MWBWG 2021 Poster Abstracts

Posters listed alphabetically by presenting author (underlined).
Student presenters designated with an asterisk (*).
Poster location in the gather.town poster room designated by the number following the title.

INSECTIVOROUS BATS CAUSE TROPHIC CASCADES THAT BENEFIT TEMPERATE DECIDUOUS FORESTS: AN EXCLUSION EXPERIMENT

(Poster #08)

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Insectivorous bats are voracious predators capable of suppressing prey populations in agricultural ecosystems, yet the question of how bats are impacting forests is largely unexplored. We used a field experiment to test the hypothesis that bats are capable of benefiting forest vegetation through their top-down suppression of forest-defoliating insects. We performed this experiment between June and mid-August of 2018–2020 in the central hardwoods region of the United States. We excluded bats but not birds from 20 large sub-canopy forest plots, each paired with an experimental control plot. We monitored the change in leaf area for up to 10 random oak or hickory saplings within each plot (196 treatment and 200 control saplings in total). We found that, on average, sapling defoliation was six times greater where bats were excluded. Additionally, bats benefitted oaks more than hickories. Our results show that insectivorous bats can cause top-down species cascades that benefit forests and that they may play an integral role in forest ecosystems.

IT'S GOING DOWN, I'M YELLING TIMBER… HARVEST PROVIDES ROOSTS FOR INDIANA AND NORTHERN LONG-EARED BATS

(Poster #21)

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There is growing interest into the effects of timber harvest on forest-dwelling bats due to the potential for timber harvest to reduce habitat. Additionally, impending changes to the federally threatened status of the northern long-eared bat requires more investigation into its habitat use. We conducted a 4-year study (2012–2015) to assess summer roosting ecology of endangered Indiana bats (*Myotis sodalis*) and northern long-eared bats (*Myotis septentrionalis*) within a managed Midwestern forest. We tracked 4 male and 11 female Indiana bats to 49 roosts ($n_{male} = 24$, $n_{female} = 25$) and 69 female northern long-eared bats to 175 roosts in south-central Indiana, USA. Female Indiana bats selected roosts under exfoliating bark on large (mean

tree height: 17 ± 2m, diameter: 35 ± 3cm) standing dead trees and in bat boxes with high solar exposure (28 ± 6% canopy closure above roosts). Male Indiana bats selected for roosts under exfoliating bark on tall trees (23 ± 2m) surrounded by snags (5 ± 1 snags/0.1 ha plot) and live trees (30 ± 3 live trees/0.1 ha plot). Female northern long-eared bats used roosts (mean tree height: 18 ± 11m, diameter: 30 ± 16cm) located under shaded exfoliating bark on mid-story dominant sassafras trees (*Sassafras albidum*) and canopy dominant oak trees (*Quercus* spp.). Female Indiana bats roosted in or ≤ 10 m from harvest openings and first-stage shelterwood cuts more than expected (15 roosts) based on their availability on the landscape. Conversely, male Indiana bats and female northern long-eared bats roosted in harvest openings as expected (3 and 14 roosts, respectively). Our results demonstrate that a managed Midwestern forest provides an array of roosts for bats and that these bat species do not actively avoid roosting near harvest openings in this forest. However, these species may partition roosting resources differently where they co-occur.

CHANGES IN BAT DIVERSITY AND ACTIVITY ALONG AN URBAN-RURAL GRADIENT IN NORTHEASTERN INDIANA

(Poster #04)

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In the past 20 years, bat species in the Midwestern United States have experienced population declines, partly as a consequence of urbanization and agricultural development reducing the occurrence of uninterrupted natural areas like wetlands and forests. As urban and agricultural areas become more prevalent, it is important to understand what habitat features may support diverse bat communities within these anthropogenic land cover types. In 2020, we began a study that investigates differences in bat activity and community composition along an urban-rural gradient created by Fort Wayne, Indiana and the surrounding agricultural land. We deployed passive acoustic detectors at 20 field sites – 10 in urban areas and 10 in rural. Each site was sampled for 4 to 5 consecutive days twice throughout the summer. In urban areas, we sampled a total of 100 nights and collected 9,973 bat calls throughout the summer (499 ± 128 calls/site). In rural areas, we sampled a total of 104 nights and collected 16,756 bat calls (798 ± 168 calls/site). Based on a preliminary analysis using BCID identification software, both urban and rural sites were dominated by big brown bats (*Eptesicus fuscus*) and silver-haired bats (*Lasionycteris noctivagans*). We also detected red bats (*Lasiurus borealis*), hoary bats (*Lasiurus cinereus*), evening bats (*Nycticeius humeralis*), tricolored bats (*Perimyotis subflavus*), little brown bats (*Myotis lucifugus*), Indiana bats (*Myotis sodalis*), and northern long-eared bats (*Myotis septentrionalis*) at both types of sites. The proportion of big brown bat calls was similar between urban (59.4% ± 7.7%) and rural areas (57.1% ± 5.7%). However, *Myotis* species calls were slightly more prevalent in rural (3.6% ± 2.8%) than in urban areas (1.6 % ± 1.1%). Further analysis will elucidate relationships between bat activity and environmental variables associated with individual sites and provide more insight into what habitat types promote large and diverse bat communities.

