

White-Nose Syndrome in North American Bats— U.S. Geological Survey Updates



White-nose syndrome (WNS), a devastating wildlife disease that has killed millions of hibernating bats since it first appeared in New York during 2007, continues to spread at an alarming rate from the northeastern to the central United States and throughout eastern Canada. White-nose syndrome was also recently confirmed in Washington, the only western State known to be affected as of December 2016. The disease is named for the fungus *Pseudogymnoascus destructans*, which often appears white when it infects the skin of the nose, ears, and wings of hibernating bats (fig. 1). To see a map of the States and Provinces where the disease has been detected, please visit <https://www.whitenosesyndrome.org/resources/map>.

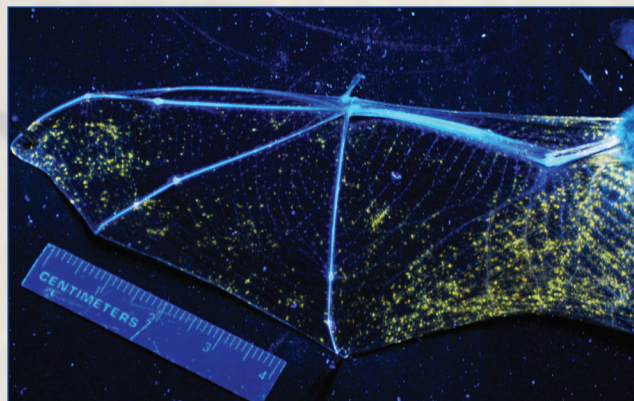
The U.S. Geological Survey (USGS) has been a leading contributor to the interagency response to WNS since 2008 and continues to provide ongoing scientific support to these efforts by performing fundamental research on bat ecology, fungal biology, and WNS epidemiology and pathology. Studies conducted by the USGS led to the discovery of WNS (Blehert and others, 2009), initial characterization and naming of the cold-loving fungus (Gargas and others, 2009), development of standardized criteria for diagnosing the disease (Meteyer and others, 2009), confirmation that *P. destructans* is the cause of WNS (Lorch and others, 2011), and a better understanding of pathogen distribution and persistence in the environment (Lorch and others, 2012).

Recent advances in field screening (Turner and others, 2014; fig. 2) and laboratory diagnostic techniques (Muller and others, 2012) have facilitated expanded surveillance to more accurately track the spread of *P. destructans*. Building on these advances, the [USGS National Wildlife Health Center](#) is assisting State and Federal partners with active surveillance for WNS and *P. destructans* throughout the Southeastern, Midwestern, and Western regions of the United States. Early detection of *P. destructans* in bat populations provides wildlife managers with more time to prepare site-specific strategies to mitigate the potential impacts of WNS.

To determine if bats are affected by WNS, scientists look for a characteristic microscopic pattern of skin erosion caused by *P. destructans* (Meteyer and others, 2009). Field signs of WNS can include visible white fungal growth on the bat's muzzle or wings (fig. 3), but these signs alone are not a reliable

Figure 1 (above). A, Light microscopy image of *Pseudogymnoascus destructans*, the fungus that causes white-nose syndrome (WNS). (Photograph by D. Blehert). B, Hibernating little brown bat with white fungal growth on muzzle and wings typical of white-nose syndrome. (Photograph by Alan Hicks, New York Department of Environmental Conservation). C, Wings of a little brown bat infected with WNS; arrows show pale areas characteristic of infection by *P. destructans*. (Photograph by C. Meteyer. Modified from Meteyer and others, 2011).

Figure 2. Wing of a bat affected by white-nose syndrome (WNS) under ultraviolet light. Areas affected by WNS appear yellow-orange under ultraviolet light. Use of ultraviolet light provides a useful tool in field and rehabilitation settings to screen bats for signs suggestive of WNS. Additional laboratory diagnostic testing is required to confirm a WNS diagnosis. (Modified from Turner and others, 2014).



indicator of disease—laboratory examination and testing are required for disease confirmation. Infected bats also arouse from hibernation more frequently than uninfected bats (Reeder and others, 2012) and often display abnormal behaviors at their underground hibernation sites, such as congregating at or near entrances and daytime flights in freezing temperatures; overall, infection with *P. destructans* results in a cascade of physiologic disturbances that can lead to death from dehydration or starvation. Harmful effects of infection occur even before notable clinical signs of illness or behavioral changes are observed (Verant and others, 2014).

The relatively widespread mortality associated with WNS is unprecedented in hibernating bats. In particular, populations of little brown bats (*Myotis lucifugus*) have been heavily impacted and may become locally or regionally extirpated because of the disease (Frick and others, 2010). Although small numbers of bats have recently been found persisting and reproducing in areas where populations had previously declined precipitously (Reichard and others, 2014), these remnant populations will require protection from other potential threats to support survival and breeding success. Even with such protections, recovery will likely be slow as reproductive females of most bat species produce only a single pup per year. Long-term bat population monitoring will be critical to fully understand the potential for bats to rebound from this devastating disease and to guide sound management decisions (Russell and others, 2015).

