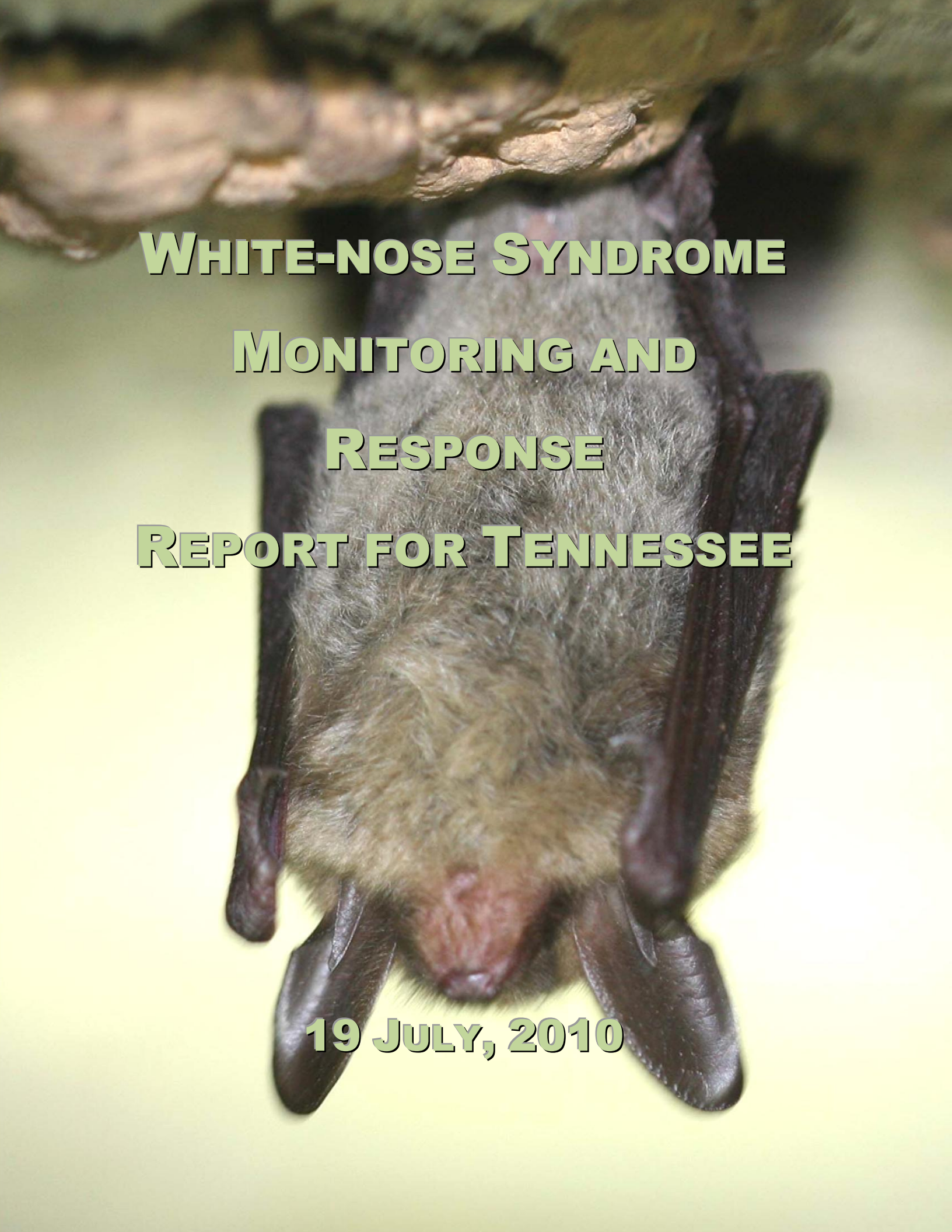

White-nose Syndrome Monitoring and Response Report for Tennessee

19 July, 2010

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Cover photo of Northern long-eared bat (Myotis septentrionalis) in Tobacco Port Cave by John Lamb

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Introduction

This report summarizes data collected by all the cooperating agencies in Tennessee during the period covered by the White-nose Syndrome Cooperative Monitoring and Response Plan for Tennessee (Arnold Air Force Base et al. 2009). The results of independent research projects are not included.

At the time of the writing of the plan, white-nose syndrome (WNS) had been 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 in Virginia. Specimens from a cave in Smyth County were confirmed for WNS in spring 2009 by the National Wildlife Health Center. Therefore, WNS was less than 100 miles from one or more major bat hibernacula in Tennessee. 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 anticipated 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 at caves in Middle Tennessee, and the tendency for gray bats to roost in large colonies, it was thought that this species could potentially serve as a vector for the transmission of WNS throughout the southeastern U.S.

WNS continues to spread. An up-to-date map of the range as well as current information can be found at the USFWS WNS web page (http://www.fws.gov/WhiteNoseSyndrome/).

All biologists conducting bat surveys in Tennessee adhered to guidance presented in the most recent disinfection protocol from the USFWS (http://www.fws.gov/WhiteNoseSyndrome/). Additionally, only one cave per day was visited to allow time for thorough decontamination. Any equipment used in a WNS positive cave was discarded or dedicated to use only in that cave.

Methods

Summer 2009

During the summer of 2009, ongoing monitoring and research projects provided a foundation upon which data was 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) evaluate site fidelity in years following the initial appearance of 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 harp 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 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

There is a considerable amount of historic data on many of Tennessee's gray bat colonies. At the time of the writing of the response plan, WNS had not been documented within the range of gray bats which, unlike the currently affected species, form summer colonies in caves. It was not known whether or how WNS would 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 involved two approaches: 1) banding bats and collecting data on reproductive condition and 2) conducting emergence counts for selected gray bat colonies. Capture methods for banding and reproductive condition assessment differed depending on the type of colony (e.g., cave, man-made structure, etc.), but the information collected was standardized. Subsequent to banding, the following data was 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)

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 were banded. These 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.

Other researchers working in Tennessee were encouraged to band all cave 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).

