland Caverns, Lost Sea, and Raccoon Mountain Caverns). These may have a greater potential for the transfer of *Geomyces destructans* spores from WNS-affected caves and to caves occupied by bats that are not affected by WNS. Therefore, many of the measures for minimizing the spread of WNS will focus on caves that offer "wild tours" and overnight visitation.

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.

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 2009 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 – The 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 2009, 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 7).

Table 7. 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
Roost ecology of the federally endangered Indiana bat Location: Cherokee and Nantahala National Forests, Great Smoky Mountains National Park	• Susan Loeb • Joy O'Keefe	• Banding bats captured during sampling • Conducting telemetry to locate roost trees for up to 10 individuals each of Indiana and northern long-eared bats • Document roost selection criteria for each species at multiple scales • Compile information on roosting behavior for each species

Dunbar Cave bat monitoring	• Andy Barrass	• Mapping of cave use by tricolor bat and other species
Testing of the efficiency of control mechanisms to limit the spread of WNS	• Eric Britzke	• Analysis of WNS control methods, including culling, application of fungicide, and blockage of bat egress and ingress out of/into caves
Use of beam-break instrumentation at bat hibernacula	• Mylea Bayless • Michael Baker	• Remote monitoring of bat activity during hibernation
Development of a method for sampling of fungi within cave sediments	• David Blehert	• Detection of *G. destructans* within cave sediments

References

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Appendix 1

Using Acoustic Surveys to Monitor Population Trends in Bats
Prepared by Eric R. Britzke and Carl Herzog

Bat populations are potentially being impacted by 2 relatively recent sources of mortality: White Nose Syndrome (WNS) and wind energy development. While it is often easy for us to document the mortality of these 2 factors at a particular site, the impact of these sources of mortality on bat populations is currently unknown. For example, a large number of bats are dying from WNS at affected hibernacula, but it is unknown if some bats are leaving the hibernacula and dying in the surrounding landscape or if the bats are relocating to other sites and surviving until typical emergence. Additionally, since researchers are not aware of all bat hibernacula we cannot assess the impacts to all hibernating bats from a population perspective. In the case of wind turbine mortality, we can estimate the number of bats killed but we have, at best, a poor idea of population size and the ability of these populations to sustain this rate of mortality. Therefore, in addition to hibernacula surveys and post construction mortality surveys at wind-power sites, we need a supporting method to assess the impacts to multiple species on a broad geographic scale.

Several techniques can provide useful data on bats during the maternity season. Exit counts at maternity roosts can provide information on local level and assessment of reproductive conditions of bats can determine the impacts on reproductive rate. However, these techniques are focused on sites that can be effectively counted or on species that can be captured at roost sites.

Recording of echolocation calls of bats as the researcher moves along a transect has been commonly used in Europe to monitor bat populations. Ultrasonic detectors are a cost effective method for monitoring multiple bat species at large spatial scales. A framework for the use of this technique includes the following points:

1. The transect (an example map is attached)
    a. should be ~ 30 miles long along a path that minimizes sampling the same stretches of road (1 way straight line movement).
    b. should be safe to drive the transect at 20 mph
    c. should pass through common habitat types of the area
    d. should minimize the amount of time spent driving on roads with small forested corridors.
    e. should be easily sampled in successive years
    f. These are simply guidelines. If you cannot come up with a transect that is 30 miles long then use a shorter version.
2. Sampling
    a. Any type of bat detector that allows for recording of echolocation calls can be used (except time expansion systems). The important thing is that the same type of detector is used whenever a transect is sampled.
    b. Sampling should be done during the time when bats are on their maternity range. To exclude most of the migrants, the period of June 1 to July 15 is probably a pretty good guide.
    c. Monitoring should only be conducted on nights that are suitable for bat activity (low wind, no rain/fog, suitable temperatures for bat activity)

d. The bat detector should be placed on the roof of the vehicle pointed straight up.
e. Sampling should be initiated 30 minutes after sunset
f. The transect should be sampled a minimum of 1 – 3 times throughout the summer. If you are going to sample a site multiple times then it is best to spread out sampling throughout the maternity season
g. If possible, it is advisable to use a computer attached to a GPS unit to mark the location when the recording is being conducted. Alternatively, you can mark the transect with a GPS when you are not sampling. Each transect should be marked with a GPS point for the start and end points and an associated map with the route marked. Basically, we need to have some record of the route.
h. An example datasheet is attached.
i. Sensitivity of the detector should be ~ 7 for Anabat. If possible it is always a good idea to calibrate the equipment to make sure that it is functioning properly.

