

Michigan Department of Natural Resources and Environment White-Nose Syndrome (WNS) Response Plan*



Healthy little brown bats (*Myotis lucifugus*), Dickinson County, Michigan. Photo: D. O'Brien, MDNRE.

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I. Administration Sections

A. Introduction

1.1. Basic information/overview of White-nose Syndrome

During the winter of 2006–2007, an affliction of unknown origin dubbed “white-nose syndrome” (WNS) began devastating colonies of hibernating bats in a small area around Albany, New York (US Geological Survey, 2010). Colonies of hibernating bats experienced 81–97% mortality in affected caves and mines surveyed. At the time of this writing (July 2010), WNS has been detected more than 800 mi away from the original site, and has infected bats in 14 states (Connecticut, Delaware, Maryland, Massachusetts, Missouri, New Hampshire, New Jersey, New York, Oklahoma, Pennsylvania, Tennessee, Vermont, Virginia, West Virginia) and two Canadian provinces (Ontario, Quebec). Most species of bats that hibernate in the northeast and northcentral regions are now known to be affected; little brown bats (*Myotis lucifugus*), northern long-eared bats (*M. septentrionalis*), and federally endangered Indiana bats (*M. sodalis*). The scope and intensity of deaths associated with WNS is unprecedented in hibernating bats.

White-nose syndrome was named for the visible white fungus around the muzzles, ears, and wing membranes (bare skin) of affected bats. A previously unreported species of cold-loving fungus (*Geomyces destructans*) has been identified as a consistent pathogen among affected animals and sites (Blehart et al., 2009; Gargas et al., 2009). This fungus, now widely considered to be the causal agent of WNS, thrives in low temperatures (40–50°F) and high humidity (>90%). These environmental characteristics are common in bat hibernacula. A consistent pattern of fungal skin penetration has been observed in more than 90 % of bats from the WNS-affected region submitted for diagnosis. Researchers have reported similar fungal growth on the faces, ears, and wings of hibernating bats in Europe, but observed no associated mortality (Puechmaille et al., 2010; Wibbelt et al., 2010).

1.1.2. Susceptibility and pathogenesis: Bats affected by *G. destructans* appear to prematurely run out of the stored body fat that they rely on for winter survival (US Geological Survey, 2010). Species of bats occurring at higher latitudes rely on insects for food, which disappear from those temperate zones during winter. Most species survive the winter by building up fat reserves during autumn and then going to places that are cool but above freezing to hibernate and wait out the winter. During hibernation, or torpor, metabolism slows so that body temperature remains just above air temperature. This survival strategy allows a bat to exist on fat reserves over winter. Bats in this latitude normally arouse from hibernation for a few hours about every three weeks and then re-enter torpor. These bouts of torpor are normal throughout the winter. These natural arousals consume about 90% of a hibernating bat’s winter fat. Chronic disturbance of hibernating bats causes abnormal arousal patterns which can result in high rates of winter mortality due to depletion of fat reserves. Similarly, the skin infection caused by *G. destructans* may act as a chronic disturbance during hibernation, shortening torpor bouts to as little as 7 days. Fungus-associated abnormal behaviors (such as bats flying outside of hibernation caves and mines during the day) likely cause bats to exhaust critical fat reserves too quickly during winter.

1.1.3. Threat and significance: Forty-five species of bats occur in the United States and Canada, and bats represent more than 10 percent of mammalian species diversity in the region. (US Geological Survey, 2010). More than half of the species of insectivorous bats that occur in the U.S. rely on hibernation as a primary strategy for surviving the winter when insect prey is not

available. The emergence and spread of WNS has the potential to undermine the basic survival strategy of more than half the bat species in the U.S. and all species of bats that occur in the higher latitudes of North America.

Among the 25 species of bats that hibernate across North America, 4 species and subspecies are federally endangered. An additional 13 are federal species of concern. All four endangered species and subspecies, which rely on undisturbed caves or mines for successful hibernation, are at risk from WNS. Two of these species are currently within the WNS-affected area, and the remaining two may be affected soon.

Epizootic disease outbreaks have never been documented previously in hibernating bats, which differ from most other small mammals in that their life history adaptations include high rates of survival and low fecundity, resulting in low potential for population growth. Most of the affected species are long lived (~15-25 years or more) and have only one offspring per year. Such species already have population trajectories that are declining or unknown (due to many environmental factors such as habitat loss) are incapable of rapid population recovery. Consequently, bat numbers do not fluctuate widely over time, and populations of bats affected by WNS are unlikely to recover quickly.

Loss of bats may also have economic consequences. Bats frequently prey upon crop and tree pests. Increased numbers of these insects could present a financial burden to farmers and foresters, as well as result in an increase in the use of insecticides. Agriculture and forest products are among the most important sectors of Michigan's economy. Bats are among the species most frequently handled by the nearly 600 wildlife damage and nuisance control permittees in Michigan. Drastic declines in bat populations will affect those businesses as well, and the suppliers and services that rely upon them. To the extent that various bat species prey upon insects that are vectors of zoonotic diseases, an overabundance of such insects could theoretically lead to an increase in disease outbreaks in domestic animals or humans, with consequent economic impacts.

1.2. Organizations involved in the Response Plan

Development of this Response Plan was undertaken as a cooperative effort both at the state and regional levels.

1.2.1. State level: Because of its statutory responsibility to manage publicly-owned free-ranging wildlife resources in trust, the lead agency at the state level is the Michigan Department of Natural Resources and Environment (MDNRE) Wildlife Division (WLD). Within WLD, responsibility for planning and implementation is principally distributed across three positions/subgroups:

- a. Endangered Species Program Coordinator, responsible for general oversight;
- b. Western Upper Peninsula Field Biologist, responsible for field aspects within the area in which the vast majority of bat hibernacula are located;
- c. Wildlife Disease Laboratory, responsible for disease diagnostics, epidemiology, control and biosecurity planning.

In addition, because the most of the bat hibernacula in Michigan (MI) occur in abandoned iron and copper mines, and management of safety repairs and inventory for most of those mines that are on state lands falls under the administrative responsibility of MDNRE Forest Management Division (FMD), that agency is a primary cooperator.

