



White-Nose Syndrome Response Plan

November 2012

Colorado Parks and Wildlife

White-Nose Syndrome Response Plan

SUMMARY

“White-nose syndrome” (WNS) is an emerging fungal disease of hibernating North American bat species. To date, WNS has likely killed between 5.7 and 6.7 million hibernating bats in caves and inactive mines in the eastern USA (USFWS News Release 1-17-2012), and has contributed to the imperilment of some bat populations and species. The WNS fungus (*Geomyces destructans*) has the potential to kill individuals of many of the 18 bat species native to Colorado. Bats are ecologically and economically important, and measures to prevent the spread of WNS and minimize its impacts on native bat species are clearly warranted.

The goal of this plan is to protect all species of bats that occur in Colorado by preventing or minimizing the human-assisted spread of WNS and, where feasible, developing approaches for early detection and control of the disease as well as actions taken if WNS is found in Colorado. Colorado Parks and Wildlife (CPW) will work proactively to anticipate, detect, and contain the spread of the WNS fungus. This document describes a surveillance plan for continued monitoring for WNS throughout the state, but CPW will also evaluate potential risks to bat roosting habitat in a tiered fashion. Sites are and will be evaluated based on species of bats, number of bats roosting, type of site (maternity vs. winter hibernacula), and distance to nearest known WNS site. CPW is committed to working with partners on devising practical disease detection and control strategies, managing potential human impacts to bats at caves and inactive mines, and working towards collaborative solutions to provide for cave recreation while minimizing risks of WNS transmission.

Colorado Parks and Wildlife

White-Nose Syndrome Response Plan

Purpose

The purpose of this plan is to describe Colorado Parks and Wildlife's (CPW) conservation and disease management actions to minimize the spread of white-nose syndrome (WNS) to bats in Colorado. CPW will use this plan to collaborate with partners including federal agencies, tribal authorities, recreational caving organizations, private landowners, and the general public to manage the threat that WNS poses to native bat populations in Colorado.

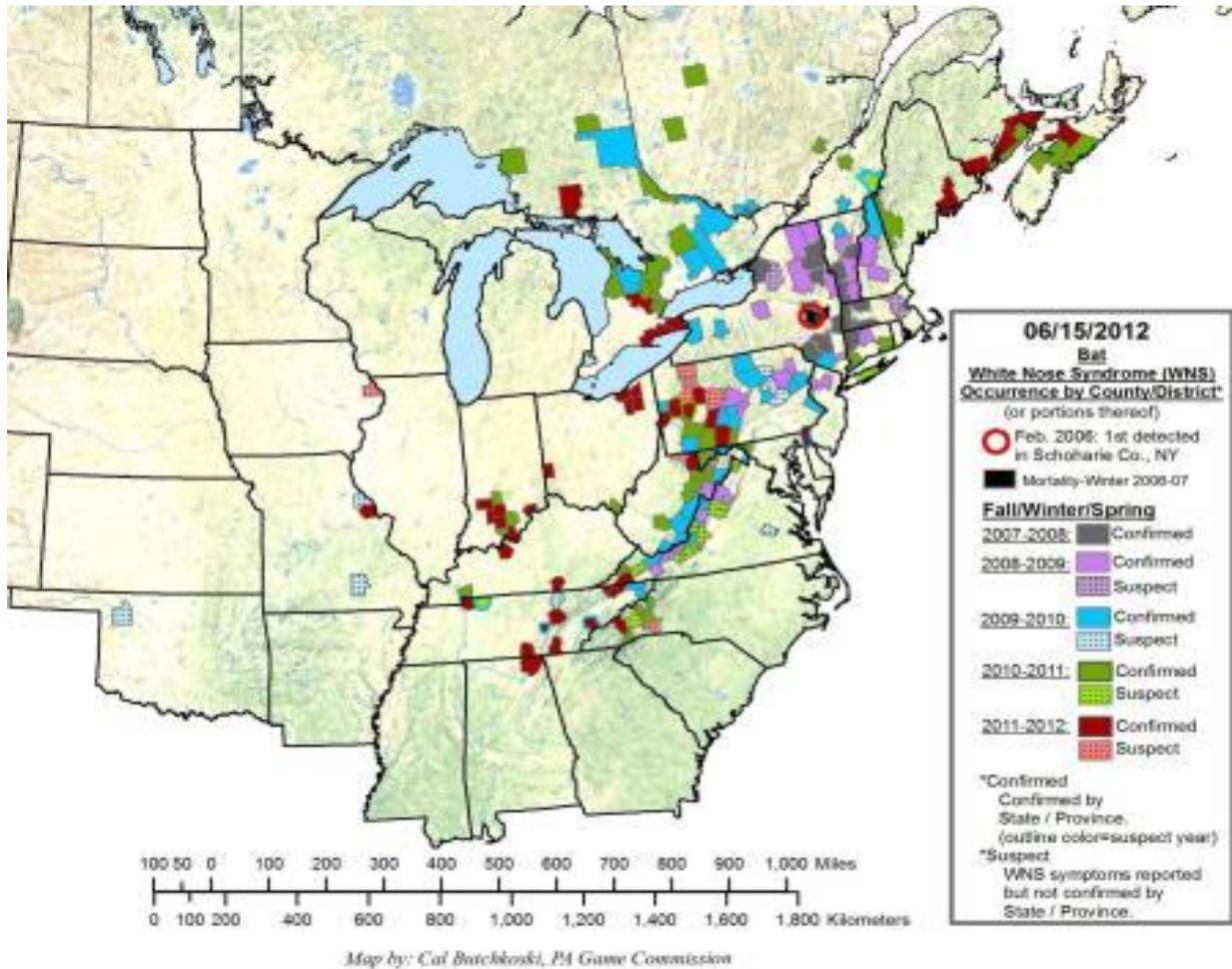
The Colorado Bat Working Group is a subcommittee of the Western Bat Working Group, and has produced a bat conservation plan (Ellison et al. 2003) for Colorado. However, WNS and its ramifications were unknown at the time that conservation plan was written. This response plan is intended to build on the existing bat conservation plan for Colorado and to augment that plan in responding to the WNS threat.