This document was written for people that are already familiar with their acoustic equipment. People that are not familiar with the technology should seek guidance from knowledge people in their area.

We are also looking for people interested in coordinating this project in their state. If you would like to help organize the effort in your state, please let me know.

Data can then be downloaded and sent to me at:

Eric Britzke
US Army Engineer Research and Development Center
EE-E/ Building 1006
3909 Halls Ferry Road
Vicksburg, MS 39180
Phone (601) 634-3641
Email: Eric.R.Britzke@usace.army.mil

ACOUSTIC TRANSECT DATASHEET

Investigator Name(s): _____

County: _____ **Date:** _____

Anabat ZCAIM # _____ **Transect Code or # (ex. KY-Scott Co.-1)** _____

Start lat/long (decimal degrees): **N** _____ **E** _____

End lat/long (decimal degrees): **N** _____ **E** _____

	Time	Temp. (F)	Wind Speed	Moon Visible?	% Cloud Cover	Moon Phase			
Start Survey:						**new**		**3/4**	
End Survey:						**1/4**		**full**	
						1/2			

Comments (ex. high insect noise, lots of traffic, break in sampling, etc):

_____

_____

_____

_____

_____

_____

_____

Please attach map with any corrections/additions/comments

Example transect route

Appendix 2

White-Nose Syndrome Submission Form

State ID Number_____ **SCWDS ID Number**_____

Date Collected: _____/_____/_____ Date Shipped for testing: _____/_____/_____
(Ship for next day delivery - receipt is not available on weekends)

Person completing this form:

Name:_____ Date: _____/_____/_____

Agency:_____ Phone:_____ Fax:_____ Email:_____

Date of initial report: _____/_____/_____ Date bat(s) were discovered: _____/_____/_____

Name of initial observer: _____ Phone: _____

Number of sick or dead bats seen:_____ Total number of bats submitted:_____

Species of bats: _____
(If multiple species are present please provide a label on the bats with their appropriate species. Please provide the #of each species)

Brief History: _____

_____

Location of bat(s):

Name of the cave: _____ UTM Coordinates:_____

Address (if available): _____

City: _____ County: _____ Zip code: _____

Bats should not be submitted if autolyzed (only ship freshly dead bats). They should be in an individual water-tight bag with the species written on the bag. They should be placed in a second water-tight bag and shipped overnight on sufficient ice packs to keep them cold for the duration of shipping. Use plastic coolers or styrofoam coolers designed for shipping. Ship samples overnight so that they arrive Monday through Thursday. We cannot receive samples on the weekend. Prior to shipping, please notify Kevin Keel or Letitia Saunders by telephone at 706-542-1741.

Bats should be sent to:

Dr. Kevin Keel
589 D.W. Brooks Drive
Southeastern Cooperative Wildlife Disease Study
College of Veterinary Medicine, University of Georgia
Athens, Georgia 30602-4393

Form Updated 10-20-09

Appendix 3

Instructions for shipping mammal material to the National Museum of Natural History

US Postal Service (for mummified or dried material for id)

ATTN: Suzanne Peurach
USGS Patuxent Wildlife Research Center
Smithsonian Institution
National Museum of Natural History
PO Box 37012
Room 378 MRC 111
Washington, DC 20013-7012

Overnight Shipping (for frozen, whole mammals for id and/or incorporation into research collections)

For FedEx or UPS Shipments:
ATTN: Suzanne Peurach
USGS Patuxent Wildlife Research Center
National Museum of Natural History
Room 378 MRC 111
10th Street and Constitution Ave NW
Washington, DC 20560-0111

Division of Mammals Contact Information

Suzanne Peurach
202-633-1277
peurachs@si.edu

- Data should be written in permanent ink or pencil, preferably on a label in an outer bag to prevent it from getting wet or bloody
- Include date, location found, who found it, and any additional notes about habitat, behavior, etc.
- Please include a copy of any required collecting or salvage permits for your area.
- Make sure animals are double bagged, frozen prior to shipping, and packed with frozen ice packs. If you do not have cooler/ice packs, contact S. Peurach.
- When sending fresh-frozen material, please call first so we know to look for it, and never send it on a Friday. Our shipping office is closed over the weekend.