The U.S. Fish and Wildlife Service coordinates Federal, State, and Tribal agencies, and nongovernmental partners on national efforts to investigate and respond to WNS (U.S. Fish and Wildlife Service, 2011). These interagency efforts have fostered considerable collaboration, including the development of a [National Plan](#), and have led to substantial advances in the understanding of WNS (please visit www.whitenosesyndrome.org for more information on the interagency effort). Researchers from the USGS are working closely with diverse partners to conduct surveillance to monitor the spread of *P. destructans*, to



Figure 3. U.S. Geological Survey scientist David Blehert inspects a bat for signs of wing damage from white-nose syndrome. (Photograph: Jennifer Redell, Wisconsin Department of Natural Resources).

develop mitigation strategies to limit the expansion of WNS, to reduce population losses, and to support recovery of impacted bat populations. This includes researching potential management approaches such as the use of microbial or chemical means to inhibit growth of *P. destructans* in hibernation environments and the development of potential vaccine candidates against *P. destructans*.

Bats are unique and valuable animals. They eat insects that damage crops and carry diseases, and many bat species also play important roles in plant pollination and seed dispersal. Future research can help us learn more about bats and examine the potential ecological consequences of bat population declines caused by WNS.

USGS Contributions to Understanding White-Nose Syndrome

The USGS works closely with Federal, State, and Tribal agencies; bat conservation groups; and cavers to better understand this devastating disease and to support management efforts. Support to WNS response includes

- diagnosing WNS in bats submitted to the National Wildlife Health Center by Federal, State, and Tribal agencies;
- investigating environmental factors that influence *P. destructans* survival in hibernation sites;
- conducting studies on WNS transmission, spread, and prevention;
- developing improved tools and strategies for WNS detection and *P. destructans* surveillance;
- investigating the microbial ecology of bat hibernation sites and bat skin;
- observing hibernating bats to understand behavioral changes associated with WNS;
- studying the physiologic effects of *P. destructans* infection that contribute to illness and death;
- researching strategies to prevent WNS and to help bat populations recover;
- communicating with the public, policymakers, natural resource managers, and scientists; and
- publishing scientific reports that contribute to understanding of WNS.

Little brown bat (*Myotis lucifugus*),
by S. M. Bishop. ©2014





Indiana bat (*Myotis sodalis*¹), by Andrew Kniewski, Department of Fish and Wildlife Conservation, Virginia Tech.



Eastern small-footed bat (*Myotis leibii*), by Virginia State Parks.



Tricolored bat (*Perimyotis subflavus*), by Larisa Bishop-Boros. ©©©



Big brown bat (*Eptesicus fuscus*), by Ann Froschauer, U.S. Fish and Wildlife Service.



Gray bat (*Myotis grisescens*¹), by Larisa Bishop-Boros. ©©©



Northern long-eared bat (*Myotis septentrionalis*²), by Pete Patavino, U.S. Fish and Wildlife Service.