Background

White-nose syndrome is a new emerging fungal disease of North American bat species (Bleher et al., 2009) that appears to have originated from Europe (Puechmaille et al. 2010, Wibbelt et al. 2010) where white fungal growth on hibernating bats has been observed since the early 1980s (Wibbelt et al. 2010). Since 2006, experts estimate that between 5.7 and 6.7 million hibernating bats in the northeastern USA have died (USFWS News Release 1-17-2012) from a fungal infection identified as *Geomyces destructans* (*Gd*) (Gargas et al. 2009), which in late stages is often visible as a white substance on the nose and wings. Because no other disease or environmental factors have been identified, the working assumption is that *Gd* is the primary pathogen causing these bat die-offs. Recent work by Wanecke et al. (2012) has shown that *Gd* isolated from caves in Europe and North America experimentally causes WNS and mortality in little brown bats, *Myotis lucifugus*. Additionally, WNS can cause severe tissue damage on the wings of bats adding to the mortality aspect of infected bats (Reichard and Kunz, 2009). Cryan et al. (2010) proposed that bat mortality is a result of catastrophic physiological disruption of the surface of wings caused by *Gd*. WNS has not been shown to infect other wildlife, domestic animal species, or humans. Based on patterns observed elsewhere (Bleher et al. 2009, Frick et al. 2010), many of Colorado's native bat species are believed to be susceptible to WNS infection, with the potential for loss of large numbers of individual bats.

WNS was first found in a cave in New York State during the winter of 2006 and has since spread to 19 states and 4 Canadian provinces (Figure 1). The rapid spread of WNS is a concern, especially the long distance "jumps" in the distribution of the fungus. One such jump was detected in May of 2010 with the report of a cave myotis infected with the fungus that causes WNS at Alabaster Caverns State Park in Oklahoma. The finding to date has been a onetime occurrence and neither *Gd* nor bats with WNS has been found in this cave since the initial finding. This represented a shift of more than 450 miles from the previous westernmost case of WNS. Given that the affected cavern was open to the public, there is

concern that human spread of the disease may have been a contributing factor. One of Colorado's most significant known bat roost sites is located within a mile of the Colorado/Oklahoma state line. The movement patterns of this colony of bats are unknown, but likely to include roosting habitats in Oklahoma.



Map of white-nose syndrome by county/district as of 06/15/2012..
 Courtesy of Cal Butchkoski, PA Game Commission.

Figure 1. Recorded occurrences of bat “white-nose syndrome” (WNS) in the United States and Canada.