WINGBEAT SYNCHRONIZATION IN MEXICAN FREE-TAILED BATS (*TADARIDA BRASILIENSIS*)
(Poster #14)
Joy Angelica Fullerton*, Alexandra Weesner, Ian Bentley, and Laura N. Kloepper. *Saint Mary's College, Notre Dame, IN 46556*

Animals in nature move in groups, with often remarkable coordination, including starling murmuration and fish schooling. Bats also exhibit coordinated group movement during foraging and navigation, and they are especially interesting because they primarily navigate with echolocation. Additionally, recent work has suggested that bats have sensory hairs on their wings that aid in flight coordination. Bats have also been recorded to pair during flight in a "leader-follower" relationship based on their flight trajectories, but the kinematics behind the pairing is unknown. Motivated by prior observations, we investigated the flight dynamics for pairs of bats engaged in leader-follower relationships that appeared to have synchronized wingbeats. Mexican free-tailed bats (*Tadarida brasiliensis*) were recorded with a thermal imaging camera while they performed nightly emergences from a cave located on private land in Oklahoma. Bat pairs with observed synchronization were extracted for digital video analysis. Using anatomical landmarks digitized in the DLTdv8 MATLAB application, we quantified the flight trajectory, position, and wingbeat dynamics of bat pairs as they moved through the camera's field of view. We report on the degree of wingbeat synchrony and discuss the advantages such synchrony could provide during group flight.

BEST DATA SETS FOR BAT HABITAT SUITABILITY MODELS
(Poster #03)
Sarah M. Gaulke*, Mark A. Davis, Brittany Rogness, and Tara Hohoff. *Illinois Natural History Survey, Prairie Research Institute, University of Illinois Urbana-Champaign, Champaign, Illinois 61820*

North American bat populations have been severely and negatively impacted by a number of factors, including disease and wind energy development. And yet, bats provide critical ecosystem services, and are thus a focus of habitat conservation and management. As wide-ranging flyers, bats utilize habitats at a variety of scales, from small, isolated patches to large, contiguous corridors. Landscape-level research is necessary to identify critical habitats, patches, and corridors to target management interventions. Habitat suitability models (HSM) identify high quality habitat by predicting species occurrence at various spatial scales based on occurrence data and environmental variables. Bat occurrence data is mainly collected by mist netting or acoustics, and a national monitoring protocol, the North American Bat Monitoring Program (NABat), provides a new data source for developing HSMs. By combining NABat data with historical data, we can compare model performance by data type, which is essential. Here we present a conceptual framework we will use to evaluate NABat data to inform viable HSMs. Using species-specific landscape and climate variables, we will create HSM for three bat species (hoary bat, eastern red bat, and tricolored) across Illinois using mist net plus acoustic data. Next, HSMs for each species will be developed, one using exclusively acoustic data and one

using exclusively mist-netting capture data to assess the veracity of each approach. Finally, we will create a HSM for each species using only data collected from the NABat protocol to evaluate the ability of NABat data to inform robust HSMs. This framework will ultimately allow for a rigorous assessment of how various data types perform in the HSM ecosystem and provide recommendations for best practices of developing habitat models for bats using disparate data sources.

ACOUSTIC MONITORING IN MINNESOTA'S NATIONAL PARKS INDICATES DECLINES IN THREE BAT SPECIES SUSCEPTIBLE TO WHITE-NOSE SYNDROME

(Poster #15)

Katy R. Goodwin. *North Dakota State University, Fargo, ND 58102*

We conducted acoustic surveys for bats in the summers of 2016–2019 at Mississippi National River and Recreation Area, Grand Portage National Monument, and Voyageurs National Park, all located in Minnesota. This effort was part of a large-scale monitoring program to assess the impacts of white-nose syndrome on bat populations in national parks in the Great Lakes region. Here, we examine trends for three species susceptible to white-nose syndrome: little brown bat (*Myotis lucifugus*), northern long-eared bat (*Myotis septentrionalis*), and tricolored bat (*Perimyotis subflavus*). We sampled 17–28 stationary points per park per year, using Wildlife Acoustics Song Meter detectors. Audio recordings were classified to species using Kaleidoscope Pro software. In total, we obtained more than 400,000 audio files containing bat calls. Approximately 40% of the total call files were attributed to the three species of interest, mostly little brown bats. We observed a substantial decrease in activity from 2016–2019, measured as call files per recording night, for little brown bats and northern long-eared bats at all three parks. Tricolored bat activity also decreased at Mississippi National River and Recreation Area (this species was not analyzed at the other two parks due to its more southerly range). In most cases the percentage of recording nights with positive detections also declined. Our results suggest that little brown, northern long-eared, and tricolored bats have been declining in Minnesota since 2016. This is the same year that white-nose syndrome was first confirmed in the state, and we believe the disease is likely responsible for the observed declines.

