15th annual meeting of the Tennessee Bat Working Group

Henry Horton State Park
Chapel Hill, Tennessee
November 21, 2019

Sponsored by:

Agenda (Times are central standard)**:**

8:00 Registration

9:00 Welcome/Opening Remarks

9:10 Business Meeting

9:20 Josh Campbell**: Annual White-nose syndrome statewide update**

9:40 Dustin Boles: **Evaluating effects to forest-dwelling bat species in Tennessee**

10:00 Piper Roby: **Torpor-assisted migration: what's good for the lasiurine is good for the myotid**

10:20 Break

10:40 Aubree Weitzel: **Variation in bat use of an ephemeral wetland in western Tennessee**

11:00 Alexandra Tsalickis: **A 14,000 YBP record of paleoenvironmental change in the Southeastern, USA inferred from bat guano**

11:20 Mallory Tate: **Bats Return—No Bull! Bat Activity After Reopening Cave in Great Smoky Mountains National Park**

11:40 Ash Cable: **Methods to inform landscape-scale conservation efforts for an endangered bat**

12:00 Lunch

1:20 Matt Grisnik: **The cutaneous microbiota of bats has *in vitro* antifungal activity against the white nose pathogen**

1:40 Reilly Jackson: **Winter Foraging Activity of Two Cave-Hibernating Bat Species in Tennessee**

2:00 Philip Allagas: **Identification of Feeding Buzzes Using Deep Learning**

2:20 Break

2:40 Joey Weber: **Right under our noses- endangered gray bats in western North Carolina**

3:00 James Kiser: **2019 Kentucky Bat Working Group Bat Blitz Results**

3:20 Emma Willcox: **Winter Torpor and Arousal Activity of Four Cave-hibernating Bat Species in the Southeastern United States**

3:40 Cory Holliday: **Gray Bat Movement and Migrations in Tennessee**

4:00 Closing remarks

Abstracts

Annual White-nose syndrome statewide update

Josh Campbell
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White-nose syndrome (WNS) was first discovered in Tennessee in 2010 in upper east Tennessee. Biologists and researchers within the state have performed over 800 cave surveys over the last 9 years to assess the progression of WNS across the state and its impacts to wintering bats. Since this discovery, the fungal causal pathogen, *Pseudogymnoascus destructans* has been detected in 56 of the 78 counties containing caves. WNS is now considered widespread in the state. Despite the presence of WNS within the state, observations are increasing for some species. However, several species continue to decline. Results from the 2018-2019 winter field season and impacts of WNS being observed by researchers will be presented.

Torpor-assisted migration: what's good for the lasiurine is good for the myotid

Piper L. Roby[1,2,3], Eric S. Vanzant[2], Mark W. Gumbert[1], and Michael J. Lacki[3]
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Many animals undergo seasonal migrations, both long and short. Several temperate zone bats are either long distance or regional migrants, but both must contend with fuel acquisition and conservation for this energy-demanding endeavor. Recently it was found that long distance migrating silver-haired bats use torpor-assisted migration. To determine if the regional migrant Indiana bat also engages in this behavior, we used temperature sensitive radio-transmitters to track female spring migrating individuals from hibernacula toward summer grounds and collected ambient temperature (T_a). We created an algorithm to determine when bats were in torpor, warming, normothermic, or cooling. We then used decision tree analysis to predict physiological state based on T_a and diel condition. T_a was significantly warmer when bats were normothermic than when they were in torpor or when they were cooling, but there was no significant difference between any other bat temperature (T_{sk}) and T_a combinations. The nighttime T_a threshold for physiological state was 9.8°C: there was an 87.7% chance bats were in torpor below this temperature. The daytime T_a threshold was 23°C: there was a 96.3% chance bats were in torpor below this temperature. We concluded that Indiana bats used torpor-assisted migration. During conducive weather, bats entered torpor during the day to conserve fuel, foraged before migrating, traveled and foraged throughout the night, and foraged before roosting. In inclement weather, bats warmed but did not emerge and then returned to torpor. Understanding how weather affects migrating bats can provide information about when bats are active on the springtime landscape.

Variation in Bat Use of an Ephemeral Wetland in Western Tennessee

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During the summer months, most species of bats in Tennessee use the forested landscape to both raise their offspring and to forage. We examined the variation in bat use of an ephemeral wetland site located in the Beech Ridge Unit of the Obion River WMA June-October 2018 using both mist net and acoustic surveys. We hypothesized that there would be variation in species richness from summer through early fall, and that both the mist net and acoustic surveys would reflect those differences. We netted bats, identified them to species, and collected morphometric data every 3 weeks beginning mid-June. Subsequently, we used a bat detector near the net survey site to record bat activity and species richness for at least two weeks after almost all net nights. After files were scrubbed for non-bat noise, species were identified, when possible, and bat activity was examined with SonoBat v. 4.2.2. The bat passes identified to species by SonoBat were then manually vetted. During the study, species richness varied by net night and month, and similar variation was reflected in both the net and the acoustic surveys. Nine species were captured either by mist net, by acoustic survey, or by both. All of the species captured via mist net were also captured acoustically, but three species were captured via acoustic survey but not mist net. The variation in bat species assemblages within this seasonal examination of the bat community at this site may have implications for future habitat management strategies.