The westward expansion of the WNS fungus, which has also been found west of the Mississippi River in Missouri and Iowa in 2012, suggests that this disease may spread into Colorado. Precisely determining the current distribution of this emerging pathogen is problematic because diagnostic methods and surveillance approaches have only recently been developed (Blehert et al. 2009, Reichard and Kunz 2009, Lorch et al. 2010, Lindner et al. 2010) and effective landscape-level surveillance for any rare or

emergent disease in free-ranging populations is technically and logistically difficult to accomplish. Bats are ecologically and economically important, both because they consume vast quantities of night-flying insects and support intricate cave ecosystems. Consequently, measures to prevent the spread of WNS among native bat species and minimize its impacts on population and species viability are clearly warranted.

The rapid spread of WNS has focused a great deal of attention on its mode(s) of transmission. Fungi and their conidia (spores) are present throughout the environment and many fungal infections are spread via air, environmental contact, or contact between individuals (Postgate 2000, Anaissie et al. 2009). A field study in February 2010 recovered 16 *Gd*-like spores on a properly disinfected backpack that had been taken into an infected mine and swabbed after exiting. Although the results do not trace all the steps in effecting an actual human-borne transmission of *Gd* spores, they do indicate that such risk is more than theoretical (Al Hicks and Joe Okoniewski, NYDEC, pers. comm.). Identification of *Gd* genetic material in soil samples from hibernacula (Lindner et al. 2010) suggests that if the fungus is present, the potential exists for it to be transmitted between bat hibernation caves upon humans, their clothing, or gear (Sleeman, 2009). One method to prevent human related spread of *Gd* is through decontamination of clothing and gear worn by persons entering caves and mines. All persons that have been issued Scientific Collection Permits for bat work in Colorado now receive standard stipulations which include WNS protocols to be followed in Colorado (Appendix I). Current WNS response activities by CPW and other agencies are listed in Appendix II.

Unlike North American bats, European bats do not appear to be suffering from WNS possibly due to some level of immunity, resistance, or hibernacula environmental conditions which prevent mortalities (Wibbelt et al. 2010). To date, no vaccine, treatment, or other measure for directly controlling or eliminating WNS in natural settings has been reported. Consequently, the best short-term approach for controlling *Gd* is to limit the spread of the pathogen.

Bat Species Native to Colorado

Nine species of bats have been infected by WNS or tested positive for *Gd* in the eastern US (Matteson, 2010). Three of these species, the little brown bat (*Myotis lucifugus*), the big brown bat (*Eptesicus fuscus*), and the tri-colored bat (*Perimyotis subflavus*), are native to Colorado (Table 1). Because little brown bats and three other species of *Myotis* have been heavily impacted by WNS in the eastern US (Frick et al. 2010), the presumption is that other *Myotis* species could be susceptible to *Gd*, including the seven species of *Myotis* native to Colorado (Table 1). Currently WNS has only been found in bat species that hibernate in caves and mines; however, other hibernacula sites have been poorly investigated due to detection and access difficulties. It is currently thought that any bat species that depend on hibernation as a strategy to survive the winter are potentially at risk for WNS (Blehert et al. 2009). Thirteen of Colorado's native bat species are known to hibernate (Table 1) and consequently could be at risk.

Table 1. Colorado's native bat species. **Shaded rows** signify species already affected by white nose syndrome in other parts of North America.

Common Name	Scientific Name	Overwintering status in Colorado
Fringed myotis	<i>Myotis thysanodes</i>	Hibernating
Long-legged myotis	<i>Myotis volans</i>	Hibernating
Little brown bat	<i>Myotis lucifugus</i>	Hibernating
Long-eared myotis	<i>Myotis evotis</i>	Hibernating
Western small-footed myotis	<i>Myotis ciliolabrum</i>	Hibernating
Yuma myotis	<i>Myotis yumanensis</i>	Hibernating
California myotis	<i>Myotis californicus</i>	Hibernating
Townsend's big-eared bat	<i>Corynorhinus townsendii</i>	Hibernating
Spotted bat	<i>Euderma maculatum</i>	Hibernating
Big brown bat	<i>Eptesicus fuscus</i>	Hibernating
Pallid bat	<i>Antrozous pallidus</i>	Hibernating
Western pipistrelle	<i>Pipistrellus hesperus</i>	Hibernating
Tri-colored bat	<i>Perimyotis subflavus</i>	Hibernating
Hoary bat	<i>Lasiurus cinereus</i>	Long-distance migrant, non-hibernating
Eastern red bat	<i>Lasiurus borealis</i>	Long-distance migrant, non-hibernating
Brazilian free-tailed bat	<i>Tadarida brasiliensis</i>	Long-distance migrant, non-hibernating
Silver-haired bat	<i>Lasionycteris noctivagans</i>	Long-distance migrant, typically non-hibernating
Big free-tailed bat	<i>Nyctinomops macrotis</i>	Long-distance migrant, non-hibernating