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. 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. It was hoped that by expanding 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.). Therefore, the reproductive condition of all captured female bats was assessed.

Sampling was concentrated during the first two weeks of June and 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 was determined according to the number and experience level of persons conducting the sampling. Captured bats were 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 and Kunz (2009) developed a Wing Damage Index (WDI) to rank the degree of damage and/or scarring. This methodology was 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 were provided to TWRA in electronic format.

During colony monitoring, WDI was assessed subsequent to aging while the wing membrane was illuminated. Photographs were used to document bats determined to have a WDI greater than 1.

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 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 to additional sites for a total of 16 caves. Selected colonies were monitored at least once before and, when possible, once after the young were volant in an effort to estimate colony productivity. Emergence counts were conducted between the dates of May 15 and June 30 for caves where only one count occurred. For caves where measurement of productivity using repeated emergence counts was desired, the pre-volancy count occurred between May 15 and June 15.

As a general rule, the post-volancy count occurred 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.

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 were 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 (pers. comm.). The routes were distributed among representative habitats in numerous Tennessee counties. Note that local grottos (i.e., chapters) of the National Speleological Society (NSS) assisted in this data collection effort. Data was submitted to Eric Britzke for analysis and compilation into a national data set.

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 was available for investigating whether changes in migratory patterns occur in response to WNS or other factors.

An extension of this project was undertaken in the spring of 2009 and 2010 with the main goal being to locate maternity colonies of Indiana bats within the North Cumberlands of Tennessee. Female Indiana bats identified by stable isotope signatures as likely to summer within the project area were captured, fitted with radio transmitters, and tracked along migration routes to diurnal roosts.

Winter 2009-2010 Hibernacula Monitoring

Tiered Monitoring

A tiered approach was used to monitor caves for the appearance of WNS and, in some caves, to track trends in bat populations. Tiers were based on the intensity and frequency of the survey methods (Table 1). 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 varied 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.

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

Tier	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 was performed. These counts have been the standard method for monitoring hibernating Indiana and gray bats. Tier 1 surveys being conducted as a continuation of ongoing survey efforts at significant gray bat hibernacula occurred between 27 and 30 January 2010 (Samoray 2010), the time period during which hibernacula monitoring for gray and Indiana bats has historically occurred. Bats were visually examined for external signs of WNS while the survey was conducted. Banded bats were handled to collect band information, provided the researcher could retrieve it safely. If not, the color of the band and whether it was on the left or right forearm was noted.

Baseline data generally was lacking for other species that form hibernating colonies and have been affected by WNS in other states. Therefore, an attempt was made to obtain baseline information using Tier 1 surveys as well as banding for one or more colonies of several species during the period immediately prior to spring emergence. Banding will aid in documenting site fidelity. Information gained in this effort is expected to be used as a basis for management decisions in the future.

Tier 2 surveys include a cursory population estimate to evaluate dramatic population fluctuations and an evaluation of roosting bats for signs of WNS. Caves were entered to document any significant changes in populations. These surveys were 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 were visually examined for WNS external symptoms.

Site Selection and Scheduling

Caves were selected based upon available species occurrence data for hibernacula in Tennessee. Caves were selected to sample as many species as possible and in significant numbers. Surveys were 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 allowed us to reduce disturbance to bats within any single cave while being able to monitor a geographic area for the appearance of WNS over a longer period of time.

An attempt was made to include hibernacula of all cave-dwelling bat species in the surveys. Big brown bats were documented opportunistically as encountered in surveys of other species, but were not targeted specifically due to typically low hibernation densities.

Response to Observation of WNS in Caves

General Response Procedure

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

- Bats that appeared to be affected were photographed if possible
- The current number of roosting bats by species and number of infected bats, also by species, if possible, was estimated
- Bats were collected and processed for testing
- TWRA and FWS Tennessee Ecological Field Services were notified

WNS Laboratory Confirmation and Disposition of Specimens

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

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 are contributing 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 are responsible for entering all bat data they collect into the SBDN/NEBWG database (http://www.sbdn.org/Bat_DB 2006.html). Data entry is in progress at the time of the writing of this report. Historical data will be entered into the database as time allows.

Experimental Control Measures

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 guidelines developed in response to this question focused on the area encompassing sites that were 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 implemented no experimental control measures in Tennessee during this period. The time period covered by the SDM has now expired.

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 were 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. 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 was Dunbar Cave State Park, at which Tennessee State Parks provided tours for the public. Dunbar Cave was closed to the public in 2010 after the discovery of a WNS positive bat.
- The Nature Conservancy concurrently closed all caves located on its properties.
- TVA closed their caves on November 10, 2009.
- Personnel of the Corps of Engineers also closed caves on their properties.

Closure signs were provided by the FWS.

Management of Caves Open to the General Public

The following caves in Tennessee were expected to remain open to public:

- Dunbar Cave State Park (closed in 2010)
- Appalachian Caverns
- Bristol Caverns
- Cumberland Caverns
- Forbidden Caverns
- Lost Sea

- Raccoon Mountain Caverns
- Ruby Falls
- Tuckaleechee Caverns

Communication with managers of these caves was 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 (http://www.nps.gov/maca/whitenose.htm), 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.

Outreach/Public Education and Cooperation with Partners

Public education was initiated through several media outlets and other venues.

Results and Discussion

Summer 2009

Bat Colony Monitoring

Banding

Bat banding was conducted at seven caves and one bridge in summer 2009 (Table 2). Gray bats (*Myotis grisescens*) were targeted at caves while little brown bats (*Myotis lucifugus*) were targeted at Beth Page Bridge. Also banded, although in low numbers, were big brown bats (*Eptesicus fuscus*), Northern long-eared bats (*Myotis septentrionalis*), and tri-colored bats (*Perimyotis subflavus*). From 2003-2008, AAFB had banded 3,531 gray bats. It is unknown the number of bats banded by other researchers in the past. Continuing this effort should further elucidate migration patterns.

Table 2. Summer 2009 banding results.