Other organizations involved and their basic roles:

- a. MI Animal Damage Control Association and MI Chapter of the National Wildlife Control Operators Association: coordination with nuisance wildlife control
- b. MI Organization for Bat Conservation: coordination and public outreach
- c. MI Bat Working Group: coordination, information sharing among agency partners and cooperators
- d. MI Department of Community Health: consultation on zoonotic diseases of bats
- e. Universities (Eastern and Western Michigan, Michigan Technological, and Grand Valley State): coordination of surveillance, research, public outreach
- f. United States (US) Fish & Wildlife Service: coordination with national WNS response
- g. US Forest Service: implementation on National Forest lands
- h. US Geological Survey (USGS) National Wildlife Health Center (NWHC): laboratory diagnostic support
- i. US Natural Resources Conservation Service (NRCS): coordinate bat-friendly mine closures on private lands
- j. US National Park Service: implementation in Keweenaw National Historic Park, (with potential educational support from Isle Royale National Park, and Pictured Rocks & Sleeping Bear Dunes National Lakeshores)

1.2.2. Regional level: Recognizing that bat populations and the areas they occupy encompass multiple states and provinces, and that locations of hibernacula are typically dictated by geology and topography rather than state boundaries, contacts have been established between state fish and wildlife management agencies in Indiana, Iowa, Illinois, Kentucky, Minnesota, Missouri, Ohio, Pennsylvania, Tennessee and Wisconsin. The intent is to develop Response Plans according to a similar format, and where possible, to share the burden of surveillance and response activities. Region III of the US Fish and Wildlife Service is acting in a coordinating role. Although no formal collaboration between MI and Canada on WNS currently exists, international cooperation and coordination with Ontario is desirable. Established contacts between the Wildlife Disease Laboratory and colleagues at the Canadian Cooperative Wildlife Health Centre in Guelph may provide an avenue to foster such collaboration.

B. Purpose

Conserving bats is important. Bats make up one-fourth of the world's mammalian species. Because the complex and sometimes subtle ecological roles played by bats are only beginning to be understood, the long term ecological effects of bat mortality due to WNS remain to be seen. However, experience to date suggests that as WNS continues to spread, entire species of bats could be lost or driven to the brink of extinction. In addition, fewer bats will likely mean increased numbers of insects, resulting in more insect damage to crops and forests, and potentially an increase in insect borne agri- and arbori-cultural disease outbreaks, with potentially increased use of pesticides.

The purpose of this Response Plan is to mitigate to the extent possible the effects of WNS on Michigan bats by:

- preventing mechanical spread of the fungus that causes the disease into and around Michigan by humans
- taking steps to conserve the bat populations (and their habitat) remaining after the disease has arrived in Michigan and die offs occur; and

- provide an organizational framework by which effective and feasible WNS control measures can be implemented in the future, should any such measures ever be identified.

C. Situation and Assumptions

1.1. History and detail of the disease to date: The history of the WNS outbreak and details of what is known about the disease current to this writing are presented in web publications of the USGS (<http://www.fort.usgs.gov/WNS/>) and the US Fish and Wildlife Service (<http://www.whitenosesyndrome.org>). A summary is presented in Section A.1.1. above.

1.2. Why planning is needed: To date, evidence suggests that WNS is transmitted by two routes. First, studies in spring of 2010 in Hell Hole Cave, West Virginia, that state's largest bat hibernacula, found it affected with WNS. Because the cave is privately owned, closed off to humans and electronically monitored to record any human intrusion, it could be documented that no humans had been in the cave since February 2007. Thus, it can be concluded with near certainty that WNS was brought into the cave by bats and propagated bat-to-bat. Second, the long distances noted between affected caves in New York (2008) and in southern Virginia (2009), or from Virginia to Tennessee, Missouri and Oklahoma in 2010, are beyond the flight ranges affected bat species move in a single year. This suggests that *G. destructans* was brought into the site by humans that had visited infected caves elsewhere. Without completely disrupting their behavior and ecology, there is currently no way to prevent bat-to-bat transmission of *G. destructans*. Consequently, the only feasible intervention that can be made to slow transmission and geographic spread is to prevent mechanical vectoring of the fungus by humans. The fungus has been isolated from footwear, clothing and caving gear (Okoniewski et al., 2010). While comparisons to other recent panzootic fungal disease outbreaks are not encouraging (Robbins and Windmiller, 2010), it is conceivable that effective measures to limit transmission and geographic spread may be developed in future. In that case, data on locations, sizes and disease status of hibernacula will be necessary, and planning to implement surveillance and control measures essential.

Michigan bat hibernacula are largely in concentrations of abandoned mines. Many of these are either privately owned or on public lands managed by the federal government. In addition, local County Mine Inspectors (elected local government positions) often are among the few individuals who know all the locations, and so effectively control access. However, state and federal wildlife agencies have statutory responsibility for wildlife management, including management of diseases of wildlife. Because bats are not game animals, and arguably are less charismatic to the public than some other wildlife species, the amount of resources available from governmental wildlife management agencies may be inadequate to support the type of disease control efforts necessary to effectively deal with large scale outbreaks. Consequently, bat conservation organizations may play a critical role in funding bat management programs and in providing public outreach. Relatively little is known currently about WNS, making research essential. Academia is likely to play a pivotal role in that research. All of these factors illustrate why any WNS response must necessarily include multiple governmental and non-governmental entities. That, in turn, necessitates planning in order for any response to be effective.

Although in some respects the knowledge base concerning WNS is still very early in its development, two striking and ominous epidemiologic characteristics of the outbreak are prominent: the rapidity with which it has spread geographically, and the high probability with which infection of hibernacula has resulted in high mortality (Langwig et al., 2010). These

factors, coupled with the aforementioned bat-to-bat transmission of the disease, suggest that the probability of WNS reaching Michigan is high. How soon that occurs may depend on how effectively human-vectored spread of the fungus can be prevented, and on the extent to which bats that hibernate in Michigan mix with bat populations from areas where the fungus, and the disease, are already present. Unfortunately, little is currently known about the latter issue. Moreover, although investigations to fill that knowledge gap are currently underway (Miller-Butterworth et al., 2010; Wilder et al., 2010), they may not generate results soon enough to be of practical use in preventing WNS from reaching Michigan. The seemingly inevitable arrival of the disease underscores the necessity of response planning.

