White Nose Syndrome Action Plan
Missouri Department of Conservation

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I. SUMMARY

White Nose Syndrome (WNS) is a new disease that has killed at least one million hibernating bats in caves and abandoned, underground mines in the northeastern USA since 2006. WNS could arrive in Missouri within one year, and it could kill many of the six species affected so far. There is concern that WNS could also infect gray bats, which could then increase WNS's rate of spread, especially westward. Bats are ecologically and economically important consuming vast quantities of night-flying insects and supporting intricate cave ecosystems. This document sets out a WNS Action Plan for the Missouri Department of Conservation (MDC), which applies to the public who enter MDC caves, MDC staff, researchers with Wildlife Collector Permits, and "cave stewards." MDC will use a measured approach based on science, with tiered actions. The goals of MDC's plan are to protect the diversity of Missouri's bats and other cave wildlife and to prevent or delay the spread of WNS. MDC's WNS Committee and its WNS Leaders will proactively detect and prevent the spread of the WNS fungus and reduce other factors that may contribute to the bat mortality observed with the syndrome. MDC bat caves have been prioritized for closure and protection when identified triggers are met. Although the infection is likely to be spread by bats, or possibly in the air, disinfection of clothing and gear is required as a precaution against accidental spread of fungal spores by humans. Closing bat caves to human entry reduces human disturbance of bats, which exacerbates the mortality rate caused by WNS, and reduces the risk of possible human-borne transmission. Twenty-three MDC bat caves are currently Class 3 (closed to human entry), and another 19 caves are closed because of hazards or sensitive resources. When any of four "WNS triggers" occurs, additional caves will be closed to human entry in tiers. "WNS Trigger 1" occurs when WNS is reliably reported or confirmed 100-200 miles from Missouri, in which case at least 17 additional high-priority bat caves would be closed to human entry. "Trigger 2" occurs when WNS is 100 miles from Missouri, in which case 22 additional medium-priority bat caves would be closed. "Trigger 3" would occur if WNS is found in Missouri, closing 18 more MDC bat caves. "Trigger 4" is when a specific MDC cave is infected with WNS, causing further restrictions for entry into the affected cave even by researchers. Thus, a total of about 100 of MDC's 290 caves could be closed and any additional caves found to have bats. New signs would be posted to inform the public and regulate caves on conservation areas, and news releases and contacts with caving groups will alert the public to the threats of WNS and actions needed to minimize its impacts on the bat populations Missourians value. Rules are detailed for entering MDC caves and abandoned, underground mines, disinfection, and conducting field and laboratory work. Since this plan has been in development during the winter of 2010, the range of WNS has spread over 300 miles to within 103 miles of Missouri's border. Therefore, conditions already require actions described for Trigger 1. Included are three appendices containing a technical supplement with bat survey methods, tables, important literature references, information on bat caves, and an MDC Wildlife Collector Advisory. MDC also is leading a cooperative effort to form an inter-agency Missouri WNS Working Group and write a statewide WNS action plan.

II. INTRODUCTION

A. Purpose

This document formalizes MDC's action plan, primarily for MDC-managed properties, against White Nose Syndrome (WNS), a new infectious disease in bats. After this plan is adopted, MDC with its partners can begin to develop a general Missouri WNS action plan encompassing other public and private cave owners (i.e., Missouri Department of Natural Resources, US Forest Service, US Fish & Wildlife Service, National Park Service, US Army Corps of Engineers, and other willing landowners) in a collaborative effort to address this threat to valued bat populations.

Although MDC has a bat management plan (Clawson, Elliott, and Burns 2006), WNS and its ramifications were unforeseen when it was written. This action plan shall be considered an addendum of our bat management plan.

B. White Nose Syndrome and Cave Defined

WNS is a new disease in cave and mine bats, with early starvation, loss of body fat during hibernation, wakefulness, and mass die-offs. Affected bats fly outside caves or mines in winter, sometimes at mid-day, when they should be hibernating. Many of the bats have a white fungal infection (*Geomyces destructans,* or Gd, a new species) visible on the face, wings, and ears. All dead and dying bats that have been examined in laboratories have been infected with Gd even if there was no fungal growth visible to the naked eye. Gd may be the primary pathogen, but it may be an opportunistic infection following malnutrition or some other health problem. Because no other contributing factor beside Gd has been identified, this plan is based on the best current scientific information that controlling the spread of Gd is the best option for controlling the spread of WNS. The mortality in six bat species since 2006 has been estimated at one to two million. Researchers documented 75-100% reductions of bat numbers using most hibernacula where WNS was confirmed. WNS apparently is transmitted bat-to-bat and via the environment; accidental, human-borne spread also is possible. WNS has **not** been shown to infect other wildlife or humans, and it had not been confirmed in Missouri as of April 12, 2010.

Six species, five common bats and the federally listed, endangered Indiana bat (*Myotis sodalis*), have died from WNS in the eastern US (Table 1), and there is concern that WNS may spread to other bats throughout the country. Most confirmed mortalities (recovered bodies) have been little brown bats (*M. lucifugus*), a species that has been considered "common" until recently. Large numbers of Indiana bat (*M. sodalis*) and other bat bodies have not always been recovered, but their numbers within affected hibernacula have declined precipitously. This suggests that bats are leaving the hibernacula before succumbing or moving to uninfected hibernacula, a theory supported by observations at affected caves and mines. Overall mortality estimates use within hibernacula baseline counts by state wildlife agencies to gauge how many bats are now missing.

Eptesicus fuscus	big brown bat
Myotis leibii	eastern small-footed bat
Myotis lucifugus	little brown bat
Myotis septentrionalis	northern (long-eared) bat
Myotis sodalis	Indiana bat
Perimyotis subflavus	eastern pipistrelle (tri-colored bat)

Table 1. Six bat species affected by WNS in the eastern US. All occur in Missouri.

To date, WNS has only been confirmed in bat species that hibernate (at least in part) in caves and abandoned, underground mines. It is currently thought that any bat species that depends on hibernation as a strategy to survive the winter is potentially at risk for WNS, but no cases have been reported in other species. Additional information is provided in Appendix 1, Technical Supplement.

Although there are many definitions of "cave," for management and enforcement purposes MDC operatively defines a cave as a natural or man-made cavity in bedrock that is at least 15 feet long or deep as measured from the mouth. This cave definition includes abandoned, underground mines because they often contain wildlife.

C. MDC's Authority and Responsibility

Under Missouri constitutional law, Article IV, Section 40(a), the Missouri Department of Conservation is charged with protecting and managing the fish, forest, and wildlife resources of Missouri. MDC manages many important bat caves, and issues Wildlife Collector Permits regulating research and monitoring of the state's wildlife. MDC must be prepared against WNS before it arrives in Missouri, especially on its own lands, by documenting occurrences, communicating with stakeholders, and lessening the impact within Missouri by slowing its spread and buying time for a solution, such as possible environmentally safe treatments being researched now.

Missouri has at least 6,300 caves, most of which probably contain bats at some time of the year. MDC owns or manages at least 290 caves, of which at least 80 (28%) are known bat caves, but many more caves probably have some bats during the winter. Seven bat species routinely use Missouri caves, mostly for hibernation, but the gray bat (*Myotis grisescens*) is dependent on caves year-round. WNS could spread faster and wider if the gray bat also becomes infected because of their year-round use of caves and because gray bat migrations tend to include more east/west movement compared with other species.

After this plan is adopted, MDC will play a lead role in coordinating a statewide action plan, which will include participation by concerned landowners.

D. Economic and Ecological Value of Bats

WNS threatens Missouri's economy and ecology because of the natural role of bats in consuming night-flying insects. Bats are the front-line defense against many agricultural and forest health pests (such as moths and beetles) and public health pests (such as mosquitoes), and provide general control of insect populations. Missouri has 12 resident species of bats, and half of those are susceptible to WNS. We do not have good statewide population estimates for most of our bats, but general estimates are in the millions (Clawson, Elliott, and Burns 2006). We have very good estimates of endangered bats, which MDC has monitored since the 1970s (Elliott 2008). Currently Missouri has fewer than 15,000 Indiana bats remaining, a 95-98% loss in 30 years. Gray bats are increasing again in some caves that are protected, numbering about 775,000. Gray bats alone are eating 540 tons of insects per year in Missouri, about 223 billion insects.

In addition to insect control, bats are an important component of cave ecosystems, providing nutrient input in the form of guano and decomposing carcasses, which support diverse communities of invertebrates and cave-adapted creatures, such as the grotto salamander, *Eurycea spelaea*. Many cave-adapted species are endemic to Missouri and the Ozarks and are part of our natural heritage. The prevalence and diversity of Missouri's cave bats are summarized in Appendix 4, tables 3 and 4.

E. Rationale for Disinfection and Cave Closures

WNS Spread:
Fungi and their conidia (spores) are ubiquitous in the environment, and many infections are spread via air, environmental contact, or contact between individuals (Postgate 2000, Anaissie et al. 2009). Bat-to-bat and environmental routes of WNS infection are likely, but, to date, the available data from researchers do not rule out the possibility of human-borne spread of WNS as a potential method of transmission.

Although the origin of GD is unknown, some scientists theorize that it originated in Europe and was somehow transported to the U.S. A recent finding of a European *Myotis myotis* bat in France confirmed to have Gd in a study by Puechmaille et al. (2010) supports this theory. Unlike American bats found with the fungus, this bat appeared healthy and unlikely to die as a result of the fungus. The exact route of original infection may not be provable, but several are possible, including spores on contaminated field gear, clothing, wind, migrating birds or bats, or even bats trapped in shipping containers or airplanes (Constantine 2003).

WNS was first found in a cave in New York State in 2006 and has spread to eleven states, from New England to Tennessee, and two provinces in Canada. The rapid spread within North America seems to indicate that several factors could be spreading the fungus. Reports from scientists indicate that bats and the environment are spreading WNS, but it may have been spread by humans too.

On February 20, 2010, WNS was discovered in Hellhole Cave, West Virginia, with hundreds or thousands of dead little browns. Some Indiana bats and tri-colored (eastern pipistrelle) bats were affected, but not the resident Virginia big-eared bats. Reportedly no humans had entered the cave since September, 2007, indicating spread by bats or airborne conidia.

An experiment by the National Wildlife Health Center (NWHC), Madison, Wisconsin, demonstrated that WNS-infected bats can infect healthy bats in a laboratory enclosure. This finding, coupled with a confirmed case of WNS from a Virginia bat collected on November 4, 2009, suggests that WNS transmission may occur during the fall bat swarm at some cave entrances, as well as during hibernation.

In February 2010, WNS appeared in tri-colored bats in Worley's Cave, Sullivan County, northeastern Tennessee. On March 18, 2010, WNS was confirmed with a PCR test in Dunbar Cave, Montgomery County, Tennessee, just 103 miles from Missouri. Both caves experience high public visitation (Gina Hancock and Cory Holliday, The Nature Conservancy, Tennessee Chapter, pers. comm.). These examples and the fact that most of the WNS positive caves seem to be popular recreational caves (Craig Stihler, West Virginia DNR, pers. comm.) support concern that human transport may be significant in the spread of WNS.

The New York State Department of Environmental Conservation (NYDEC) and the NWHC documented that healthy bats can become infected from affected caves or mines with an experiment conducted from October 2009-January 2010. A total of 79 apparently healthy little brown bats collected from Maiden Rock Mine, Wisconsin, were released on October 26-27 into Greely and Bridgewater mines in Vermont, known WNS sites then absent of bats. The mines were doubly or triply screened to prevent exchange of bats. As of March 12, 2010, nearly all of the new bats had died with obvious infection on most prior to death (Al Hicks, NYDEC, pers. comm.). All are being analyzed at NWHC for WNS infection.

A field study in February 2010 recovered 16 Gd-like conidia on a properly disinfected backpack that had been taken into an infected mine, then swabbed after exiting the mine. Although the results do not trace all the steps in an actual human-borne transmission of Gd spores, they do indicate that the risk is more than theoretical (Al Hicks and Joe Okoniewski, NYDEC, pers. comm.). Identification of Gd genetic material in environmental samples suggests that the fungus is present, and the potential exists for fungus to be transmitted between bat hibernation caves upon humans, their clothing, or gear (Sleeman, 2009).