Townsend's big-eared bat (*Corynorhinus townsendii*) is a species of special concern in Colorado. Two of three western sub-species of *C. townsendii* are found in Colorado. *C. t. pallescens* is known to occur in southeast Colorado (Baca County), along the Front Range, and in southwest Colorado in Mineral County, with the largest known colony occurring in southeast Colorado. *C. t. townsendii* is known to occur largely on the western slope and in north-central Colorado in sympatry with *C. t. pallescens* (Piaggio et al. 2009, Piaggio and Perkins, 2005). This bat is a colonial species and is considered a cave/mine obligate. Less than 20 Townsend's big-eared bat maternity roosts have been discovered in Colorado. Most of these roosts are small, supporting colonies of less than 30 individuals. Although this species does not appear to be strongly migratory, Piaggio et al. (2009) found evidence for gene flow between *C. t. pallescens* and *C. t. townsendii* roosts that were >300 km apart. So individuals of this species may travel longer distances than previously thought, and could potentially move *Gd* between colonies (for example in the spring when adult females move from hibernacula and congregate in maternity sites). Townsend's big-eared bat is known to be highly sensitive to human disturbance at roost sites, especially maternity roost sites. Adams (2003) and Fitzgerald et al. (1994) have detailed accounts of bat species in Colorado.

Bats are a vital defense against many agricultural and forest insect pests (such as moths and beetles) and public health pests (such as mosquitoes). 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. The spread of WNS into Colorado poses a threat to the state's economy and ecology because of the role native bat species play in consuming night flying insects and contributing to cave ecosystems.

Population estimates for bat species native to Colorado are not currently known. Based on the impact of WNS in the eastern US, it is reasonable to assume that WNS-related mortalities could cause significant population-level reductions in Colorado in up to 13 of the 18 native bat species. It is also possible that some of these bat species will suffer range-wide declines, local extirpations, and possible species-level imperilment with accompanying significant economic impacts (Frick et al. 2010).

Colorado Parks and Wildlife Authority and Responsibility

Colorado revised Statute 33-2-102 states that "*The general assembly finds and declares that it is the policy of this state to manage all nongame wildlife, recognizing the private property rights of individual property owners, for human enjoyment and welfare, for scientific purposes, and to ensure their perpetuation as members of ecosystems*". This charges CPW with protecting nongame wildlife, including bats. CPW intends to prepare for WNS before it arrives in Colorado. Through management activities, the issuing of Scientific Collection permits and monitoring of bat populations, CPW will contribute to the prevention, early detection, containment and minimization of potential WNS impacts in Colorado. CPW is playing a lead role in coordinating the development and implementation of a statewide action plan for Colorado.

ACTIONS

1. Coordination and Outreach

- a. All CPW activities related to bat conservation and all scientific collection permit applications from non- CPW entities handling bats will be evaluated by the Division's Wildlife Health Program for consistency with established WNS guidelines to protect bat populations and minimize spread of *Gd*. Decontamination protocols, limitations to access of target caves and inactive mines supporting bat colonies, or even denial of access (i.e., agency closures) may be stipulated in permit applications.
- b. The Wildlife Health Program will serve as the clearinghouse for *Gd* reports and samples submitted by biologists or researchers, and for receiving and investigating reports from the public about possible WNS occurrences. Priority for follow-up will be given to reports of unusual bat behavior or die-offs in the winter months.
- c. CPW will continue to develop education and outreach materials which stress the importance of WNS and utilizing current decontamination protocols. Methods of outreach will include news releases, web-based information sheets, and signs at trailheads and caving locations.
- d. CPW will maintain a WNS Working Group to promote coordination of WNS management and public outreach in the state. This group will be comprised of Federal, State, Municipal, and NGO representatives. Bob Davies (Wildlife Health Program) and Tina Jackson (Terrestrial Species Conservation Program) will represent CPW in this capacity.

2. Monitoring and Surveillance

Although WNS has not yet been observed in Colorado, monitoring of bat populations that are currently unaffected is critical, both for early identification of the disease and collection of pre-WNS baseline information in this region. Control methods for WNS are still in the experimental stage, but early identification of the presence of *Gd* will give managers the opportunity to field test experimental control methods to stop or slow the spread of the disease. Baseline data on bat roost site parameters, such as winter activity levels, population densities, reproductive status, and hibernacula micro-climate, are needed to establish surveillance thresholds and compare pre-WNS to post-WNS bat populations.