PUBLIC MISUNDERSTANDING OF BATS DOES NOT PRECLUDE POSITIVE ATTITUDES TOWARDS BATS IN MISSOURI

(Poster #24)

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Fifteen years have passed since the introduction of white-nose syndrome (WNS) in North America. The decline of several WNS-susceptible bat populations led to the development of bat educational efforts to increase public support for bat conservation. However, few studies

reviewed the efficacy of these efforts concerning the public's understanding and perceptions of bats. This study addressed this shortcoming by assessing rural Missourian's attitudes and perceptions towards bats, WNS awareness, knowledge of bat natural history, and level of trust in a local conservation agency. This research's primary goal included informing local conservation agencies of the public's misperceptions of bats, which could help generate strategies for improving bat education. Respondents generally perceived bats positively, especially due to their insect control ecosystem service. Despite the availability of educational resources to Missourians, we found numerous limitations in respondents' knowledge of WNS and bat ecology. Certain factors influenced public understanding, as the observance of gated caves best explained the respondents' knowledge of WNS, and respondents with higher education identified Missouri as a WNS-positive state. Lastly, respondents trusted the local conservation agency. Future bat conservation efforts in the Midwest should enhance educational initiatives in public messaging, boost signage at gated caves, and maintain trust in conservation agencies when making management decisions.

WHAT DO WE KNOW ABOUT BAT TICKS IN THE MIDWEST?

(Poster #26)

Tara Hohoff and Holly Tuten. *Illinois Natural History Survey, Prairie Research Institute, University of Illinois Urbana-Champaign, Champaign, Illinois 61820*

Bat ticks are soft-bodied haematophagous ectoparasites from the genus *Carios* (*Ornithodoros*). One species commonly found in the Midwest is *Carios kelleyi*, which can carry potentially novel pathogens in the *Rickettsia* and *Borrelia* genera. They are known to feed on bats in the *Eptesicus* and *Myotis* genera and occur in cracks and crevices of natural and man-made roosts. If bats are excluded from a structure, the ticks left behind could seek another host (Sonenshine and Roe, 2013), indicating they could come into contact with humans in domestic structures. Indeed, one study following bat exclusion from a home found a *Carios kelleyi* tick that had fed on human blood. While current evidence indicates disease risk of these ticks is low, a need exists to better characterize their potential as pathogen vectors, particularly if *E. fuscus* and human associations are increasing. We intend to solicit information and samples of bat ticks from bat biologists and wildlife exclusion professionals to determine factors associated with peridomestic risk of these ticks, such as occurrence, prevalence, and the presence of infectious agents. We have developed a website https://publish.illinois.edu/bat-ticks to collect encounters, photos, and tick samples from the professional bat community. Using photos and samples, we will be able to identify the genus or species of ticks associated with roosts. We intend to extract genetic information from physical specimens to test for potentially infectious disease agents. We also hope to disseminate information about bat ticks to the professional wildlife control community so that it becomes standard practice to look for ticks during bat exclusions from homes.

INCREASING ROCKET BOX USE BY MATERNAL INDIANA BATS IN NORTHERN KENTUCKY
(Poster #07)
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Previous research showed Indiana bats, *Myotis sodalis,* prefer rocket box style bat boxes over other roost styles. However, we know less about how Indiana bats acclimate to rocket boxes over time. Our objectives were to evaluate maternal Indiana bat roost preference for several rocket box designs over multiple years and across varied solar treatments at Veterans Memorial Wildlife Management Area in Scott County, Kentucky. In 2019 we deployed 20 rocket boxes of five designs across four landscape positions (open, forest, east-facing, west-facing), adding to 19 existing bark-mimic roosts at the site. During 2019 and 2020, spotlight checks and exit counts were performed 3–4 times per week from May to August. In rocket boxes, mean daily abundance and total abundance nearly quadrupled from 2019 to 2020. In both years, mean daily abundance was highest for boxes receiving east or west solar exposure, with low abundance rates for interior forest boxes; however, bats primarily utilized forest boxes in May prior to colony formation. Boxes receiving open solar exposure had no bats either year. Mean daily abundance also increased as the season progressed in both years. Increased roost use was most pronounced for vent-removal and chimney designs in 2020, but bats used all designs to some extent. The higher number of bats using rocket boxes in 2020 is likely related to the time it took for bats to discover the novel roosts. However, other factors could have contributed to increasing use across years, e.g., bats developing search images for the roost or assessing microclimate through trial and error.