Human disturbance, long known to affect bat survival (Tuttle and Stevenson 1978), has been implicated as increasing mortality of bats infected with WNS. In January 2010, the Pennsylvania Game Commission reported 99% bat mortality at a WNS-infected mine in which the gate was breached multiple times, whereas undisturbed WNS sites had approximately 85% mortality (Greg Turner and Cal Butchkoski, pers. comm.). Therefore, it is important to keep WNS-infected sites closed to minimize human disturbance.

Disinfection requirements and minimizing human disturbance:
Due to the evidence that gear and clothing may transport Gd fungus among caves, MDC already requires holders of Wildlife Collector Permits not to bring any equipment into Missouri that has contacted bats in WNS-affected states and to disinfect any gear that has contacted bats from nonaffected states before use in Missouri (Appendix 2). This requirement will need updating to keep pace with U.S. Fish and Wildlife Service (FWS) advisories. Since January 2010, the latest FWS Disinfection Protocol (June 2009a or later, Appendix 3) has been required for entry in all MDC caves by MDC staff and permittees. Public education, news releases, outreach to caving

groups, and area signs will notify casual cave visitors and cave owners to follow disinfection rules when entering MDC caves and encourage their use in other caves.

To reduce the risk of accidental spread of spores between caves and until definitive evidence indicates otherwise, MDC will require precautionary disinfection of clothing and gear before entering caves and abandoned, underground mines on MDC lands. In addition, bat caves have been prioritized according to their importance to bats and their vulnerability for unauthorized entry. A tiered system of triggers has been described with each resulting in increasing restrictions and closure of bat caves (defined as closed to human access without appropriate signs or permit) based on their rank. Not only are strategic cave closures and restrictions to entry needed to reduce the potential for human transport of spores, the closures are intended to minimize human disturbance to bats to allow them the greatest opportunity for survival to fight this new disease, currently the only action available thought to reduce mortalities. While the human transport of Gd is not scientifically confirmed, extensive information is available to demonstrate that human intrusion generally reduces bat survival (Tuttle and Stevenson 1978).

Detection efforts:
Soil sampling in caves and mines for Gd has not proven to be a useful, early detection tool because the fungal DNA has been found only in sites where bats with WNS were already confirmed. Funding limits also hampered analysis of all soil samples at the USGS National Wildlife Health Center, Madison, Wisconsin. Therefore, MDC discontinued its soil sampling program, started in 2009 in cooperation with the USGS and the National Speleological Society. MDC will sample suspect bats with fungal lift tape, swabs, or other means when the need arises. Ongoing research and field observations are reported by state wildlife agencies and the U.S. Fish & Wildlife Service (FWS) at meetings and in a bi-weekly telephone conference, in which MDC participates. Because of the rapid spread of WNS, there has been insufficient time for many published reports to appear; however, some key developments are given below.

MDC also will use reliable reports from biologists, agencies, and the public to assist in the detection of WNS. Clear communication channels within and between agencies will allow WNS information to be collected, thus enabling a better picture of the timeline of its movement.

WNS Leaders may initiate a “Cave Stewardship Program” where selected, trained cavers, master naturalists, managers, biologists, and other volunteers would be trained to monitor designated caves in coordination with the WNS Leaders. Such visits may involve simply going to a gated entrance in midwinter to look for bats behaving abnormally, checking electronic equipment, or, if the situation allows, entering some caves for further checking while following strict disinfection and observational procedures.

III. MDC WNS ACTION PLAN

A. MDC WNS Committee

This plan establishes the WNS Committee with the authority to conduct actions proposed in the plan, based on science and data. The WNS Committee comprises William R. (Bill) Elliott (cave biologist and gray bat recovery leader) as Chairman, Anthony (Tony) Elliott (bat ecologist and

Indiana bat recovery leader) as Vice Chairman, and Norman Murray, Resource Science Division; Janet Sternburg, Policy Coordination Unit; Peggy Horner, Gene Gardner, Mike Schroer, Wildlife Division; Mike Huffman, Mike Hoffman, Lynn Barnickol, Forestry Division; Joe Jerek, Outreach & Education Division; Dean Harre, Protection Division; and Keith Jackson, Private Land Services Division. The Committee may add members as needed, including a representative from Design and Development Division.

Within the committee Bill Elliott and Anthony Elliott will act as the "WNS Leaders" to evaluate data, implement the action plan, and act as MDC representatives in Missouri multi-agency, regional, or federal WNS action planning and implementation activities.

B. Plan Essentials

The goals of MDC's WNS action plan are to protect the diversity of Missouri's bats and other cave wildlife and to prevent or delay the spread of WNS. No actions will be taken that are detrimental to the ecology of a cave or to the state's wildlife. No wildlife collector permits will be issued for experimental treatments of bats, mines, or caves without prior review by the WNS Leaders for potential detrimental outcomes.

The objectives of MDC's WNS action plan are to: 1) protect bat populations from exposure to the causative agent(s) of WNS, 2) continue essential research, monitoring and counting of bat populations, except in cases where entry into sites, even with disinfection procedures, presents a substantial risk to bats, 3) protect bats from unnecessary stress to allow them the greatest chance to survive, and 4) prevent spread of WNS to other sites when practicable.

With the adoption of this plan and prior to any WNS trigger outlined below, all MDC personnel, cooperators and permit holders **must** use appropriate, disinfected personal protection equipment when entering **any** Missouri cave or mine: helmets with chinstraps and electric headlamps, two other reliable light sources, spare batteries, rubber boots with gripping soles or other suitable boots that have been disinfected, sterile gloves, and other gear for safe travel. Disposable coveralls are not required, but they may be used to protect clothing worn in no more than two caves on the same day, provided that the clothing remains clean and the coveralls are properly bagged and disposed after exiting each cave. Fresh, disinfected clothing and gear must be used each day. Clothing, boots, helmets, and other gear must have been disinfected since the last use with FWS-approved disinfectant and procedures (FWS June 2009a, Appendix 3).

To assist MDC staff, arrangements have been made for a state agency laundry to disinfect and launder caving clothes when necessary. Disinfection supplies include Formula 409® antibacterial and Hillyard Re-Juv-Nal® (both with quaternary ammonium), Dupont Proshield® disposable coveralls, disposable nitrile gloves, and other products for field use, but similar products may be acceptable. Disposable coveralls are optional, but may be used to protect clothing underneath from having to be changed before entering a second cave the same day. Limited quantities of these supplies are available to MDC staff and cooperators from WNS Leaders.

With the adoption of this plan only MDC personnel and permit holders who have been trained and authorized by the WNS Leaders may enter closed "MDC bat caves," which are MDC caves designated in Appendix 4, Table 5. These lists will be updated by the WNS Leaders by definition or by email documents.

C. Core WNS Action Plan

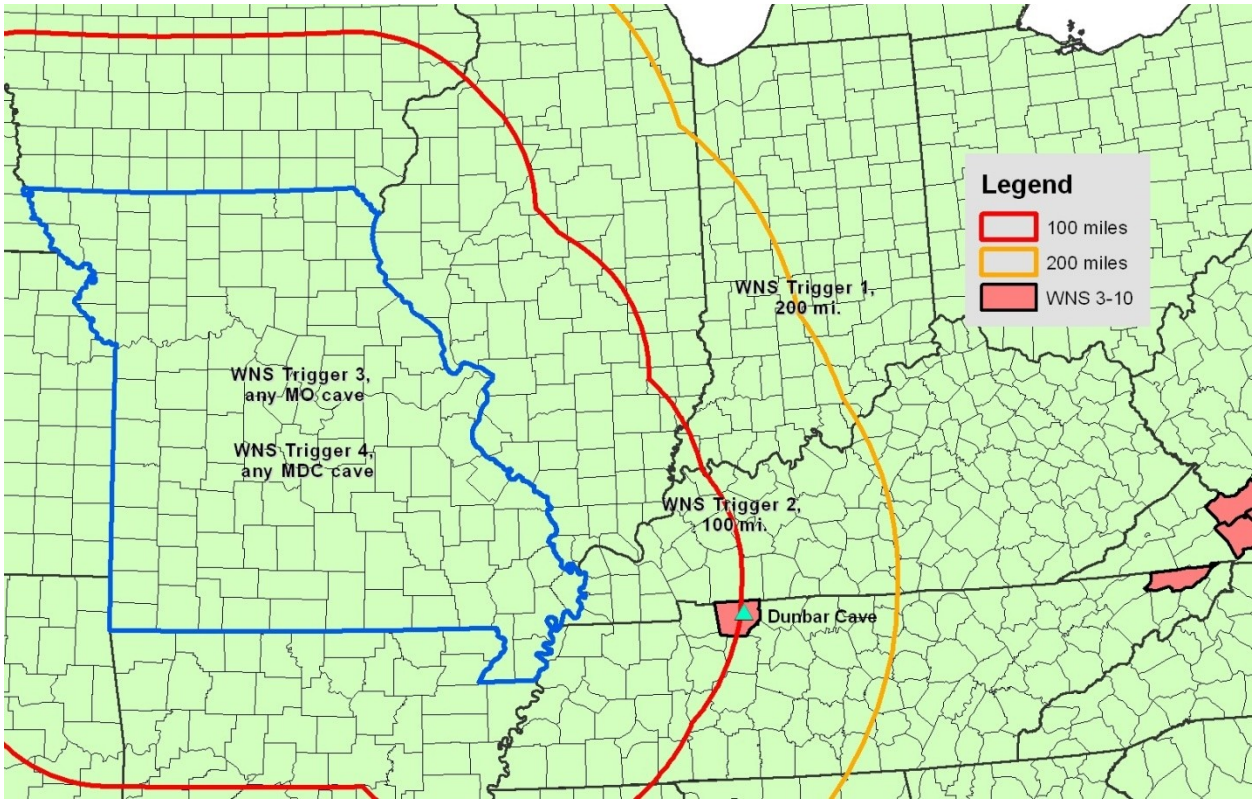

Figure 1. MDC's 200- and 100- mile WNS Triggers are an early warning system to defend against the disease. As of March 18, 2010, WNS was confirmed about 103 miles from Missouri at Dunbar Cave, Montgomery County, Tennessee, placing MDC in Trigger 1.

Current Precautions

WNS is confirmed 103 miles from Missouri as of March 18, 2010 (see Figure 1).

Actions

- Establish the MDC WNS Committee to provide guidance on MDC cave management and write an action plan.
- All MDC staff are required to disinfect before entering any cave.
    - WNS Leaders (Bill Elliott and Anthony Elliott) begin training MDC staff in WNS disinfection.

- Area managers require the public to disinfect before entering MDC caves.
- Raise awareness of current regulations for MDC-managed caves (i.e., caves on MDC property are closed unless signed open or with Special-Use or other appropriate permit).
    - WNS Leaders and Outreach & Education Division inform public.
    - WNS Leaders work with appropriate staff to update Area Resource Management Policy relating to cave and karst management.
    - WNS Leaders conduct regional workshops for managers to train them in disinfection procedures, WNS Plan, and current policy and regulations.
    - Forestry and Wildlife staff post a new general sign (Appendix 1C) at Conservation Area information boards stating that **all** MDC caves are closed unless signed open or permits are available, and that WNS-disinfection is required before entering any cave.
        - New "Restricted-access" signs are posted on a limited number of Class 1 nonbat caves, intended to be open to public use with some restrictions, until Trigger 3.
        - Old cave signs that may cause confusion are removed.
- MDC bat caves are prioritized and actions are identified to protect high priority caves.
    - Prioritization Criteria (field names and scores assigned in Cave Life Database):
        - Batcode (1 = nonendangered bats recorded, 2 = MO Species of Concern bats recorded or priority 2 bat caves, 3 = priority 1 bat caves)
        - Batdiv (diversity) (1 = 1 or 2 bat spp., 2 = 3 or 4 bat spp., 3 = 5 or more bat spp.)
        - Disturb (potential for disturbance) (1 = low, 2 = moderate, 3 = high human disturbance at the site)
        - Access (ease of access) (1 = low, 2 = moderate, 3 = high accessibility)
        - Protect (need for additional protection) (1 = low need for more protection, 2 = more protection needed but not a gate, 3 = needs cave gate)
        - Priority (sum of the five factors above, used for ranking)
    - As additional information is gained for caves, the caves will be re-evaluated and prioritized appropriately based on the above criteria.
- Enforcement actions will be prioritized for bat caves and other sensitive caves.
- The Missouri WNS Working Group is established.
- A Cave Stewardship Program is established.