Banding Location	***Eptesicus fuscus***	***Myotis grisescens***	***Myotis lucifugus***	***Myotis septentrionalis***	***Perimyotis subflavus***	**Total**
Ament Cave	-	59	-	-	-	**59**
Bellamy Cave	-	50	-	-	-	**50**
Beth Page Bridge	-	15	49	-	-	**64**
Caney Hollow	-	449	-	-	-	**449**
Herron Cave	-	45	-	-	-	**45**
Oaks Cave	-	50	-	-	-	**50**
Trussell Cave	-	84	-	-	10	**94**
Yell Cave	1	83	1	4	13	**102**
Total	**1**	**835**	**50**	**4**	**23**	**913**

Reproductive Condition

Female reproductive condition (i.e., pregnant, lactating, post lactating, non-reproductive) was documented at five gray bat maternity caves. A reproductive index was calculated as the percent of females classified as reproductive out of the total number of females captured (Table 3). Continued monitoring of the reproductive index at these caves should detect any dramatic changes over time.

Table 1. Reproductive index from five gray bat maternity caves.

Cave	**Survey Date**	**Reproductive Index**
Ament Cave	6/1/2009	85.7
Bellamy	6/3/2009	95.8
Caney Hollow	6/11/2009	73.8
Herron Cave	6/8/2009	42.8
Oaks Cave	6/8/2009	92.8

Wing Damage Assessment

No significant wing damage was documented in the summer of 2009.

Thermal Infrared Emergence Counts

Thermal infrared (TIR) emergence counts were conducted at 16 caves in 2009. Of the six that also had counts in 2008, numbers were similar in 2009. Counts will continue at these caves to detect trends over time. No significant information was gained at the five caves at which pre- and post-volant counts were conducted (Table 4). It is recommended that harp trapping be used as the preferred method to determine productivity.

Table 4. 2008 and 2009 TIR results from gray bat caves.

Cave	2008	2009 Pre-volant Census	2009 Post-volant Census
Ament Cave	-	21,134	-
Alexander Cave	-	30,398	-
Bat Cave (Lincoln Co.)	-	39	-
Bellamy Cave	74,000	80,300	11,400
Caney Hollow Cave	7,638	7,158	-
Duds/Haile Caves	-	8,800	-
Gallatin Steam Plant	-	15,427	16,954
Herron Cave	-	315	-
Knowles Ridge Cave	-	2,800	-
Nickajack Cave	-	69,722	-
Oaks Cave	3,800	5,500	10,900
Pearson Cave		44,828	10,230
Rose Cave	5,200	6,100	11,525
Tobaccoport Cave		14,243	-
Trussell Cave	2,705	1,675	-
Yell Cave	9,192	9,344	-

Acoustic Surveys

In Tennessee, 21 acoustic routes were run covering 24 counties in 2009. Presented here is a summary of data for all the routes and nights they were run (Table 5). The "mean" is the average number of calls for each species over all monitoring events (i.e. mean number of calls recorded for each species on each night routes were run). Detailed results are in Appendix 1 and National level data are being summarized by Eric Britzke.

Table 5. Summary results of acoustic survey data analyzed by Eric Britzke.

	# of files	*Eptesicus fuscus*	*Lasiurus borealis*	*Lasiurus cinereus*	*Myotis grisescens*	*Myotis lucifugus*	*Myotis septentrionalis*	*Perimyotis subflavus*
Total	4535	502	1444	78	17	39	5	542
Mean	71.98	7.97	23.29	1.26	0.27	0.62	0.08	8.60

These data serve as a baseline for Tennessee. Red bats (*Lasiurus borealis*) were the most abundant species followed by Tri-colored bats (*Perimyotis subflavus*), big brown bats (*Eptesicus fuscus*), and hoary bats (*Lasiurus cinereus*) on routes in 2009. The three Myotis species detected on routes - gray bat (*Myotis grisescens*), little brown bat (*Myotis lucifugus*), and Northern long-eared bat (*Myotis septentrionalis*) - were detected in low numbers.

Fall 2009

The more negative the stable isotope signature for a bat, the farther north that individual spent its previous summer (Figure 1). Based on the analysis, the proportion of bats in Wolf River Cave that spent their summers in more northern areas has decreased relative to the proportion that summered in more southern latitudes (Britzke pers. comm. 2010).