1.3. Potential ecological impact of WNS: Predictions concerning the potential ecological impact of WNS are numerous and dire (US Geological Survey, 2010), and are documented in detail elsewhere. These predictions are based to a great extent on the high rates of mortality that have been observed in eastern hibernacula affected by WNS (Langwig et al., 2010). In addition, because the subtle ecological roles played by bats are only beginning to be understood, there is great uncertainty concerning what large-scale population declines will mean with respect, for example, to abundance of insect populations preyed upon by bats.

Particular attention has been devoted to issues related to endangered and threatened status under the federal Endangered Species Act. These range from impacts WNS may have on species that are already endangered (such as *M. sodalis*), species that are currently uncommon but not yet endangered (such as *M. septentrionalis*), and species that are currently abundant but that are experiencing the highest mortality rates from WNS (such as *M. lucifugus* and the eastern pipistrelle/tricolored bat *Perimyotis subflavus*). Recent modeling results suggest a 99% probability of regional extinction for the little brown bat within 16 years (Frick et al., 2010). From a practical standpoint, the impacts WNS may have on the status of these and other bat species may rival ecological impacts in importance to state and federal wildlife management agencies. As more species of bats become threatened and endangered because of WNS-related population declines, their habitat, how it is managed, and what activities are legal to carry out there, will receive much more intense scrutiny and regulation. That is likely to complicate management of abandoned mines in Michigan considerably, and may affect summer roosting habitat in Michigan forests as well. Given bat populations slow speed of recovery from drastic declines, those complications are likely to persist for decades (Frick et al., 2010), as will the need to commit budget and personnel resources to management and recovery. Because the post-WNS status of hibernating bat species is currently not known, this plan focuses on the initial response to WNS. Recovery planning for bats will be handled at some future date.

D. Concept of Operations

1.1. Overall approach to WNS response in MI: Given the rapid geographic spread of WNS (US Geological Survey, 2010), the high mortality rates (Langwig et al., 2010), the lack of efficacious, let alone practical, treatments (Hicks et al., 2010; Reeder et al., 2010; Songsasen et al., 2010; Timonen et al., 2010) and the grave population projections in the aftermath of the disease (Frick et al., 2010), **the overall approach in responding to WNS in Michigan will be to 1) delay human-assisted introduction and spread to the extent possible, and 2) to purposefully conserve whatever bat populations remain after the disease has arrived and progressed.** The former will be accomplished primarily through public education and implementation of biosecurity protocols, while the latter will necessitate preservation of critical hibernacula from

unnecessary human disturbance. Both of these objectives will require significant public outreach efforts and long term commitment of resources from state and federal agencies and non-governmental organizations. Moreover, regional coordination will be imperative for the latter objective.

Details of the Response are presented in the Annexes.

1.2. Designated task of each agency or cooperating organization: See Section I.A.1.2.1. for general responsibilities.

As the agency with statutory authority for management of free-ranging wildlife and their diseases, overall responsibility will initially lay with the MDNRE. As the disease progresses and species decline in numbers, federal responsibilities and oversight through the Endangered Species Act will likely increase. The Michigan Bat Working Group will act in an advisory and coordinating role, and as a means to keep cooperators informed of the status of response and bat conservation activities.

1.3. Plan activation and deactivation thresholds: In light of the rapidity of WNS' geographic spread and the seeming inevitability of introduction into MI, the Plan will be activated immediately upon approval of the Director of the MDNRE. It will remain in force until such time as the MDNRE, in consultation with the Michigan Bat Working Group, deems that it is appropriate to discontinue Response Plan provisions. Reasons may include, but are not limited to: unanticipated consequences of disease introduction and progression; lack of resources to continue Plan provisions; and loss of management authority to federal agencies.

E. Organization of Responsibilities

See Section I.A.1.2.1. for general responsibilities.

1.1. Agency and cooperator contacts:

- MDNRE WLD Endangered Species Program coordinator, responsible for statewide WNS response (currently Dan Kennedy, kennedyd@michigan.gov, (517) 284-6194)
- MDNRE WLD Western Upper Peninsula Field Biologist, responsible for WNS in the western Upper Peninsula (currently John DePue, depuejl@michigan.gov; 906-353-6651)
- MDNRE WLD Wildlife Disease Laboratory, responsible for disease aspects including: diagnostics, epidemiology, control and biosecurity planning (current contact: Dan O'Brien, obriend@michigan.gov, 517-336-5035)
- MDNRE Forest Management Division (FMD), responsible for abandoned mines needing safety repair on state-owned lands managed by FMD and listing of mine sites needing repair on all other DNRE lands; (current contact: Milt Gere, gerem@michigan.gov; 517-335-3249)
- MDNRE Public Information Officer, responsible for coordinating public communications; (current contact: Ed Golder, goldere@michigan.gov; 517-284-6241)
- MI Animal Damage Association: coordination with nuisance wildlife control (current contact: Dave Kugler, dkugler@crittercatchersinc.com)
- MI Organization for Bat Conservation: coordination and public outreach (current contact: Rob Mies)
- MI Bat Working Group: coordination, information sharing among cooperators (current chairperson: Rob Mies)

- MI Department of Community Health: consultation on zoonotic diseases of bats (current contact: Kim Signs, signsk@michigan.gov; 517-335-8165)
- Universities: coordination of surveillance, research, public outreach with state and federal regulatory agencies (current lead contact: Al Kurta, Eastern Michigan University, akurta@emich.edu; 734-487-1174)
- United States (US) Fish & Wildlife Service: coordination with national WNS response (current contact: Rich Geboy, Region 3)
- US Forest Service: implementation on National Forest lands (current contact: Dave Dillman, ddillman@fs.fed.us, Ottawa National Forest; Chris Schumacher, cmschumacher@fs.fed.us, Huron-Manistee National Forest)
- US Geological Survey (USGS) National Wildlife Health Center (NWHC): laboratory diagnostic support (current contact: Dave Blehert)
- US Natural Resources Conservation Service: (Chris Reidy)
- US Park Service: implementation in Keweenaw National Historic Park

1.2. Lines of authority (chain of command) for decision making: It is assumed throughout this document that all regulatory agencies maintain their statutorily-established authorities on the lands that fall under their jurisdiction. This Plan confers no new authorities to any party or cooperator. The Michigan Bat Working Group is a valuable partner, and efforts will be made by the lead agency (MDNRE) to consult with the contacts listed above to advise them of imminent or anticipated WNS management actions prior to implementation to obtain their input.

