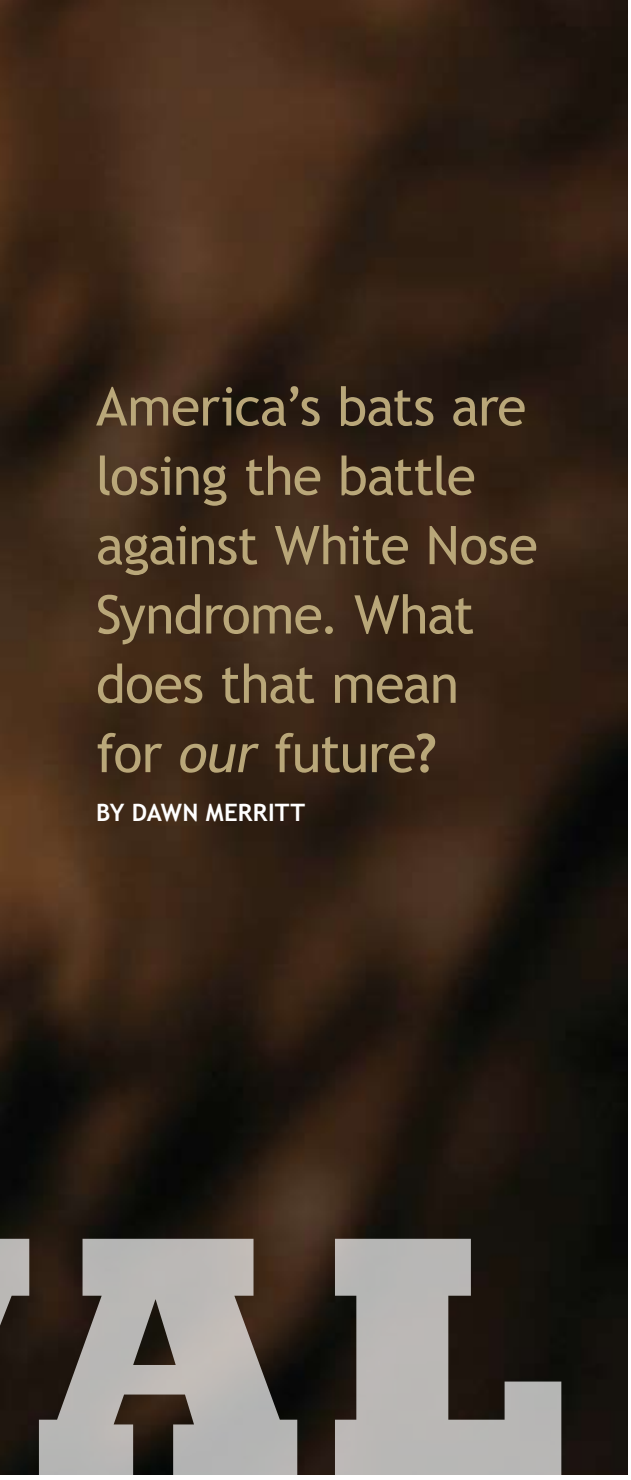
A tri-colored bat in central Pennsylvania's Mifflin County showing symptoms of White Nose Syndrome.

GREG TURNER, PENNSYLVANIA GAME COMMISSION

Battling for SURVIV

It's not unusual for cavers to come across hibernating bats during cold winter months. However, in February 2006, a caver visiting a popular site outside Albany, New York, found something he'd never seen before: Bats with a white substance on their muzzles. He also found 18 dead bats on the floor of the cave. The caver photographed both groups of bats but did not feel cause for alarm — in fact, he didn't even report what he'd found until two years later, when it became a key piece of a larger puzzle.

In the early months of 2007, biologists from the New York State Department of Environmental Conservation documented unusual bat behaviors and mortality. They found bats emerging from caves during hibernation, flying erratically — and several hundred dead bats. By 2008, the danger was clear. A disease affecting bats had spread from New York to three nearby states — Connecticut, Massachusetts, and Vermont — and the mortality rate for affected bats was more than 90 percent.



America's bats are losing the battle against White Nose Syndrome. What does that mean for *our* future?

BY DAWN MERRITT

Scientists named the new disease White Nose Syndrome (WNS) after the white material growing on the bats' noses. To date, more than one million hibernating bats have died from WNS along the East Coast, from Tennessee all the way up to Ontario, Canada. In 2010, suspected cases of WNS were identified as far west as Oklahoma and Missouri, and infected sites were found this year in Indiana and North Carolina. Once one bat in a hibernating population is infected, the mortality rate for the whole site is nearly 100 percent within two years. And so far, scientists have found no way to stop the spread of the disease.

