ECHOLOCATOR

WISCONSIN BAT PROGRAM

Volume 10
Issue 1
Feb. 2021

In A World Turned Upside Down

Thank You For Helping Us Through 2020

Table Of Contents

Wisconsin Bat Program

In a world seemingly flipped upside down, reaching out to friends helped us get by in 2020. These hibernating little brown bats paired up to make it through the winter. Photo, flipped for effect: Heather Kaarakka

Echolocator is an annual publication of the Wisconsin Bat Program, part of the DNR's Natural Heritage Conservation Program. DNR conservation biologists statewide monitor, research and inventory Wisconsin's eight bat species in collaboration with other state and federal agencies, universities, conservation groups, other non-governmental groups and hundreds of volunteers.

Echolocator presents bat conservation work and research relevant to Wisconsin and welcomes ideas for future articles and featured groups.

Please contact Jennifer.Redell@wisconsin.gov to share your suggestions.

Editor, Jennifer Redell
Graphic Design, Rebecca Rudolph

State of Wisconsin
Department of
Natural Resources
Box 7921
Madison, WI
53707

WISCONSIN
DEPT. OF NATURAL RESOURCES

Reflections From The Editor

Hundreds Of Volunteers Fly In To Help Bats

By Jennifer Redell
DNR Conservation Biologist, Bat Program Cave and Mine Specialist

Similar to most people, COVID-19 impacted our work in direct and indirect ways. Some things looked the same, many tasks were modified or dropped, and we forged ahead using technologies allowing us to track bats remotely. What remained constant, however, was the dedication of the volunteers who play a vital role in helping us understand the changes we're seeing in Wisconsin bat populations due to white-nose syndrome (WNS).

Despite the many challenges of the past year, Wisconsin Bat Program volunteers monitored more roosts and completed a greater proportion of acoustic surveys during a significantly shortened monitoring season. This work from dedicated volunteers is critical in helping us observe how populations are responding after WNS caused severe declines at the majority of Wisconsin hibernation sites beginning six years ago.

Our streamlined newsletter summarizes these surveys and other core activities and highlights two key partnerships. Amy Wray's doctoral research at the University of Wisconsin-Madison has been instrumental in our understanding of bat diets in Wisconsin, and how little brown bats are especially important for filling an important role as an ecosystem predator and for their voracious consumption of agricultural pests and mosquitos. She summarizes her research in this issue and we wish her well as she begins work at the University of Wyoming to improve how chronic wasting disease in deer can be studied.

"What remained constant, however, was the dedication of the volunteers who play a vital role in helping us understand the changes we're seeing in Wisconsin bat populations due to WNS."

Researchers Skylar Hopkins, Kate Langwig and Joseph Hoyt of Virginia Tech publish results of their long-term study to see if bats alter their roosting preferences in hibernacula in response to the arrival of WNS.

Some of our typical winter 2021 work remains on hold due to COVID-19. Our routine winter hibernation surveys will be much more limited in the coming months while we wait our turn for the COVID-19 vaccine and the possibility of again searching caves and mines with colleagues. Our longstanding safety practice has been to search underground hibernacula only with a group of people.

We're capitalizing on technologies that allow us to track bats and learn more about them remotely. Relatively new antenna systems installed at several hibernacula will allow us to read the activity of bats carrying Passive Integrated Transponders (PIT) tags. As we move into summer, thermal cameras and PIT tag readers will help us better understand what's going on inside roosts.

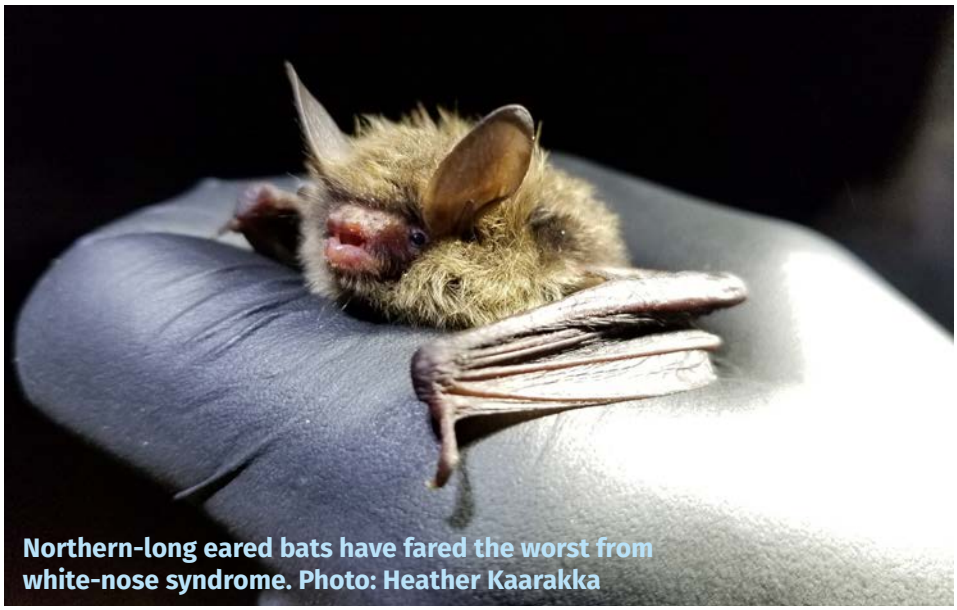
As bats emerge from caves on to the landscape and migrate home from other states where they over-wintered later this spring, we hope our outdoor summer work can be conducted in a mostly normal way.

Whatever may come, we remain especially grateful for the dedication of, and the inspiration provided by, hundreds of volunteers working individually or with members of their household to help Wisconsin bats.

Bat Q & A With J. Paul White

Right now, Wisconsin's four cave bat species are in their winter hibernation sites. Since white-nose syndrome was first detected in a Grant County mine in 2014, the disease has spread to hibernation sites statewide and resulted in dramatic decreases in overall bat populations, with losses at sites ranging from 70-100 percent. Little brown bats, eastern pipistrelles, also known as tricolored bats, and northern long-eared bats have been hit hardest while big brown bats have fared better.

We catch up with J. Paul White, DNR Mammal Ecologist and Bat Program Lead, to understand the latest news for Wisconsin bats.



Northern-long eared bats have fared the worst from white-nose syndrome. Photo: Heather Kaarakka

Q: Where are Wisconsin bat populations today?
J. Paul White: The picture is still developing and we see both signs of encouragement and cause for concern.

We incorporate survey data collected by volunteers, agencies and partners from winter hibernation sites, summer maternity roosts, and state-wide surveys using acoustic detectors to record bat calls along set routes. Together these data describe a still vulnerable cave bat population, prone to choosing "ecological traps" where seemingly suitable hibernating conditions are just a deadly disguise (read more about research into these ecological traps on page 18.) Yet, in some areas, we see resilience through summer and winter colonies alike, as numbers appear to have stabilized after hitting bottom. We're also seeing welcome signs of juvenile recruitment, which means some individual bats choose wisely in their hibernation strategies and/or are genetically better suited to cope with the deadly fungal pathogen causing white-nose syndrome.

Q: What's next?
J. Paul White: Our mission is to work with others to identify, protect, monitor and manage populations of native bat species; enhance and restore their habitats; address human-bat coexistence, and promote knowledge, appreciation and stewardship of bats in Wisconsin for present and future generations.

Guided by the national plan and the DNR's strategy, Wisconsin's conservation and recovery efforts will be prioritized to protect our sensitive bat population during critical points in their life -- hibernating or raising pups -- while controlling the disease (vaccine development) to the point where bat populations may recover.

Q: Broadly, what are the research questions we need answers for to better advance recovery?
J. Paul White: Understanding distances traveled and how bats use the landscape surrounding permanent hibernation sites during movement between winter and summer habitat can aid management decisions for species. For example, it makes little sense to manage forest 100 miles from a hibernaculum when species typically migrate shorter distances. Identifying core use areas by bats is also critical for understanding best management practices for forests, as bats have been shown to return to the same summer habitat in consecutive years. In addition, little to nothing is known about the connection between winter hibernacula and active summer habitat for most bat species in North America.