LONG-TERM BAT MONITORING IN THE MIDWEST: INTRODUCING THE NEW NABAT MIDWEST BAT HUB
(Poster #22)
Louis Hunninck, Joy O'Keefe, and Brian Reichert. *University of Illinois Urbana-Champaign, Urbana, IL 61801 (LH, JO); Fort Collins Science Center, U.S. Geological Survey, Fort Collins, CO 80526 (BR)*

Many bat species in North America are experiencing a dramatic decline in population size and distribution, in part due to the white nose syndrome and wind energy development. To be able to understand and remedy those declines, extensive monitoring of bat populations and distribution shifts is critical. However, few comprehensive large-scale programs exist in the USA. As part of the North American Bat Monitoring program (NABat) – a long-term, multi-agency, multinational conservation program – the Midwest Bat Hub aims to consolidate the conservation efforts on bat species in the Midwest by forming regional partnerships with institutions, academics, NGOs, and volunteers. The goal of the Midwest Bat Hub is to study trends in bat species distribution and occupancy to aid decision-makers in their conservation efforts. To do this, the Midwest Bat Hub is initially focusing on establishing new partnerships

and collating data on bat presence. NABat uses a randomised method of sampling 10km^2 areas to allow for powerful, unbiased statistical analyses. NABat has also proposed several field and data analysis protocols, which are encouraged for future data collection. The Midwest Bat Hub has partnered with DNRs in IA, IL, IN, MI, MN, MO, and OH, plus federal agencies and academic institutions, to collect a wealth of historic and contemporary data from both stationary and mobile acoustic monitoring. We invite anyone in the Midwest region to reach out to us if they would want to contribute previously collected acoustic data or are collecting new data and would like to become a partner of the NABat. Our combined knowledge and resources, organised through the Midwest Bat Hub, will allow for the first time to study regional patterns in bat population distributions and facilitate a holistic approach to bat conservation management in the Midwest.

BAT-FRIENDLY COMMUNITIES, RISE UP AND BE RECOGNIZED!

(Poster #18)

Jennifer Summers, Scott Hygnstrom, and Monae Taylor. *Wisconsin Center for Wildlife at University of Wisconsin-Stevens Point, Stevens Point, WI, 54881 (JS, SH, MT)*

The Wisconsin Center for Wildlife at the University of Wisconsin–Stevens Point is proposing to develop a *Bat City USA* program that recognizes urban communities across the nation that are actively reducing threats to bats, managing and protecting bat habitat, and educating residents about the benefits of bats and how to coexist with them. This program is in the conceptual phase and is seeking partners to assist with development and implementation. The program is being be modeled after a *Bat-friendly Communities* program in Canada and the Wisconsin Bird City program that promote wildlife, citizen pride, public recognition, community engagement, and education. This poster presents a logic model we are developing to facilitate planning, programming, and evaluation. We welcome a broad group of partners in this endeavor, who can help in urban planning, outreach, and education.

POTENTIAL FOR NEONICOTINOID INSECTICIDE EXPOSURE IN BATS OF THE CORN BELT

(Poster #11)

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Neonicotinoid insecticides (clothianidin, imidacloprid, thiamethoxam) have been widely promoted as an effective means of agricultural pest management due to their acute toxicity in invertebrates while having minimal toxic effects on vertebrates. While mounting evidence suggests neonicotinoid exposure is responsible for large-scale mortality events of non-target invertebrates, such as bees and other insect species, minimal research has been conducted to investigate the impacts of neonicotinoid exposure on mammals. This includes insectivorous

bats, which forage within neonicotinoid contaminated environments. We began a multi-year study in the summer of 2020 to investigate if bats had been exposed to neonicotinoid insecticides, if bat diet was a potential vector of exposure, and the effects of neonicotinoid exposure on bat body condition. During our 1st year of sampling, big brown bats (*Eptesicus fuscus*) and their invertebrate prey items were sampled from four DeKalb County, Indiana sites that had recorded concentrations of neonicotinoids in adjacent streams. We captured a total of 38 big brown bats over 4 calendar nights and collected 52 tissue samples (blood and fur). We also sampled potential flying invertebrate prey items using malaise traps. Mean forearm mass index (FMI), glucose, or hematocrit values did not differ significantly between our sampling sites. However, the FMI values of big brown bats captured in this agriculturally dominated (and historically neonicotinoid exposed) landscape are lower (0.35 ± 0.01 g/mm) than those from more forested landscapes (0.44 ± 0.06 g/mm). While analyses of neonicotinoid concentrations in potential prey items, bat fur, and bat blood are still on-going, these results suggest that neonicotinoids may have a negative effect on bat body condition.

A SURVEY OF OHIO'S OVERWINTERING BAT POPULATIONS

(Poster #01)

Levi E. Johnson* and Joseph S. Johnson. *Department of Biological Sciences, Ohio University, Athens, OH 45701*