It is not anticipated that an Incident Command System (ICS) will be established as part of the Michigan WNS response. Michigan will evaluate a potential role in an ICS as part of a regional WNS response should one be established.

1.3. Shared responsibilities: Notwithstanding the general responsibilities listed above, the following responsibilities will be shared among these primary cooperators:

- Disease surveillance: MDNRE WLD, Eastern Michigan University, USGS NWHC
- Risk mitigation of hibernacula: MDNRE (FMD & WLD), USDA NRCS, US Forest Service, County Mine Inspectors, commercial tourist mine operators
- Public education and outreach: MDNRE WLD, USF&WS, Michigan Organization for Bat Conservation, US Park Service, Michigan Animal Damage Association
- Research: MDNRE WLD, Eastern Michigan University, USGS NWHC, US F&WS, and others.

F. Administration and Logistics

1.1. Provision of response supplies: These cooperators will provide the following physical resources needed for the WNS response:

- MDNRE Wildlife Disease Laboratory: personal protective equipment, disinfectant, and biosecurity supplies to prevent human-transported introduction and spread of *G. destructans* during surveillance and MDNRE research activities. This does not include provision of biosecurity supplies for commercial tourist mines or the Keweenaw National Historic Park.
- MDNRE WLD Education and Outreach Unit: Educational posters and other materials.

1.2. MDNRE staff contacts and response roles: See Section I.E.1.1.

Reports from the public regarding large numbers (≥ 6) of dying or dead bats (especially at or near a mine opening), bats that are behaving abnormally (having difficulty flying; flying during the daytime or during winter; bats roosting on roofs of houses in winter), or hibernating bats with white fungus on their face or wings observed during winter should be directed to the MDNRE Sick or Dead Bird or Mammal reporting form at (http://www.michigandnr.com/diseasedwildlifereporting/disease_obsreport.asp) for those willing to use the internet, or to the MDNRE Wildlife Disease Laboratory at 517-336-5030 for others. The Lab will coordinate appropriate response with field staff.

1.3. Budget for WNS response: Within MDNRE WLD, financial resources to support response activities will be drawn from state wildlife grants and other sources for funding nongame programs. The WLD recently received a competitive grant to cover \$83,500 of the costs of WNS response. This funding is budgeted for FY2011-2013. At the time of this writing, no MDNRE funding for WNS research is available. However, future funding will be targeted to research priorities as noted in Section II.B.2 should monies ever become available.

G. Authorities

1.1. Legal basis for the response/planning: The Natural Resource and Environmental Protection Act (NREPA; Public Act 451 of 1994; Michigan Compiled Laws Chapter 324) was enacted to “to protect the environment and natural resources of the state; to codify, ...to regulate the use of certain lands, waters, and other natural resources of the state; to prescribe the powers and duties of certain state and local agencies and officials.”

Section 40107(1)(c) of NREPA dictates that “the department shall manage animals in this state. In managing animals, the department (MDNRE) may issue orders to ... determine the animals or kinds of animals that are protected. Further, Section 9.3(2) of the Wildlife Conservation Order specifies bats as protected animals and section 9.1(4) specifies the only conditions under which they may be legally taken.

Specifically as relevant to WNS response activities on the part of MDNRE, NREPA Section 502 stipulates that “The department may...Promulgate and enforce reasonable rules concerning the use and occupancy of lands and property under its control.” Section 503 states “The department shall protect and conserve the natural resources of this state...and foster and encourage the protecting and propagation of game and fish. The department has the power and jurisdiction over the management, control, and disposition of all land under the public domain.” And, Section 36502 provides that “The department shall perform those acts necessary for the conservation, protection, restoration, and propagation of endangered and threatened species of fish, wildlife, and plants in cooperation with the federal government...”

II. Annexes

A. Surveillance for WNS

1.1. Introduction: The surveillance component of Michigan’s WNS Response Plan has two primary goals: 1) to detect introduction of the disease as soon as practical; and 2) to characterize bat habitat (i.e. hibernacula) so that locations and descriptions of critical hibernacula are documented for conservation purposes, and for potentially efficacious disease control strategies (should those become available and practical to implement).

This Response Plan recognizes that federal agencies and non-governmental organizations will likely be conducting WNS surveillance within the borders of the state simultaneous with, but separate from, surveillance being conducted by MDNRE and its contractors. The MI Bat Working Group will act as a coordinating body for information concerning what surveillance activities are ongoing, so that efforts are complementary rather than duplicative and critical data are shared in a timely fashion.

1.2. Detection surveillance-identifying WNS: As is the case with other contagious diseases, early detection of WNS will provide the greatest possible opportunity to respond in an effective manner. Detection surveillance under the organization of MDNRE will take two forms: active surveillance of winter hibernacula, and passive surveillance via public reporting.

1.2.1. Active surveillance: See Section 2, below.

1.2.2. Passive surveillance: The Wildlife Disease Lab of MDNRE maintains a Sick or Dead Bird or Mammal reporting form at (http://www.michigandnr.com/diseasedwildlifereporting/disease_obsreport.asp). The site is routinely monitored by Lab staff, with appropriate response actions taken based upon the history, species, clinical signs, and scenario reported. The form gathers information on the date and location of the observation, animals and clinical signs observed, as well as open-form comments and contact information so that the observer can be contacted for more information or clarification. The main phone number of the Lab is also provided for those who wish to speak to a staffperson. The reporting form has been used successfully for routine public reporting of common and sporadic Michigan wildlife diseases, as well as during outbreaks of West Nile Virus, Eastern Equine Encephalitis, Epizootic Hemorrhagic Disease, and others. It is straightforward to use and well-accepted by the public.