- a. CPW, with the input of the WNS Working Group, will continue to implement and refine the comprehensive Surveillance and Monitoring Plan for Colorado. The CBWG WNS committee will serve in an advisory capacity to inform the planning efforts. The latest version of the Surveillance and Monitoring Plan was released December 2011; this plan will be updated each December in preparation for the winter surveillance season.
- b. A priority list of sites to be surveyed will be based on the following general criteria to determine relative risk or vulnerability:

- i. Distance of Colorado caves and inactive mines from the infected site in western Oklahoma or new discovery of WNS in surrounding states.
 - ii. Potential transmission by bat-to-bat movements and migratory patterns from the known infected areas to Colorado bat populations.
 - iii. Significance of cave or inactive mine roost to the state bat populations and risk level posed by the potential for human transmission.
- c. The Surveillance and Monitoring Plan will use the following guidelines:
- i. Surveillance will emphasize less intrusive methods to minimize bat disturbance, especially for Townsend's big-eared bat roost sites. Human disturbance has long been known to affect bat survival (Tuttle and Stevenson 1977) therefore it is important to minimize human activity in hibernacula.
 - ii. Many of the known hibernacula have been gated and do not provide internal access. Surveillance may consist of visiting a prioritized list of sites in mid-late winter and early spring surveying for bat activity at the mouth of the cave/mine and bat mortalities within 100 yards of the cave/mine mouth. An acoustic surveillance approach will develop a baseline of winter activity at known hibernacula, which can then be used to monitor for changes in activity that may indicate potential emergence of WNS. Entry of caves/mines during the hibernation season will be closely managed to minimize the potential for disturbance of bat populations and all WNS precautions and decontamination protocols will be followed.
 - iii. Surveillance will be of 3 types:
 - 1. High-priority sites – these will be known hibernacula or other significant roost sites from a prioritized list of hibernacula based on factors such as importance, proximity to the closest known WNS positive site, potential migratory stop-over's, swarming roosts, species of bats, proximity to maternity roosts, accessibility during winter, and potential role in the Surveillance and Monitoring Plan.
 - 2. Coordinate work with on-going Bats in Inactive Mines Program (BIMP) and Abandoned Mine Lands (AML) programs to increase the number of mines that will be surveyed for WNS. Sites that are already scheduled for work or survey under these programs will be included in the priority list of sites being surveyed as described in the Surveillance and Monitoring Plan. Other agencies (USFS and BLM) and members of the caving community will be contacted so efforts may be coordinated and data shared.

3. General public – press releases asking for the public’s assistance to report any winter bat activity or mortalities will be drafted and distributed yearly. Emphasis will be made to ask people to stay out of any mines/caves they encounter due to the possibility of spreading *Gd* and a reminder that caves on public lands may be closed to protect bats.
- d. CPW will continue to share existing bat habitat data, both empirical and spatial, with USFS, Region 2; and BLM, Colorado Office, to facilitate monitoring plans and refinement of cave and inactive mine sites to be included in the public access closures enacted by these agencies.
 - e. CPW will continue to work with federal and state agencies to prioritize existing bat roost sites for conservation importance and risk of WNS infection.
 - f. CPW will continue to work with private, NGO and governmental landowners with important winter hibernacula where recreation use also exists to raise awareness and implement WNS prevention measures (including potential closures).
 - g. CPW will continue to communicate with the Colorado Department of Public Health and Environment (CDPHE) which houses the state rabies lab. The potential exists for WNS infected bats to be turned into CDPHE for rabies testing. CPW will work with CDPHE to test bat mortalities received for rabies testing for the presence of *Gd* or wing damage indicative of WNS, and follow-up with on-site investigation of any unusual bat die offs reported through CDPHE.
 - h. CPW will continue to coordinate with municipal animal control agencies and bat rehabilitators regarding WNS.
 - i. CPW will continue to coordinate with the Colorado Department of Reclamation and Mine Safety, Colorado Natural Heritage Program, USFS, and BLM to implement WNS monitoring guidelines and protocols in the implementation of the Bats in Inactive Mines Program (BIMP).
 - j. CPW will identify caves and mines that are popular public attractions (‘show caves’) and coordinate with the responsible agency/organization to identify bat use, limit the exposure to WNS, and monitor for the presence of WNS.

3. Response to finding *Gd*/WNS in Colorado

If the fungus that causes WNS is found and confirmed on bats in Colorado the following will be done:

- a. Notification:
 - i. CPW Director and Leadership Team will be informed of the finding within 24 hours.
 - ii. The property owner if private property or land management agency will be notified within 48 hours.