Q: What can I do to help bats?
J. Paul White: Bats continue to need our help as white-nose syndrome, among other threats, exist in Wisconsin and throughout the midwest. From respecting their privacy in the winter, to engaging in a citizen-based bat monitoring project, to installing bat houses to support these voracious insect-eaters, each little action can have a positive impact on learning more about their populations and/or supporting their survival as an important part of Wisconsin ecosystems. Find more information about ways to help on this Bat Frequently Asked Questions web page.

Winter Surveys Show Average 89% Drop In Bat Populations At 55 Sites

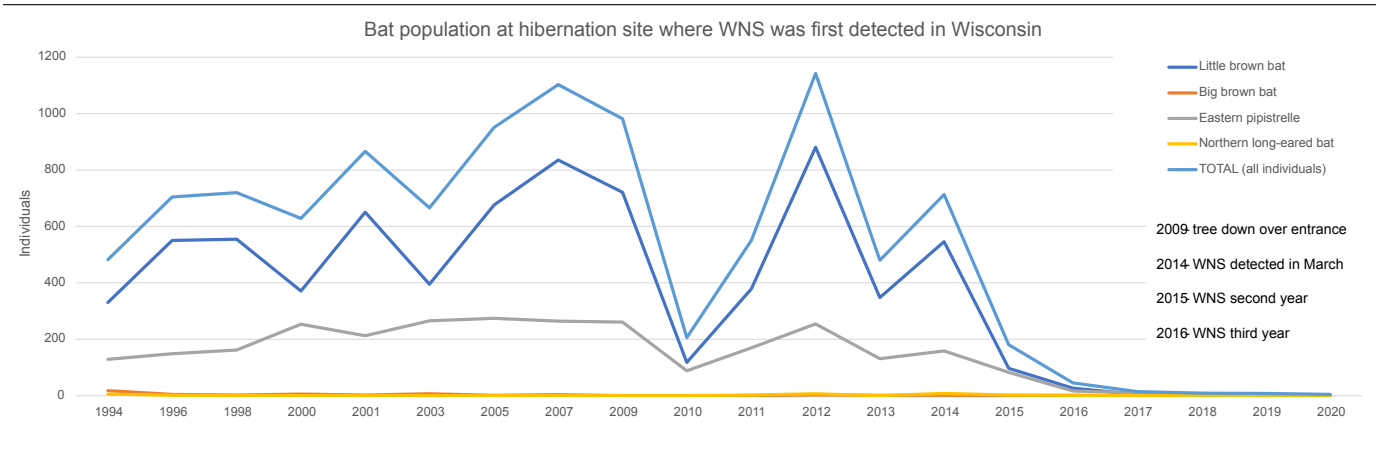
DNR staff and Virginia Tech researchers count hibernating bats in Wisconsin in 2015. Photo: Joseph Hoyt

By Jennifer Redell
DNR Conservation Biologist, Bat Program Cave and Mine Specialist

Wisconsin Bat Program staff collected data on bat populations, species and distribution from bat hibernacula infected with white-nose syndrome at 55 sites in early 2020.

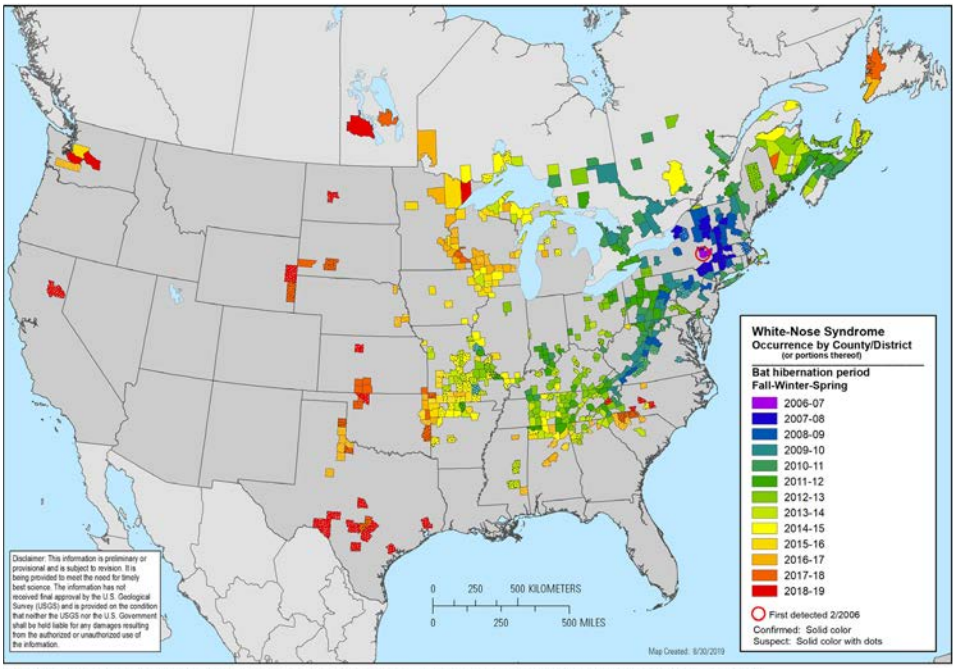
Hibernating bat populations previously exposed to WNS, particularly in years two and three of WNS infection, observed steep declines. We continued to see bat populations in some hibernation sites with smaller populations reduced by WNS to zero bats. Declines averaged 89% from their pre-WNS average populations at specific sites.

Wisconsin's only site in its seventh year since infection still had four bats hibernating in it, including one



northern long-eared bat. That handful of bats found in 2020 represents a 99.5% reduction from the site's pre-WNS average. Since the disease was first detected in 2014, at least 64 sites in 25 Wisconsin counties have been confirmed as WNS-positive or WNS-suspect.

These datasets have been entered into the Cave & Mine Catalogue and added to the Natural Heritage Inventory, where the location and other information will help the state and private citizens protect and manage them. Key findings from the site visits are highlighted below.



Citation: White-nose syndrome occurrence map - by year (2019). Data Last Updated: 8/30/2019. Available at: https://www.whitenosesyndrome.org/static-page/wns-spread-maps.

Notable Observations In 2019-2020 Hibernation Season

- White-nose syndrome has now affected cave bat populations in Wisconsin for seven hibernation seasons and the WNS fungus is considered present in hibernation sites statewide.
- Two of Wisconsin's largest surveyed sites are down 87% and 71% from their pre-WNS average populations. Both sites originally held tens of thousands of little brown bats and other species. Both sites are now in their fifth year of infection.
- Hibernacula now in year six of disease progression have experienced an overall decline of over 89% compared to the pre-WNS average.
- The site where WNS was first detected in Wisconsin, now in its seventh year of infection, has experienced a 99.5% population decline when compared to baseline data, as see in the graph on page 5.
- The DNR has focused on understanding bat survivorship, immigration/emigration and fidelity to hibernation sites. To this end, DNR and our Virginia Tech partners banded over 1,800 bats between fall 2019 and spring 2020.
- We continue to locate a few "long-term survivor" bats in the sites where they were first banded before discovery of WNS in Wisconsin in 2014.

Sobering Numbers

- 35 U.S. states and 7 Canadian provinces confirmed with WNS
- 4 more states confirmed with the fungus P. destructans (Pd), causing the disease
- 12 bat species confirmed with WNS, 6 more with Pd
- 5.7 to 6.7 million bats estimated dead of WNS as of 2011
- Wisconsin: 64 sites in 25 counties confirmed as WNS positive or WNS suspect.
- Bat population changes have ranged from minor increases at a very few sites to 100% declines where no bats remain in a given cave or mine.

Photo: Jennifer Redell
Condensation forms on an eastern pipistrelle bat.