WNS Trigger 1

WNS is reliably reported or confirmed 100-200 miles from Missouri, which is the situation as of March 18, 2010. "Reliably reported" means that a report of WNS has been accepted by a state or federal wildlife agency based on the following three criteria: 1) documented WNS-related bat behavior and/or *Geomyces destructans* (Gd) fungus infection, 2) photographs, carcasses, or other valid evidence are collected, and 3) names of observers, their qualifications, dates, locations, and a report are provided to MDC. "Confirmed" means Gd was confirmed in a laboratory analysis of a carcass or tissue sample.

Action 1

- The first tier of 17 additional high-priority MDC bat caves are closed and new "WNS closed" signs (Appendix 1 page 30) are posted at 30 both previously and newly closed caves (Table 2, Appendix 1C, and Appendix 4, Table 5).
    - All closures include MDC staff without a monitoring/research/enforcement need.
    - WNS Leaders may grant access to a few closed caves for holders of essential, WNS-related Wildlife Collector's Permits (WCPs), essential MDC monitoring, and important, ongoing mapping projects and research. Rescue and enforcement activities may be carried out without necessarily contacting the WNS Leaders.
- WNS Leaders continue to train MDC staff and partners in WNS disinfection.
- WNS Committee develops criteria for cave and WNS-related Special-Use Permits, which are issued by the WNS Leaders.
    - All cave and bat-related permits require that cave trips and bats observed be reported within one week to the WNS Leaders.
- Install electronic devices to monitor disturbance at high priority caves for information and enforcement purposes.
- WNS Leaders begin training cave stewards for monitoring selected caves for WNS or human disturbance.
- Post WNS-closed signs (with hand-written permit option; Appendix 1 page 30) on a limited number of Class 2 caves, but without entry allowed between October 15 and April 15. These dates add 15 days of protection at the beginning of the season than the current October 30-April 15.
- Protection actions identified for the highest priority caves are implemented.

WNS Trigger 2

WNS is reliably reported or confirmed, as above, within 100 miles of Missouri.

Action 2

- Second tier of 22 additional medium-priority MDC bat caves are closed.
    - Old signs granting access are removed
    - New WNS closed signs are posted at all 30 medium-priority bat caves and as staff time allows.
- Special-Use and Wildlife Collector Permits are restricted in number, season, and only for WNS-related essential monitoring and research purposes in closed bat caves.
- Wildlife Collector Permits for any bat-capturing work will be reviewed and additional restrictions may be applied to reduce the potential for spreading WNS.
- MDC personnel may only enter 1 cave per day.

WNS Trigger 3

WNS is reliably reported or confirmed, as above, in Missouri.

Action 3

- All remaining MDC bat caves are closed to public access without Special-Use or Wildlife Collector's Permit.
    - 18 more caves.

  - Old signs granting access are removed
  - New WNS closed signs are posted as needed and as staff time allows
- A limited number of Class 1 and 2 caves will be made available by permit for monitoring by trained personnel, but will be closed if bats are found (see Appendix 1, II, D.)
- Further restrict research and monitoring to limited, low-impact, essential WNS-related monitoring and research permitted by the WNS Leaders. Monitoring trips into some uninfected bat caves are permitted because of the need to check bats, especially gray bats, which currently are not infected by WNS, unless other states find WNS in gray bats.
- Trained cave stewards or MDC staff monitor selected cave entrances in late winter for WNS-related behavior using a permit and protocol issued by the WNS Leaders.

WNS Trigger 4

WNS is reliably reported or confirmed, as above, in any MDC cave.

Action 4

- Discontinue ALL entry for any purpose during hibernation period to the cave for 3 years unless required for disease detection by the WNS Leaders.
  - Allow entry during summer months only for essential WNS-related research or monitoring.
- Trained cave stewards or MDC staff monitor the cave entrances in late winter for WNS-related behavior using a permit and protocol issued by the WNS Leaders.

Annually or with Major Developments in WNS

Each January or February or if bats are decimated, WNS fades, new information about a cave is developed, or an environmentally safe, contained medical treatment for infected bats proves effective.

Action 5

- The WNS Leaders may recommend reclassification of caves on a case-by-case basis, share updates on WNS status and science, review the action plan, and recommend revisions to the WNS Committee for approval.

D. MDC's Cave Management System

MDC uses a cave classification system like other natural resource agencies, in which caves are classified as Class 1 (open with certain restrictions), Class 2 (permit), or Class 3 (closed) in MDC's "Cave Management and Recreation Policy" in the *Area & Resource Management Policies and Procedures*. Cave signs are specified in the MDC sign manual. Caves on MDC lands are to be reported to the cave biologist, who keeps the central registry and database of known MDC caves and their resources, and determines their management classification in consultation with area managers and biologists.

According to regulation and policy, MDC caves are currently closed to public entry without special permit unless a sign permitting entry is posted. The goal for additional closures in this plan is to protect as many bat sites from WNS as possible without causing unnecessary

disruption of essential monitoring and research, especially if it is WNS-related. However, MDC does not believe that closure of all caves would be effective in Missouri because there are too many caves and visitors to adequately enforce such a general rule. Only about 2% of Missouri's 6,300 caves are gated (Appendix 4, Table 5). MDC will work with partner agencies and collaborating landowners in the Statewide WNS Committee to restrict access to other priority bat caves to provide additional protections against WNS.

Table 2 outlines our initial plan for cave closures. MDC has examined its inventory of 290 caves, of which 80 have bats (Fig. 2). All of the bats may be vulnerable to WNS, therefore our bat caves will be closed (Class 3) with a series of WNS Triggers 3. An additional 20 caves already are Class 3 because of hazards, sensitive features, and related issues, and will remain so.

Class	Now	WNS Plan	Class 3 Now	Addl. Closures	Gated	Not Gated
1 restricted	188	158			0	158
2 permit	60	32			1	31
3 closed now	42					
3 high bats		30	13	17	17	13
3 medium bats		30	8	22	3	27
3 low bats		20	2	18	3	17
3 no bats, other issues		20	19	1	2	18
Totals	**290**	**290**	**42**	**58**	**26**	**264**
Closed after WNS		***100***				

Table 2. MDC's caves will be reclassified as WNS triggers occur. 58 additional bat caves will become Class 3 (closed), for a total of 100 out of 290 caves. Other caves may be closed if bats are discovered.

E. Communications and Statewide Action Plan

Communication Plan

MDC will use reliable reports from biologists, agencies, and the public to assist in the detection of WNS. Clear communication channels within and between agencies will allow a better picture of the timeline of WNS movement. Clear communication will also allow MDC to explain WNS, research, and regulatory actions taken, and how others can help MDC's efforts to stop, slow, or track the spread of WNS.

There are five main objectives of the state WNS communication plan:

1. WNS Leaders will create a secure blog or listserve for the Missouri WNS working group, with a point person from each organization. Membership will be limited and will share test results, coordinate plan updates, meetings, training, and deployment of response teams.

2. WNS Leaders will handle reports by telephone, mail, and email from professionals and the public about possible WNS occurrences. We shall not encourage untrained people to visit caves. Reports in summer are unlikely to be WNS due to the fact that it is not visible on active bats. We need the public to report unusual bat behavior in winter, not by going inside caves but outside cave entrances and on the landscape when WNS drives them from their caves.

3. Communications should share what we are learning about the disease and its spread, what MDC is doing about it, and how volunteers might get involved. Announcements about WNS would be published as WNS triggers necessitate cave closures, and the new "WNS Cave Closed Sign" would be posted at MDC bat caves (see below). Information can be disseminated via MDC's public webpage, press releases, radio and television interviews, articles, pamphlets, and outreach to caving organizations.

The WNS Leaders and Committee shall:

- Present information on WNS and the Plan at upcoming division, Expanded Staff, and Commission meetings.
- Share WNS Plan with partners and work with them to develop a state WNS plan.
- Work with Policy Coordination to revise/update ARM policy.
- Prepare a memo to appropriate staff notifying them of current cave regulations and actions needed in the WNS Plan.
- Prepare an executive summary of the WNS Plan to serve as a briefing for the Commission.
- Prepare a Science Note on what is currently known about WNS.
- Meet with caving organizations to discuss WNS and actions needed to minimize its impacts.

Communication Strategy for Changes in WNS Trigger Status:

- WNS Leaders will notify immediate supervisors.
- Supervisors will notify RSD Division Chief.
- RSD Division Chief will notify Deputy Directors, Director, and Forestry, Wildlife, O&E, and Private Land Chiefs.
- Director will notify the Commission.
- The WNS Committee Chairman will notify FWS.
- The WNS Committee will draft a memo to appropriate management staff alerting them to the trigger and what actions need to be taken.
- WNS Leaders and Outreach Specialist will immediately draft a news release to notify the public that WNS has been documented within the specified trigger and the actions MDC is taking.
- WNS Leaders will provide a Question & Answer document for staff to use when answering public inquiries about WNS.

Statewide Action Plan

MDC held a "Bats and Caves Luncheon" on February 5, 2010, at the Missouri Natural Resources Conference, which initiated the Missouri WNS Working Group. MDC and FWS will lead the

Missouri WNS Working Group with a goal of working toward a statewide action plan, which could use many elements of the MDC plan. The first meeting to begin identifying goals and a process for writing this plan is being held in Springfield, Missouri on April 13, 2010. This group includes representatives from federal and state agencies, nongovermental organizations, private show caves, and private landowners.

F. Division Roles

1. Resource Science Division (RSD)

WNS Leaders will lead bat and WNS monitoring efforts and will provide disinfection and protection equipment to a limited number of designated personnel. They also will provide recommendations to the WNS Committee for actions needed to minimize impacts due to WNS.WNS Leaders will provide regional training to MDC personnel and cave stewards who need to enter caves for necessary work approved by the WNS Committee.

The WNS Committee will develop wording for new cave signs and WNS Leaders will order the signs and send them to area managers who have bat caves identified in Appendix 4, Table 6 (see Figure 2 for the geographic dispersal of caves managed by MDC). The WNS Leaders will train cave stewards, who will notify the cave biologist and the area managers when they plan to work on conservation areas. However, an area manager may request that a cave steward be rejected for good reason and will work with the WNS Leaders and others to resolve issues.

2. Forestry and Wildlife Divisions

These divisions have primary management responsibility over MDC lands with caves. Administrators will periodically update WNS Leaders with lists of current area managers, their areas, counties, and contact information. Managers of MDC areas with caves will participate in cave and WNS training offered by the WNS Leaders. Area staff will post new “Caves generally closed signs” at parking lots on all conservation areas having caves and the new “WNS Cave Closed Sign” at selected MDC bat caves as determined in Table 6 and supplemented by the cave biologist. Old cave signs will be removed if they are inappropriate or confusing. Selected Class 2 caves may be signed with the new “WNS Cave Closed Sign” provided that the following is added to the contact block on the sign: “Caving permits may be obtained. WNS disinfection required. Contact:” plus a telephone number.

There will be additional work in issuing and controlling Special-Use Permits and monitoring important caves for intruders and WNS-related bat behavior. Cave gates will be checked periodically and reported to WNS Leaders using a written form.

3. Protection Division

Additional surveillance and enforcement by conservation agents will be requested at priority MDC caves. RSD, Protection, and others will work together to deploy electronic security devices and respond to alerts. Conservation Agents will be able to inform the public about caving and disinfection rules and to enforce the WNS rules by requiring anyone to show a caving permit if they are in a Class 2 or 3 cave or a cave without a sign posted authorizing public entry.

4. **Outreach & Education Division (O&E)**

O&E's role in communications (below) will be essential, such as publishing news about the WNS Committee's actions and magazine and online articles about MDC's WNS Action Plan. To avoid misunderstandings, all material about WNS, bats, and caves should be developed mutually by the WNS Leaders and O&E. If feasible, O&E will assist with the creation of a secure blog (requiring a password for access) for the Missouri WNS Working Group.

5. **Information Technology (IT)**

IT will assist with the creation of a secure listserve through Office of Administration if that proves to be a better option than a secure blog.

6. **Private Land Services Division**

This plan does not apply to privately owned caves, but statewide plan development may be of interest to some private landowners. Private Land Services will advise the WNS Committee on partnering with private landowners.