- iii. Cooperating agencies and partners involved with WNS surveillance activities and the National WNS team will be notified within 48 hours.
 - iv. All media notifications/releases will be handled by CPW Public Affairs Unit.
- b. Actions in Response to *Gd*/WNS being found in Colorado:
- i. All known caves/mines within a 10 mile radius will be surveyed for presence of WNS
 - ii. Increase surveillance activities within a 50 mile radius of the affected site.
 - iii. Recommend the affected cave/mine be immediately closed to public access.
 - iv. Recommend closure for public access of all caves and mines within a 10 mile radius of the affected mine/cave until they can be surveyed for WNS.
 - v. Recommend closure of all new WNS positive sites and take steps 1-5 for all new sites.
 - vi. Increase surveillance at cave/mines with use by the species found with *Gd*/WNS and other species known to use the site where *Gd*/WNS was detected.
 - vii. In coordination with landowners and agencies impacted, develop a specific strategy for containment of *Gd*/WNS within the state, taking into account the species and location of detection. To speed the implementation of this step, a generic draft plan will be developed by December, 2013.
 - viii. Mapping of the spread of WNS will be completed showing the spread of WNS if more than one site is found positive for WNS.

ACKNOWLEDGEMENTS

This plan was prepared using WNS action plans developed by Missouri Department of Conservation (2010), Alabama Bat Working Group (2010), and New Mexico Game and Fish Department (Anonymous, 2010) as models. Review by Kirk Navo, Colorado Division of Wildlife, and recent discussions conducted by the Colorado Bat Working Group also provided valuable perspectives on monitoring and the inclusion of Townsend's big-eared bat in monitoring.

REFERENCES

- A national plan for managing white-nose syndrome in bats. 2010. 16 pp.
[Draft WNS National Plan](#)
- Adams, R. A. 2003. *Bats of the Rocky Mountain West*, University of Colorado Press. 289 pp.
- Alabama Bat Working Group. 2010. Alabama white-nosed syndrome management plan. 26 pp.
- Anonymous. 2010. White-nose syndrome (WNS) interagency response plan for New Mexico. 8pp
- Anaissie, E. J., M. R. McGinnis, and M. A. Pfaller. 2009. *Clinical Mycology*. Second Edition. Churchill Livingstone, Elsevier. 688 pp.
- Blehert D.S., A.C. Hicks, M. Behr, C.U. Meteyer, B.M. Berlowski-Zier, E.L. Buckles, J.T.H. Coleman, S.R. Darling, A. Gargas, R. Niver, J.C. Okoniewski, R.J. Rudd, W.B. Stone. 2009. Bat white-nose syndrome: an emerging fungal pathogen? *Science* 323:227.
- Cryan, P.M., C.U. Meteyer, J.G. Boyles, D.S. Blehaert. 2010. Wing Pathology of White-nose syndrome in bats suggests life threatening disruption of physiology. *BMC Biol.* 8:135
- Ellison, L. E., M. B. Wunder, C. A. Jones, C. Mosch, K. W. Navo, K. Peckham, J. E. Burghardt, J. Annear, R. West, J. Siemers, R. A. Adams, and E. Brekke. 2003. Colorado Bat Conservation Plan. Colorado Committee of the Western Bat Working Group. 107 pp.
- Fitzgerald, J. P., C. A. Meaney, D. M. Armstrong. 1994. *Mammals of Colorado*. Denver Museum of Natural History and University Press of Colorado. 467 pp.
- Frick, W.F., J.F. Pollock, A.C Hicks, K.E. Langwig, D.S. Reynolds, G.G. Turner, C.M. Butchkoski and T. H. Kunz. 2010. An emerging disease causes regional population collapse of a common North American bat species. *Science*. Vol. 329 pp 679-682.
- Gargas, A., M.T. Trest, M. Christensen, T.J. Volk and D. S. Blehert. 2009. *Geomyces destructans* sp. Nov. associated with bat white-nose syndrome. *Mycotaxon*. Vol. 108 pp 147-154.
- Lindner, D.L., A. Gargas, , J.M. Lorch, M.T. Banik, J. Glaeser, T. H. Kunz, and D.S. Blehert. 2010, DNA-based detection of the fungal pathogen *Geomyces destructans* in soil from bat hibernacula. *Mycologia*. 10-262v2-10262.
- Lorch J.M., A. Gargas , C.U. Meteyer , B.M. Berlowski-Zier , D.E. Green , V. Shearn-Bochsler , N.J. Thomas, D.S. Blehert . 2010. A rapid diagnostic test for bat white-nose syndrome using PCR. *J Vet Diagn Invest* 22:224–230.