Cave & Mine Catalogue Update

Wisconsin's Bat Data Aids National Species Status Assessments

By Jennifer Redell
DNR Conservation Biologist, Bat Program Cave and Mine Specialist

Results from winter 2019-2020 hibernacula surveys in Wisconsin will help determine possible protections for three bat species nationally. In spring 2020, the DNR submitted bat data to the North American Bat Monitoring Program (NABAT) as part of a nationwide data request by the United States Fish and Wildlife Service to help fill in data gaps on three sensitive bat species being considered for federal protection: little brown bat, eastern pipistrelle bat (aka tricolored bat) and northern long-eared bat. These species already receive state protection in Wisconsin, having been added to the state threatened species list in 2011.

Hibernacula data submitted to NABAT came from 616 site visits to 133 hibernacula in 29 counties. Sites included beer caves, railroad tunnels, caves and mines surveyed between 2010-2020. In total, for the three cave bat species across all survey years, 1,045,029 bats were counted.

WNS Vaccine Trials Show Promise
Since 2014, the Wisconsin Bat Program has worked with the United States Geological Service National Wildlife Health Center, University of Wisconsin-Madison, Mississippi Valley Conservancy and Virginia Tech to develop and evaluate vaccines to help bat populations recover, including undertaking the first vaccine trials in the wild for any disease affecting bats. In the past year we continued to provide support to the project, the goal of which is to determine if immunization of bats against WNS improves their survival and/or reduces the occurrence of the disease. In 2020 two potential vaccine candidates were tested for effectiveness in little brown bats in the field. Additionally, timing of vaccination was tested, both at summer maternity colonies and during fall swarm/early hibernation at hibernacula.

Passive Integrated Transponder (PIT) systems were installed at the primary bat entrances of two study sites in Pierce County in September 2019 to monitor activity by research bats that were marked with a PIT tag. More than 300 little brown bats were vaccinated and distributed among treatment groups at two hibernacula in Pierce County. During our regular winter surveys we opportunistically re-sighted and processed (scanned, band read, swabbed, wing check) some of these project bats. In addition to providing onsite support during research trips, local DNR staff changed batteries on the PIT tag systems to allow for continuous reading of treatment animals to assess seasonal activity levels and survival.

The field trials in early 2020 demonstrated the vaccines were safe for bats, and at least one vaccine increased survival in males and significantly reduced levels of the fungus causing white-nose syndrome. More trials began this fall in Wisconsin to test specific vaccine candidates.

Logistical Support Provided To WNS Transmission Study

In 2020 our program continued its partnership with the University of California- Santa Cruz/Virginia Tech white-nose syndrome project

Little brown bats receive an oral WNS vaccine from USGS National Wildlife Health Center staff. Photo: Jennifer Redell

investigating movement and transmission of Pd/WNS across the midwest.

This ongoing project is providing a unique look at sites before WNS arrived, during the infection, and after. In total, 20 sites were visited one to two times in fall 2019 and spring 2020. We provided landowner access and field support when necessary. Samples from hibernacula environments as well as all four cave bat species were collected from fall of 2019 and through spring of 2020, ending just before state restrictions were enacted due to the pandemic.

Take A Virtual Tour Of Kickapoo Caverns

Finally, if you're keen to explore an underground space from the comfort of home, join me on a virtual tour of Kickapoo Caverns, one of Wisconsin's longest cave systems and an important bat hibernaculum. The online tour hosted by caverns owner Mississippi Valley Conservancy is titled "Home to Hibernating Bats" and is available in two parts on the conservancy's Youtube channel. The tour covers general bat ecology, white-nose syndrome, how our program and partners study bats and the cave's geology, history and importance as a bat hibernaculum.

Acoustic Bat Monitoring Update

Volunteers Take To The Water, Detect Mixed Results For Bats

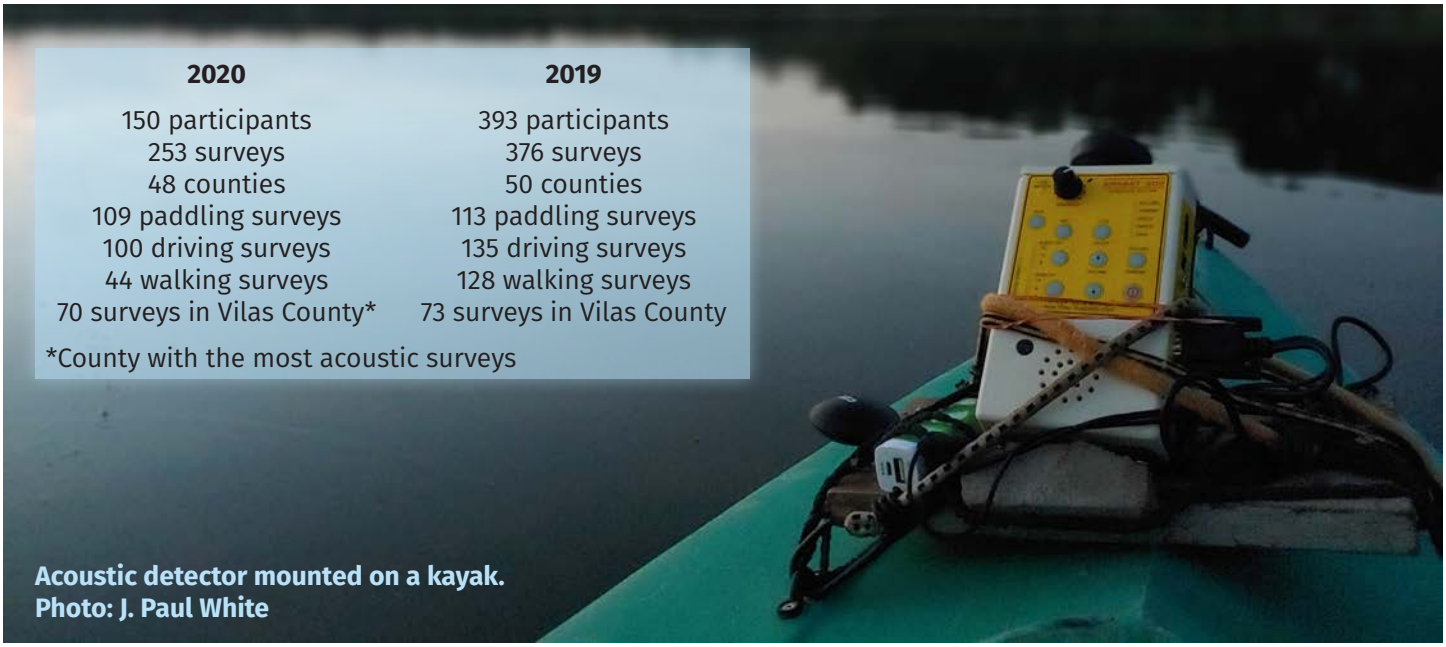
By J. Paul White
DNR Mammal Ecologist, Bat Program Lead

A Year Like No Other

Unfortunately, due to....well, you know the rest of that sentence all too well. It's no mystery why things looked and felt very different this year. Nevertheless, once we figured out how to safely monitor for bats in mid-June, mobile acoustic bat surveys began flooding in. In fact, despite missing the first two months of the bat monitoring season, looking at the numbers – 253 acoustic surveys in 48 (of 72) counties – one would not have known our volunteers were restricted by a pandemic. Perhaps their survey effort was a result of an outdoor activity that could easily (and more importantly, safely) be conducted alone or within a family group. Or could it be attributed to an amazing core of coordinators and volunteers who would stop at nothing to collect bat data? Both likely account for such a strong outpouring of data amidst very trying circumstances. A sincere thank you from the Wisconsin Bat Program to everyone who participated in the 2020 acoustic bat monitoring season!