With the decline of several bat species due to white-nose syndrome (WNS), the need to locate and protect remnant populations has become increasingly important. There is increasing evidence that some populations persist despite WNS, but accounts of these survivors in Ohio are scarce. Research in other states has shown that overwintering bats are not limited to caves and mines, suggesting that efforts to describe Ohio's bat population should also include surveys of non-traditional hibernacula such as aboveground rock crevices and cliff lines. This study seeks to describe the overwintering bat population in Ohio and identify hibernacula characteristics that best explain the presence of remnant populations. We conducted visual surveys of 92 underground hibernacula between December and March of 2018–2020. During surveys, we counted the number of each bat species present and deployed environmental dataloggers when possible. We also searched for bats hibernating aboveground at 52 different properties during this time. Aboveground surveys were performed by walking cliff lines or exposed rock outcrops and looking for bats in crevices. For all aboveground roosts, and at randomly sampled locations, we collected a suite of habitat measures describing the roost site. Data collection is still underway, but preliminary results show that few little brown myotis (*Myotis lucifugus*) are found in caves and mines, with 97% of this species found in abandoned railroad tunnels. Tricolored bats (*Perimyotis subflavus*) were also rare inhabitants of caves and mines, with 66% of this species found in abandoned tunnels. Big brown bats (*Eptesicus fuscus*) were more commonly found in caves and mines and the number of species found during surveys exhibited a significant, curvilinear relationship with temperature. Big brown bats were also found hibernating aboveground, with 89 non-traditional roosts located to-date. Species

also found hibernating aboveground include silver-haired bats (*Lasionycteris noctivagans*) and eastern small-footed myotis (*Myotis leibii*).

SEX-BIASED INFECTIONS AND MORTALITY IN A MULTI-HOST FUNGAL PATHOGEN OF BATS
(Poster #13)
Macy J. Kailing*, Joseph R. Hoyt, J. Paul White, Heather M. Kaarakka, Jennifer A. Redell, John E. DePue, William H. Scullon, Katy L. Parise, Jeffrey T. Foster, A. Marm Kilpatrick, and Kate E. Langwig. *Department of Biological Sciences, Virginia Tech, Blacksburg, VA 24060 (MJK, JRH, KEL); Wisconsin Department of Natural Resources, Bureau of Natural Heritage Conservation, Madison, WI 53703 (JPW, HMK, JAR); Michigan Department of Natural Resources, Baraga, MI 49870 (JED, WHS); Center for Microbial Genetics and Genomics, Northern Arizona University, Flagstaff, Arizona 86001 (KLP, JTF); Department of Ecology and Evolutionary Biology, University of California, Santa Cruz 95064 (AMK)*

Emerging infectious diseases are a key threat to wildlife and understanding disease dynamics within populations is fundamental for the conservation of impacted species. Intersex differences in infection are widely observed across disease systems and may have consequences for host population recovery. We explored sex-biased infections of bat species impacted by an emerging fungal disease, white-nose syndrome, and evaluated disease-associated differences in mortality between sexes and potential effects on population structure. We collected fungal swabs, morphometrics, and environmental data from five species of hibernating bats at 43 sites spanning the eastern and midwestern U.S. to characterize infections and host traits over the course of an annual outbreak. We also used RFID systems at hibernacula and PIT-tagged bats to determine the role of sex-based activity patterns in shaping intersex infection patterns. We found females suffered from more severe infections than male conspecifics when there was a clear sex-bias. In addition, we found females were less likely than males to be recaptured overwinter and accounted for a smaller proportion of populations over time. Notably, female-biased infections were evident by early hibernation, suggesting that sex-based dynamics prior to hibernation may play an important role in shaping WNS outbreaks. Higher fall activity in male bats compared to female bats may enable males to reduce infections relative to female bats. Higher impacts in female bats may have cascading effects on bat populations and extend the consequences of WNS beyond the hibernation season, such as limiting recruitment and increasing the risk of Allee effects.

ESTIMATING CAVE BAT POPULATIONS WITH PASSIVE ACOUSTICS
(Poster #19)
Laura Kloepper. *Department of Biology, Saint Mary's College, Notre Dame, IN 46556*

Passive acoustic monitoring is widely used to identify animal species and corresponding spatial and temporal activity patterns by analyzing individual calls. Recently, a new method was developed that uses passive acoustics to census dense bat populations during roost emergence.

Instead of determining population by counting individual calls, this method uses the overall acoustic amplitude from a specific time window to estimate the nightly population of the entire roost. Once a cave location is initially ground-truthed with synchronized video and acoustic recordings, the nightly population can be estimated with low-cost acoustic recorders. Here, I will describe the details of this method and report on its performance across multiple caves, with several acoustic sensors, and with two species of bats. This method provides a less invasive censusing option compared to in-cave counts, and I will discuss the potential to expand this method for long-term, autonomous population monitoring.

HOST CONTRIBUTIONS TO THE *PSEUDOGYMNOASCUS DESTRUCTANS* ENVIRONMENTAL RESERVOIR

(Poster #06)

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White-nose syndrome has had devastating effects on hibernating bat populations across North America. *Pseudogymnoascus destructans,* the fungal pathogen that causes white-nose syndrome in bats*,* is known to persist for long periods of time in the environment, which can result in widespread infection and mortality. Species suffer from differential infections from white-nose syndrome and therefore may not contribute equally to the buildup of the environmental reservoir. Here we examine shedding of the fungal pathogen, *P. destructans,* from a range of different host species and environments. We collected samples from bat roosts in subterranean environments from 23 sites over a 3-year period during *P. destructans* invasion of the Midwestern United States. We observed differential pathogen shedding into the environment, where some species disproportionally contributed more pathogen to the environmental reservoir given their level of infection compared to other species present in the community. Additionally, we found that roost selection for crevices in hibernacula, resulted in pathogen hot spots, and bats roosting in these locations had significantly higher fungal burdens. Our results show that species-dependent pathogen shedding and roost choice interact to drive the extent of the environmental reservoir, which ultimately determines the population and species level impacts.