Matteson, M. 2010. Deadly White-nose Syndrome jumps to ninth bat species. Center for Biological Diversity. News Release June 15, 2010.

MDC WNS Committee and Derek Shiels. 2010. Missouri Department of Conservation White Nose Syndrome Action Plan. 22 pp., 5 app.

Piaggio, A. J., K. W. Navo, and C. W. Stihler. 2009. Intraspecific comparison of population structure, genetic diversity, and dispersal among three subspecies of Townsend's big-eared bats, *Corynorhinus townsendii townsendii*, *C. t. pallescens*, and the endangered *C. t. virginianus*. *Conservation Genetics* 10: 143-159.

Piaggio, A. J., and S. L. Perkins. 2005. Molecular phylogeny of North American long-eared bats (Vespertilionidae: *Corynorhinus*); inter- and intraspecific relationships inferred from mitochondrial and nuclear DNA sequences. *Molecular Phylogenetics and Evolution* 37: 762-775.

Postgate, J. 2000. *Microbes and Man*, Fourth Ed. Cambridge University Press, 373 pp.

Puechmaille, S.J., P. Verdeyroux, H. Fuller, M. Ar Gouilh, M. Bekaert, and E. C. Teeling. 2010. White-nose syndrome fungus (*Geomyces destructans*) in bat, France. *Emerging Infectious Diseases*, Centers for Disease Control, Feb. 2010, Epub preprint.

Reichard, J. No Date. Wing Condition of Bats Affected by White-nose Syndrome. Center for Ecology and Conservation Biology, Department of Biology, Boston University, Boston, MA 02215.

<http://www.caves.org/WNS/Bat%20Wings.pdf>

Reichard, J.D. and T. H. Kunz. 2009. White-nose syndrome inflicts long lasting injuries to the wings of little brown myotis (*Myotis lucifungus*). *Acta Chiropterologica*, 11(2): 457-464.

Sleeman, J.. 2009. Update on White-Nose Syndrome. *USGS Wildlife Health Bulletin*, 2009. 03:1-2.

http://www.nwhc.usgs.gov/publications/wildlife_health_bulletins/index.jsp

Tuttle, M. D. and D. E. Stevenson. 1977. Variation in the cave environment and its biological implications. Pp. 108-121 in *National Cave Management Symposium Proceedings*, 1977.

Warnecke, L., J.M. Turner, T. K. Bollinger, J. M. Lorch, V. Misra, P. M. Cryan, G. Wibbelt, D. S. Blehert, and C. K. R. Willis, 2012 *Proceedings of the National Academy of Sciences*, April 9, 2012

Wibbelt G, A. Kurth, D. Hellmann, M. Weishaar, A. Barlow, M. Veith, et al. 2010. White-nose syndrome fungus (*Geomyces destructans*) in bats, Europe. *Emerging Infectious Diseases*, 16 (8).

Appendix I

Colorado Division of Wildlife Scientific Collection Permit Stipulations 2012

1. The latest USFWS Decontamination protocols must be followed. They can be found at http://www.fws.gov/WhiteNoseSyndrome/pdf/WNSDecon_Researchers_v012511.pdf or at <http://www.fws.gov/WhiteNoseSyndrome/>. This includes decontaminating any equipment or clothing that is carried into bat habitats (caves and mines) and any equipment that comes into contact with bats. At no time should any equipment or clothing that has been used in a WNS-affected state or region be used in Colorado.
2. Any bats showing indications of WNS should be submitted to the CPW Wildlife Health Lab for evaluation.
3. The handling and processing time of bats should be kept to a minimum. When necessary to handle bats, the wings and tail membranes should be examined for scarring and damage associated with White-nose Syndrome, during spring and early summer. The Wing Damage Index developed by Reichard (http://www.fws.gov/northeast/PDF/Reichard_Scarring%20index%20bat%20wings.pdf) should be used when evaluating wing damage. Wing damage should be documented by photograph. If extensive damage is apparent, a wing punch should be taken (following the USFWS Decontamination guidelines for wing biopsies) in the area and preserved in 10% formalin. All punches should be submitted to the CPW Wildlife Health Lab for analysis.
4. If necessary, bats should be temporarily held individually in breathable bags. Disposable bags (such as paper bags) are preferred. Cloth bags are to be used to hold one bat per night and decontaminated between uses. Use of holding cages is not permitted.
5. Disposable gloves should be worn when handling bats. Gloves are to be changed with each bat handled.
6. New or decontaminated mist nets are to be used each night. Nets can be boiled for at least 15 minutes and dried between each night of use.
7. Protocols and procedures can change at any time due to new information on the presence or science of WNS infection. Permit holders should be prepared to respond to these changes when they occur.
8. Permit holders are required to contact the local CPW Terrestrial Conservation biologist prior to field work, to review the decontamination protocols and ensure that the necessary equipment and supplies are available, and that the guidelines are fully understood. To ensure the protocols are being followed, field site visits by CPW personnel are possible.