In the case of WNS, members of the public are asked to fill out an online report if they observe:

- a) bats flying during the daytime or during winter;
- b) having difficulty flying;
- c) large numbers (≥ 6) of dying or dead bats, especially at a mine opening; or
- d) hibernating bats with white fungus on the face or wings observed during winter (fungus on the body of bats has not been observed at any other time of year, although wing scarring from the fungus may be visible yearround).

The reporting form was modified for WNS reporting and made live on 7/14/2010. It is linked to MDNRE's WNS website, and web links will be made to the sites of other agencies and cooperators as needed to facilitate public reporting.

1.2.3. Sample submission: Effective surveillance and response for WNS will be best served by an efficient, consistent sampling scheme that directs samples through an experienced wildlife disease laboratory for submission to appropriate diagnosticians. Such a protocol will help ensure consistent, accurate reporting and notification of cooperators and the public. Consequently, MI's WNS surveillance will limit sample collection to a small number of trained entities, and direct all samples for testing through a single lab, MDNRE's Wildlife Disease Lab.

Active surveillance (See section 2.1, below) will primarily be conducted by a single experienced contractor for a multiyear period. That contractor will direct samples gathered

through MDNRE field staff, primarily the Western U.P. Field Biologist. Under arrangement of the MDNRE WLD, samples will be delivered via truck by MDNRE staff to the Wildlife Disease Lab in Lansing. Acting on information gathered via passive surveillance, Lab staff will either follow up on credible suspect reports via field visits, or make arrangements with WLD field staff for field investigation of the report, with samples subsequently forwarded to the Lab as above.

The US Geological Survey (http://www.nwhc.usgs.gov/disease_information/white-nose_syndrome/USGS_NWHC_Bat_WNS_submission_protocol.pdf) has published guidelines for submission of bats for WNS diagnostic testing in situations where unusual bat mortality, suspicious fungal growth, or severe wing damage are observed during field surveys. In general, MDNRE and contractor sampling protocols will follow these guidelines. Wildlife veterinarians at WDL will decide, based on issues such as case backlog and cost, whether samples will routinely be directed to the National Wildlife Health Center (NWRC) in Madison, WI, or to another qualified lab. Methods for PCR diagnosis of WNS have been published (Lorch et al., 2010). Polymerase Chain Reaction tests can be run at the Michigan State University Diagnostic Center for Population and Animal Health, co-housed in the same building as the MDNRE WDL, and collaborators at Michigan State (MSU) have been in communication with the NWRC concerning methods. If PCRs are run in house at MSU, the first suspect in-house WNS diagnosis will be confirmed via duplicate sample submitted to the NWRC.

Prior to first diagnosis of WNS in Michigan, and subsequently until *G. destructans* becomes widely disseminated geographically, observance of biosecurity measures by surveillance staff will be necessary to avoid human-mediated spread of the fungus to uninfected areas. Decontamination guidelines relevant to surveillance personnel have been published (<https://www.whitenosesyndrome.org/topics/decontamination>) and will be followed, with personal protective equipment (PPE) being provided to MDNRE staff and contractors via the Wildlife Disease Lab, which keeps stores of such items as part of general MDNRE preparedness for zoonotic wildlife disease outbreaks (see section II.B.2. for more information).

2. Establishing surveillance priorities

2.1 Databases of bats and mines: A critical part of preparation for response to any disease outbreak is characterizing the population-at-risk, ensuring that information is in a format that is readily accessible, and making sure disease responders have access to the information in a timely fashion. In other words, in order to carry out disease surveillance and control activities, it is critically important to know where susceptible populations are, how big they are, what species are present, site characteristics, and the like. White-nose Syndrome is no different, yet even basic data on the number, size and locations of MI bat populations are incomplete, and until recently, were lacking entirely.

Although a survey of abandoned MI mine sites was conducted by Michigan Technological University (MTU) researchers in the 1990s, the results were copyrighted by the contractor with no provision for the data to be shared with the State of Michigan in a readily useable format. Because of concerns about the data being available to the public under Freedom of Information Act requests, the contractor has never allowed electronic copies of the database to come into possession of MDNRE, making incorporation of the information into Geographic Information Systems (GIS) impractical. Thus, other than knowing that there are ~800 mine sites comprising ~2300 shafts and adits that may potentially be bat hibernacula spread across the western UP, the data in the MTU survey are of little use for WNS response planning.

More recently, researchers from Eastern Michigan University have undertaken characterization of abandoned mine sites with specific attention to their suitability and importance as bat habitat. Under contract to MDNRE WLD, these researchers have completed development of a comprehensive tabular database of all known cave and mine bat survey work and pertinent literature information which can be assimilated into GIS. This database will greatly enhance the DNRE's ability to effectively coordinate disease surveillance, response, and prioritize post-WNS conservation of critical bat habitat.

Winter hibernacula surveys are to be conducted during the period of November 1 and completed prior to April 15 each year of the multiyear contract period, with a comprehensive summary survey report due May 31 each year. Where physically possible, a minimum population count will be conducted; otherwise appropriate sampling techniques will determine population estimates. Estimates will include species present and proportion of population by species. Bats will be systematically evaluated for clinical signs of WNS. Any bats that appear diseased or otherwise abnormal will be collected per section II.A.1.2.3. above. Any suspected or confirmed detection of WNS will require immediate notification of DNRE, with DNRE coordinating subsequent notification of cooperators and the general public. Between all survey sites decontamination of all field and personal equipment will be carried out in accordance with accepted WNS decontamination protocols (per section II.A.1.2.3. above), with PPE provided by the MDNRE Wildlife Disease Lab. The contract period will be for five survey field seasons from November 1, 2010 through May 31, 2016.

Based on survey results and recommendations of the survey team a prioritization of mine sites that warrant additional protection measures will be shared amongst the Michigan Bat Working Group partners. This will enable the responsible state or federal agency with appropriate jurisdiction to effectively develop protection mechanisms for these sites. Protection measures for mine sites with significant bat populations and/or substantial public safety concerns typically include construction of a bat friendly gate structure (designed to allow bats to come and go freely but exclude the public) or safety fencing in accordance with Michigan law.