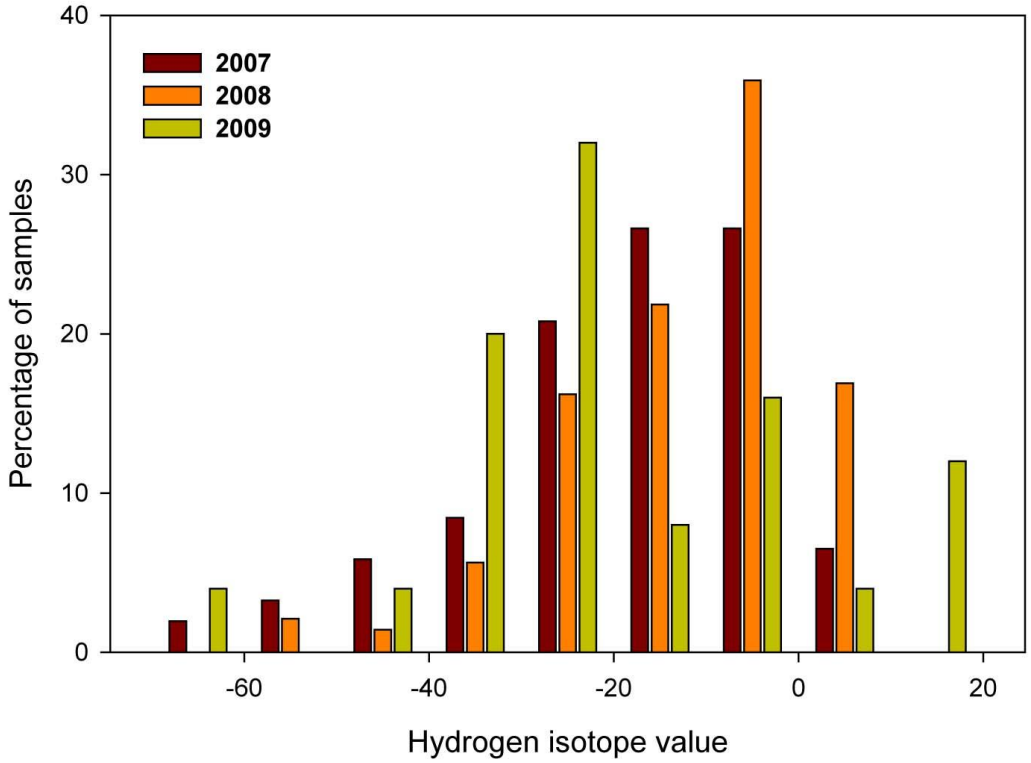

Figure 1. Histogram of isotope values of female Indiana bats from Wolf River Cave (Britzke unpublished data).

To date 15 female Indiana bats from three caves (Wolf River Cave – Fentress County, Cornstarch Cave – Fentress County, and Rose Cave – White County) have been fitted with transmitters and tracked by air and ground crews. Successful tracking of individual bats has varied and, to date, no Indiana bat maternity colonies have been located within the project area.

Winter 2009-2010 Hibernacula Monitoring

Tiered Monitoring

Tier one surveys in winter 2009-2010 were limited to gray bat hibernacula and sites where banding of other species occurred. A complete description of the gray bat hibernacula censuses can be found in Samoray (2010); presented here is a brief description of the results with the author's and TNC's permission (Table 6). Numbers have changed little since the

previous census. No visible signs of WNS were detected. These censuses will continue to be conducted every three years to detect any changes.

Table 6. 2006 and 2010 gray bat census results

(* Census conducted in 2007).

Cave	**2006**	**2010**
Tobaccoport Cave	-	54
Bellamy Cave	139,364	152,159
Hubbards Cave	520,326	513,084
Pearson Cave	278,357 *	208,191
Total	**938,047**	**873,488**

A combined 114 bat bands were reported from Bellamy, Hubbards, and Pearson Caves. These recaptures, along with data from previous recaptures by AAFB, data from Hall and Wilson (1966), data supplied by the 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), allowed George Wyckoff to produce a migration map that demonstrates the potential for transmission of WNS by gray bats (Figure 2).

Tier 1 surveys were also conducted in caves where banding was conducted in winter hibernacula of other species just prior to emergence (Table7). These caves will be visited in subsequent years to attempt recaptures. Information regarding other hibernacula is needed in order to increase this effort and obtain a larger data set.

Table 7. Number of bats banded and estimated total number of bats at non gray bat hibernacula

Cave	*Myotis lucifugus*		*Myotis sodalis*		*Perimyotis subflavus*		*Corynorhinus rafinesquii*	
	Banded	Total	Banded	Total	Banded	Total	Banded	Total
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**

Banding success was greatest for the Indiana bat (*Myotis sodalis*) and Rafinesque's big-eared bat (*Corynorhinus rafinesquii*) followed by tri-colored bat (*Perimyotis subflavus*). Attempts will be made prior to the winter of 2010-2011 to identify larger colonies of little brown bats (*Myotis lucifugus*) and other species that were not banded in this year's efforts.

Forty-four WNS surveys were conducted 31 caves in 15 counties in Tennessee during the winter of 2009-2010 (Appendix 2). WNS was confirmed in six caves and three species beginning in February of 2010 (Table 8, Figure 2). Considering the number of caves located in Tennessee it is possible that occurrences were missed during this monitoring period.

Table 8. 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*)

Outreach/Public Education and Cooperation with Partners

Public education was initiated through several outlets. An official tally was not kept but the following were some of the outreach efforts:

- WNS presentation & Q/A session for state park summer intern program- Fall Creek Falls SP
- Two WNS presentations & Q/A sessions for Upper Cumberland Grotto
- Cave resources/WNS educational booth at SERA (Southeastern Regional Assoc. of the Nat'l Speleological Soc.) "Cave Carnival" - Monteagle, TN
- Numerous newspaper articles
- Numerous radio interviews
- An episode about WNS on the Tennessee’s Wild Side television program
- Miscellaneous communications with Scouts, commercial cave managers, etc.