2020	2019
150 participants	393 participants
253 surveys	376 surveys
48 counties	50 counties
109 paddling surveys	113 paddling surveys
100 driving surveys	135 driving surveys
44 walking surveys	128 walking surveys
70 surveys in Vilas County*	73 surveys in Vilas County

*County with the most acoustic surveys



Acoustic detector mounted on a kayak. Photo: J. Paul White

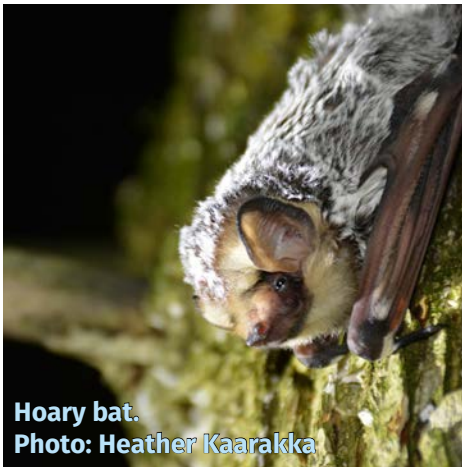
Sobering Results For Two Species But Better News For Little Brown Bats

Volunteers, DNR staff and partners like the United States Forest Service took part in the shortened 2020 acoustic bat monitoring season. Most surveys (94%) were one- or two-person surveys and on average lasted one hour and 20 minutes. The most surveyed areas in Wisconsin this year were aquatic waterways (109 surveys) – thank you Vilas County! – while 100 surveys were driven and 44 were walking routes.

From these surveys, over 14,900 bat calls were collected, analyzed and catalogued. Unfortunately, not one of the nearly 15,000 bat encounters was classified as a northern long-eared bat and only six were labeled as calls of the eastern pipistrelle bat. The acoustic silence is, regrettably, also reflected in our winter hibernation surveys, in which each year fewer bats of either species are observed or in some cases, not found at all.

Fortunately, it wasn't all bad news. For every three acoustic surveys completed, two detected a little brown bat, which is good news. Since little brown bats commonly forage on aquatic insects found at rivers, lakes and streams, a finding from the bat diet study Amy Wray summarizes on page 15 I think we can all agree that more little brown bats eating flies, midges and mosquitoes is a good thing. The frequency of detection is likely bolstered by that fact that 84% of water surveys detected little brown bats and there were more of such surveys than either driving or walking routes.

Big brown bats and hoary bats were found on roughly 75% of all surveys completed, making them the most frequently encountered species followed by little brown bats (65.2%),


Hoary bat.
Photo: Heather Kaarakka

eastern red bats (67.2%) and silver-haired bats (36.4%).

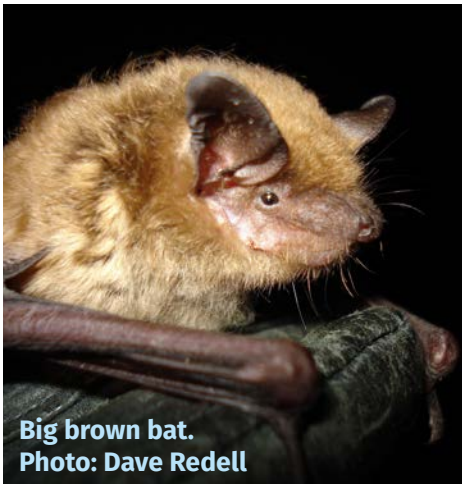
See page 10 for a map of most commonly detected species.

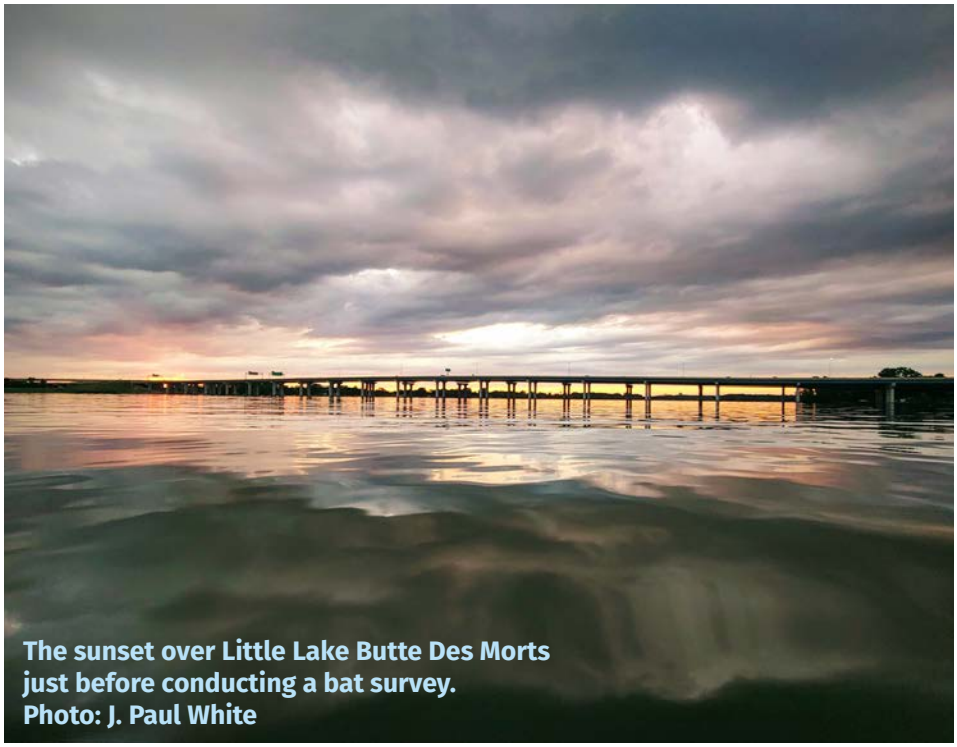
Eastern pipistrelles and evening bats were found only on a total of five surveys and there were zero northern long-eared bat encounters.

With the multitude of threats bats continue to face from white-nose syndrome to wind energy-related mortality, the Wisconsin Bat Program will continue to collect acoustic bat data from this highly mobile and secretive group of mammals to assess Wisconsin's bat population at the local, state and regional level.

A Call For Data

In spring 2020 the Wisconsin Bat Program submitted acoustic bat data to the North American Bat Monitoring Program (NABAT) as part of a nationwide data request by U.S. Fish and Wildlife Service to help fill in data gaps on sensitive bat species being considered for federal protection. The species -- little brown bats, eastern pipistrelles and northern long-eared bats – are already on Wisconsin's threatened species list. Acoustic data that fit the service's request came from acoustic bat driving transects and stationary sources. In total, the Wisconsin Bat Program submitted 32,482 acoustic files from mobile surveys spanning seven years (2013-2019) and 313,046 acoustic files from five stationary long-term bat monitoring stations (2007-2017). These data were not only collected by DNR staff but also federal partners like the U.S. Forest Service, tribal partners from the Bad River Band of Lake Superior Chippewa Indians and volunteers.


Big brown bat.
Photo: Dave Redell


The sunset over Little Lake Butte Des Morts just before conducting a bat survey.
Photo: J. Paul White

Notable Notes From This Year

We encourage you to report your supplemental observations whether they relate to bat activity, the functionality of the detector or other interesting notes. From birds, to amphibians, to mammals, to local weather conditions or other "interesting" comments, we will happily accept all notes. Since surveyors are active when many folks are inside for the night, there are opportunities to observe interesting nighttime behavior or rare wildlife. In some cases, we've passed along observations to DNR species experts that have helped confirm species in new locations or where they haven't been observed for many years, if not decades. Here are a few observations surveyors turned in from 2020 routes:

- Driving route – Central Lake Michigan Coastal 1 (Shawano County) – "Saw a barred owl, two porcupine, three raccoons, many deer. Heard whip-poor-wills in Navarino State Wildlife Area and eastern gray tree frogs."
- Paddling route - Little Tamarack Flowage survey (Vilas County)- "What a beautiful evening for a bat survey! So lucky to have my daughter and son-in-law to share the experience."
- Walking route - Sanders Park (Racine County) - "Nice evening, but bits of rain near 3/4 mark - hence early quit. Had trouble walking that far - this lockdown has eliminated staying in shape. Or whatever excuse is needed."