Appendix 4

American Museum of Natural History
Central Park West at 79th Street
New York, NY 10024-5192

SPECIMEN TRANSFER FORM

The objects described below have been sold/given to AMNH by:

Name _____ Tel: _____

Institution of Affiliation, if relevant: _____

Address: _____ Fax: _____

email: _____

To the American Museum of Natural History, Department of Mammalogy. These specimens are hereby transferred with no limiting conditions or restrictions. I hereby represent that I have full right and title to the objects hereby transmitted and authority to dispose thereof.

Specimen # or Number of Specimens with Description:

I collected/obtained the material through legal means from:

If the material was obtained from outside the United States of America, I verify that it was imported into the US by legal mean and I have provided copies of all relevant documentation (permits, field notes, etc.)

If these specimens were collected on State or Federal lands within the US, please attach a letter specifying where and when. Include copies of all permits or relevant correspondence.

Date of Delivery of object(s) to the AMNH: ____/____/____

Seller's/ Donor's Signature: _____ Date: ____/____/____

Curator's Signature: _____ Date: ____/____/____

Gift ☐ Exchange ☐ Purchase ☐ Other ☐

1/1999 rev'd 12/2006

Appendix 5

WING PUNCH AND HAIR SAMPLING PROTOCOLS

Tissue and hair samples can be taken from live bats. Follow normal protocols for safe and humane handling of the animals. If you are going to take wing punches or hair samples, plan ahead and make sure you have the necessary equipment.

See http://research-staging.amnh.org/mammalogy/batgenetics/conditions.htm for more information on donating samples.

List of Equipment:

Lighter (to flame instruments)
Vials containing storage solution for membrane punches
Empty vials for hair samples
Storage box for vials
Fine-point or tissue forceps
Iris scissors
Biopsy punches (3 mm)
Bottle of alcohol or alcohol swabs for wiping instruments and surface
Latex gloves (optional)

To request vials for storing samples, contact Nancy Simmons (simmons@amnh.org)

Biopsy punches can be obtained from many sources. One source is VWR
http://www.vwrsp.com/catalog/product/index.cgi?catalog_number=82030-344&inE=1&highlight=82030-344

Wing Punches:

Wing punches are small (3mm) circles of skin removed from the wing membrane using a biopsy punch. Based on recaptures of sampled bats, the holes in the membrane usually grows back within 2-3 weeks, so there are no long-term effects. Bats are commonly captured while mistnetting with holes in their wings that are much larger than those inflicted by wing punching, and these holes don't appear to result in a loss of flight ability. When taking tissue from the wing membranes, take the samples from close to the body (between the leg and the fifth digit in the wing); this is thought to minimize the effect on flight performance. Do not punch areas with large blood vessels.

1. Flame the biopsy punch and forcep thoroughly to sterilize them and ensure that no tissue or hair from the last bat remains. The instruments should get hot.

2. Let the instruments cool by placing them on the vial box in such a way that the business ends do not touch anything and therefore remain sterile. If you don't let them cool, you will cauterize the bat's skin when you take the punch, which may prevent proper healing of the hole.

3. Wipe the instruments with an alcohol swab to remove any residue from the flaming and let the instruments dry for a few seconds.

4. Remove the bat from its holding bag and stretch the wing over a flat, hard or semi-hard surface (cutting board, clipboard, binder, cardboard, etc.). While the membrane is stretched, press the punch down onto the membrane of one wing close to the legs (between the legs and the fifth digit), and twist and/or rock the punch slightly until you can tell the punch has gone through the membrane on all sides. There is no need to hammer the punch down through the membrane, and doing so will decrease the life of the punch. Each punch can be reused multiple times (5-40 depending on how hard you are on it), but please use your judgement as to how well the punch is cutting, and dispose of punches as soon as they start to dull.