SEASONAL ACTIVITY OF A REMNANT POPULATION OF NORTHERN MYOTIS (*MYOTIS SEPTENTRIONALIS*) IN CENTRAL PENNSYLVANIA

(Poster #12)

Mattea A. Lewis, Gregory G. Turner, Michael R. Scafini, and Joseph S. Johnson. *Department of Biological Sciences, Ohio University, Athens, OH 45701 (MAL, JSJ); Pennsylvania Game Commission, Harrisburg, PA (GGT, MRS)*

Northern myotis (*Myotis septentrionalis*) recently received federal protection in the United States due to the effects of white-nose syndrome. Recovery of the northern myotis will rely on seasonally applicable management actions coupled with conservation of occupied habitats. Current knowledge of the ecology and behavior of northern myotis is sparse and largely based on summer studies, with less known about habitat use following the end of the maternity season. Our goal was to locate summer and autumn day-roosts of northern myotis in central Pennsylvania to determine if bats use different roosts after young become volant and to determine habitat characteristics important in the region. To do so, we tagged 27 northern myotis in central Pennsylvania with radio-transmitters and deployed acoustic bat detectors at 4 foraging corridors and 1 area with a non-traditional hibernaculum feature (rock crevice outside of caves and mines). We located 79 tree roosts and found that bats selected roosts based on tree decay stage and basal area of the forest stand. Radio-tagged northern myotis never left the study area and were tracked to day roosts until early November. Counts of bats exiting roost trees revealed that maternity roosts were as frequently used during autumn (August 15–October 31) as during summer (21 June–August 14). One radio-tagged female and one male northern myotis were tracked to a ground-level rock crevice during October and November. Acoustic activity of northern myotis at this suspected hibernaculum was recorded from February–November and peaked during late summer when northern myotis are known to swarm. Bats were observed emerging from this roost during spring and autumn but not during summer. These data show that northern myotis in central Pennsylvania roost in maternity trees until at least late October and adds to growing evidence that some surviving northern myotis hibernate outside of caves.

BAT ROOSTS IN BRIDGES: ASSESSING ILLINOIS BRIDGES FOR BAT USE

(Poster #17)

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The Illinois Natural History Survey (INHS) works with the Illinois Department of Transportation in order to conduct presence/absence surveys in compliance with the Endangered Species Act. From 2017 through 2020, INHS conducted 341 structure assessments on bridges and culverts in throughout the state following protocols from the Indiana Bat and Northern Long-eared Bat Section 7 Consultation and Conservation Strategy for the Federal Highway Administration, Federal Railroad Administration and Federal Transit Administration. All bridges were checked during the daytime, using high powered headlamps to illuminate crevices and expansion joints. Binoculars were used to assess portions of bridges that were inaccessible due to water depth or

height of the structure. We found evidence (guano or staining) of bats roosting in 51 of 341 structures surveyed (48 bridges, 3 culverts; 15%). We observed more than 650 big brown bats and 10 tri-colored bats present in these structures.

POPULATION MONITORING AND HABITAT USE OF GRAY BATS IN SOUTHEAST KANSAS
(Poster #10)
Haley B. Price* and Andrew D. George. *Pittsburg State University, Biology Department, Pittsburg, KS 66762*

The gray bat (*Myotis grisescens*) was listed as federally endangered in 1976 after studies revealed significant declines due to habitat loss. Whereas gray bat populations have benefited from conservation efforts, their status following the introduction of white nose syndrome (WNS) is poorly understood. The objectives of this project were to monitor the population size and investigate habitat use of the only known colony of gray bats in Kansas, which is located in a storm sewer beneath the city of Pittsburg. We placed acoustic detectors at 31 potential foraging sites across Crawford and Cherokee counties, Kansas, and Barton County, Missouri, to detect calls from June to September. Emergence counts were also conducted using an infrared video system placed at roost exits twice per week. Thus far, a total of eight bat species has been detected in the study area, including gray bats. Up to 725 bats were detected from emergence surveys, roughly a 50% decline from two years ago. Preliminary findings suggest that the gray bat colony in Pittsburg may benefit from the proximity of several water sources. However, data analysis is ongoing.

FOR THE LOVE OF GUANO IN THE ILLINOIS COMMUNITY
(Poster #20)
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The Illinois Bat Conservation Program (IBCP), founded in 2016, focuses on the conservation and management of bats in Illinois. In 2017, a community science roost form was made accessible to the public through the IBCP's website (illinoisbats.org). This form collects data on the type of roost structure and its location and includes instructions for conducting emergence counts to determine approximately how many bats are present. As of early 2021, we have received 64 roost form submissions from 29 Illinois counties after promotion through social media and outreach. Roost categories with the highest submissions were "tree" and "other" which included park shelters and bridges. In summer 2020, to gain additional insights, we asked participants to collect a guano sample to mail back to us, to determine the bat species in their roost. Eleven guano samples were returned from nine different counties. This community science project provides insight into the type of roosts used, the species that are using them, their location in Illinois, and approximately how many individuals are at each roost.