The Benefits of Bats

Although bats are most often portrayed as the stuff of Halloween pranks and gothic folk tales, people in the conservation community know that bats play a critical role in ecosystems across the country. Bats have an amazing appetite for insects. From mosquitoes to crop-damaging moths, bats eat what bugs us.

According to Bat Conservation International (BCI), bats are the primary predators of insects that cost American farmers and foresters billions of dollars each year. For example, Mexican free-tailed bats from central Texas eat approximately two million pounds of insects every night, mostly corn earworm moths. Corn earworms are responsible for corn crop losses in the southern United States of up to 16 percent and sweet corn losses of up to 50 percent. The corn earworm diet also includes tomatoes, cotton, green beans, lettuce, peppers, and soybeans. Each female moth can lay 500 to 2,000 eggs during her 2-week life span, so bat consumption of these moths can drastically reduce the number of crop-eating larvae each year.

BCI also reports that in Indiana, a colony of just 150 big brown bats consumes enough cucumber beetles each summer to prevent them from laying eggs for 33 million larvae. Additional examples abound. Bat predation on crop-eating insects saves crops, saves money, and prevents excessive use of pesticides.

Some bats help control mosquito populations. Approximately 80 percent of the little brown bats living in the northern United States and Canada eat mosquitoes. One little brown bat can capture 1,200 insects in an hour; a nursing female eats more than her own body weight nightly — up to 4,500 insects. BCI cautions that bats are not a one-stop-shop for solving mosquito problems, but they can play an important part. The key to attracting bats to mosquito-heavy areas is ensuring there's enough food for the bats to eat throughout the spring, summer, and fall — not just the times when mosquitoes are plentiful.

Bats are also important pollinators in some parts of this country and around the world. In the American southwest, bats pollinate the

Pennsylvania Game Commission biologist Greg Turner examining layers of dead bats in the snow outside a mine in Lackawanna County.

KEVIN WENNER, PENNSYLVANIA GAME COMMISSION

Saguaro cactus and other plants and flowers. In tropical forests, bats pollinate fruit-bearing trees like banana and mango.

Bats have a short list of predators, including snakes, owls, and small mammals such as cats. The greatest danger to bats is us. When human development alters a cave system, for example, bats can be left with few options for hibernation. Disturbing a maternity colony can cause the mother bats to abandon their young, which cannot survive alone, and disturbing bats while they hibernate causes them to burn energy they need to survive the winter.

Bats Under Attack

But no human threat has been as destructive to bats as this new disease called White Nose Syndrome. A fungus that scientists named *Geomyces destructans* is the likely cause of the disease.

For most mammals, a fungal infection isn't life threatening. That's because our warm body temperatures keep fungal growth in check. The cold, humid caves or mine shafts where bats hibernate turn out to be ideal conditions for the *G. destructans* fungus to grow, however. Scientists also believe that a side effect of bat hibernation might be suppression of a bat's immune system responses, which could also help the fungus grow aggressively on hibernating bats.

The *G. destructans* fungus also needs a source of food. Again, hibernating bats oblige. Fungi normally do not invade living tissue; they stay on our skin or nails. However, this new fungus invades the bats' skin and digests live cells — it literally eats them alive while they hibernate.

Symptoms of White Nose Syndrome in bats include

- Fungus on the skin and muzzle
- Changes in behavior, such as moving to a colder location at the front of a cave or becoming unresponsive to disturbance during hibernation
- Flying during the daytime and leaving the hibernation site mid-winter (called "early emergence")
- Death

Although the most noticeable sign of White Nose Syndrome may be the namesake white substance on a bat's muzzle, that's actually one of the last symptoms of the disease, according to Pennsylvania Game Commission biologist Greg Turner, one of the country's foremost experts on White Nose Syndrome. Before external signs of WNS appear, significant damage has already been done to the bat's wings. "When we were trying to diagnose our first sites early in the disease cycle," says Turner, "only 15 or 20 of the bats we found had visible fungal infections, but other behavioral symptoms were already starting to appear." Turner and his colleagues hypothesized that there had to be more to see. They found that a bat wing examined under ultraviolet (UV) light told a different story. "When we looked at the bat wings under UV light, we could see where the fungus had grown into the skin, causing significant damage to the wings before other external symptoms set in."