Stay safe and best wishes for 2021.

Most Common Bat Species by Ecological Region

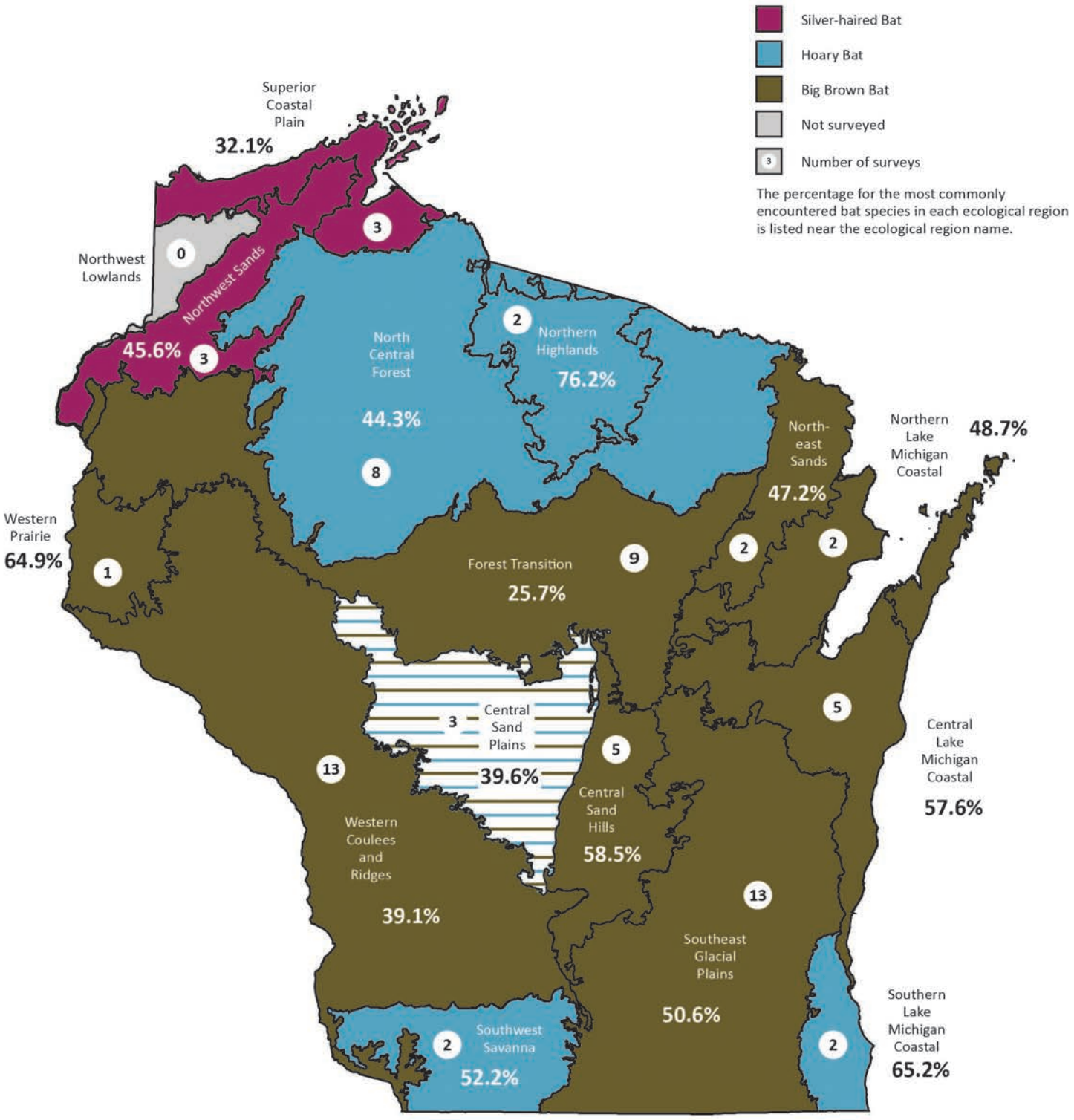


Figure 7. The most commonly encountered bat species by ecological region were hoary bat (6) and the big brown bat (8) in 2020. One landscape (Central Sand Plains) had equal hoary bat and big brown bat encounters.

Roost Monitoring Update

Even A Global Pandemic Couldn't Stop Bat Monitoring Volunteers From Surveying Bats This Year

By Heather Kaarakka
DNR Conservation Biologist, Bat Program Roost Monitoring Coordinator

Like most things this year, the pandemic played a role in how summer bat roost monitoring worked in 2020. Social distancing and safer-at-home directives meant volunteers could not travel to or gather at several of our large little brown bat roosts to count bats and delayed our annual Great Wisconsin Bat Count. Bat monitoring volunteers are resilient, however, and surveyors still completed nearly 600 bat counts at 178 roost sites. Even more impressively, they monitored more roosts than ever, adding several new little brown bat roosts to our database as well as 12 big brown bat roosts.

In 2020, volunteers counted a total of 12,844 bats, not so different from the 13,408 bats counted during 774 surveys in 2019. Based on the highest count from each site, volunteers and landowners counted 7,771 little brown bats, 4,792 big brown bats but only six eastern pipistrelles. The remaining bats were from sites that house both little brown bats and big brown bats or it is still unknown which species uses the roost.

This year's Great Wisconsin Bat Count continued although the pre-volancy count – the count taken before pups begin flying (volancy refers to flight) -- was delayed until mid-June. Roost monitors surveyed at 90 roosts in June and 125 roosts in July. The first count in June aims to record adult colony sizes and the second count in July records numbers in colonies after pups start flying. These differences in numbers before and after pups fly can give us a sense of reproduction in colonies. We see increases in bat numbers at almost every roost site (and in acoustics surveys too) after juvenile bats begin to fly. See our infographic below for this year's numbers and read more about bat roost monitoring in the 2020 Annual Roost Monitoring Report.

2020 Counts Add To Evidence Bat Populations Are Stabilizing After White-Nose Syndrome

Like 2019, this year's bat roost counts were similar to the previous year, which gives a little more evidence that bat populations are possibly stabilizing after white-nose syndrome (WNS). Some little brown bat roosts even went from zero bats in 2019 to 10 to 20 bats in 2020. It's difficult to say whether this is evidence of increasing populations or whether bats are still moving among roosts as we've discovered that they do quite a bit. We also know there's no set number of bats at a roost and bat counts can change dramatically even daily.

Little brown bats and eastern pipistrelles continue to be the hardest hit by white-nose syndrome at monitored bat houses and building roosts. While little brown bats are starting to show some evidence of colony stabilization and possibly even recovery, eastern pipistrelles were not observed this year at two of the three summer roosts monitored. This year, again, summer roost counts of these two bat species mirror low numbers recorded on acoustic surveys. We will continue to watch these known eastern pipistrelle roosts closely in the coming years and hope that we see bats return.