7. **Policy Coordination Unit**

Policy Coordination will coordinate with RSD in updating the Area Resource Management Policy on caves and karst.

8. **Design & Development Division**

D&D will work with the WNS Leaders to inspect and repair or renovate existing cave gates.

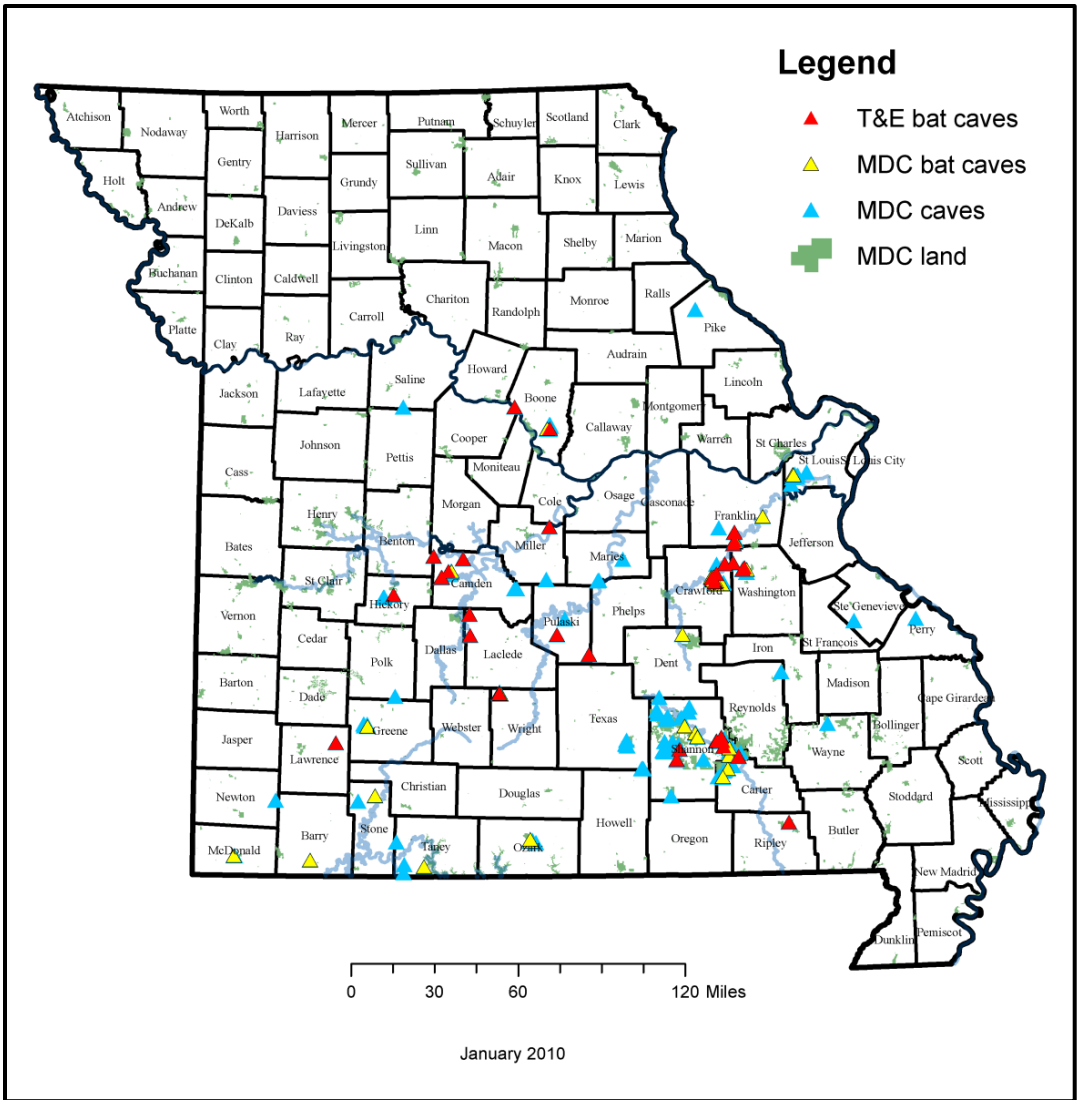

Figure 2. MDC's 290 caves (including karst springs) are distributed widely in southern Missouri, with 80 identified as bat caves. "T&E bat caves" (red) have endangered gray bats or Indiana bats.

IV. FUNDING AND FUTURE WORK

MDC's has devoted considerable time to WNS monitoring and planning. In September 2009 the Fish & Wildlife Service, Ecological Services Office, Columbia, Missouri, provided $25,000 funding to RSD's cave program for bat cave protection and WNS-related work over two years. This funding will be used for testing electronic security equipment, cave gating supplies, disinfection supplies, and caving gear. A Cave Preservation Fund, about $2,700 in the Missouri Conservation Heritage Foundation, will be used as an "Emergency Cave Gate Repair Fund" for important bat caves.

On October 30, 2009, Congress passed a Department of Interior appropriations bill containing $1.9 million for research, monitoring and related activities to respond to the massive mortality in bats from WNS. An initial offering of funds to the states was made through a multi-state SWG (state wildlife grant). MDC will receive some funding via Bat Conservation International for traveling to important WNS meetings. In late March RSD staff worked with a nationally recognized cave gating consultant to visit five caves for preliminary cave gate design, cost analysis, and planning. A proposal for $50,000 to fund gate construction for some of these caves was submitted to FWS and awards will be announced in late April. A second round of funding will be available for research.

By May 1, 2010, the WNS Leaders, in coordination with management divisions, will identify high priority bat caves for protection work, and develop recommendations, budgets, and schedules for cave gates and security systems.

Research Needs:

Non-intrusive estimation of bats in hibernacula
Bat monitoring efforts have continually evolved as technology and scientific procedures improved and concern for the disturbance to bats during the monitoring increased. Monitoring techniques incorporating photography (both still and video) have increased precision over methods based on measuring the area of new guano and allow scientists to spend less time in the caves while collecting the data, reducing potential disturbance to bats. Newer technology (e.g., thermal infrared video) allows monitoring of bat emergences at maternity colonies and fall swarms without even entering the caves, virtually eliminating disturbance to bats while increasing the quality of the estimates.

The most intrusive monitoring remaining is the estimation of bats by species hibernating in specific caves. To date, these estimates require entry into the cave to locate bat clusters and measure or photograph them for identification and estimation of numbers. Still photography of bat clusters has reduced the time required to estimate the numbers of bats within clusters. However, this methodology still requires entry to the cave and presence near the bats. Development of methods to estimate bats hibernating in the caves through the use of thermal infrared video during the fall or spring as bats enter or exit the cave would eliminate the need for cave entry and reduce stress to bats.

Species identification in conjunction with TIR video estimates
Linking thermal infrared video estimates with acoustic data or still photography of the cave entrance may allow species-specific estimates to be made. Currently, the video estimates provide total numbers but do not distinguish among species or even allow an estimate of the species make-up of the bats observed. Acoustic devices that detect the frequencies of bat calls may be used in coordination with video estimates to provide species composition. Another possibility is the use of high resolution still photography that would allow species to be identified.

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APPENDICES

Appendix 1. Technical Supplement

Appendix 2. MDC Scientific Collector Advisory

Appendix 3. Disinfection Protocol

Appendix 4. Missouri's Bat Caves and Mines (Tables 3-6)

Appendix 5. Questions and Answers about WNS

Appendix 1. Technical Supplement

I. SURVEILLANCE

A. Surveillance for WNS

The goal of "surveillance" in this plan is detection of WNS in bats. "Electronic surveillance" is a term that we often apply to detecting human intruders at important caves using special equipment, but it could also be used for an experimental infrared "beam-breaker" method for detecting aberrant activity in WNS-infected bats. Acoustic surveillance with Anabat® ultrasound detectors also is used to monitor unusual bat activity in winter possibly caused by WNS. .).

Although WNS has not yet been observed in Missouri, monitoring bat populations in states that are currently unaffected is crucial, both for early identification of the disease and for pre-WNS baseline monitoring in this region. Although control methods for WNS are still in the experimental phase, early identification of the disease will give managers and researchers the earliest opportunity to use control methods to stop or slow the spread of the disease when they become available. Critical baseline data on parameters, such as population densities, health (e.g., body condition and wing damage in unaffected bats), reproductive status, and hibernacula microclimatic data, are needed from unaffected states for ongoing research dedicated to understanding how the disease is spread and how it can be controlled.

Coordination among researchers within Missouri and outside of the state is needed to minimize stress and disturbance of bats whenever possible, and to reduce redundancy in sampling efforts. Preventing infection of and stress to the bats should a primary consideration in the selection of methods used for monitoring and in the number of hibernacula and roosts selected for monitoring.

A number of databases (including the Natural Heritage, Cave Life, MDC Cave, and Mammal databases) contain information useful for planning, baseline information, and predicting WNS effects. A new Bat Database will contain information on all bats studies in Missouri. MDC also is a partner in the Missouri Speleological Survey database, which contains proprietary data on the state's approximately 6,300 caves, some of which is summarized in Appendix 4. Data from Wildlife Collector Permittee annual reports and other sources are entered into appropriate databases.

Within the MDC Cave Database and Cave Life Database, precise cave locations and many environmental parameters are recorded, including species, numbers observed or collected, temperature, and general conditions. MDC has extensive temperature datalogger data from hibernacula caves from 1998-2003, and spot temperature readings in hibernacula going back 30 years. This information may be helpful in predicting and understanding where Gd can survive or will spread.

B. Establishing Surveillance Priorities

The goal of MDC's surveillance priorities will be to plan efficient monitoring of potentially impacted sites using scientific evidence and reliable information. Information contained in Appendix 4, Table 6, along with accessibility, disturbance levels, etc. will be used to prioritize surveillance efforts.

Objectives of prioritization:

1. Use existing databases for prioritization of bat caves for closure and monitoring,
2. Provide effective surveillance across Missouri,
3. Detect the arrival of WNS (if it occurs) in a timely manner,
4. Efficiently use limited available resources.

Levels of WNS detection:

1. Presence or absence of WNS – this can be a more passive method of detecting WNS that relies on public reporting or indirect methods of WNS monitoring (e.g., bat counts).
2. Early detection – this is a more active method of detecting WNS that relies more on direct methods of surveillance (e.g., capture and sampling of bats, digital photography surveillance) as well as public reporting and indirect methods.
3. Prevalence – is the proportion of a defined population with the disease. This is also a more active method of WNS surveillance after the disease is present.

A detailed discussion of acceptable bat survey methods follows, noting that some methods have a higher risk of infecting bats with WNS. MDC will seek the most appropriate and safe methods of capture.

C. Bat Survey Methods for WNS

a. Fall and Spring Surveys

Fall and spring surveys may be needed to determine the presence or absence of species of conservation concern. These surveys are also used as an index for population size; methods can also be used as an indirect method for disease detection.

1. Capture and handling of bats

FWS recently recommended against granting federal permits for harp trapping due to bat-to-bat contact (Appendix 2). Disinfecting a harp trap is difficult and mist netting increases handling stress. However, obtaining measures of body condition (weight) or genetic samples requires capture and handling of bats. Because much of the interest in these parameters relates to hibernation, this requires trapping in fall and spring at hibernacula. Relevant biosecurity actions must be taken during trapping to reduce the likelihood of cross-contamination of individuals. There is an ongoing cooperative effort (MDC and USFS Northern Research Station) to document pre- and post-hibernation weights of bats at Great Scott Cave. There is also a long-term record of fall harp-trapping at the entrance of Pilot Knob Mine. These studies will be useful, especially in detecting effects on of WNS on Indiana bats. Trapping methods also will be important when developing and testing methods of monitoring fall and spring emergences to replace current methods to monitor hibernating colonies.

2. Emergence counts

An emergence count is an example of an indirect method for detecting changes in relative abundance. This method requires some knowledge/measurements from previous time periods to detect a change in the bats. No hibernacula in Missouri have good pre-WNS data sets for comparison. (Also see Summer Surveys below.)

b. Winter Surveys

Because WNS has only been confirmed in bat species that hibernate (at least in part) in caves and mines, these immediate monitoring protocols are focused on methods for monitoring these species only. Winter monitoring is also important for documenting aberrant behaviors associated with the disease such as roosting in colder areas of the hibernacula or flying during daylight hours. Most mortality associated with the disease has occurred during the winter months.