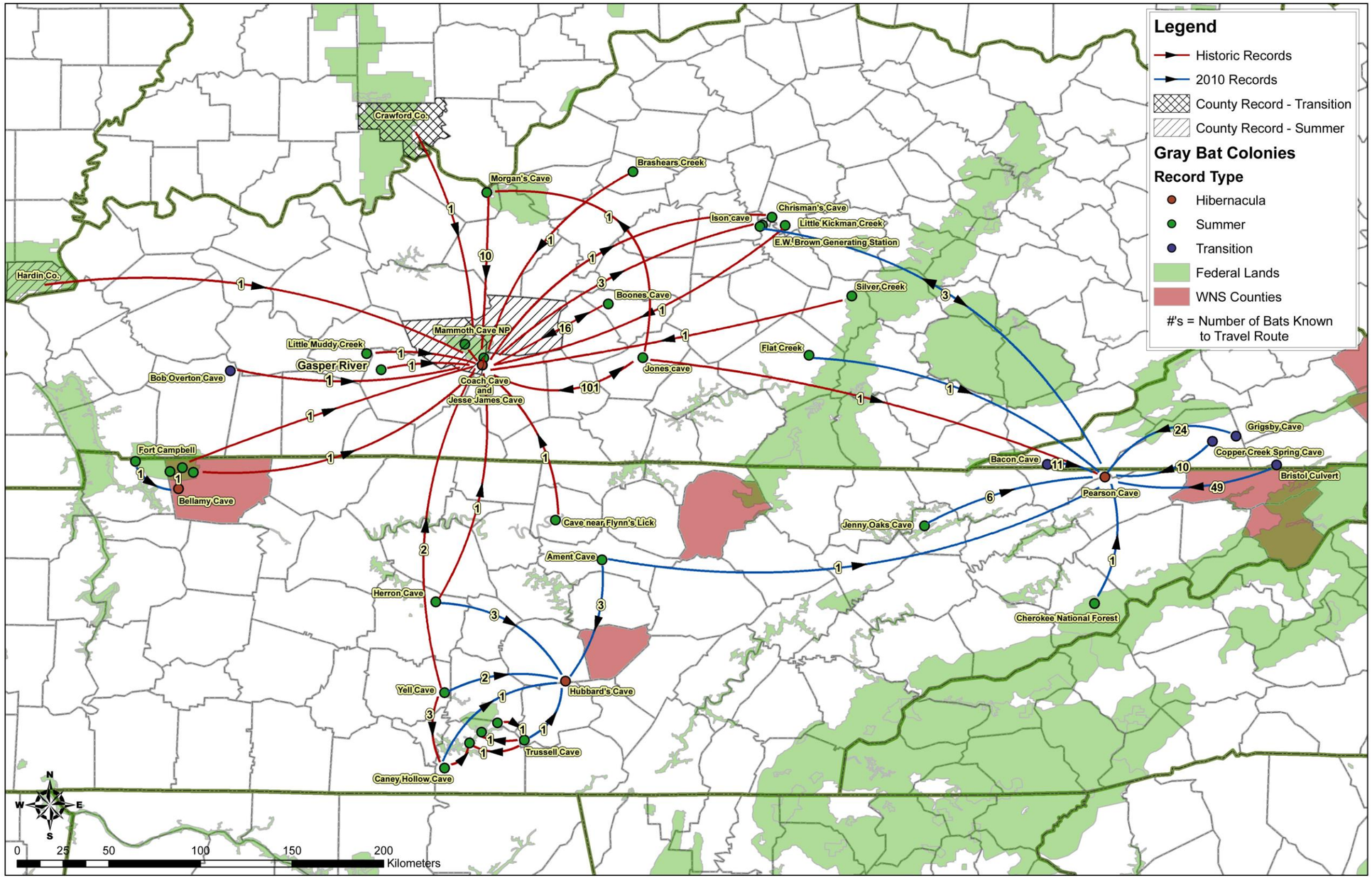

Figure 2. Gray bat migration patterns and WNS positive counties.

(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))

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Appendix 1 – 2009 Acoustic Survey Results

County	Transect	Date	# of files	EPFU	LABO	LACI	MYGR	MYLU	MYSE	PESU
Bedford	AAFB2	13-Jul	97	0	2	0	0	0	0	0
Bedford	AAFB2	16-Jun	75	0	16	0	0	0	0	4
Bedford	AAFB2	29-Jun	64	0	31	0	0	0	0	7
Campbell	NCWMA	9-Jun	78	2	3	6	0	8	0	13
Campbell	NCWMA	20-Jul	106	10	7	1	0	0	5	47
Carter	CHNFN1	18-Jun	51	3	7	0	0	2	0	12
Carter	CHNFN1	13-Jul	38	7	5	0	0	0	0	7
Cheatham	CHWMA	5-Aug	71	0	29	1	5	0	0	27
Claiborne	T1	7-Jun	24	0	4	2	0	0	0	6
Claiborne	T1	1-Jul	5	0	0	0	0	0	0	0
Coffee	AAFB1	13-Jul	147	0	81	0	0	0	0	8
Coffee	AAFB1	16-Jun	52	0	29	0	0	0	0	6
Coffee	AAFB1	29-Jun	110	5	44	1	0	0	0	11
Coffee	AAFB4	16-Jun	101	0	49	0	0	0	0	5
Coffee	AAFB4	29-Jun	114	9	61	4	0	0	0	9
Coffee	AAFB4	13-Jul	97	0	47	0	0	0	0	0
Coffee	AAFB5	16-Jun	46	2	16	0	0	0	0	5
Coffee	AAFB5	29-Jun	87	2	23	5	0	0	0	0
Coffee	AAFB5	13-Jul	124	0	81	2	0	0	0	5
Cumberland	CAWMA1	10-Jun	106	14	25	2	0	6	0	24
Cumberland	CAWMA1	25-Jun	307	166	22	4	0	4	0	44
Cumberland	CAWMA1	29-Jun	190	24	55	4	0	0	0	60
Cumberland	T1	9-Jul	4	0	0	0	0	0	0	0
Franklin	AAFB3	13-Jul	103	8	62	0	0	0	0	6
Franklin	AAFB3	16-Jun	78	0	40	2	0	0	0	5
Franklin	AAFB3	29-Jun	124	11	66	1	0	0	0	11
Greene	CHNFN2	18-Jun	58	2	25	0	0	0	0	5
Greene	CHNFN2	14-Jul	41	9	9	1	0	0	0	3