ASSESSING THE IMPACTS OF FRAGMENTATION AND IMPERVIOUS SURFACES ON BAT ACTIVITY AND DIVERSITY

(Poster #02)

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Fragmentation and roads have variable impacts on bats, since some bat species forage on the edges created by roads, but others avoid them. This study looks at the impacts of edge habitat and impervious surfaces on bats, by comparing differences in bat activity and species richness, between edge and interior sites and between parking lots and sites outside parking lots (100 m away), at paired stationary points in parks of the Oak Openings Region (an area with fragmented ecosystem remnants in a landscape undergoing rapid development). In addition, we estimated the percent of each land-cover type and kilometers of roads in 100-m and 500-m buffers around each point, distance to certain land-cover types, and large-scale light pollution. Fragmentation was assessed using FRAGSTATS. Canopy cover, percent vegetation clutter, and vegetation height were measured at stationary points. Acoustic calls were identified using BCID and AnalookW software. All eight local bat species were located at both edge/interior and parking lot/outside parking lot sites. Interior sites had higher bat activity than edge ones, although there was no difference between the two in species richness. There was no difference in bat activity or species richness between sites in parking lots and 100 m outside them, although hoary bats were more common in parking lots. Bray-Curtis indices showed 32% dissimilarity in bat species composition between edge and interior sites and 48% between parking lots and sites outside them. Across all stationary points, bat activity and richness were lower with higher percent upland conifer forest within 100 m. Bat activity and richness were positively correlated with higher maximum percent canopy cover and clutter at the 0–3-m level, although clutter at the 3–6.5-m level was negatively correlated with richness. These results will help manage bat habitat in fragmented landscapes.

BAT ACTIVITY TRENDS AT MARGERY RUN BAT CONSERVATION SITE IN NORTHWESTERN WEST VIRGINIA FROM 2015 TO 2020

(Poster #16)

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Loss of summer habitat is a factor in the decline of myotine species across the United States. In order to offset forest clearing for development, the United States Fish and Wildlife Service West Virginia Field Office has required conservation measures, including the creation of offsite bat conservation sites. As a result, one of the bat conservation sites that AllStar Ecology LLC (ASE) created was Margery Run Bat Conservation Site (Margery Run) in Tyler County, West Virginia. Using the Myotine Suitable Habitat Assessment Model (MSHAM), ASE was able to target the highest-quality myotine habitat available for purchase. Conservation measures implemented at Margery Run included creation of roosting (artificial roosts, reforestation, and snag creation) and foraging habitat (vernal pools). ASE set up long-term acoustic monitoring at the site to monitor bat populations. A total of 15,249 bat calls comprising 10 species was recorded from

2015 to 2020 at Margery Run. The three most-prominent species were eastern red bats (*Lasiurus borealis*; 5,765 calls; 37.8%), hoary bats (*Lasiurus cinereus*; 4,420 calls; 29.0%), and silver-haired bats (2,803 calls; 18.4%). Northern long-eared bats (*Myotis septentrionalis*) were recorded at a lower rate (458 calls; 3.6%) and confirmed at the site via capture. Most calls were recorded between April and August (13,834 calls; 90.7%), with May having the highest number of calls (6,504 calls; 42.7%), although every month except December had call recordings. With confirmed calls of tricolored bat present as early as 2 February and no known hibernacula located nearby, further investigations are warranted to investigate possible winter habitat close to Margery Run for this species of concern.

EPTESICUS FUSCUS WITH CHRONIC *PSEUDOGYMNOASCUS DESTRUCTANS* EXPOSURE WEIGH LESS IN NORTHERN LATITUDES COMPARED TO SOUTHERN LATITUDES

(Poster #05)

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Pathogen introductions can cause shifts in organismal traits. Trait shifts can allow organisms to adjust to pathogen exposure for survival, but pathogens can also cause mortality. *Pseudogymnoascus destructans* (*Pd*), the fungal pathogen causing white-nose syndrome, has devastated North American temperate bat populations since its introduction to the US in 2006. Since *Pd* infection depletes host energy stores, highly susceptible bat species surviving *Pd* infection have increased fat stores. However, little is known about trait changes in less susceptible species, which could experience cumulative weight loss from chronic *Pd* exposure over time. This pattern could also be confounded by latitude because *Pd* grows optimally in cool temperatures, and northern latitudes have cooler climates. Since big brown bats (*Eptesicus fuscus*) are less susceptible to *Pd* infection, we hypothesized their mass would decrease with *Pd* exposure time and latitude across the eastern U.S. We compiled *E. fuscus* capture data from wildlife agencies and researchers across the eastern U.S. and created linear mixed-effects models for female and male mass as functions of exposure time, latitude, reproductive status (females only), and capture site. We identified a latitudinal inflection point and further quantified differences across it, by creating secondary linear mixed-effects models replacing latitude for categories north or south of the threshold. Once *Pd* was established on the landscape (5+ years), northern *E. fuscus* weighed less than southern *E. fuscus* and differences in mass across the inflection increased over time. This suggests 1) physiological responses to pathogen interactions in less-susceptible species may be more recognizable with long-term exposure compared to initial impact, and 2) responses are likely confounded with environmental conditions associated with latitude. Our results further suggest a spatial threshold for focused management and conservation practices and warrant further research into trait changes of less-susceptible species with long-term *Pd* exposure.