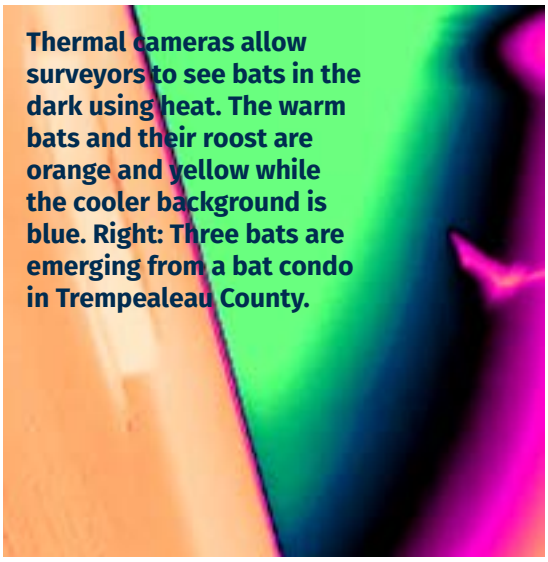
Study Explores Linkage Between Roost Characteristics & Bat Declines

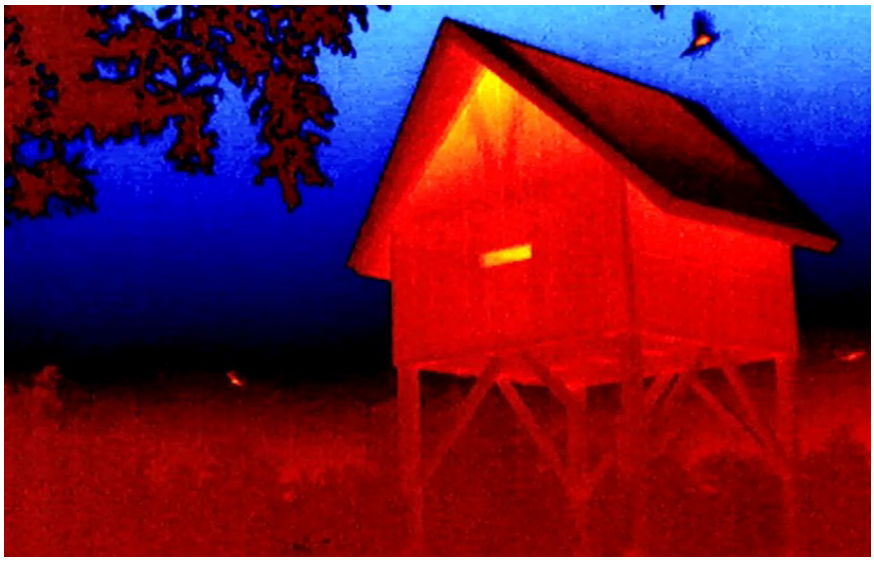
While we were not able to start our project marking bats at persisting colonies this year, we began a study looking at why there may be differences in declines at little brown bat roost sites. By using yearly colony estimates collected since 2010 by landowners and volunteers at 35 sites, we can investigate the change in colony size year-to-year. From these changes we can learn when the biggest declines occurred and start comparing the roosts using factors such as age of the roost, how close it is to permanent water and distance to hibernation sites. This winter we're hoping to get an idea of whether there are habitat and landscape aspects that impact how big declines have been and how quickly colony sizes may stabilize after WNS.

A little brown bat snug in a barn in Jefferson County in 2019. Photo: Heather Kaarakka

Thermal Imaging Project Heats Up

Another project we were able to pursue in 2020 used thermal cameras to record bat numbers and behaviors. Since these cameras are remote and don't require direct interaction with landowners or the bats, we were able to continue another season of daily counts at several little brown bat roost sites. We placed cameras later than we hoped due to the pandemic but also left them later into the fall to see colony dynamics in late summer. We're still analyzing footage, but at one site, bat numbers and behavior appear similar to last year, which provides more evidence some little brown bat colonies may be stabilizing.

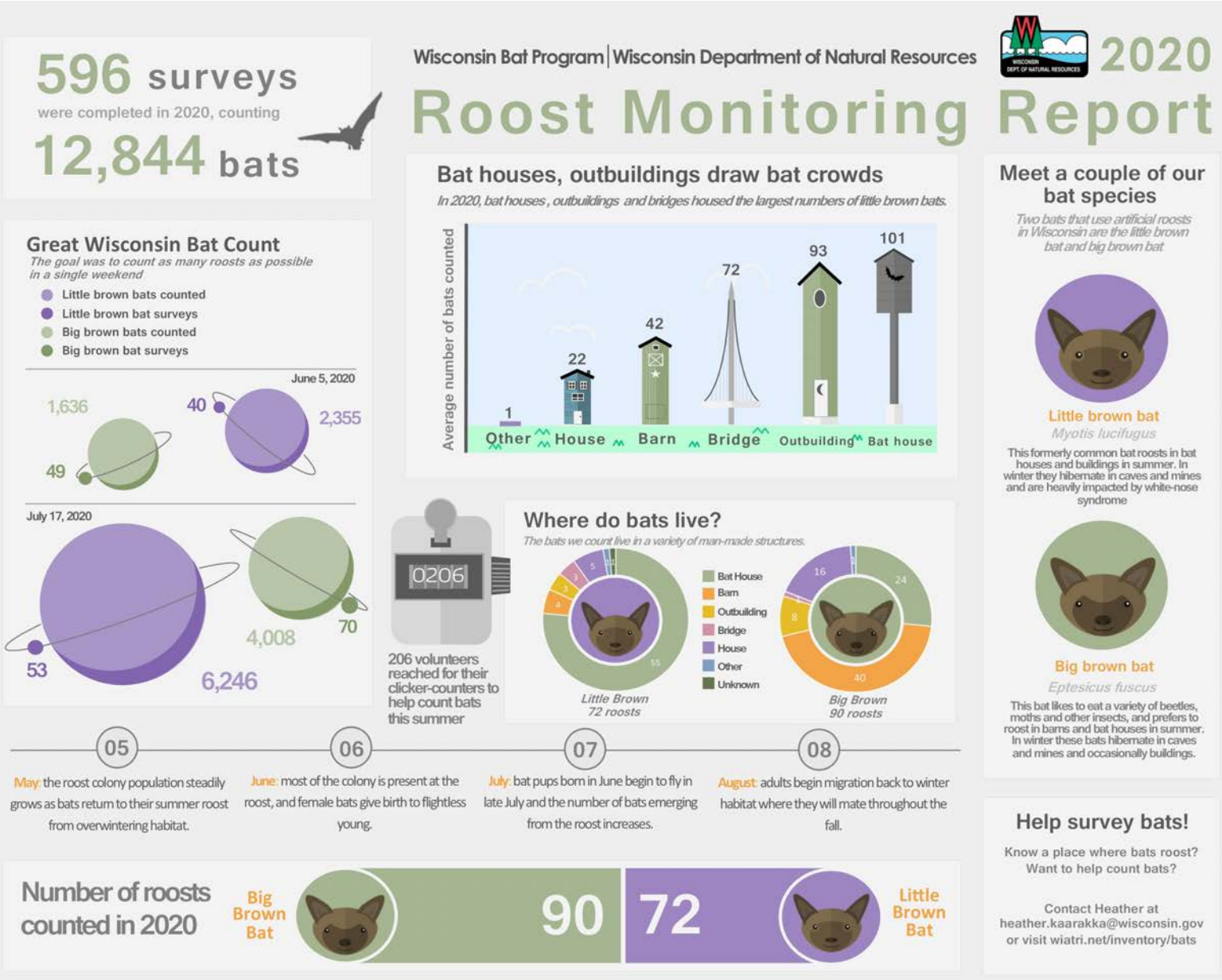




Thermal cameras allow surveyors to see bats in the dark using heat. The warm bats and their roost are orange and yellow while the cooler background is blue. Right: Three bats are emerging from a bat condo in Trempealeau County.

Thank You For Your Dedication & Information

Even a global pandemic couldn't stop bat monitoring volunteers from surveying bats this year, and it reminds us how much the Wisconsin Bat Program has benefitted from the dedication and hard work of everyone who counts bats at roost sites or drives around with a microphone on their car to record bat calls. The information that hundreds of volunteers have helped collect for over a decade have opened doors to research that can help us learn more about bat biology and ecology and the impacts that threats like white-nose syndrome are having on Wisconsin's bats. Thank you to everyone who surveyed bats this year and at any point since 2008. The Wisconsin Bat Program would be very different without you.