Turner has been working with Dr. DeeAnn Reeder, a professor in the Department of

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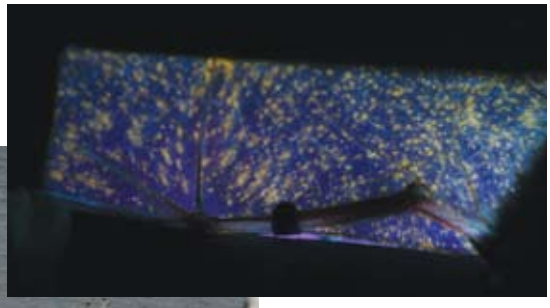
Biology at Bucknell University, and many other colleagues to gather data on exactly what happens to WNS-infected bats during the hibernation period. Turner and Reeder built their own data loggers and worked with colleagues to tag both infected and healthy bats in multiple states to compare the data. The results showed that WNS bats were arousing twice as often as other bats and/or raising their body temperature longer than unaffected bats.

Researchers are testing different hypotheses on why all this is happening and how it causes bat mortality. One theory is that by waking up more often, WNS bats are burning fat supplies too early in the winter and could be flying outside in search of food to replenish their fat stores — which would also help explain why many of the bats have little fat left on their bodies when they are found dead. Another theory, says Turner, is that "a toxin from the fungus is distorting the bats' internal clocks. Not all bats we



Photos of a little brown bat affected by White Nose Syndrome. An ultraviolet (UV) light behind the wing shows areas where the fungus is digesting live cells (above).

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examined were at the point of starving to death when they flew out of the hibernation site. A few had severely reduced fat stores but not to the point of causing death, so fat loss is not always the ultimate cause of mortality."

Researchers from the U.S. Geological Survey (USGS) released a study in November 2010 with another theory. They propose that thirst is driving the bats outside when they are supposed to be hibernating, using up body fat so vital to survival. The USGS researchers hypothesize that damage to the bat's wings caused by the *G. destructans* fungus could increase evaporation of water through the wings, leading to dehydration.

Whatever the biological cause of death, it's clear that White Nose Syndrome is wreaking havoc with bat populations — and scientists are at a loss for how to stop it.

Due to the variables involved with their initial study of hibernation sites across the eastern United States, Turner and Reeder selected two Pennsylvania sites to monitor extensively for several years. Both sites had healthy hibernating little brown bat populations when the study began. Now in their third year of monitoring these sites — both now infected with White Nose Syndrome — Turner and Reeder have acquired data from the same bats over several years and hope to analyze and publish the data soon.

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Netting Solutions

Greg Turner and his colleagues at the Pennsylvania Game Commission have been studying bats in the state for 20 years. They are familiar with many of the bat hibernation sites across the state, and in the past they built barriers to keep human visitors out of some of these sites. Last winter, the team tried several methods

of temporarily netting cave and mine entrances to keep infected bats *in* and prevent them from infecting other hibernation sites. They also netted "clean" sites to try to keep infected bats out.

When faced with the first round of nets, the bats figured out how to squeeze along the uneven rock surface above the nets to wriggle out of caves and actually dug holes in the ground to get under the nets on other attempts. Turner and his colleagues constructed the next batch of nets with wooden frames that they secured top

Little brown bats in Mifflin County, Pennsylvania, showing various signs of White Nose Syndrome.

GREG TURNER, PENNSYLVANIA GAME COMMISSION

and bottom and made sure they extended down into the dirt. Then they used expanding foam to seal the gaps between the frame and cave/mine walls. Turner says this new approach "appears to work well in sites with known openings. If a site has lots of small cracks that connect to the above-ground world, they will find a way around the net. But it appears to work in our mine settings." The team hopes that by keeping infected and healthy bats separate, they can slow the rate at which White Nose Syndrome spreads across the state.

Bats can pass White Nose Syndrome to each other, but could a bat contract the disease by hibernating in a site that previously held infected bats? "We don't think successful reintroduction of bats that have never encountered WNS is possible once a hibernation site has been infected," says Turner. Researchers in New York introduced 16 healthy bats into a cave where 100 percent of the original bat colony had died from White Nose Syndrome; some of those 16 bats were dead from WNS within 8 weeks and all perished shortly thereafter.

Turner and his colleagues are setting up a similar experiment with a longer timetable. They plan to reintroduce healthy bats to a site two years after the previous residents died from White Nose Syndrome to see if the site will remain contaminated for that period of time. "The challenge for us is finding a way to eliminate the fungus from such a site without killing anything else in the cave," says Turner. "Each natural cave can be it own ecosystem, supporting globally rare and native endemic animals. So we can't just spray it down with bleach or pharmaceutical chemicals. It is quite possible that this new fungus is now so embedded into the community of native bacteria and fungi that we will never be able to remove it without causing irreparable harm."

The origins of the *G. destructans* fungus could provide some clues on how to fight it. In the United States, the fungus is found only in bat hibernation sites confirmed to be affected by WNS and displaying high mortality, says Turner. But a genetically similar fungus has been found in bat hibernation sites in Europe — with no documented impact on current bat populations. Scientists plan to compare European and American bats to determine, if possible, what makes European bats resistant to the fungus and whether this can be used to increase survival rates for American bats.