County	Transect	Date	# of files	EPFU	LABO	LACI	MYGR	MYLU	MYSE	PESU
Hancock	T1	10-Jun	78	0	28	11	0	6	0	0
Hancock	T1	8-Jul	47	0	7	9	0	3	0	0
Hancock	T1	21-Jul	110	6	30	3	0	0	0	7
Jackson	T1	6-Jul	77	0	6	0	0	0	0	0
Johnson	T1	22-Jul	96	0	3	2	0	5	0	0
Marion	PCWMA1	6-Jul	70	0	29	0	7	0	0	3
Marion	PCWMA1	10-Jul	100	4	23	0	0	5	0	20
Marion	PCWMA1	11-Jul	47	0	18	0	0	0	0	0
Monroe	CHNFT1	19-Jun	72	0	39	1	0	0	0	20
Monroe	CHNFT1	15-Jul	103	11	46	1	0	0	0	15
Overton	T1	1-Jul	6	2	0	0	0	0	0	0
Overton	T2	25-Jun	179	71	6	0	0	0	0	0
Overton	T2	14-Jul	19	0	0	0	0	0	0	0
Polk	CHNFO1	20-Jun	33	0	16	0	0	0	0	4
Polk	CHNFO1	15-Jul	46	3	17	0	0	0	0	9
Polk	CHNFO2	19-Jun	43	2	25	0	0	0	0	7
Polk	CHNFO2	14-Jul	64	12	13	0	0	0	0	6
Putnam	T1	10-Jul	14	0	0	0	0	0	0	0
Putnam	T1	17-Jun	5	0	0	0	0	0	0	0
Putnam	T2	24-Jun	39	0	24		0	0	0	9
Putnam	T2	16-Jul	42	2	23	1	0	0	0	6
Rhea	YWMA1	17-Jun	34	0	16	1	0	0	0	4
Rhea	YWMA1	22-Jun	34	0	18	0	0	0	0	6
Rhea	YWMA1	24-Jun	57	0	20	0	0	0	0	17
Sullivan	CHNFW1	16-Jun	59	11	24	0	0	0	0	10
Sullivan	CHNFW1	13-Jul	79	34	13	1	0	0	0	3
Sullivan	T1	22-Jul	93	45	12	0	0	0	0	9
Unicoi	T1	22-Jul	84	9	27	2	0	0	0	10
Union	CSWMA1	8-Jun	13	0		1	5	0	0	0
Union	CSWMA1	18-Jul	26	0	2	5	0	0	0	0
White	BFWMA1	17-Jun	50	2	16	3	0	0	0	7

County	Transect	Date	# of files	EPFU	LABO	LACI	MYGR	MYLU	MYSE	PESU
White	BFWMA1	7-Jul	46	6	18	1	0	0	0	8
White	BFWMA1	15-Jul	80	8	46	0	0	0	0	5
White	T1	3-Jul	6	0	0	0	0	0	0	0
Williamson	Natchez1	27-Jul	86	0	40	0	0	0	0	27
		Total	**4535**	**502**	**1444**	**78**	**17**	**39**	**5**	**542**
		Mean	**71.98**	**7.97**	**23.29**	**1.26**	**0.27**	**0.62**	**0.08**	**8.60**

Appendix 2 – Winter of 2009- 2010 WNS Surveys

Note: Table is an abbreviated representation of data supplied to the USFWS.

COUNTY	HIBERNACULUM NAME	WNS_2010 (YES/NO)	SURVEY DATE	NUMBER OF LIVE BATS AT SITE (EST.)	NUMBER OF DEAD BATS AT SITE (EST.)	% OF TOTAL POP WITH VISIBLE WNS FUNGUS	NO. SAMPLES COLLECTED '10	LABS '10	RESEARCH PROJECT	*MYOTIS SODALIS*		*MYOTIS GRISESCENS*		*MYOTIS LUCIFIGUS*		*MYOTIS SEPTENTRIONALIS*		*MYOTIS LEIBII*		*PERIMYOTIS SUBFLAVUS*		*EPTESICUS FUSCUS*		*Corynorhinus rafinesquii*		*SURVEYOR(S) '10*	ADDITIONAL COMMENTS 010
										% OF TOTAL SPP	% W/ VIS. FUNGUS	% OF TOTAL SPP	% W/ VIS. FUNGUS	% OF TOTAL SPP	% W/ VIS. FUNGUS	% OF TOTAL SPP	% W/ VIS. FUNGUS	% OF TOTAL SPP	% W/ VIS. FUNGUS	% OF TOTAL SPP	% W/ VIS. FUNGUS	% OF TOTAL SPP	% W/ VIS. FUNGUS	% OF TOTAL SPP	% W/ VIS. FUNGUS		
Blount	White Oak Blowhole Cave	Yes	3/30/2010	8,000	0	.1	3	NWHC		80	.1			8	1	.1	0			3	0					David Pelren and Daniel Nolfi	Evidence of fungus on about 20 bats. Two M. lucifugus euthanized for NWHC analysis, one tape sample taken from a M. sodalis for NWHC analysis.
Campbell	New Mammoth Cave	No	2/17/2010	500	2	0	0			3				65		16		1		16		1				Sterling Daniels, Cory Holiday	Keith Housmann on the neighboring property guided us through the cave. Knoxs News Sentinel produced a story on the visit
Campbell	Norris Dam Cave	No	2/11/2010	42																100	0					H. LeGrand, J. Doyle, D. Nestor, C. Phillips, D. Wilson	ATV'd to trailhead and walked into site, searched for 2 hours
Carter	Carter Saltpeter Cave	No	2/20/2010	50	0	0	0									6				92		2				Sterling Daniels, Robby Speigel	Majority of the bats were located in the first crawl passage to the right.
Carter	Conway Cave	No	2/20/2010	12	0	0	0	0												100	0					Cory Holliday, Alex Wyss	Numerous troglobitic invertebrates noted including diplurans, spring tails, and millipeds.
Carter	Grindstaff Cave	Yes	3/8/2010	200	2	15	3	NWHC								68	10			28	5	4	0			Sterling Daniels, Cory Holiday	There were a lot of bats staged around the entrance. WNS was discovered within 120 feet of the dripline. Several bats showed obvious signs of the presence of G. destructans and later tested positive for the presence of the fungus.
Carter	Kaylor Cave	No	3/9/2010	20	0	0	0	0												75	0	25	0			Cory Holliday, Sterling Daniels	
Carter	Poga Cave	No	2/21/2010	8	0	0	0											25		63		13				Sterling Daniels, Cory Holiday	Cave has through small entrances located along the road. There is another cave 1 mile up the road that is often called Poga Cave that was not