Wisconsin-Based Research Continues To Illuminate WNS

Studies with our research partners using data collected in Wisconsin culminated in several new publications over the past months. These results are advancing understanding of impacts of white-nose syndrome and informing how we might support bat populations during recovery.

- Results confirmed that bats are most likely to spread Pd when they are highly infectious, but have reduced mobility and the timing of Pd introduction has had consequential effects for some bat communities. Report: *Mobility and infectiousness in the spatial spread of an emerging pathogen*, as seen in Journal of Animal Ecology (pre-print).
- Lower levels of Pd in caves and mines consistently meant delayed onset of WNS in bats, fewer and less severe infections, and reduced population impacts across regions. Extensive and persistent environmental reservoirs led to early and widespread WNS presence and severe population declines. Continental differences in the persistence or decay of Pd in the environment altered infection patterns in bats and influenced whether host populations were stable or experienced severe declines from this disease. Report: *Environmental reservoir dynamics predict global infection patterns and population impacts for the fungal disease white-nose syndrome*, as seen in PNAS.
- Out of concern that our own research and monitoring visits could harm hibernating bat populations, we quantified the effects of research or census-related visitation frequency on populations. We found no evidence that more frequent visits decreased population growth rates for any of these species. These results indicate that visitation frequency (1–3 research visits per year) had undetectable impacts on bat population growth rates both with and without the additional stress of an emerging infectious disease. Report: *Impact of censusing and research on wildlife populations*, as seen in Conservation Science and Practice
- In our neighboring state of Michigan, several banded, male Little brown bats aged 18-25 years have been recaptured in a hibernaculum where WNS likely has been present since 2013–2014, indicating that these old and apparently healthy males are in their seventh season of exposure to the disease. These findings have been mirrored by several similar recaptures at a hibernation site here in Wisconsin. This gives us hope that certain individual bats can live for many years despite the presence of WNS in their hibernaculum. Report: *Exceptional Longevity in Little Brown Bats Still Occurs, despite Presence of White-nose Syndrome*, as seen in the Journal of Fish and Wildlife Management
- Using a cross-disciplinary approach, diverse subject matter experts created an influence diagram used to identify uncertainties and prioritize research needs for WNS management. Critical knowledge gaps were identified, particularly with respect to how WNS dynamics and impacts may differ among bat species. Targets for WNS research were highlighted. This tool will be used to maximize the likelihood of achieving bat conservation goals within the context and limitations of specific real-world scenarios. Report: *Identifying research needs to inform white-nose syndrome management decisions*, as seen in Conservation Science and Practice.
- Diverse microbial skin assemblages, including fungal communities, may prevent pathogens (Pd) from colonizing a bat's skin. Samples collected from bats in Wisconsin were used to determine that bat species with low skin fungal diversity and abundance were more susceptible to WNS than bat species with higher fungal diversity and abundance (big brown bats). Report: *Skin fungal assemblages of bats vary based on susceptibility to white-nose syndrome*, as seen in The ISME Journal.
- Instead of avoiding warm and deadly underground sites where the WNS fungus thrives, bats continue to use them year after year. Bats are mistakenly preferring sites where fungal growth is high and therefore their survival is low. This is one of the first clear examples of an infectious disease creating an "ecological trap" for wildlife. Report: *Continued preference for suboptimal habitat reduces bat survival with white-nose syndrome*, as seen in Nature Communications.

Diet Study Reveals Bats' Importance To Ecosystem

Amy Wray, right, and field technician Jamie Wang set up solar-powered traps in 2018 to capture the night-flying insects bats eat. Photo: Elaine Swanson

By Amy Wray
University of Wisconsin-Madison
PhD Researcher

A University of Wisconsin-Madison study examining the diets of bats in Wisconsin has revealed that different bat species target different insects and highlighted the importance of little brown bats to agriculture and the nocturnal food web.

Over a 4-year period, we collected 560 guano samples to analyze bat diets using molecular methods, captured and identified 2,003,493 insects in order to quantify changes in bat prey communities, and recorded 6,245 nights of bat calls to understand changes in bat activity. This study also incorporated roost emergence counts from the Great Wisconsin Bat Count, with the goal of understanding the ecological consequences of little brown and big brown bat declines from white-nose syndrome.

Different Bat Species Eat Different Foods

Overall, we found that little brown and big brown bats eat different prey, with big brown bats eating more beetles and caddisflies and little brown bats eating more moths and flies (especially certain types of midges). These results were mostly consistent with previous studies on bat diets in other regions, except Wisconsin bats tended to consume more insect prey typically associated with aquatic habitats. We also found that even though insect communities changed from week to week, bats tended to eat their favorite foods regardless of the abundance of other options. These findings suggest that both little brown and big brown bats selectively hunt for particular prey, further establishing their sophistication as nocturnal predators.

Smaller Bat Species Suffer Bigger Declines At Study Sites

Between 2015 and 2018, we unfortunately observed little brown bat emergence counts decline

Little Brown Bats' Big Appetite
Mosquitoes & Ag Pests Beware

A single bat can eat the equivalent of half its body weight in insects every night. Amy Wray, UW-Madison PhD researcher, identified, quantified, and analyzed what's on the menu for Wisconsin bats and why that matters. She found:

- Bats consumed 17 distinct types of mosquitoes, including nine species known to carry West Nile virus.
- Bats consumed 24 species of agricultural pests, including black cutworm moths, fruit tree leafroller moths, tarnished plant bugs and spotted wing drosophila.
- Little brown bats' smaller size makes them more agile and better adapted for capturing smaller prey. Sadly, these bat species are one of the three species in Wisconsin most decimated by white-nose syndrome, a deadly disease of bats.
- Declines in little brown bats due to white-nose syndrome may lead to short-term increases in the abundance of certain insect prey.

Captured insects are sorted before identification and counting by microscope. Photo: Amy Wray

Guano samples collected for analysis of bat diets using DNA. Big brown bats have big brown poops (left) while little brown bats have little brown poops (right). Photo: Amy Wray

by about 95% at our study sites. Similarly, we detected a nearly 80% decline in high-frequency acoustic activity around the study sites, which corresponds to little brown bats but also includes tricolored bats, northern long-eared bats and eastern red bats. Based on previous studies and hibernacula surveys, these declines in little brown bats are largely attributable to white-nose syndrome. In comparison, we found that big brown bat emergence counts declined by 40%, but this trend was mainly driven by a decline in a single large roost which may have been related to movement rather than to white-nose syndrome. We also did not see a statistically meaningful decline in low-frequency bat activity, which corresponds to big brown bats but includes other species such as hoary bats and silver-haired bats.

A black-light trap full of Chironomid midges. Photo: Amy Wray

Declines In Little Brown Bats May Have A Bigger Impact On Food Web

From our insect trapping surveys, we found that between 2015 and 2018, the total abundance of insects declined by nearly 50% at our study sites. The reason for these declines is not totally clear and could represent either a natural fluctuation or a declining trend warranting further investigation. However, our study was mainly set up to address how bat population declines influenced the abundance of insects, which we investigated by setting up insect traps near bat roosts and at paired "control" sites further away with lower bat activity.

When comparing these different experimental treatments, we found that most insect groups displayed similar patterns in abundance at sites near bat roosts and at sites far from bat roosts. As a notable exception, we saw an increase in the abundance of Chironomidae, a family of midges, at little brown bat roost sites compared to control sites. These trends were observed in 2016 and 2017, the first two years

A Cecropia moth captured in a black-light trap was not found in the diets of Wisconsin bats. Photo: Amy Wray

after declines from white-nose syndrome were observed among little brown bats in Wisconsin. Since Chironomidae are one of the favored prey items of little brown bats, these results suggest that declines in little brown bats may lead to a local-scale increase in the abundance of these midges. While many studies have shown other bat species controlling insect abundance, including suppressing agricultural pests, our study suggests that little brown bats may have an impact on other types of insects too.