Many scientists suspect that *G. destructans* spores were brought to that first U.S. site outside Albany, New York, by people who had visited infected sites in Europe — the spores likely hitched a ride on clothes or equipment. The rapid and extensive spread of White Nose Syndrome in this country — large leaps in geography,

Bats are long-lived but slow to reproduce. So recovering bat populations lost to White Nose Syndrome will take decades or possibly centuries.

Researchers recovering data loggers from Barton Cave bats in southwest Pennsylvania (from left to right): Sarah Brownlee, Bucknell University graduate student; Colleen Patterson, Pennsylvania Game Commission bioaide; Dr. DeeAnn Reeder, Department of Biology, Bucknell University; Greg Turner, Pennsylvania Game Commission.

Inset: Little brown bats with data loggers.

appearance at commercial or highly visited recreational sites, and the spread to Western bat species that do not mingle with Eastern bat species — also suggest that bat movement is not the only means of spreading the disease. "As underground disturbance to hibernating bats continues," says Turner, "the threat for this disease to envelop the nation continues at record pace."

The Future of Bats

Bats are long-lived but slow to reproduce. Each adult female gives birth to just one pup per year. So recovering bat populations lost to White Nose Syndrome will take decades or possibly centuries, says Turner.

There is one glimmer of hope: A few bats seem to be resistant to White Nose Syndrome. Scientists found a colony of several hundred little brown bats in Massachusetts in an area where every other colony was decimated by WNS. Scientists don't know yet whether these survivors are resistant to White Nose Syndrome or just managed to avoid infection. They are monitoring the bats remotely with cameras to see whether reproduction is occurring and if the young bats will survive hibernation, says Turner.

In addition, Turner notes that certain species of bats, including big brown bats, may not be affected by White Nose Syndrome to the same degree as other hibernating bats. These less affected bats may soon become the next focus of research.

A colony of dead bats is a sad occurrence. One million dead bats — and counting — is an epidemic. Picture yourself walking in the woods when you happen upon a hibernation site infected with White Nose Syndrome. "The first thing you'll notice is the smell of death permeating the air, thicker near the entrance of the cave or mine," says Turner. "Then, near the cave entrance, you'll see piles of dead bats, possibly hundreds clustered together. Inside, you would find thousands more dead bats and perhaps others near death crawling futilely over the piles of dead ones." That's what Turner is seeing at Pennsylvania's largest sites. It's gruesome and shocking — and spreading fast across the country. Models based on current mortality trends show the potential for complete loss of some American bat species within 20 years. "Take pictures now," says Turner, "because in five to eight years, large maternity sites of bats will not be a common occurrence."

What can YOU do?

The most critical need right now is funding for research. In October 2010, the U.S. Fish and Wildlife Service awarded $1.6 million in grants for White Nose Syndrome research. However, leading bat scientists requested a five-year budget of $55 million, with first year funding of $15 million for critical

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efforts to understand the role of the G. *destructans* fungus and determine what can be done to stop WNS before the damage to bat populations becomes irreversible. Write your members of Congress. Let them know that bats are important to our nation's ecosystems and agriculture — and to human health — and that you support increased funding for White Nose Syndrome research. You can also take action locally:

- **Follow cave closures.** One of the most important things we can do to prevent the spread of White Nose Syndrome is to stay out of closed caves. (You can find details on cave closures on the Fish and Wildlife Service Web site at *www.fws.gov/whitenosesyndrome/cavers.html*.) In addition, you can support legislation to protect hibernating bats from disturbance.
- **Collect bat data** for your state Department of Natural Resources. The Pennsylvania Game Commission is asking residents to help them find WNS survivors and conduct bat emergence counts at maternity sites. "We need to know where summer colonies are to protect them," says Turner. You can find links to report unusual bat behaviors and deaths in Arizona, Delaware, Michigan, Pennsylvania, Texas, and Vermont on the U.S. Fish and Wildlife Service Web site at *www.fws.gov/WhiteNoseSyndrome/report.html*.
- **Install bat boxes** in suitable locations where bats can safely rear their young for years. Visit the Bat Conservation International Web site (*www.batcon.org/pdfs/bathouses/bathousecriteria.pdf*) for tips on building a successful bat house, from ensuring your bat box is warm (but not too warm!) to keeping bats safe from predators and disturbances.

Bats play a critical role in ecosystems across this country. Without immediate action to address the destruction caused by White Nose Syndrome, all we may have left to remember them are those Halloween decorations.

— Dawn Merritt is Director of Communications for the Izaak Walton League's national office in Gaithersburg, Maryland.

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