1. Internal Winter Survey Objectives:

   (a) To provide WNS surveillance,
   (b) To provide population estimates of bat species,
   (c) To provide information on potential changes in clustering behaviors and roost locations.

a. Photographic surveys of hibernacula

Although the original FWS "Protocol for 2008–2009 Hibernacula Surveys of Cave Bats" focuses on surveying populations of Indiana bats, the most recently revised version also addresses the need and methods for surveying all bat species within Indiana bat hibernacula to the extent practical. This protocol recommends high-quality digital photography during surveys of Indiana bats to increase accuracy of density estimates and to increase the ability of researchers to monitor bats (particularly in hibernacula with tall ceilings) for the appearance of fungus or emaciation. Photography is not suitable for all sites or for all species; survey teams must use their judgment of the best method(s) to use at a given site. MDC has been implementing photographic surveys and will continue to do so until better methods are developed.

Plans are to conduct internal surveys of 10-15 minor Indiana bat hibernacula and at least one of the pit-cave and major gray bat hibernacula during the winter of 2009/2010. The regularly visited Indiana bat hibernacula will be visited again during the regularly scheduled survey year of 2010/2011.

b. Minimizing Disturbance during Winter Surveys

The goal of MDC is to maintain or reduce the level of winter disturbance in important bat hibernacula in Missouri. Groups entering hibernacula should be small and they should move quietly. MDC will continue to enter important Indiana bat hibernacula during the winter once every other year, and will encourage partners to adhere to similar standards. Other important bat hibernacula will be considered on an individual basis for restrictions on surveyor access. Furthermore, researchers will carry sampling supplies with them in case WNS is observed so the hibernaculum does not have to be re-entered to obtain WNS samples.

2. External Winter Survey Objective: To provide WNS surveillance.

a. Systematic External Survey Methods

External monitoring approaches are likely to be most effective on sites with larger numbers of bats. Plans are still in development for external surveys by MDC personnel, but the hope is that entrances of major hibernacula will be visited once or twice during the winter of 2010/2011 to check for aberrant bat behavior, such as roosting at the entrances, flying outside during cold weather (especially during daytime), or mortalities outside hibernacula.

b. Surveillance through Public Reports of Sick or Dead Bats

Reports may come from the public of aberrant bat behavior described above, particularly as awareness of WNS continues to spread. Therefore, MDC plans to use press releases, magazine articles, and the internet to educate the public about this threat and encourage reliable reports to MDC (see Communications). Coordination with other agencies is essential so that if other agencies are contacted they can direct the person to the WNS Leaders.

MDC will continue communications with the state rabies lab. Because of increased activity in WNS-infected bats in winter, there have been increases in the number of bats submitted to rabies labs in WNS-affected states. In addition to potentially providing information on the geographic distribution of sick/dead bats found on the landscape, rabies labs bats can also provide a valuable source of information and samples to be tested for WNS if they are received during the late fall through early spring.

c. Summer Surveys

Most of the mortalities associated with WNS have been documented during the winter. However, summer surveys allow researchers to collect crucial information on variables of uninfected bats, which may require handling of the bats that may not be possible during winter surveys. Summer surveys may also be useful for providing information at the landscape scale that can be examined over time for changes in diversity and relative abundance of bats.

1. Acoustic Transect Surveys

Acoustic transect surveys can be used to measure the diversity and relative abundance of bats. Acoustic transect surveys performed prior to the arrival of WNS and after its discovery in 2007 have been used to document bat declines at the landscape scale in the Northeast. Regionally and nationally, data from Acoustic Transect Surveys are currently submitted to Eric Britzke (eric.r.britzke@usace.army.mil). MDC is not participating in these surveys currently but is interested in conducting surveys beginning in the summer of 2010. The Mark Twain National Forest began conducting some surveys during the summer of 2009.

2. Emergence Counts at Maternity Roosts

Since 2004 MDC has used near-infrared (NIR) video recordings of gray bats for population estimates. During the summers of 2008 and 2009 MDC used thermal-infrared (TIR) video equipment to make recordings for emergence counts at a number of gray bat maternity caves throughout the state. These counts will continue in the foreseeable future and they may serve

well if gray bats become infected with WNS and populations decrease. TIR can be tried as a potential, nonintrusive method to estimate spring emergences at hibernacula.

A research project focused on summering Indiana bats in northeastern Missouri began in the summer of 2008, with the initial phase of the project to be completed in the summer of 2010. The original intent of the project was to study maternity colonies of Indiana bats in relation to timber management. However, with the approach of WNS, a project proposal will be developed for a second phase during the probable arrival of WNS. TIR and NIR video could be tested to observe Indiana bat movements among trees.

Additional summer research and monitoring projects are being conducted by partners throughout the state and MDC will continue to cooperate and coordinate with these partners for the maximum use of collected data. Researchers who handle bats in Missouri have been encouraged to examine wings of captured bats to document baseline levels of wing and tail membrane damage/scarring and monitor any changes as WNS approaches. Scarring will be considered a clue, but not confirmatory evidence of WNS. MDC will cooperate in these efforts and encourage all partners to conduct these examinations.

d. Bat Banding

Bat banding is not a standard survey method because of documented band injuries and very low recovery rates. However, banding of bats can provide information about movement between sites and interaction between bats. This information could be crucial for predicting the speed and range of WNS spread. Currently workers at Missouri State University are banding bats as part of least two different research projects. Cooperation will continue on this work in order to report any band recoveries and learn more about the movement of bats that are being captured in Missouri. Also, genetic samples collected by the USFS Northern Research Station can document bat movement through confirmed individual recaptures and relatedness measures between individuals captured at one site or different sites. Gathering this information will contribute to continued prioritization of surveillance (i.e., if WNS is documented at one cave and bats from that cave have been documented moving between it and a second cave, surveillance of the second cave will become a high priority).

e. Identifying WNS

Currently, positive confirmation of WNS requires necropsy of a bat carcass with an associated histopathologic examination. The laboratory conducting these examinations is the U. S. Geological Survey National Wildlife Health Center (NWHC) in Madison, Wisconsin. Protocols for submission of samples to this lab have been distributed by the U.S. Geological Survey, National Wildlife Health Center (2009b) and they will be followed by MDC. Additional means of documenting suspect occurrences include using PCR to genetically confirm the presence of *G. destructans* and photographs of bats displaying fungal growth. The NWHC and the USFS Northern Research Station laboratory can conduct the PCR confirmation. Samples or photos from trained staff or public will be submitted to Bill Elliott or Tony Elliott who will then send likely samples to the appropriate laboratory.

II. REHABILITATION

Rehabilitation of WNS-suspect or confirmed bats is still a contentious issue. The acute symptoms have been arrested in rehabilitation settings, but it is unknown whether the fungus was eliminated and there is a worry that these "cured" bats could contribute to the spread of WNS. Additionally, cross-contamination in a rehabilitation facility conceivably could lead to infection of other noncave hibernating bats.

Rehabilitation Options:

1. **Euthanasia**. Except for a limited number of individuals for research use, all WNS-suspect bats would be euthanized. The drawback of this approach is the loss of bats that may recover naturally, thus eliminating natural selection's role in increasing resistance in the population. MDC does not support this approach.

2. **Leaving infected bats** where they were found except for the removal of some for research. MDC will generally follow this approach.

3. **Rehabilitation**. If any rehabilitation were done, facilities that harbor WNS-suspect bats must be willing and able to quarantine these bats in order to prevent cross-contamination (or only work with WNS-suspect bats). There are two possible outcomes:

    a. **Release rehabilitated bats**. After all known measures have been taken to cure and disinfect WNS-suspect bats they would be released back into the wild.
    b. **No release of rehabilitated bats**. Rehabilitated bats would be used for research or captive propagation.

WNS Leaders will contact the permitted rehabilitators in Missouri to see how many bats are normally rehabilitated and how many facilities would be willing and able to follow strict quarantine procedures. Further information and discussion would be needed before launching a rehabilitation program, and perhaps only in the case of populations under threat of imminent extinction.

III. CAVE MANAGEMENT

A. Cave Gates

Cave gating is an essential tool for the protection of important caves from human intruders. Cave gates usually are funded because of endangered bats that may be stressed or driven out by visitors during sensitive periods, such as hibernation (many bats) or maternity (gray bats). More cave gates will be necessary to prevent human intruders at priority bat caves (Appendix 4). While cave gates cannot prevent fungus brought in by bats or air currents, they do reduce human-caused stress in the bats and possible human-borne fungus. Some caves are not gateable because of violent flooding or other conditions.

Poor cave gates can harm wildlife and cave resources. Often there are reasons for not gating a cave and cave gating is not automatically recommended by MDC. Cave gating is a technical subject that requires knowledge and experience. Knowledge of the cave's ecology, especially bats, is necessary before a gate is considered. MDC assists cave owners in cave gating, but first a decision guide (Elliott 2010) and experts must be consulted.

MDC provides training in cave gating, for example the 6th National Cave Gating Workshop in October, 2009, at Cliff Cave, St. Louis County. This workshop trained 35 people who eventually may be protecting WNS-infected caves.

B. Cave Signs

Three new signs (**"Caves generally closed sign," "WNS cave closed sign"** or **"WNS cave restricted sign")** will be posted at conservation areas and selected MDC caves.

MDC's existing cave signs are 12" x 16" brown plastic with white lettering and are specified in the MDC sign manual. We often place cave signs inside the entrance so as not to attract attention to the cave. They may be fastened to the wall with masonry screws, or nailed to a tree with aluminum nails.

Before WNS arrives in Missouri the following **"Caves generally closed sign"** shall be posted at MDC conservation areas that contain caves:

NOTICE

CAVES ARE CLOSED

TO ENTRY UNLESS SIGNED OPEN OR YOU HAVE A VALID PERMIT

You may not enter a Missouri Department of Conservation cave that lacks a sign giving access. Written permits may be available for selected caves. For information see http://www.mdc.mo.gov or contact:

Proper disinfection is required before entering caves to reduce the spread of White Nose Syndrome (WNS), a wildlife disease that has killed millions of bats (search www for "FWS WNS"). Bats die more often when disturbed.

It is against the law to enter closed caves or caves with no signs, bypass or tamper with a cave gate or fence, dig, remove natural, prehistoric, or historic objects, build a fire, leave trash, take vehicles or animals into, deface or vandalize caves. Persons violating these requirements will be prosecuted.

The Missouri Wildlife Code protects native wildlife. Disturbance of certain wildlife at caves may be punishable by fines up to $50,000 for each violation of the Endangered Species Act.

Caves that are signed should have the name of the cave on the sign for better communication if the public inquires about certain caves. Class 3 caves will receive the "WNS cave closed" sign below. Class 2 caves also may be posted with this sign provided that the following is added to the second block on the sign: "Caving permits may be obtained. WNS disinfection required. Contact:" plus a telephone number. The sign may be provided to public or private landowners if they first discuss use of the sign with the MDC cave biologist.

[Cave name hand-printed on white bar]

CLOSED

for protection of bats from White Nose Syndrome (WNS).

No one may enter closed caves without a written permit from the owner and WNS disinfection. Please contact:

[If Class 2 hand print "Caving permits may be obtained. WNS disinfection required. Contact: (phone number).]

WNS is a wildlife disease that has killed millions of bats and may be spread to new sites by bats or humans. Only authorized personnel with a permit and properly WNS-disinfected gear may enter this cave for any reason.

It is against the law to enter closed caves or caves with no signs, bypass or tamper with a cave gate or fence, dig, remove natural, prehistoric or historic objects, build a fire, leave trash, take vehicles or animals into, deface or vandalize caves. Persons violating these requirements will be prosecuted.

The Missouri Wildlife Code protects native wildlife. Disturbance of certain wildlife at caves may be punishable by fines up to $50,000 for each violation of the Endangered Species Act. Registered with the Missouri Department of Conservation and its cooperators.

Below is the new "WNS cave restricted sign" that will be posted only at selected Class 1 caves in which public access is allowed without permit. Old signs will cause confusion, so they will have to be removed when posting the new sign.