COUNTY	HIBERNACULUM NAME	WNS_2010 (YES/NO)	SURVEY DATE	NUMBER OF LIVE BATS AT SITE (EST.)	NUMBER OF DEAD BATS AT SITE (EST.)	% OF TOTAL POP WITH VISIBLE WNS FUNGUS	NO. SAMPLES COLLECTED '10	LABS '10	RESEARCH PROJECT	*MYOTIS SODALIS*		*MYOTIS GRISESCENS*		*MYOTIS LUCIFIGUS*		*MYOTIS SEPTENTRIONALIS*		*MYOTIS LEIBII*		*PERIMYOTIS SUBFLAVUS*		*EPTESICUS FUSCUS*		*Corynorhinus rafinesquii*		*SURVEYOR(S) '10*	ADDITIONAL COMMENTS 010
										% OF TOTAL SPP	% W/ VIS. FUNGUS	% OF TOTAL SPP	% W/ VIS. FUNGUS	% OF TOTAL SPP	% W/ VIS. FUNGUS	% OF TOTAL SPP	% W/ VIS. FUNGUS	% OF TOTAL SPP	% W/ VIS. FUNGUS	% OF TOTAL SPP	% W/ VIS. FUNGUS	% OF TOTAL SPP	% W/ VIS. FUNGUS	% OF TOTAL SPP	% W/ VIS. FUNGUS		visited
Carter	Poga Road Cave	No	2/21/2010	7	0	0	0	0										30		60		10				Cory Holliday, Sterling Daniels	This location is listed in the TCS as Poga Road Cave, it was later discovered that another local cave shares the same name.
Carter	Sculpture Cave	No	3/7/2010	12	0	0	0	0												100	0					Cory Holliday, Sterling Daniels	
Cheatham	Neptune Saltpeter Cave	No	3/29/2010	26	0	0	0	0												96	0	4	0			Cory Holliday, Stephen Samoray	
Davidson	Hardin Cave	No	4/16/2010	365	0	0	1	NWHC	WNS	0	0	0	0	0	0	0	0	0	0	1	0	0	0			Andrea English, Nashville Grotto	1 Little Brown Bat was collected, frozen and submitted to USGS National Wildlife Disease Center. Bat tested negative for WNS.
Fentress	Coriolis Cave	No	12/19/2010	65	0	0	0	0		5	0			35	0	3	0	2	0	40	0			16	0	Cory Holliday, Alex Wyss	
Fentress	East Fork Saltpeter Cave	Yes	4/5/2010	800	0	0.25	2	NWHC		31	0			56	0	5	100			8	0					Cory Holliday, Price Sewell	Two M.sept. showed minor potential signs of the presence of G. destructans, one of the bats tested positive for the presence of the fungus.
Fentress	Little Jack Creek Cave	No	3/2/2010	28	0	0	0	0												5	0			10	0	Cory Holliday	About 25 Myotids were noted, but were too high for confident identification by observer.
Fentress	Redbud Cave	No	3/2/2010	79	0	0	0			3	0			24	0					73	0					David Pelren and Mark Thurman	
Fentress	Wolf River Cave	No	1/6/2010																							TWRA	This was an entrance survey only
Hawkins	Pearson Cave	No	3/23/2010	Bats not counted	50	0	0	0				100	0													Cory Holliday, Sterling Daniels	The lower creek passage was all that was surveyed. The dead bats had excessive condensation on their exterior.
Hawkins	Pearson Cave	No	1/30/2010	208,191	50	0	12	SCWDS				100	0													Cory Holliday, Sterling Daniels, Jim Kennedy	Several dead bats were collected and sent to NWHC, but tested negative for the presence of WNS.
Lauderdale	Collier Cave	No	2/10/2010	448																98	0	2	0			H.LeGrand, W.	docked at mouth entrance, observed

COUNTY	HIBERNACULUM NAME	WNS_2010 (YES/NO)	SURVEY DATE	NUMBER OF LIVE BATS AT SITE (EST.)	NUMBER OF DEAD BATS AT SITE (EST.)	% OF TOTAL POP WITH VISIBLE WNS FUNGUS	NO. SAMPLES COLLECTED '10	LABS '10	RESEARCH PROJECT	*MYOTIS SODALIS*		*MYOTIS GRISESCENS*		*MYOTIS LUCIFIGUS*		*MYOTIS SEPTENTRIONALIS*		*MYOTIS LEIBII*		*PERIMYOTIS SUBFLAVUS*		*EPTESICUS FUSCUS*		*Corynorhinus rafinesquii*		*SURVEYOR(S) '10*	ADDITIONAL COMMENTS 010
										% OF TOTAL SPP	% W/ VIS. FUNGUS	% OF TOTAL SPP	% W/ VIS. FUNGUS	% OF TOTAL SPP	% W/ VIS. FUNGUS	% OF TOTAL SPP	% W/ VIS. FUNGUS	% OF TOTAL SPP	% W/ VIS. FUNGUS	% OF TOTAL SPP	% W/ VIS. FUNGUS	% OF TOTAL SPP	% W/ VIS. FUNGUS	% OF TOTAL SPP	% W/ VIS. FUNGUS		
																										Gates	prior to entering for internal survey; searched for 2 hours
Lauderdale	Key Cave	No	2/10/2010	6																66	0	33	0			H. LeGrand, W. Gates	WORE TYVEK SUITS
Montgomery	Bellamy Cave	No	1/28/2010	152,159	0	0	0	0				100	0													Cory Holliday, Andrea English, Josh Campbell, Richie Wyckoff, John Lamb, Jim Kennedy	
Montgomery	Bellamy Cave	No	3/25/2010	Bats not counted	0	0	0	0				100	0													Cory Holliday, Andrea English, Josh Campbell, , Jim Kennedy	Bats had ungroomed guano on their bodies with fungus growing on the guano, this is likely a result of our previous disturbance in Jan.
Montgomery	Broom Hollow Cave	No	4/2/2010	66	0	0	0	0				2	0							98	0					Cory Holliday, Stephen Samoray	Three Summer roost areas were noted in the cave.
Montgomery	Coleman Cave	No	3/26/2010	43	0	0	0	0						2	0	2	0			93	0	2	0			Cory Holliday, Andrea English	
Montgomery	Doyle Moore Cave #2	No	4/1/2010	26	0	0	0	0												100	0					Cory Holliday, Stephen Samoray	This is a cold cave, we expected to see more species. A dead raccoon and dead fox were noted in the cave.
Montgomery	Eclipse Cave	No	3/30/2010	1	0	0	0	0												100	0					Cory Holliday, Stephen Samoray	Roost staining was noted in the cave. This cave is warm and likely serves as a gray bat night roost during the summer.
Montgomery	Meriweather Cave	No	3/31/2010	0	0	0	0	0																		Cory Holliday, Stephen Samoray	This cave was within close proximity to Dunbar Cave, but had no bats. Lots of Pseudanopthalmus noted.
Roane	Marble Bluff	No	2/12/2010	92																100	0					H. LeGrand, E. Wadl, Scott Meeks (Cultural), Annie (Cultural - UT)	entered smaller entrance first, once inside mouth, headed right and then left to the two holes that drop to the water, Bernie will survey when survey for cavefish. No bats observed. Bill then headed down guano slide to tributary to survey while Holly at top to