It is anticipated that the database created by EMU researchers will serve several critical functions. First, it will (at least for the work that can be accomplished prior to the arrival of WNS) establish a pre-outbreak baseline of mine conditions. Second, it will facilitate establishment of state surveillance priorities. Third, incorporation into GIS will allow spatial analysis both of the progression of the outbreak and subsequent bat population recovery in the context of other spatially-referenced datasets. Finally, as bat populations decline, it will provide a baseline for the more intensive scrutiny and recordkeeping required for species designated as threatened or endangered.

2.2. Other potential surveillance mechanisms and their coordination: The many cooperating partners in the response to WNS will provide numerous and diverse opportunities for a variety of WNS surveillance programs. Although MDNRE's surveillance will likely be limited to winter hibernacula surveys, and yearround passive surveillance via public reporting of sick or dead bats, the MI Bat Working Group will provide a forum where results of other surveillance conducted by all partners can be shared. Examples of such surveys could include, but are not limited to, acoustic surveys, wind energy pre/post construction surveys, and emergence counts from hibernacula or maternity colonies.

3. Assessment surveillance: responding to WNS detection: It is anticipated that in MI, the detection and assessment phases of WNS surveillance will effectively form a continuum, with only a few practical changes to strategy and protocol between the periods before and after the disease is detected.

Lack of both personnel and money, as well as competing priorities, will pose serious constraints making it difficult for MDNRE WLD to justify expending resources simply “documenting the decline” of bat populations following the arrival and progression of WNS in MI. Consequently, the primary substantive difference between pre-and post-arrival surveillance will be the emphasis given to minimizing human disturbance of hibernacula, in order to conserve surviving bat populations. Thus, as the EMU contract survey for MDNRE characterizes bat hibernacula, that information will be used to prioritize sites for conservation, which in turn will set the stringency of constraints on disturbance (e.g., priority for bat gating, frequency of visitation by agency personnel and researchers, etc.). The MI Bat Working Group will provide a forum where prioritization can be discussed and partners informed.

B. Management: Managing WNS Risk

1. Introduction: The Management component of Michigan’s WNS Response Plan has two primary goals: 1) to delay human-assisted introduction to the extent possible, and once present, minimize human dissemination of *G. destructans*, and 2) to purposefully conserve whatever bat populations remain after the disease has arrived and progressed. A concurrent aim will be to accumulate sufficient information on MI bat populations and hibernacula, as well as develop a minimum organizational infrastructure, to be able to effectively implement population-level WNS control measures, should any effective measures ever be developed.

2. Coordination of research and management activities: Research is undeniably of value in the process of understanding emerging diseases, implementing control measures, and charting courses for population recovery following disease progression. That said, not all research is likely to yield information of sufficient importance to justify expending scarce resources or risk disturbance of animal populations already stressed by disease.

Proposals for research projects associated with WNS in MI will be evaluated critically for their potential to enhance scientific information about WNS, the strength of their design, parsimonious use of available resources, and their potential to yield results which are of practical relevance to management of bats and WNS in the field. Studies likely to yield results immediately applicable to management will be given highest priority for cooperation. The MI Bat Working Group will act as a forum for prioritization of research projects. Notwithstanding the collective decision of that group, ultimate decision making authority with respect to whether a project is conducted will belong to the agency with regulatory authority over free-ranging wildlife at the proposed research site (i.e., federal land vs. non-federal land).

3. Biosecurity: Because human-assisted spread of *G. destructans* is one of the documented means by which WNS is disseminated to uninfected areas, biosecurity (essentially, measures to mitigate transport of diseases by humans) is critical. Moreover, it is currently the only effective control measure available for use against WNS. The most effective method of biosecurity is to minimize the number of humans entering bat hibernacula, and this method should be used in all situations where its application is feasible.

Broadly speaking, consideration of two groups that may enter bat hibernacula is necessary in biosecurity planning: 1) those for whom biosecurity can effectively be made mandatory (e.g. state and federal agency personnel, researchers, and cooperating NGOs); and 2) those for whom biosecurity will remain voluntary (e.g., visitors to commercial mines, cavers, nuisance wildlife control operators, etc.).

3.1. Mandatory biosecurity: A detailed decontamination protocol has been developed by the US Fish & Wildlife Service for field researchers (<https://www.whitenosesyndrome.org/topics/decontamination>). This document should be self-explanatory for agency personnel, researchers and NGOs, and provide sufficient options to provide some flexibility of implementation.

For MDNRE personnel and contractors who may be visiting different mines with frequency, disposable Tyvek coveralls and over gloves are likely to be useful. Clean Tyveks and gloves can be donned at each site, used, and sealed in labeled biohazard bags prior to leaving the site. Their use will simplify decontamination by allowing chemical disinfection to focus only on boots, headgear, and equipment that can be decontaminated in the field. Sealed biohazard bags can then be transferred via MDNRE field staff to the Wildlife Disease Lab, where they can be incinerated.

Tyvek coveralls, over gloves and biohazard bags are routinely maintained by the MDNRE Wildlife Disease Lab for use in wildlife disease response activities, and will be provided to MDNRE field staff and contractors. The Lab will consider requests from others for distribution of personal protective equipment as resources allow.

3.2. Voluntary biosecurity: Biosecurity planning for commercial mines and nuisance wildlife contractors must take into account the fact that these operations are for-profit businesses. Implementation must strike a balance between ideally rigorous biosecurity and avoiding inconveniencing visitors and businesses to the point where biosecurity measures are ignored altogether. Consequently, planning and implementation necessarily involve education and outreach as well.

The US National Park Service at Mammoth Cave National Park has developed a useful interactive tool that it uses to screen cave visitors who may have previously visited infected hibernacula and so be vectoring *G. destructans*. Carefully designed screening tools such as this should minimize (but are unlikely to eliminate) visitors reluctance to participate, or their propensity to lie about their previous cave/mine visitation. Once such high-risk individuals are identified, they can be targeted for WNS intervention strategies such as personalized education efforts (e.g., to convince them not to enter hibernacula with contaminated clothing or objects) or decontamination procedures. Those decontamination procedures can then be the same as those discussed in Section II.B.3.1.