[Cave name hand-printed on white bar]

RESTRICTED ACCESS

No one may enter this cave without proper WNS disinfection and caving gear. Avoid and report bats. For information see http://www.mdc.mo.gov or contact:

[Phone no.]

WNS is a wildlife disease that has killed millions of bats and may be spread to new sites by bats or humans. Disinfection is required.

You may enter this cave only with the following restrictions:

- **WNS Disinfection Precautions:** No clothing worn in caves east of the Mississippi River may be worn in this cave, only one cave per day may be entered, clothing must be soaked in bleach or quaternary ammonium disinfectant, then laundered between Missouri caves.

- **Proper Caving Gear:** Helmet with chin strap, 3 sources of light and spare batteries, durable, nonslip boots.

It is against the law to enter closed caves or caves with no signs, bypass or tamper with a cave gate or fence, dig, remove natural, prehistoric or historic objects, build a fire, leave trash, take vehicles or animals into, deface or vandalize caves. Persons violating these requirements will be prosecuted. The Missouri Wildlife Code protects native wildlife. Disturbance of certain wildlife at caves may be punishable by fines up to $50,000 for each violation of the Endangered Species Act. Registered with the Missouri Department of Conservation and its cooperators.

Appendix 2. MDC Scientific Collector Advisory

Considerations of White-nose Syndrome in Bats during Scientific Collecting Activities

Since you have applied for a Wildlife Collector's Permit to trap, salvage, or collect bats in Missouri, you are likely aware of White-nose Syndrome (WNS) and the danger it poses to populations of cave bats in North America. If you are not familiar with this disease, please take the time to familiarize yourself. A few websites that provide good information and additional links are:

NSS (National Speleological Society) http://caves.org/WNS
US Fish & Wildlife Service http://www.fws.gov/northeast/white_nose.html
Bat Conservation International http://www.batcon.org/wns
USGS National Wildlife Health Center http://www.nwhc.usgs.gov/disease_information/white-nose_syndrome/index.jsp

Even if you are already aware of WNS, it is a good idea to check one or more of these websites regularly because new information is posted quite often.

Because the fungus associated with WNS apparently only grows at relatively low temperatures (<20^{o} C) the noticeable signs during summer are more likely to be scars and damage to wings and other membranous tissues as opposed to the namesake white fuzz on the nose and wings.

See the following website for descriptions and pictures of affected tissues – http://www.fws.gov/northeast/PDF/Reichard_Scarring%20index%20bat%20wings.pdf . **Examine all bats handled or collected in the Missouri for wing damage and score them according to this index. Pictures of suspicious damage should be taken and submitted.**

Report any signs of WNS to the Missouri Department of Conservation (Anthony.Elliott@mdc.mo.gov) as soon as possible.

It is currently unknown whether humans are contributing to the spread of WNS by moving a causal agent from place to place on equipment. Because human spread of WNS is considered a possibility, the following special notes apply to your Wildlife Collector's Permit – **Any equipment (nets, traps, gloves, etc.) that has been in contact with bats outside of Missouri must be disinfected with a 10% bleach solution, or other USFWS recommended disinfectant, before being used in Missouri. Any equipment that has contacted bats or has been inside caves or mines in confirmed WNS-affected states may not be used in Missouri.**

USFWS is requiring case by case approval for the use of harp traps (especially at hibernacula entrances during fall swarming and spring emergence), please contact the USFWS Field Office in Columbia, MO if you are planning to use a harp trap in Missouri.

See http://www.fws.gov/northeast/pdf/2008%20Summer%20Protocols_15May2008b.pdf for additional disinfection protocols.

Appendix 3. Disinfection Protocol

Recommended Procedures to Prevent the Spread of White-nose Syndrome (WNS)
U.S. Fish and Wildlife Service
June 2009

You should not handle bats. If you come across live or dead bats with white-nose syndrome, click on the links below to contact your state wildlife agency or your nearest U.S. Fish and Wildlife Service Ecological Services Field Office, or email WhiteNoseBats@fws.gov.

State Office Listing - http://www.fws.gov/offices/statelinks.html
USFSW Office Listing - http://www.fws.gov/offices/

We ask that you take the following precautions to prevent the possible spread of WNS ("cave" includes all caves, fissures, mines, portals, etc.):

- The U.S. Fish and Wildlife Service recommends that all cavers observe all cave closures and advisories in all states, especially in WNS affected states[1] and unaffected adjacent states[2]. Some states have instituted closures and issued advisories beyond normal permanent and seasonal closures. Other states have instituted, or are considering instituting, closures of caves with bats and/or advisories to stay out of caves with bats. **Please visit** http://fws.gov/northeast/wnscavers.html **for a list of current cave closures**. If closure information from a state in which you plan to go caving is not listed, contact that state's wildlife agency to obtain the latest information on cave access. Before caving in another country, check with the country's wildlife agency for information on cave access.

- Should you enter a cave, whether inhabited by bats or not, upon exiting a cave in the affected zone of New York, Vermont, Connecticut, Massachusetts, New Hampshire, New Jersey, Pennsylvania, Virginia, and West Virginia and adjacent states (Rhode Island, Maine, Maryland, Delaware, Ohio, Tennessee, North Carolina, and Kentucky), follow the containment and decontamination procedures below.

- **Decontaminate all clothing, footwear, and gear prior to departing for a caving outing if you did not decontaminate these items after last exiting a cave.** To avoid contaminating a cave in a currently unaffected state, we ask that you not use gear that was used in a WNS affected state[1] if that gear cannot be thoroughly decontaminated or disposed of (e.g., if harnesses, ropes, or webbing cannot be decontaminated, we advise that you not enter caves or parts of caves requiring use of this gear).

- Because clothing, footwear, and gear used in a cave in a WNS affected state[1] within the past 3 years could pose a risk of spreading WNS, the Service advises that these items not be used in caves anywhere.

- We advise that you decontaminate previously used gear immediately (see decontamination procedures below), store them away, and thoroughly wash and

decontaminate any surfaces with which these items may have come into contact (e.g., car trunk, duffle bag, etc.). Currently, 10% bleach solution, Lysol® All-purpose Professional Cleaner, and the antibacterial form of Formula 409® have been demonstrated to be effective at killing *Geomyces* sp., the fungus associated with WNS, on nonporous surfaces.

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[1] **WNS Affected States:** Connecticut, Massachusetts, New York, Pennsylvania, Vermont, New Hampshire, New Jersey, West Virginia, and Virginia

[2] **Adjacent States:** Maine, Rhode Island, Maryland, Delaware, Ohio, Kentucky, Tennessee, and North Carolina

Note: The listed WNS affected and adjacent states are current as of 6-2-09, please visit http://www.fws.gov/northeast/white_nose.html for the most updated information.

White-Nose Syndrome Containment and Decontamination Procedures

The Service asks that cavers please follow these procedures for containment and decontamination in the circumstances identified above. The main goal of this discussion is to put in place reasonable practices that reduce the transfer of infectious agents, which potentially affect bats, from one cave to another cave. Prior to each caving outing, please check http://www.fws.gov/northeast/wnscavers.html for updates to these procedures.

Any gear, including outer clothing, should not be used in multiple caves in the same day unless the cleaning and disinfection recommended below can be performed. Companion animals should be kept out of caves. A cave should only be entered with clothing, boots, and equipment that have been fully cleaned with the protocol below and rinsed prior to entry to remove disinfectant residue. Upon exiting a cave, scrape or brush off any dirt and mud from your clothes, boots, and gear and then place them in a sealed plastic bag or plastic container with lid to be cleaned and disinfected off site. Outer clothing should be removed prior to entering a vehicle after/between a site visit. A clean change of clothing is recommended. Surface cleaning of exposed skin (arms, face, neck, hands, etc.) with antibacterial hand sanitizer (i.e. Purell®) should occur prior to entering the vehicle's cab.

The first step of decontamination is to remove all soil and organic material from equipment, clothing, and boots using repeated rinses with water. This is especially important as organic material (i.e. clay soils) can prevent the cleaning and disinfecting agents from penetrating equipment, clothing, and boots, etc.

Submersible Gear (i.e. clothing and soft-sided equipment):

- For clothing – Wash all clothing and any appropriate equipment in washing machine using the hottest cycle possible for material and conventional detergents. Laboratory testing has found Woolite® fabric wash to be the best surfactant for clothing. Rinse thoroughly, and then follow by soaking with sodium hypochlorite bleach (i.e. household

bleach) solution diluted to 1 part bleach to 9 parts water in a tub or plastic container. Soak for 10 minutes, then rinse and air dry.

- For other submersible gear (i.e. bags, gloves, etc.) – Disinfect any equipment that can be submersed in a solution with an appropriate and compatible disinfectant such as sodium hypochlorite bleach (i.e. household bleach) solution diluted to 1 part bleach to 9 parts water in a tub or plastic container or ≥ 3% concentration of quaternary ammonium compounds (i.e. Sparquat 256, Lysol® All-purpose Professional Cleaner or the antibacterial form of Formula 409®). Keep submerged for 10 minutes, then rinse and air dry.

Non-submersible Gear (i.e. hard-sided equipment):

- For non-submersible gear (i.e. hard hats, flashlights, etc.) – Disinfect any equipment that cannot be submersed by applying an appropriate and compatible disinfectant to the outside surface by using ≥ 3% concentration of quaternary ammonium compounds such as Lysol® All-purpose Professional Cleaner, Lysol® disinfecting wipes or the antibacterial form of Formula 409®; or use sodium hypochlorite bleach (i.e. household bleach) solution diluted to 1 part bleach to 9 parts water. Keep on surface for 10 minutes, then rinse and air dry.

- For boots – Boots need to be fully scrubbed and rinsed so that all soil and organic material is removed. The entire rubber and leather boots, including soles and leather uppers, can then be disinfected with an appropriate disinfectant such as ≥ 3% concentration of quaternary ammonium compounds (i.e. Sparquat 256, Lysol® All-purpose Professional Cleaner or the antibacterial form of Formula 409®) and sodium hypochlorite bleach (i.e. household bleach) solution diluted to 1 part bleach to 9 parts water. Keep on surface for 10 minutes, then rinse and air dry.

It should be noted that product guidelines should be consulted for compatibility before using any disinfectant on specific equipment. **Also, detergents should not be mixed directly with bleach as this will inactivate the bleach and in some cases produce a toxic chlorine gas**.

Ropes and harnesses:

This equipment should be dedicated to one cave or not used at all. Decontamination of vertical equipment is recommended. However, the performance integrity may be compromised by using these disinfecting agents mentioned above repeatedly. Laboratory testing is ongoing.

Cameras and other electronic equipment:

If possible, do not bring electronic equipment to a cave. If practical, cameras and other similar equipment that must be brought to a cave may be wrapped in plastic wrap where only the lens is left unwrapped to allow for photos to be taken. The plastic wrap can then be decontaminated by using Lysol® disinfecting wipes and discarded after use. If using plastic wrap is not practical, alcohol wipes or Lysol® disinfecting wipes can be applied directly on surfaces.

Vehicles:

In addition to caving gear, vehicles used to transport equipment may harbor spores. It is important to keep vehicles as clean as possible by storing gear in clean containers, and to decontaminate those containers along with your gear.

Also note: Puregreen 24 disinfectant (compound) DOES NOT KILL the fungus.

Disclaimer: Use of trade names does not in any way signify endorsement of a particular product.

Useful Websites and References:
http://www.cfsph.iastate.edu/BRM/resources/Disinfectants/CharacteristicsSelectedDisinfectants.pdf
http://www.cfsph.iastate.edu/BRM/resources/disinfectants/Disinfection101Feb2005.pdf
http://www.fws.gov/northeast/white_nose.html
http://protectyourwaters.org/prevention/prevention_generic.php
http://www.westdenvertu.org/NZMS/waderbootinfo.htm
(see product compatibility with 10% bleach disinfectant)

Merchant, D.F. 2003. Life on a line. Published online at draftlight.net/lifeonaline
($14.95 PDF file; see Maintenance, inspection and disposal of equipment)

What is known about *Geomyces* sp. viability:

- The fungus survives exposure to mammalian body temperature (38° C/100° F) for at least 3 days but does not remain viable after 8 days (W. Stone, NYSDEC, pers. communication 4/14/09).

- The fungus survives exposure to temperature (30° C/86° F) for at least 15 days (W. Stone, NYSDEC, pers. communication 4/14/09).

