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National Wildlife Health Center

White-Nose Syndrome in Bats: U.S. Geological Survey Updates

White-nose syndrome (WNS) is a devastating disease that has killed millions of hibernating bats since it first appeared in New York in 2007 and has spread at an alarming rate from the northeastern to the central United States and Canada. The disease is named for the white fungus ***Geomyces destructans*** *that infects the skin of the muzzle, ears, and wings of hibernating bats (fig. 1). To see a map of States and Provinces in which the disease has been detected, please visit http://www.nwhc.usgs.gov/disease_information/white-nose_syndrome/index.jsp.*

The U.S. Geological Survey (USGS) National Wildlife Health Center (NWHC), the USGS Fort Collins Science Center, the U.S. Fish and Wildlife Service, and other partners continue to play a primary role in WNS research. Studies conducted at NWHC led to the discovery, characterization, and naming (Gargas and others, 2009) of the cold-loving fungus *G. destructans* and to the development of standardized criteria for diagnosing the disease (Blehert and others, 2009). Additionally, scientists at the NWHC have pioneered laboratory techniques for studying the effects of the fungus on hibernating bats (Lorch and others, 2011).

To determine if bats are affected by white-nose syndrome, scientists look for a characteristic microscopic pattern of skin erosion caused by *G. destructans* (Meteyer and others, 2009). Field signs of WNS can include visible white fungal growth on the bat's muzzle, wings, or both, but these signs alone are not a reliable disease indicator—laboratory examination and testing are required for disease confirmation. Infected bats also arouse from hibernation more frequently than uninfected bats (Warnecke and others, 2012) and often display abnormal behaviors in their hibernation sites, such as congregating at or near cave openings and daytime flights during winter. These abnormal behaviors may contribute to the bat's accelerated consumption of stored fat reserves, causing emaciation, a characteristic documented in some of the bats that die with WNS.

During hibernation, bats likely have lowered immunity (Bouma and others, 2010), which may facilitate the ability of *G. destructans* to colonize and damage large areas of wing membrane (fig. 2). A current hypothesis suggests that erosion or ulceration of wing membrane caused by the fungus has the potential to alter the physiology of hibernating bats, resulting in fatal disruption of hydration, electrolyte balance, circulation, and thermoregulation (Cryan and others, 2010).

Current estimates of bat population declines in the northeastern United States since the emergence of WNS are over 80 percent (Turner and others, 2011). This sudden and widespread mortality associated with WNS is unprecedented in hibernating bats, among which large-scale disease outbreaks have not been previously documented. It is unlikely that species of bats affected by WNS will recover quickly because most are long-lived and have only a single pup per year. Consequently, repopulation after widespread mortality of breeding adults will be a slow process.

Bat species affected by WNS include (as of June 2012):

Little brown bat (*Myotis lucifugus*)
Tri-colored bat (*Perimyotis subflavus*)
Northern long-eared bat (*Myotis septentrionalis*)
Big brown bat (*Eptesicus fuscus*)
Eastern small-footed bat (*Myotis leibii*)
Indiana bat (*Myotis sodalis*)*
Gray bat (*Myotis grisescens*)*

* Federally endangered

Figure 1. Hibernating little brown bat with white muzzle and spots on wings typical of white-nose syndrome. (Photo by Greg Turner, Pennsylvania Game Commission)

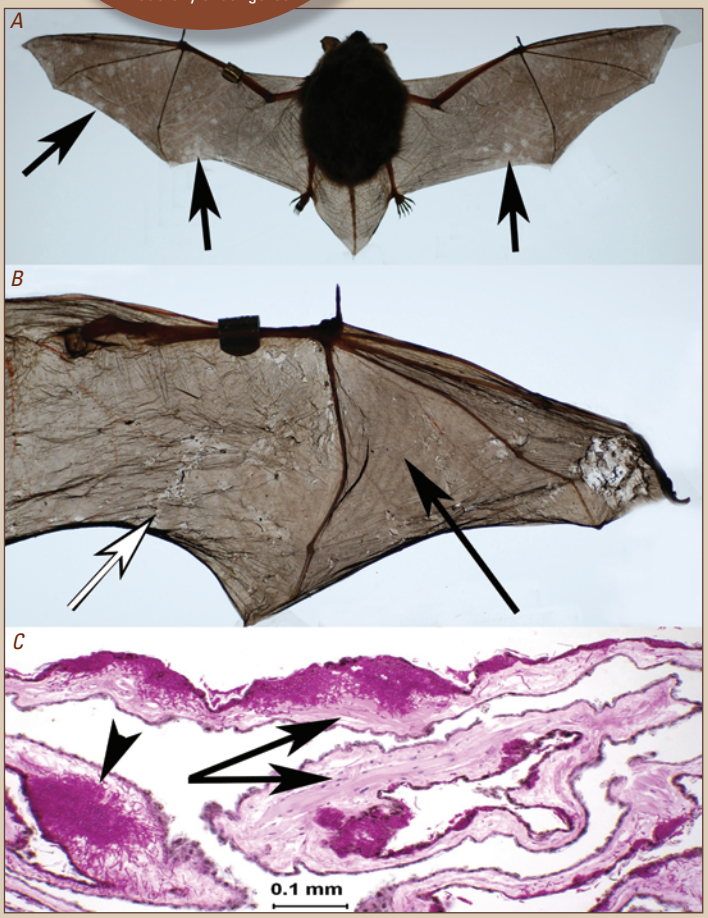

Figure 2. Wings of little brown bats infected with white-nose syndrome. *A*, Pale areas (arrows) on the wings indicate areas of infection with *G. destructans*. *B*, Areas of relatively normal tissue elasticity (black arrow) and an infected area (white arrow) that looks like crumpled tissue paper and shows loss of tissue elasticity, surface sheen, and areas of irregular pigmentation. *C*, Microscopic section of folded wing membrane shows extensive infection with *G. destructans* (magenta). (Photo by Carol Meteyer. Source: Meteyer and others, 2011)

Worldwide, bats play essential roles as pollinators, seed dispersers, and as primary consumers of insects. The true ecological consequences of the recent large-scale reductions in populations of hibernating bats are not yet known. However, farmers might feel the impact. A recent economic analysis indicated that insect control services (ecosystem services) provided by bats to U.S. agriculture is valued between 4 to 50 billion dollars nationwide per year (Boyles and others, 2011). The number of North American bats estimated to have died from WNS thus far had the capacity to consume up to 8,000 tons of insects per year (Boyles and others, 2011).