Appendix II

WNS Response Activities by the CPW and Other Agencies (as of 09/01/12)

1. CPW will require holders of scientific collection permits to adhere to the most updated guidelines for WNS disinfection. These guidelines stipulate among other things that no equipment that has been used in surveys of bats or cave explorations in known WNS areas anywhere may be used in Colorado.
2. CPW web site contains the following links concerning bat conservation and information/guidance concerning WNS:
 - i. <http://wildlife.state.co.us/WildlifeSpecies/Profiles/Mammals/BatsOfColorado/>
 - ii. <http://wildlife.state.co.us/NR/rdonlyres/1CEA8E33-B3FC-4A93-8F37-59423F949641/0/WhitenoseSyndromeBatsBrochure20090615.pdf>
 - iii. <http://wildlife.state.co.us/Research/WildlifeHealth/WNS/>
 1. Includes Interim Guidelines for WNS in Colorado, and a Bat White-nosed Syndrome Submission Protocol for mortalities
 - iv. http://www.cnhp.colostate.edu/RASwebpage/cbwg_website/cbwg_index.htm
 - v. <http://www.wbwg.org/>
3. Due to the evidence that gear and clothing may transport *Gd*, the latest USFWS Disinfection Protocol has been required for entry in all caves by CPW staff and permit-holders since January 2010. The wing-damage index described by Reichard (No Date) and Reichard and Kunz (2009) was used for any bats captured during survey efforts. Watching for any bats with wing damage that might indicate the possibility of WNS was also emphasized.
http://www.fws.gov/WhiteNoseSyndrome/pdf/WNS1pageDecontaminationProtocol_073110.pdf
4. Beginning in 2009, the Colorado Division of Reclamation, Mining and Safety (DRMS) required contractors engaged in mine closures to implement decontamination steps for all closure and reclamation work associated with these projects. These steps were developed through the Bats/Inactive Mine Program (BIMP) as recommendations for the 2009 field season, and included decontamination procedures for both equipment and clothing used between mine closure projects, and for all bat evaluation work associated with DRMS projects . This was intended to help prevent the potential of spreading the fungal spores between sites involved in AML programs within Colorado. DRMS incorporated these guidelines into their Standard Health, & Environmental Action Plan Response Items, stating that all contactors must comply with these guidelines when working on DRMS projects.
5. The USFS, Washington DC Office, provided direction to staff and Regional Foresters via memo on July 28, 2010, including:

- a. A USFS WNS Interim Responsive Strategy, dated July 2010,
 - b. Decontamination Procedures for Use on NF System Lands to Help Prevent the Spread of WNS Associated With Cave and Abandoned Mine Entry, dated July 21, 2010, and
 - c. Recirculation of a Communication Plan, "Slow-the-Spread of White-nose Syndrome, dated April 5, 2010.
6. On August 1, 2012, by Order of the Regional Forester (R2-10-01) for the Rocky Mountain Region in the States of Colorado, Kansas, Nebraska, South Dakota and Wyoming, an emergency closure was announced for most caves and abandoned mines on NF System Lands, and requiring decontamination prior to entry and departure from where access by humans was permitted. This closure provides exemptions for active members of the National Speleological Society and Cave Research Foundation for activities consistent with national agreements.
7. The BLM provided an Instruction Memorandum to all Field Offices, dated August 19, 2010 and effective immediately. Included with the memorandum were an Interim Response Strategy, Containment and Decontamination Procedures, and a Site Feature Bat Inventory Spreadsheet. This memorandum directed BLM officials to:
 - a. coordinate and conduct outreach to stakeholders,
 - b. emphasize ongoing inventory of abandoned mines,
 - c. consider restricting access,
 - d. implement containment and decontamination procedures, and
 - e. recommend locations to test for the presence of WNS at a subset of sites with important bat resources.