- Short-term incubation of fungus at higher temperatures reduces the number of conidia present and alters the morphology of the hyphae which may not inhibit growth once returned to colder temperatures (W. Stone, NYSDEC and D. Blehert, USGS NWHC, pers. communication 4/14/09).

- Clothes dryer heat treatment (49° C/ 120° F) alone increases fungal spore germination and does not kill the fungus (H. Barton, NKU, pers. communication 4/22/09).

What kills the *Geomyces* sp. fungus (spores):

Method	Conditions	Kill Time	Source	Cautions*
Disinfectant				
5.25% Chlorine bleach	10% bath solution (1 part bleach: 9 parts water)	10 min	Over the counter	Inactivated by organic material, detergents; corrosive to metals; produces toxic gas if combined with ammonia; skin irritant
Lysol® Professional Antibacterial All Purpose Cleaner	1:128 bath solution (1 oz per 1 gal water)_	10 min	Janitorial supply	Corrosive; skin & eye irritant
	1:64 bath solution (2 oz per 1 gal water)	5 min		
Sparquat 256	½ oz per 1 gal water	10 min	www.chemsearch.com	May require license to obtain; requires special disposal methods
PromicidalTM	1:128 bath solution (1 oz per 1 gal water)	10 min	www.chemsearch.com	May require license to obtain; requires special disposal methods
GrenadierTM	1:64 bath solution (2 oz per 1 gal water)	10 min	www.chemsearch.com	May require license to obtain; requires hazardous waste disposal methods
	1:32 bath solution (4 oz per 1 gal water)	5 min		
Formula 409®	At least 0.3% concentration	10 min	Over the counter	
Woolite®	Refer to product label		Over the counter	
Dawn® antibacterial hand soap	Refer to product label		Over the counter	
Purell®	Refer to product label		Over the counter	
Lysol disinfecting wipes®	Refer to product label		Over the counter	

70%-95% ethanol	Undiluted bath	2 min	Lab supply distributor	Flammable, skin irritant
Temperature				
Dry heat	110° F/ 43°C	12 hr	Oven, incubators	
	165° F/ 74° C	15 min		
	175° F/ 79° C	5 min		
	180° F/ 82° C	5 min		
Sterilization				
Steam autoclave	121 F; 15 psi	15 min	Laboratory or hospital settings	
Gas sterilization	Ethylene oxide	16-18 hr	Only available at hospitals	
Flame sterilization	Alcohol & open flame	15-20 sec		Fire hazard; burn injuries

* The effects of different decontamination methods on the integrity of caving equipment are currently being tested.

Appendix 4. Missouri's Bat Caves and Mines

Data are drawn from MDC's Missouri Cave Life Database and other databases.

Table 3. Bat Prevalence in MO Caves

	No.	No. or %	Remarks
MO caves	6,211	2,109	or more may have pipistrelles, *Perimyotis subflavus*, possibly 90%
Biocaves (have bio. records)	1,137	18.3%	of all caves
Known bat caves	540	47.5%	of biocaves
Bat species records in caves	1,083		
Mean no. bat species per cave	2.0		
Perimyotis subflavus	386	33.9%	of biocaves
Myotis grisescens	225	19.8%	of biocaves
Eptesicus fuscus	140	12.3%	of biocaves
Myotis sodalis	128	11.3%	of biocaves
Myotis lucifugus	90	7.9%	of biocaves
Myotis septentrionalis	90	7.9%	of biocaves

Table 4. Bat Diversity in 540 MO Bat Caves

Bat Species	Caves	%	Cave Names
8	4	0.7%	Great Spirit Cave, Branson Cave, Tumbling Creek Cave, Lone Hill Onyx Cave
7	2	0.4%	Pilot Knob Mine, Round Spring Cavern
6	25	4.6%	Devil's Icebox Cave, Rocheport Cave, River Cave, Onyx Cave, Saloon Cave, Bear Cave, Copper Hollow Sinkhole, Cave Hollow Cave, Mary Lawson Cave, Frankford Cave, Brooks Cave, Davis Cave #2, Joy Cave, Ryden Cave, Wolf Den Cave, Bat Cave, Bluff Cave, Cookstove Cave, Martin Cave, Powder Mill Creek Cave, Wind Cave, Donovan Cave, Great Scott Cave, Hamilton Cave, Scotia Hollow Cave
5	25	4.6%	Chimney Rock Cave, Hunters Cave, Lower Burnt Mill Cave, Toby Cave, Coalbank Cave, Panther Spring Cave, Secesh Cave, Jagged Canyon Cave, Cat Hollow Cave, Paul - Petroske Memorial Cave, Slaven Cave, Whites Creek Cave, North Fork Bear Cave, Knife Cave, Onyx Cave, Piquet Cave, Tunnel Cave, Bald Eagle Cave, Bunker Hill Cave, Jam up Cave, Medlock Cave, Mose Prater Cave, Sycamore Cave, Tyson Quarry (mine), Mossy Spring Cave
4	28	5.4%	Holton Cave, Kings Onyx Cave, Moles Cave, Lost Man Cave, Bat Cave, Still Spring Cave, Wildcat Cave, Blackwell Cave, Coffin Cave, Creech Cave, Marsh Creek Cave #2, Indian Ford Cave, Kelly Hollow Cave, Onyx Cave, Turner Spring Cave, Peninsula Cave, Big Cave, Bounds Branch Cave, Little Bluff Cave, Marvel Cave, McDonald Cave, Railtree Cave, Williams Ford Cave, Williams Mountain Cave, Cliff Cave, Coldwater Springs Cave, Marvel Cave, Smittle Cave
3	41	7.6%	
2	77	14.3%	
1	338	62.6%	

Table 5. MDC's 80 known bat caves will be closed when there is a valid WNS trigger. **Bats:** Epfu = *Eptesicus fuscus* (big brown bat), Labo = *Lasiurus borealis* (eastern red bat), Laci = *Lasiurus cinereus* (hoary bat), Lano = *Lasionycteris noctivagans* (silver-haired bat), Mygr = *Myotis grisecens* (gray bat), Mylu = *Myotis lucifugus* (little brown bat), Myse = *Myotis septentrionalis* (northern bat), Myso = *Myotis sodalis* (Indiana bat), Pesu = *Perimyotis subflavus* (tri-colored bat or eastern pipistrelle). Caves that are **Gated/fenced** are noted with 1 in that column. Some caves are not gateable. Fields used for closure prioritization: **Batcode** (1 = nonendangered bats recorded, 2 = MO Species of Concern bats recorded or priority 2 bat caves, 3 = priority 1 bat caves), **Batdiv** (diversity) (1 = 1 or 2 bat spp., 2 = 3 or 4 bat spp., 3 = 5 or more bat spp.), **Disturb** (potential for disturbance) (1 = low, 2 = moderate, 3 = high human disturbance at the site), **Access** (ease of access) (1 = low, 2 = moderate, 3 = high accessibility), **Protect** (ability for additional protection) (1 = low need for more protection, 2 = more protection needed but not a gate, 3 = needs cave gate), **Priority** (sum of the five factors above, used for ranking). **Class Now** is the curent classification of the cave, but all 80 bat caves would be Class 3 (closed) if a WNS trigger is announced by MDC. Caves with a Priority 10 or more are closed after Trigger 1, Priority 8 or 9 are closed after Trigger 2, and all lower priority bat caves are closed after Trigger 3.

County	Area	Cave	Length ft.	Bats	Gated/ fenced	Bat-code	Batdiv	Dis-turb	Access	Pro-tect	Prio-rity	Class Now	Trigger
Barry	Roaring River CA	Cliff Notch Cave	600	Pesu		1	1	1	2	1	6	2	3
Boone	Three Creeks CA	Hunters Cave	6200	Epfu, Mygr, Mylu, Myso, Mysp, Pesu	1	2	3	2	3	3	13	2	1
Boone	Three Creeks CA	Lawson Cave	10	Mygr		3	1	1	1	2	8	3	2
Boone	Three Creeks CA	Tumbling Cave	952	Epfu, Pesu		1	1	2	3	1	8	3	2
Boone	Rocheport Cave CA	Rocheport Cave	3020	Epfu, Mygr, Mylu, Myse, Myso, Mysp, Pesu	1	3	3	1	2	3	12	3	1
Camden	Fiery Fork CA	Fiery Fork Cave	1000	Epfu, Mygr, Mylu		2	2	3	2	2	11	2	1
Camden	Fiery Fork CA	Kings Onyx Cave	364	Epfu, Mylu, Myse, Pesu		2	2	3	2	1	10	1	1
Camden	Grandpa Chippley CA	Grandpa Chippley Cave	750	Epfu, Mygr, Pesu	1	3	2	2	2	3	12	3	1
Camden	Burnt Mill CA	Lower Burnt Mill Cave	1300	Epfu, Mygr, Mylu, Myse	1	2	2	1	3	3	11	3	1
Camden	Burnt Mill CA	Upper Burnt Mill Cave	800	Mygr		2	1	2	2	1	8	1	2
Camden	Moles Cave CA	Moles Cave	1000	Mygr, Mylu, Myse, Pesu		3	2	2	2	3	12	2	1
Carter	Peck Ranch CA	Johnny Holt Cave	123	Pesu		1	1	1	1	1	5	1	3
Carter	Peck Ranch CA	Mitchell Hollow Cave	80	Epfu		1	1	1	1	1	5	1	3

County	Area	Cave	Length ft.	Bats	Gated/ fenced	Bat-code	Batdiv	Dis-turb	Access	Pro-tect	Prio-rity	Class Now	Trigger
Crawford	Huzzah CA	Bat Cave	400	Epfu, Mygr, Myso, Pesu	1	2	2	1	1	2	8	3	2
Crawford	Huzzah CA	Bear Cave	630	Epfu, Pesu		1	1	2	3	1	8	1	2
Crawford	Huzzah CA	Campsite Cave	100	Pesu		1	1	2	3	1	8	1	2
Crawford	Huzzah CA	Chicken House Cave	200	Mylu		1	1	2	3	1	8	1	2
Crawford	Huzzah CA	Doss Cave	1146	Myse, Pesu		2	2	2	3	2	11	1	1
Crawford	Huzzah CA	Fleming Cave	400	Pesu		1	1	2	3	1	8	2	2
Crawford	Huzzah CA	Indian Cave #2	100	Epfu, Pesu		1	1	2	3	1	8	1	2
Crawford	Huzzah CA	Island Cave	240	Epfu		1	1	1	2	1	6	1	3
Crawford	Huzzah CA	Jagged Canyon Cave	3042	Epfu, Mygr, Mylu, Myso, Pesu		2	3	2	3	3	13	2	1
Crawford	Huzzah CA	Mud River Cave	200	Epfu, Myso, Pesu		2	2	2	3	2	11	2	1
Crawford	Huzzah CA	Narrows Cave	390	Pesu		1	1	3	3	1	9	1	2
Crawford	Huzzah CA	Saloon Cave	600	Epfu, Mygr, Mylu, Myse, Myso, Pesu	1	2	2	2	3	2	11	2	1
Crawford	Huzzah CA	Scotia Cave	105	Pesu		1	1	1	1	1	5	1	3
Crawford	Huzzah CA	Sewer Cave	425	Pesu		1	1	2	3	2	9	1	2
Crawford	Onyx Cave CA	Onyx Cave	1000	Epfu, Mygr, Mylu, Myse, Myso, Pesu	1	2	3	1	3	3	12	3	1
Dent	Short Bend Access	Money Cave	750	Pesu		1	1	3	3	1	9	1	2
Franklin	lease	Twin Springs Cave	721	Mygr		2	1	2	2	2	9	2	2
Franklin	Meramec CA	Indian Cave #2	346	Pesu		1	1	3	3	1	9	1	2
Franklin	Meramec CA	Lone Hill Onyx Cave	3946	Epfu, Labo, Lano, Mygr, Mylu, Myse, Myso, Pesu		2	3	3	3	2	13	1	1
Franklin	Meramec CA	Mine Cave	584	Pesu		1	1	2	1	1	6	1	3
Franklin	Meramec CA	Panther Cave	276	Mygr, Pesu		2	2	3	3	2	12	2	1
Franklin	Meramec CA	Roaring Spring Cave	75	Mygr		2	1	2	2	2	9	3	2
Franklin	Meramec CA	Wet Hollow Cave	102	Epfu, Pesu		1	1	2	2	1	7	1	3
Franklin	River 'Round CA	River Round Cave #1	80	Pesu		1	1	1	2	1	6	1	3
Franklin	River 'Round CA	River Round Cave #3	30	Pesu		1	1	1	2	1	6	1	3
Greene	Bois D'Arc CA	Watkins Cave	1551	Pesu	1	1	1	2	2	2	8	2	2