The area of North America affected by WNS continues to expand. Within the last 2 years, the disease has been confirmed in several Central States, including Alabama, Indiana, Kentucky, Ohio, Tennessee, and Missouri. High mortality of bats has not yet been reported at these locations, and it remains to be seen if WNS will develop and manifest in other States with the same severity as that in the Northeast.

References Cited

Blehert, D.S., Hicks, A.C., Behr, M., Meteyer, C.U. Berlowski-Zier, B.M., Buckles, E.L., Coleman, J.T.H., Darling, S.R., Gargas, A., Niver, R., Okoniewski, J.C., Rudd, R.J., and Stone, W.B., 2009, Bat white-nose syndrome: An emerging fungal pathogen?: Science, v. 323, p. 227.

Bouma, H.R., Carrey, H.V., and Krose, F.G.M., 2010, Hibernation: the immune system at rest?: Journal of Leukocyte Biology, v. 88, p. 1–6.

Boyles, J.G., Cryan, P.M., McCracken, G.F., and Kunz, T.H., 2011, Economic importance of bats in agriculture: Science, v. 332, p. 41–42.

Cryan P.M., Meteyer, C.U., Boyles, J.G., and Blehert, D.S., 2010, Wing pathology of white-nose syndrome in bats suggests life-threatening disruption of physiology: BMC Biology, v. 8, p. 135.

Everette, L., 2011, Development of a white-nose syndrome (WNS) disease tracking system: accessed May 29, 2012, at *http://www.fort.usgs.gov/Research/research_tasks.asp?TaskID=2401*.

Gargas, A., Trest, M.T., Christensen, M., Volk, T.J., and Blehert, D.S., 2009, *Geomyces destructans* sp nov associated with bat white-nose syndrome: Mycotaxon, v. 108, p. 147–154.

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., Reeder, D.M., and Blehert, D.S., 2011, Experimental infection of bats with *Geomyces destructans* causes white-nose syndrome: Nature, v. 480, p. 376–378.

Meteyer C.U., Buckles, E.L., Blehert, D.S., Hicks, A.C., Green, D.E., Shearn-Bochsler, V., Thomas, N.J., Gargas, A., and Behr, M.J., 2009, Pathology criteria for confirming white-nose syndrome in bats: Journal of Veterinary Diagnostic Investigation, v. 21, p. 411–414.

Meteyer, C.U., Valent, M., Kashmer, J., Buckles, E.L., Lorch, J.M., Blehert, D.S., Lollar, A., Berndt, D., Wheeler, E., 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, p. 618–626.

Turner, G.G., Reeder, D.M., and Coleman, J.T.H., 2011, A five-year assessment of mortality and geographic spread of white-nose syndrome in North American bats and a look to the future: Bat Research News, v. 52, p. 13–27.

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 May 29, 2012, at *http://www.fws.gov/WhiteNoseSyndrome/pdf/WNSnationalplanMay2011.pdf*.

Warnecke, L., Turner, J.M., Bollinger, T.K., Lorch, J.M., Misra, V., Cryan, P.M., Wibbelt, G., Blehert, D.S., and Willis, C.K.R., 2012, Inoculation of bats with European *Geomyces destructans* supports the novel pathogen hypothesis for the origin of white-nose syndrome: Proceedings of the National Academy of Science, v. 109, p. 6999–7003.

USGS Contributions to Understanding White-Nose Syndrome

Since 2008, USGS researchers have become recognized leaders in pioneering WNS research. In 2011, scientists from the USGS NWHC published a study confirming the cold-loving fungus *G. destructans* causes WNS (Lorch and others, 2011). The USGS continues to work closely with other Federal and State partners to better understand this devastating disease. USGS science support for WNS includes:

- diagnosing WNS in bats submitted to the NWHC by Federal and State agencies;
- conducting studies on WNS disease transmission, progression, and recovery from WNS;
- developing improved tools for rapid detection of *G. destructans*;
- investigating the microbial ecology of *G. destructans* in caves where bats hibernate;
- video-monitoring of bats in caves and mines to observe behavior changes associated with WNS, including unsustainable energy-consuming behaviors during hibernation;
- analyzing blood chemistry as a means of studying the life-threatening health effects of WNS skin infection;
- creating an online WNS Disease Tracking System (Everette, 2011);
- developing new laboratory and field methods for assessing the physiological effects of WNS on hibernating bats;
- providing scientific support for the *White-Nose Syndrome National Plan* (U.S. Fish and Wildlife Service) by serving on committees, implementation teams, and working groups;
- communicating test results and new research findings related to WNS to policy makers, natural resource managers, and other science partners through the distribution of Wildlife Health Bulletins, workshops, presentations, and scientific publications, and
- publishing scientific reports that contribute to a better understanding of WNS (available at at *http://www.nwhc.usgs.gov/disease_information/white-nose_syndrome/wns_publications_list.jsp*).

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