Little Brown Bats Eat Dozens Of Species Of Agricultural Pests

Since ecosystem services provided by bats are always important to quantify, we also looked at how many agricultural pests were present in

bat diets. At least one agricultural pest species was detected in 45% of little brown bat guano samples and in 34% of big brown bat guano samples. Interestingly, before declines from white-nose syndrome, little brown bat guano samples contained more agricultural pests (53% of samples had at least one pest species) in comparison to guano samples collected after declines from white-nose syndrome (16% of samples had at least one pest species). This change in little brown bat diet composition might indicate that larger populations of bats are more likely to consume a higher diversity of insects overall, and therefore may be more likely to eat a greater number of agricultural pests.

Little Brown Bats, Hard Hit By WNS, Have A Unique Role As Predators In Food Web

Finally, we assessed whether big brown bats, which demonstrate some resistance to white-nose syndrome, could potentially fill the ecological role of little brown bats as predators. We did this by comparing diet composition before and after declines from white-nose syndrome, specifically with the goal of quantifying whether big brown bats would select more of the prey previously consumed by little brown bats. We found that following little brown bat declines, there was little change in the diet composition of big brown bats, and the amount of dietary overlap between the two bat species also did not increase over time. While these species may appear similar at first glance, little brown and big brown bats are ecologically distinct as predators. Little brown bats, with their smaller body size, are more agile and better adapted for capturing smaller prey. As such, big brown bats may be somewhat constrained by their larger body size and cannot capture smaller insects as easily. Cumulatively, our studies provide more evidence that little brown bats not only influence prey communities, but also appear to have a unique role as insect predators in the nocturnal food web. In light of bat population declines from white-nose syndrome and other factors, continuing to protect and support bats therefore remains important from an ecosystem-wide perspective.

These studies would not have been possible without the support of the DNR, the many volunteers who contributed to emergence counts, and the landowners who allowed sampling of bat guano and insects on their property. Study sites also included Governor Dodge State Park, Yellowstone Lake State Park and Silverwood County Park, and we are most appreciative of their participation.

Bats With White-Nose Syndrome Prefer Suboptimal Habitats Despite The Consequences

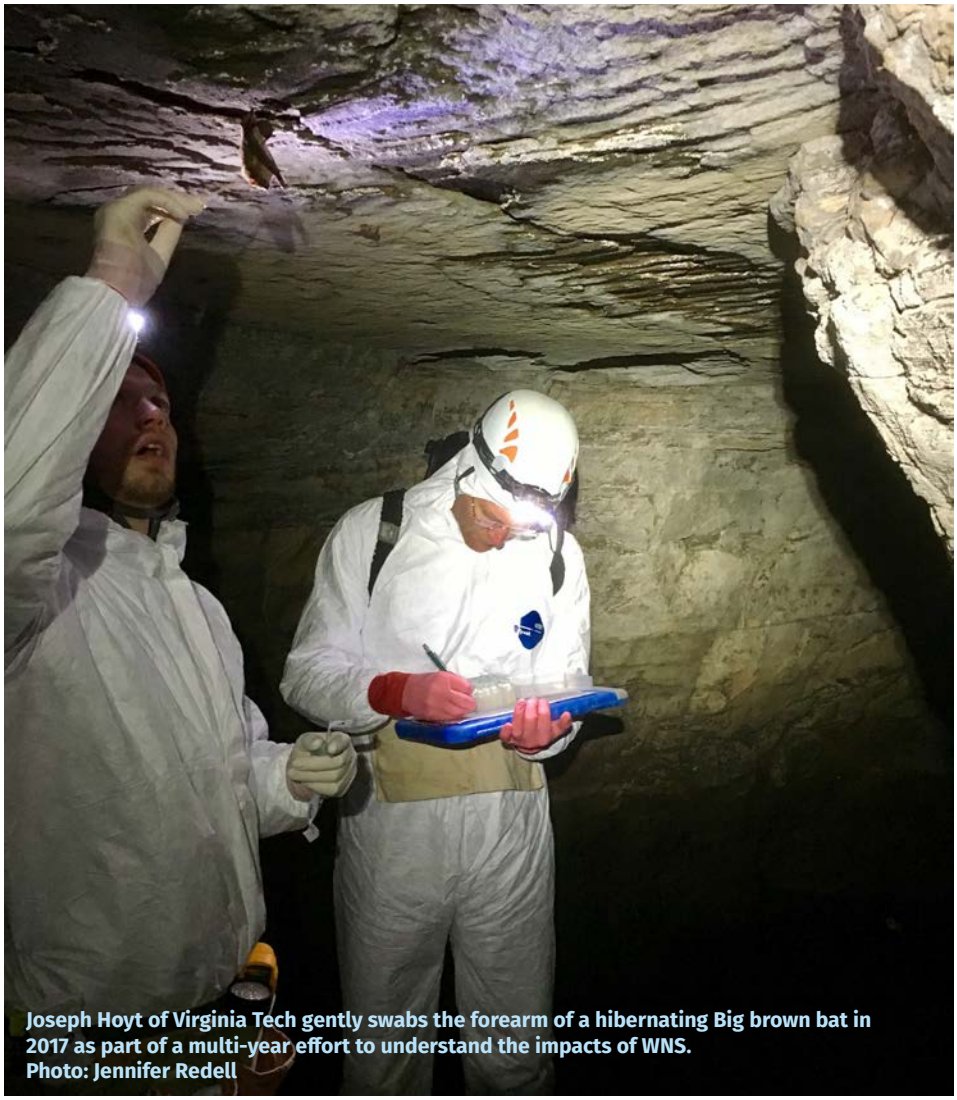
Excerpted from
Virginia Tech News Sources

Since 2006, a fungal disease called white-nose syndrome has caused sharp declines in bat populations across the eastern United States. The fungus that causes the disease, Pseudogymnoascus destructans (Pd), thrives in subterranean habitats where bats hibernate during the winter months.

Bats roosting in the warmest sites have been hit particularly hard, since more fungus grows on their skin, and they are more likely to die from white-nose syndrome, according to a new study by researchers at Virginia Tech.

But instead of avoiding these warm and deadly sites, bats continue to use them year after year. The reason? Bats are mistakenly preferring sites where fungal growth is high and therefore their survival is low. This is one of the first clear examples of an infectious disease creating an "ecological trap" for wildlife.

Dr. Kate Langwig and Dr. Joseph Hoyt, both assistant professors from the Department of Biological Sciences in the College of Science, have been studying little brown bat (Myotis lucifugus) populations in Michigan and Wisconsin since 2012, before the fungus first reached those states. This long-term study was the perfect opportunity to see if bats alter their preferences across hibernacula, or hibernation sites, in response to the invasion of white-nose syndrome.



Joseph Hoyt of Virginia Tech gently swabs the forearm of a hibernating Big brown bat in 2017 as part of a multi-year effort to understand the impacts of WNS.
Photo: Jennifer Redell

"We see that there is a shift across the regional bat population over time," said Skylar Hopkins, a previous postdoctoral scholar at Virginia Tech and now assistant professor at North Carolina State University.

"When we look at the population post-invasion, we see that more than 50 percent of the bats are still choosing to roost in warmer sites, even though colder sites are available. But on average, bat roosting temperatures have declined, because the colder-roosting bats have had higher survival rates."

Now that they know that bats are preferring high mortality sites, Hopkins hopes that their data can

be used to think about which sites researchers and conservationists need to prioritize for conservation and how to conserve them.

"Because we know that bats are doing better in the cold sites, the cold sites may be good ones for us to conserve," said Hopkins. "We can also think more about the warm sites that are acting as ecological traps and whether we should be trying to manage those sites in a different way. Maybe there are interventions that should be done at those si tes to prevent most of the population from going there each year and having these big mortality events."

Doctors Langwig, Hoyt and Kilpatrick collect samples of the WNS fungus from hibernating Big brown bats in Wisconsin in 2015. Photo: Jennifer Redell