COUNTY	HIBERNACULUM NAME	WNS_2010 (YES/NO)	SURVEY DATE	NUMBER OF LIVE BATS AT SITE (EST.)	NUMBER OF DEAD BATS AT SITE (EST.)	% OF TOTAL POP WITH VISIBLE WNS FUNGUS	NO. SAMPLES COLLECTED '10	LABS '10	RESEARCH PROJECT	*MYOTIS SODALIS*		*MYOTIS GRISESCENS*		*MYOTIS LUCIFIGUS*		*MYOTIS SEPTENTRIONALIS*		*MYOTIS LEIBII*		*PERIMYOTIS SUBFLAVUS*		*EPTESICUS FUSCUS*		*Corynorhinus rafinesquii*		*SURVEYOR(S) '10*	ADDITIONAL COMMENTS 010
										% OF TOTAL SPP	% W/ VIS. FUNGUS	% OF TOTAL SPP	% W/ VIS. FUNGUS	% OF TOTAL SPP	% W/ VIS. FUNGUS	% OF TOTAL SPP	% W/ VIS. FUNGUS	% OF TOTAL SPP	% W/ VIS. FUNGUS	% OF TOTAL SPP	% W/ VIS. FUNGUS	% OF TOTAL SPP	% W/ VIS. FUNGUS	% OF TOTAL SPP	% W/ VIS. FUNGUS		
																											minimize disutrbance and silt load into water
Sullivan	Kaylor Cave	No	3/9/2010	11	0	0	0													64		36				Sterling Daniels, Cory Holiday	
Sullivan	Worley Cave	Yes	2/8/2010	45	2	6	3	NWHC								5				94		1				Sterling Daniels, Wes Combs	Call was received about a suspect WNS bat. I visited the site to collect a specimen with a local caver Wes Combs.
Union	Oaks Cave	No	3/4/2010	65	0	0	0					2				4				93		2				Sterling Daniels, Rick	Visited the cave to pull data logger and conducted a Tier 2 count while present
Van Buren	Cagle Saltpeter Cave	No	2/26/2010	110	0	0														72	0	2	0	26	0	AAFB, TDEC	
Van Buren	Cagle Saltpeter Cave	Yes	3/25/2009	Bats not counted	1		3	NWHC																		Richie Wyckoff, Stuart Carroll	Cave was rechecked after possible signs of WNS were reported.
Van Buren	Camps Gulf Cave	Yes	2/26/2010	282	0	0.71								36	0					59	0	1	0			USFWS, TWRA	Two bats were observed with a white substance on the forearms but not taken.
Van Buren	Rice Cave	No	3/4/2010	205						16	0			3	0					81	0					TWRA, TDEC, AAFB, USFWS	
Van Buren	Measles Gulf	No	3/18/2010	171	0	0	0	0												7	0	2	0	91	0	Cory Holliday, John Lamb, Richie Wyckoff	52 CORA were Banded
Warren	Hubbards Cave	No	1/29/2010	513,130	0	0	0	0		0	0	100	0													Cory Holliday, Mark Thurman, John Lamb, Richie Wyckoff, Jim Kennedy	
Warren	Little Bat Cave	No	3/16/2010	65	0	0	0	0												2	0			98	0	Cory Holliday, John Lamb, Richie Wyckoff	15 CORA were banded
Warren	Hubbards Cave	No	3/16/2010	Bats not counted	0	0	0	0																		Cory Holliday, John Lamb, Richie Wyckoff	Teir 3 survey, cave not entered

COUNTY	HIBERNACULUM NAME	WNS_2010 (YES/NO)	SURVEY DATE	NUMBER OF LIVE BATS AT SITE (EST.)	NUMBER OF DEAD BATS AT SITE (EST.)	% OF TOTAL POP WITH VISIBLE WNS FUNGUS	NO. SAMPLES COLLECTED '10	LABS '10	RESEARCH PROJECT	*MYOTIS SODALIS*		*MYOTIS GRISESCENS*		*MYOTIS LUCIFIGUS*		*MYOTIS SEPTENTRIONALIS*		*MYOTIS LEIBII*		*PERIMYOTIS SUBFLAVUS*		*EPTESICUS FUSCUS*		*Corynorhinus rafinesquii*		*SURVEYOR(S) '10*	ADDITIONAL COMMENTS 010
										% OF TOTAL SPP	% W/ VIS. FUNGUS	% OF TOTAL SPP	% W/ VIS. FUNGUS	% OF TOTAL SPP	% W/ VIS. FUNGUS	% OF TOTAL SPP	% W/ VIS. FUNGUS	% OF TOTAL SPP	% W/ VIS. FUNGUS	% OF TOTAL SPP	% W/ VIS. FUNGUS	% OF TOTAL SPP	% W/ VIS. FUNGUS	% OF TOTAL SPP	% W/ VIS. FUNGUS		
White	Great Expectations	No	2/12/2010	240																83	0					TWRA, TNC	
White	Lost Creek Cave	No	2/12/2010	251	0					20										80	0					TWRA, TNC	
White	Rose Cave	No	1/15/2010	575	0	0	1	SCWDS		13	0			87	0											USFWS, TWRA	One MYLU was submitted because of extensive wing damage. The specimen tested negative for WNS