Using the Mammoth Cave interactive tool as a guide, MDNRE WDL has developed a handout combining a flowchart and brief decontamination guidelines from the US Fish & Wildlife Service. It may serve as an outreach tool for use in tourist mines and caves.

It should be noted, at least from a regional perspective, that even perfectly executed biosecurity precautions are in all likelihood a stop-gap control measure only, given the fact that *G. destructans* is also transmitted bat-to-bat. Frick et al. (2010) have reported that all sites they

surveyed in the northeastern US “have become infected within 2 years of the disease arriving in their region”.

4. Disease management and treatment options: White-nose Syndrome management can be conceptualized as occurring through environmental modification, through management of human activities, and through other management options as yet undescribed. In practice however, management and treatment options at the time of this writing are extremely limited. Options investigated to date include:

- Creation of thermal refugia in hibernacula which might allow bats to conserve body fat and extend survival (Boyles and Willis, 2010; Reeder et al., 2010; Timonin et al., 2010). Thus far, in field trials, bats have either avoided the refugia (Timonin) or survival of infected bats was longer in colder conditions (in contrast to the anticipated outcome; Reeder).
- Treatment of infected individuals with antifungal compounds (Hick et al., 2010; Reeder et al., 2010) might kill *Geomyces* and cure or mitigate the effects of the disease. Thus far, in field trials on bats, none of the putative chemotherapeutic agents have increased (and in fact have decreased; Hicks) survival. Preliminary results communicated in the popular media from a study by Chaturvedi et al. reported from the American Society for Microbiology conference identified several classes of chemotherapy agents with activity against *Geomyces in vitro*. including fluconazole. However, how these agents would perform *in vivo* remains undemonstrated.

More problematic still is the issue of how even an effective treatment could be implemented in the field in order to treat a sufficient proportion of the population, and in a cost effective manner. In addition, the potential benefits of treatment will have to be weighed against potential adverse effects to cave ecology and other species, effects which will require considerable time consuming research to ascertain.

Management of human behavior involves issues such as limiting access of humans to critical bat hibernacula for conservation purposes (see Section II.B.5. below), and decontamination to minimize human vectored spread to uninfected areas (see Section II.B.3. above).

A related issue is management of carcasses of dead bats in WNS-infected caves. Beyond carcasses being taken for testing or research purposes, cleanup of carcasses is unlikely to be an efficient use of limited resources. By the time mass mortality has occurred in a hibernaculum, the hibernaculum itself must effectively be considered completely contaminated because it will likely be logistically impossible to determine accurately what parts of the hibernaculum are contaminated and which are not. Moreover, infected and uninfected bats mixing within a hibernaculum will eventually contaminate any portion of the hibernaculum to which bats have access. Thus, leaving carcasses *in situ* is unlikely to make the situation any worse. In addition, it makes sense to leave carcasses where they are, in a location that is already contaminated, particularly if human access to the hibernaculum is limited.

At the time a contaminated hibernaculum is found, it will be difficult, if not impossible, to know with certainty the local spatial distribution of the disease. Because bats will presumably be transmitting WNS to each other concurrently, cleaning up dead bats at mine entrances may have little epidemiological impact. That is, the added risk posed by scavengers or humans moving carcasses around is unlikely to change the ultimate distribution of the disease (barring minimal mixing of bats from different hibernacula, or a scenario where a human deliberately

moves a carcass a long distance to an uninfected area). Cosmetic clean up might be viewed by some as desirable in highly visited caves or tourist mines, in order to avoid disturbing sensitive visitors. However, in that case, visitor access to the obviously contaminated cave is unwise, and biosecurity precautions will be necessary to avoid vectoring the infection to new areas via movement of visitors or the contaminated carcasses.

In summary, there is currently no practical and effective treatment for WNS, and no demonstrated effective way to implement treatment *en masse* in the field. Thus, MI WNS planning will focus on habitat conservation, and creating a prioritized database of critical bat habitat so that targets for intervention are known, should an effective treatment and implementation strategy become available (see Section II.A.3, above).

5. Mine closures management: With respect to WNS, the primary purpose of mine closure plans is to purposefully conserve colonial bat populations and their habitat by minimizing human disturbance of hibernacula (in MI, primarily mines), while closing those hibernacula in a way that preserves bat access. An associated goal is to promote human safety by making casual human access difficult, which will in turn help protect state and federal agencies and private landowners from liability claims.

Coordination among many landowners and agencies is a critical component necessary for MI's mine closure program to succeed. First and foremost, the locations of mines must be known with certainty before they can be assessed as bat habitat and for closure. In MI, County Mine Inspectors in the counties containing mines (Baraga, Dickinson, Gogebic, Houghton, Iron, Keweenaw, Marquette and Ontonagon) hold primary responsibility for abandoned mine safety, and are typically the most knowledgeable about mine locations and conditions. Obtaining their cooperation is a high priority for WNS response planning, as they can become a central and primary source of information for the EMU survey team contracted to MDNRE. A variety of federal and state agencies manage lands that host abandoned mines or provide outreach services to landowners, including the US Forest Service (Ottawa National Forest), Natural Resources Conservation Service of USDA, MDNRE Forest Management Division (State forests) and MDNRE Recreation Division (State parks). Although the MI Bat Working Group provides a partial forum where discussion of closure issues can occur, the principal dialogue between agencies will likely occur amongst field staff. Notably, cooperative field contacts among the agency partners have already been established, and cooperation on a number of mine closures has already successfully occurred. MDNRW WLD has installed bat gates on four mines in Dickinson County, while MDNRE Recreation Division has gated at least one mine site in the Porcupine Mountains State Park, and USDA NRCS has gated more than a dozen mines in the Keweenaw Peninsula and Western UP. Gates are specially designed and constructed, with predetermined vertical and horizontal bar spacing to allow bats to come and go freely while restricting human access. An example of industry bat gate construction standards can be found at Bat Conservation International's website (<http://www.batcon.org/pdfs/sws/AgencyGuideCaveMineGating2009.pdf>).

Based on information obtained by the EMU/MDNRE contract survey team, mines will be prioritized for closure based on suitability as bat habitat, the species they house, the number of bats they hold, their current *G. destructans* infection status, site characteristics, and the like. These recommendations are shared with the appropriate agency and the MI Bat Working Group annually. Where possible, mines will be closed so as to preclude casual human access to all parts of the mine, or at least to areas frequented by bats.