County	Area	Cave	Length ft.	Bats	Gated/ fenced	Bat-code	Batdiv	Dis-turb	Access	Pro-tect	Prio-rity	Class Now	Trigger
Hickory	Truman Lake	Blackwell Cave	150	Epfu, Mygr, Pesu	1	2	2	3	2	3	12	3	1
Laclede	Coffin Cave CA	Coffin Cave	660	Epfu, Mygr, Myso, Pesu	1	3	2	1	2	3	11	3	1
Laclede	Lawson (Mary) CA	Mary Lawson Cave	5831	Epfu, Mygr, Mylu, Myse, Myso, Mysp, Pesu	1	3	3	1	1	3	11	3	1
Lawrence	Paris Springs Access	Turnback Cave	5000	Mygr, Pesu	1	2	1	1	2	3	9	3	2
McDonald	Huckleberry Ridge CA	Long Cave	950	Mylu, Pesu		1	1	3	2	1	8	1	2
Miller	Bat Cave CA	Bat Cave	620	Mygr		3	1	1	1	3	9	3	2
Ozark	Caney Mountain CA	Bear Mountain Cave	130	Pesu		1	1	1	1	1	5	1	3
Ozark	Caney Mountain CA	Mud Cave	400	Mylu, Pesu	1	1	1	1	1	3	7	3	3
Ozark	Caney Mountain CA	Onyx Cave	280	Pesu		1	1	2	1	1	6	1	3
Pulaski	Great Spirit Cave CA	Great Spirit Cave	10599	Epfu, Labo, Laci, Mygr, Mylu, Myse, Myso, Pesu	1	2	3	1	2	3	11	3	1
Pulaski	Ryden Cave CA	Ryden Cave	1700	Epfu, Mygr, Mylu, Myse, Myso, Pesu	1	2	3	2	2	3	12	2	1
Pulaski	Ryden Cave CA	Stockpen Cave	105	Epfu		1	1	2	3	2	9	2	2
Ripley	Little Black CA	Whisper Cave	100	Mygr, Myso, Pesu		2	2	1	2	2	9	3	2
Shannon	Angeline CA	Bay Branch Arch Cave	28	Pesu		1	1	3	3	1	9	1	2
Shannon	Angeline CA	Cave Hollow Cave	1200	Mylu, Myse, Pesu		2	3	2	2	1	10	1	1
Shannon	Angeline CA	Keyhole Cave	300	Pesu		1	1	2	2	1	7	1	3
Shannon	Angeline CA	Spring Hollow Cave #1	650	Pesu		1	1	2	1	1	6	2	3
Shannon	Angeline CA	Sunset Cave	150	Epfu, Mygr, Pesu		2	2	1	1	1	7	2	3
Shannon	Current River CA	Douglas Hollow Cave	300	Myso		3	1	2	2	3	11	2	1
Shannon	Current River CA	Shop Hollow Cave	1700	Epfu, Mygr, Myse, Pesu		2	2	1	2	3	10	2	1
Shannon	Rocky Creek CA	Beaver Den Cave	1200	Pesu		1	1	1	2	1	6	2	3
Shannon	Rocky Creek CA	Blair Creek Cave	1150	Pesu		1	1	3	3	1	9	2	2
Shannon	Rocky Creek CA	Cardareva Cave	290	Epfu, Pesu		1	1	1	1	1	5	2	3

County	Area	Cave	Length ft.	Bats	Gated/ fenced	Bat-code	Batdiv	Dis-turb	Access	Pro-tect	Prio-rity	Class Now	Trigger
Shannon	Rocky Creek CA	Forester Cave	2200	Mygr, Pesu		2	1	1	2	2	8	2	2
Shannon	Rocky Creek CA	Larkin Ford Cave	850	Mygr, Pesu		2	1	3	2	1	9	1	2
Shannon	Rocky Creek CA	Marvel Cave	500	Epfu, Mygr, Myso, Mysp, Pesu		3	2	2	2	3	12	2	1
Shannon	Rocky Creek CA	Powder Mill Creek Cave	46685	Epfu, Mygr, Mylu, Myse, Myso, Pesu	1	3	3	1	2	3	12	3	1
Shannon	Sunklands CA	Sugar Tree Hollow Cave	400	Epfu, Mylu, Pesu		1	2	1	1	1	6	2	3
St. Louis	Rockwoods Res.	Cobbs Cavern (Mine)	200	Epfu	1	1	1	1	1	2	6	3	3
St. Louis	Rockwoods Res.	Rockwoods Cave	200	Myse, Pesu	1	2	1	2	1	1	7	2	3
Stone	Hayes Spring CA	Hayes Spring Cave	650	Pesu	1	1	1	1	2	3	8	3	2
Taney	Drury-Mincy CA	Bear Mountain Cave	258	Myse		2	1	2	2	1	8	2	2
Texas	Barn Hollow NA	Big Barn Hollow Cave	500	Mygr, Pesu		3	1	1	2	2	9	1	2
Washington	lease	Scotia Hollow Cave	3650	Epfu, Mygr, Mylu, Myse, Myso, Mysp, Pesu	1	3	3	2	2	3	13	3	1
Washington	Pea Ridge CA	Great Scott Cave	14524	Epfu, Mygr, Mylu, Myse, Myso, Pesu	1	3	3	2	1	3	12	3	1
Washington	Pea Ridge CA	Little Scott Cave	4784	Mylu, Myse, Pesu	1	2	2	2	2	2	10	2	1
Washington	Pea Ridge CA	Mossy Spring Cave	2483	Mygr, Mylu, Myse, Myso, Pesu	1	2	3	1	1	3	10	3	1
Wright	Fuson CA	Little Smittle Cave	1200	Pesu		1	1	3	3	1	9	1	2
Wright	Fuson CA	Lowell Cave	5200	Pesu		1	1	3	3	1	9	1	2
Wright	Fuson CA	Smittle Cave	9700	Epfu, Mygr, Myso, Pesu,	1	3	2	2	2	3	12	3	1

Table 6. Summary of Protected* Caves in Missouri						
Owner	**Fences**	**Gates**	**Sum**	**Protected Caves**	**Total Caves**	**% Protected**
cities			0	0	41	0.0%
counties	2	4	6	4	10	40.0%
MDC	**2**	**29**	**31**	**31**	**290**	**10.7%**
MODNR/State Parks		14	14	13	171	7.6%
MODOT		1	1	1	34	2.9%
Pioneer Forest		3	3	3	107	2.8%
universities			0	0	2	0.0%
USACE	1	1	2	2	13	15.4%
USDOD/Ft. Leonard Wood		2	2	2	65	3.1%
USFS/Mark Twain NF	1	13	14	14	598	2.3%
NPS/Ozark Natl. Scenic River.	2	7	9	8	286	2.8%
USFWS			0	0	1	0.0%
Subtotal nonprivate	9	73	82	73	1,611	4.5%
private		43	43	43	4,598	0.9%
Total MO caves	**9**	**116**	**125**	**116**	**6,224**	**1.8%**
private			46		4,705	1.0%
state & local			52		546	9.5%
federal			27		963	2.8%

* “Protected” is defined as having a fence or gate designed for reducing trespass.

Appendix 5. Questions and Answers about WNS

Facts about White Nose Syndrome (WNS)

Whom at MDC can I contact about bats and WNS?
Calls about cave bats should go to Dr. Bill Elliott, 573-522-4115 ext 3194, Bill.Elliott@mdc.mo.gov and/or Derek Shiels, ext 3641, in the Central Office, Jefferson City.

Calls about forest and urban bats go to Tony Elliott, Kirksville, 660-785-2424 ext 257, Tony.Elliott@mdc.mo.gov

What is White Nose Syndrome?
WNS is a disease caused by a fungus, *Geomyces destructans*, that attacks cave-hibernating bats and has only been known from the U.S. since 2006. First discovered in New York in 2006, it has rapidly spread throughout the northeastern U.S., down the Applachians, and into Canada. Since 2007, it has been documented to kill at least 1 million bats of six species. All species of bats known to be susceptible are found in Missouri. WNS has only been found to infect bats and human are not known to be affected.

If I find a bat that looks sick, what should I do?
Many bats in spring and summer may be sick with various illnesses, or exhausted. The public should not handle bats, but call MDC. There is a small but real risk that the bat could be rabid, especially in summer, and rabies is fatal to humans and mammals. WNS is not a symptom of rabies. WNS is more likely to be found in late winter or early spring, and the bat would likely have a white, fuzzy fungal growth on the face, ears, and wings, but not always.

Why do you require disinfection to enter some caves?
WNS is caused by a fungus, *Geomyces destructans*, that is passed from bat to bat, but also possibly on the wind or via contaminated clothing and gear that has been in an infected cave. Cleaning all caving gear with bleach or certain quaternary ammonium disinfectants reduces the risk of infecting new caves and bats. We can provide more information on this subject. See http://www.fws.gov/northeast/pdf/2008%20Summer%20Protocols_15May2008b.pdf for additional disinfection protocols.

Is WNS in Missouri yet?
We believe that White Nose Syndrome is not in Missouri yet, but it could appear by the winter of 2010/2011. It was found in Tennessee in March, 2010. We want reports of many dead or dying bats on the ground or near caves, but we do not want the public to go into caves or mines looking for bats. That is a job for trained people who use proper disinfection of their gear to prevent accidental introduction of the WNS fungal spores to new sites.

Why are bat caves being closed, especially if we disinfect our clothes?
Bats sick with WNS are very weak and further human disturbance increases their mortality rate. So, the bats need a lot of quiet time. Closing bat caves also reduces the risk of human-borne infection between caves. The lives of millions of bats potentially are at stake.

Why should I care so much about bats?
WNS threatens Missouri's economy and ecology because of the natural role of bats in consuming night-flying insects. Bats are our front-line defense against many forest, agricultural, and public health pests (such as moths and mosquitoes), and provide general control of insect populations. Gray bats alone are eating 540 tons of insects per year in Missouri, about 223 billion insects. We have at least 12 species of bats in Missouri, and six species are susceptible to WNS infection. Bats also are an important component of cave ecosystems, providing nutrient input in the form of guano and decomposing carcasses, which support diverse communities of invertebrates and cave-adapted creatures.

Can't the bats just live somewhere else besides a cave? What about bat houses or bridges?
Many bats require cold, quiet conditions to hibernate, some species for up to 8 months. Certain caves and abandoned, underground mines provide just the right conditions for efficient hibernation, but this new WNS fungus thrives in cold, damp conditions. If the bats try to hibernate in warmer or colder sites, they may starve before springtime. Artificial habitats, like bat houses or attics, only suit some bats during the summer. And bats need to be free from predators and human disturbance.

How long will this WNS problem be with us, and will it infect humans?
No one can predict how long the WNS epizootic (epidemic) will be here. It has not infected more than six species of bats so far, but it could spread to other species of bats that come in contact during fall mating swarms or during hibernation. The fungus dies out in warmer, drier conditions.

Is there a cure for WNS?
Not yet, but researchers are studying various medical treatments. We will not allow general fumigation of caves, as that could poison a whole cave ecosystem, but we are hopeful that a safe, contained treatment of the bats themselves might be found through research. Congress voted $1.9 million for WNS monitoring and research, and the National Speleological Society (NSS) has donated to research too. MDC has applied for funds to defend against WNS.

What should a landowner do if they have a bat cave on their property?
MDC welcomes opportunities to collaborate with private landowners on cave management. Landowners are recommended to require cave visitors to disinfect their clothing, boots, and gear before entering a Missouri cave, if they have been in any cave (see above question on disinfection). Visitors also should not enter bat caves between mid-October and mid-April, to avoid disturbance of hibernating bats. MDC can assist cave owners in protecting caves by surveying bat use of caves, providing signs, responding to trespass or vandalism issues, and possibly erecting a cave gate or other type of protection depending on the situation.

April 9, 2010