References Cited

- Blehert, D.S., Hicks, A.C., Behr M., Meteyer C.M., Berlowski-Zier, Brenda, Buckles E.L., Coleman, J.T.H., Darling, S.R., Gargas, Andrea, Niver, Robyn, Okoniewski, J.C., Rudd, R.J., and Stone, W.B., 2009, Bat white-nose syndrome: an emerging fungal pathogen?: Science, v. 323, no. 5911, p. 227, accessed November 2016 at <http://dx.doi.org/10.1126/science.1163874>.
- Frick, W.F., Pollock, J.F., Hicks, Alan, Langwig, Kate, Reynolds, D.S., Turner, G.G., Butchowski, Calvin, and Kunz, T.H., 2010, An emerging disease causes regional population collapse of a common North American bat species: Science, v. 329, no. 5992, p. 679–682, accessed November 2016 at <http://dx.doi.org/10.1126/science.1188594>.
- Gargas, Andrea, Trest, M.T., Christensen, Martha, Volk, T.J., and Blehert, D.S., 2009, *Geomyces destructans* sp. nov. associated with bat white-nose syndrome: Mycotaxon, v. 108, p. 147–154.1
- Lorch, J.M., Meteyer, C.U., Behr, M.J., Boyles, J.G., Cryan, P.M., Hicks, A.C., Ballmann, A.E., Coleman, J.T.H., Redell, D.N., Reeder, D.M., and Blehert, D.S., 2011, Experimental infection of bats with *Geomyces destructans* causes white-nose syndrome: Nature, v. 480, no. 7377, p. 376–378, accessed November 2016 at <http://dx.doi.org/10.1038/nature10590>.
- Lorch, J.M., Muller, L.K., Russell, R.E., O'Connor, Michael, Linder, D.L., and Blehert, D.S., 2012, Distribution and environmental persistence of the causative agent of white-nose syndrome, *Geomyces destructans*, in bat hibernacula of the Eastern United States: Applied and Environmental Microbiology AEM.02939–12, accessed November 2016 at <http://dx.doi.org/10.1128/AEM.02939-12>.
- Meteyer, C.U., Buckles, E.L., Blehert, D.S., Hicks, A.C., Green, D.E., Shearn-Bochsler, Valerie, Thomas, N.J., Gargas, Andrea, and Behr, M.J., 2009, Histopathologic criteria to confirm white-nose syndrome in bats: Journal of Veterinary Diagnostic Investigation, v. 21, no. 4, p. 411–414.
- Meteyer, C.U., Valent, Mick, Kashmer, Jackie, Buckles, E.L., Lorch, J.M., Blehert, D.S., Lollar, Amanda, Berndt, Douglas, Wheeler, Emily, White, C.L., and Ballmann, A.E., 2011, Recovery of little brown bats (*Myotis lucifugus*) from natural infection with *Geomyces destructans*, white-nose syndrome: Journal of Wildlife Diseases, v. 47, no. 3, p. 618–626, accessed November 2016 at <http://dx.doi.org/10.7589/0090-3558-47.3.618>.
- Muller, L.K., Lorch, J.M., Lindner, D.L., O'Connor, Michael, Gargas, Andrea, and Blehert, D.S., 2012, Bat white-nose syndrome—A real-time TaqMan polymerase chain reaction test targeting the intergenic spacer region of *Geomyces destructans*: Mycologia, v. 105, no. 2, p. 253–259, accessed November 2016 at <http://dx.doi.org/10.3852/12-242>.
- Reeder, D.M., Frank, C.L., Turner, G.G., Meteyer, C.U., Kurta, Allen, Britzke, E.R., Vodzak, M.E., Darling, S.R., Stihler, C.W., Hicks, A.C., Jacob, Roymon, Grieneisen, L.E., Brownlee, S.A., Muller, L.K., and Blehert, D.S., 2012, Frequent arousal from hibernation linked to severity of infection and mortality in bats with white-nose syndrome: PLoS ONE, v. 7, p. e38920, accessed November 2016 at <http://dx.doi.org/10.1371/journal.pone.0038920>.
- Reichard, J.D., Fuller, N.W., Bennett, A.B., Darling, S.R., Moore, M.S., Langwig, K.E., Preston, E.D., von Oettingen, Susi, Richardson, C.S., and Reynolds, D.S., 2014, Interannual survival of *Myotis lucifugus* (Chiroptera: Vespertilionidae) near the epicenter of white-nose syndrome: Northeastern Naturalist (Steuben), v. 21, no. 4, p. N56–N59, accessed November 2016 at <http://dx.doi.org/10.1656/045.021.0410>.
- Russell, R.E., Thogmartin, W.E., Erickson, R.A., Szymanski, J.A., and Tinsley, Karl, 2015, Estimating the short-term recovery potential of little brown bats in the eastern United States in the face of white-nose syndrome: Ecological Modelling, v. 314, p. 114–117, accessed November 2016 at <http://dx.doi.org/10.1016/j.ecolmodel.2015.07.016>.
- Turner, G.G., Meteyer, C.U., Barton, Hazel, Gumbs, J.F., Reeder, D.M., Overton, Barrie, Bandouchova, Hana, Bartonicka, Tomás, Martinková, Natália, Pikula, Jiri, Zukal, Jan, and Blehert, D.S., 2014, Nonlethal screening of bat-wing skin with the use of ultraviolet fluorescence to detect lesions indicative of white-nose syndrome: Journal of Wildlife Diseases, v. 50, no. 3, p. 566–573, accessed November 2016 at <http://dx.doi.org/10.7589/2014-03-058>.
- U.S. Fish and Wildlife Service, 2011, A national plan for assisting States, Federal agencies and Tribes in managing white-nose syndrome in bats, accessed September 2016 at <https://www.whitenosesyndrome.org/white-nose-syndrome-response-plans>.
- Verant, M.L., Meteyer, C.U., Speakman, J.R., Cryan, P.M., Lorch, J.M., and Blehert, D.S., 2014, White-nose syndrome initiates a cascade of physiologic disturbances in the hibernating bat host: BMC Physiology, v. 14, p. 10, accessed November 2016 at <http://dx.doi.org/10.1186/s12899-014-0010-4>.

By Emily W. Lankau and Gail Moede Rogall

For additional information contact:

USGS National Wildlife Health Center
6006 Schroeder Road
Madison, WI 53711
(608) 270-2400
<http://www.nwhc.usgs.gov>
<http://www.whitenosesyndrome.org>