WHAT HAVE YOU GOT TO LOSE? TRADEOFFS IN SOUND QUALITY AND COST FOR PASSIVE ACOUSTIC SENSORS

(Poster #27)

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Ecologists often use automatic sensors, ranging in quality and cost, to collect data for a variety of research objectives. One such sensor is the passive acoustic device, used to record sound on the landscape. Most passive acoustic devices (recorder + microphone) are expensive (i.e., >700 USD); however, a less expensive option is now available. We asked how the less-expensive device compared to a traditional, more expensive device. To compare file quality between the two types of devices, we set up the two devices simultaneously at 10 sites for 5 nights to record free-flying bats. We paired files from both devices when they occurred within 3 sec, and for each file pair we measured the call duration (ms), maximum frequency (kHz), and bandwidth (kHz). We defined lower-quality calls as having shorter duration, lower maximum frequency, and shorter bandwidth. We also used an auto identification program to classify calls as low-frequency, mid-frequency, or *Myotis* bats, and we compared the proportion of calls in each group between devices. The less-expensive device consistently recorded lower-quality calls compared to the more-expensive device. However, there was no difference in the proportion of calls classified as mid- or low-frequency bats. Less-expensive alternatives for automatic recording sensors may not be appropriate for studies that require high-quality information (e.g., behavioral studies) but may be critical when research objectives call for multiple devices and are constrained by budget.

THE INFLUENCE OF EXCLUSION ON MOVEMENT AND ROOSTING BEHAVIOR OF BIG BROWN BATS

(Poster #25)

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Big brown bats *(Eptesicus fuscus)* use anthropogenic structures to form maternity colonies and for hibernation. Many homeowners may consider bats roosting in their homes a nuisance and hire a professional to perform an exclusion to evict the colony from the building. Little is known about the movements and roosting behaviors of big brown bats after exclusion. We investigated big brown bat roosting behavior during August and September 2019 by monitoring bat fidelity to original roosts, determining the frequency of roost switching among alternate roosts, and identifying distance among original roosts and alternate roosts. We radio-equipped 22 big brown bats from 3 separate colonies within homes; each colony existed in a uniquely developed environment (rural, suburban, and semirural). Bats were captured at the roost by hand 3–5 days before exclusion was performed. Individual bats were tracked to alternative roosts using radio-telemetry for 10–14 days. Our preliminary results suggest individuals did not exhibit roost fidelity after roost disturbance and occupied alternative anthropogenic and

natural roosts within an average of 883 meters from the original roost. Bats switched roosts an average of 2.2 times after leaving the original roost. While exclusion is an effective strategy for removing bats from structures, big brown bats appear to be loyal to a general area and will readily occupy nearby roosts. Future research goals include investigating roost selection criteria and investigating movement differences among sex-age classes.

MOBILE ACOUSTIC TRANSECTS DOCUMENT DECLINES IN SUMMER ACTIVITY OF *MYOTIS LUCIFUGUS*, *M. SEPTENTRIONALIS*, AND *PERIMYOTIS SUBFLAVUS*

(Poster #23)

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Understanding trends in summer bat activity over large spatial scales can help inform species assessments. Unfortunately, these kinds of analyses are sorely lacking. Bat activity recorded during mobile acoustic transects provides an index of abundance and can be used to determine changes in populations over time. Multiple states and agencies adopted the method to monitor bat populations, especially in the eastern and midwestern regions of the United States. The North American Bat Monitoring Program adopted the method in 2015. However, no holistic nationwide or regional analysis has been conducted to date. We acquired data from the North American Bat Monitoring Program database supplemented with data contributed from West Virginia and New York. We curated and analyzed data for *Myotis lucifugus*, *M. septentrionalis*, and *Perimyotis subflavus* to help inform Species Status Assessments by the United States Fish and Wildlife Service. We used generalized linear mixed models to describe and predict bat activity along transects from 2009–2020, focusing on the effects of white-nose syndrome and wind-energy development. We document a 62% decline in summer activity rates of *M. lucifugus* across 698 sampled sites, a decline of 83% in activity of *M. septentrionalis* at 121 sites, and a decline of 50% in *P. subflavus* activity at 958 sites. Declines were strongly correlated with arrival of *Pseudogymnoascus destructans*, the fungus that causes white-nose syndrome and increased wind-energy development in the region. The continued use of mobile transects and contribution of data to NABat will facilitate range-wide population monitoring for multiple species.