Given the probability that post-WNS bat populations will need long periods of time to rebound, if they can rebound at all, maintaining mines in a closed state solely as bat habitat is a high priority of WNS response. Nonetheless, it is recognized that a variety of circumstances could arise which might result in mines being reopened. These include, but are not limited to, mineral market conditions that promote renewed extraction of copper or iron, private landowner decisions, development of an efficacious treatment and delivery strategy for WNS, and others.

C. Communication

1. Introduction: Per Section I.A.1.2, planning and response for WNS involves a large number of cooperators who must be kept informed and who must present consistent messages to other stakeholders and to the public. Consequently, communication is critical, both for coordination and education. During the initial period of WNS planning and response before the disease is identified in MI, the primary goals of communication are:

- to educate the public about the disease (both generally and for purposes of passive surveillance)
- to communicate biosecurity protocols in order to minimize human-vector spread
- to coordinate surveillance planning
- to coordinate resources and interagency efforts devoted to mine closure and bat conservation

Once WNS is identified in MI, goals for communication will likely shift more uniformly towards messages supporting and coordinating bat conservation, through continued public education as to its value, and through mine closures and habitat preservation. Communications anticipating threatened and endangered status for all the colonial bat species will need to prepare cooperators, stakeholders and the general public during this time as well.

2. Internal (between cooperators) communications: The MI Bat Working Group will function as the primary forum for communications between cooperators regarding WNS. This will include initial dialogue on the provisions of the WNS Response Plan; Plan updates; and coordination of resources, effort and outreach. As WNS surveillance is implemented in the field, the regular meetings of the Working Group will become the forum for sharing the findings, discussing the implications, and formulating how conservation measures will be implemented in the field.

In the event that WNS is first diagnosed subsequent to a passive surveillance report by the public to MDNRE WLD or via samples gathered by the EMU surveyors under contract to MDNRE, press releases to notify the public will be coordinated by the MDNRE Office of Communications in consultation with EMU. The Chair of the MI Bat Working Group will be informed prior to public release.

In the event that WNS is first diagnosed on federal lands (e.g., National Historic Parks, National Forest) via federal surveillance efforts independent of the MDNRE-initiated surveys, press releases to notify the public will be coordinated by communications officials of the lead federal agency. The MDNRE Office of Communications and the Chair of the MI Bat Working Group will be informed prior to public release.

Prior to releasing the location of the *G. destructans* positive hibernaculum, MDNRE and cooperators will critically evaluate the accessibility of the infected site to humans, as well as any evidence that multiple sites are infected. If there is good evidence that only one site is involved, to the extent possible measures will be taken to ensure access to the site is restricted prior to

release of specific location information (to minimize human-vector spread). If multiple sites are involved, prioritization of sites for bat gates will follow the protocol in Section II.A.3.

3. Regional communications: Communication channels must also be kept open between two regional groups. First, MDNRE WLD needs to maintain its contacts with the wildlife management agencies in other states in the region, in readiness for implementing regional WNS response measures should they become feasible and necessary. These regional contacts were established in February 2010, and the WNS coordinator for Region 3 of the US Fish & Wildlife Service will likely perpetuate those relationships.

Second, regional contacts with broader cooperators and stakeholders, including academic institutions and NGOs, will be maintained via the Midwest Bat Work Group. With an annual conference attended by several members of the MI Bat Working Group, long established contacts with the Midwest Group will continue to be a route of regional communication.

4. Principal communication messages and tools: At the time of this writing, several members of the MI Bat Working Group have proactively developed public communications tools, principally websites, for WNS, including MDNRE, US Fish and Wildlife Service, US Forest Service, and the MI Organization for Bat Conservation. While content and areas of emphasis differ somewhat between these outlets, information sharing within the MI Bat Working Group facilitates coordination and consistent content.

Within MDNRE WLD, a WNS Communication Strategy was finalized in August, 2010. It provides the guiding framework for WLD communications both internally and externally, with several key elements (dates of completion):

- Create a web page devoted to information on WNS (completed and online July, 2010).
- Create Talking Points on WNS for WLD staff to use (completed September, 2010).
- Create Frequently Asked Questions to post online for the public and distribute internally to staff (completed September, 2010).
- Keep the public and staff informed of WNS developments by issuing press releases (as needed; first issued June 10, 2010).
- Post latest updates and information on Social Networking sites (i.e. Facebook, Twitter, online forums, etc.)
- Keep the MI Bat Working Group up-to-date with new information and have them share with key constituents and interested groups (ongoing).
- Keep the Natural Resources Commission up-to-date on the distribution of WNS and response efforts.
- Create a media campaign to raise awareness of bats and how WNS will affect them, ecosystems and people.
- Create a poster depicting species of bats found in Michigan and include information on general bat life history as well as information on WNS. (completed September, 2010)

In addition, communications tools regarding bats, mines and WNS that were developed previously remain available and will support MDNRE's WNS Communication Strategy:

- Educational signs on bats generally, and on mine closures developed for UP mines that are already bat gated
- Public reporting of dead bats, developed for the MI Rabies Working Group
- Biosecurity protocols for mines and caves (see Section II.B.3.)

A remaining communications task is development of outreach tools for nuisance wildlife control contractors. Big brown bats (*E. fuscus*) frequently hibernate in walls of residential houses, and nuisance wildlife contractors could inadvertently vector *G. destructans* from one group of bats to others (although the geographic distance of such spread is likely to be modest). Nuisance animal control operators are represented on the MI Bat Working Group. It is anticipated that development of specific communication tools and messages for those cooperators will occur via the Working Group.

5. Assessment of communication efficacy: A number of members of the MI Bat Working Group have established contacts with stakeholder groups (e.g., MI Karst Conservancy, County Mine Inspectors, western UP geology enthusiasts, and others) who will be targets of WNS communications as part of the response effort. Those individuals, via ongoing dialogue with their respective groups, can help assess the effectiveness of WNS communications. In addition, communications staff with MDNRE and the involved federal agencies can help assess outreach to agency staff and policymakers.

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