A 14,000 YBP Record of Paleoenvironmental Change in the Southeastern, USA Inferred from Bat Guano

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The southeastern United States is experiencing a period of environmental change from population increases, climate change, and land use alterations creating the need to understand baseline conditions and environmental change prior to human impacts. While paleoenvironment data can be reconstructed from a variety of archives (e.g., lake sediments, tree rings, speleothems), some geographic areas (e.g. southeastern United States) lack such records. One scientific medium capable of tracking moisture regimes and other paleoenvironmental changes over millennial timescales, but has received little attention, are guano deposits in cave systems. Guano deposits reside in many cave environments in the southeastern United States and can be used as an archive of paleoclimate data including precipitation, vegetation, and other environmental change. Here, we present a 14,000-year record of moisture (wet/dry) and other periods of paleoenvironmental change based on stable isotopes ($\delta^{15}N$, $\delta^{13}C$, δD) in a guano core collected from Cave Springs Cave in Alabama, USA. Moisture was inferred from changes in deuterium. Results showed that the early (11,151 – 13,764 YBP) and late (0 – 4,177 YBP) Holocene were drier than the middle (4,388 – 10,916 YBP) Holocene which encompasses the Holocene Climatic Optimum (HCO) (5,000 – 9,000 YBP). These changes strongly coincided with vegetation changes based on pollen records from previous studies. Stable carbon and nitrogen are complex in interpretation thus limiting inferences from stratigraphic change. This study suggests that future research investigating guano deposits from caves in the southeastern United States can provide a long-term record of local paleoclimate and paleoenvironmental change.

Bats Return—No Bull! Bat Activity After Reopening Cave in Great Smoky Mountains National Park

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The Great Smoky Mountains National Park contains many caves, four of which are Indiana bat hibernation sites. Bull Cave is a Priority 1 Indiana bat hibernacula and considered critical habitat for the endangered species. Northern long-eared bats, little brown bats, tri-colored bats, eastern small-footed bats, and big brown bats also use this cave as a hibernation site. During the fall of 2017, we discovered this cave serves as an important swarming site for several bat species, with high bat activity from August–October, 2017. Monitoring efforts resumed in fall of 2018, but bat activity decreased drastically by the end of August. After further investigation, we realized the entrance to the main corridor of the cave was sealed by a large, fallen boulder. Reopening cave entrances within the boundaries of National Parks is unprecedented. However, discussion among managers with the National Park Service, Unites States Fish and Wildlife Service, and United States Geological Survey, and researchers from the University of Tennessee led to the decision that the potential benefits to bats from reopening the cave warranted action. Great Smoky Mountains National Park personnel removed the boulder in July of 2019, and bat monitoring efforts resumed in August 2019. We will present this case study and detail the response of bats to the re-opening of Bull Cave.

Methods to inform landscape-scale conservation efforts for an endangered bat

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Conservation for the endangered Indiana bat (*Myotis sodalis)* is typically focused on local maternity sites; however, the species is a regional migrant, interacting with the environment at multiple spatial scales. Hierarchical levels of management may be required, but we have limited knowledge of landscape-level requirements of this species and the distribution and connectedness of its habitat in large landscapes. We sought to 1) identify factors that influence *M. sodalis* maternity colony distribution in Illinois, a large mosaic landscape, 2) map maternity habitat to identify the distribution of suitable areas, and 3) examine functional connectivity of the habitat network. We used 3 decades of maternity occurrence data to test a suite of hypothesis-based Habitat Suitability Models. We mapped relative suitability across the study area using the plausible models and performed a connectivity analysis to enhance our knowledge of important habitat patches for bats. Factors affecting landscape-scale suitability included limited agriculture, more forest and forest edge, proximity to medium-sized water bodies, lower elevations, and limited urban development. Areas closer to hibernacula and rivers were the most suitable. Thirty-four percent of the study area was classified "highest suitability" or "moderate suitability" maternity habitat, and only nine habitat patches (7.4% of study area) were important for functional connectivity. Suitability modeling identifies factors that make areas attractive as maternity sites which can inform landscape-scale management. Additionally, suitability maps can help identify areas where unidentified colonies are potentially present. Connectivity analysis can prioritize areas to target habitat restoration to maintain functional connectivity and prevent habitat isolation.

The cutaneous microbiota of bats has *in vitro* antifungal activity against the white nose pathogen

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Since its introduction into the USA, *Pseudogymnoascus destructans* (*Pd*), the fungal pathogen of white-nose syndrome, has spread killing millions of bats. Recent work has identified bacteria capable of inhibiting the growth of fungal pathogens within the host associated microbial assemblage of bats which has led to interest in understanding how these bacterial species interact with pathogens. Our objectives were to determine if resident bat cutaneous bacteria have antifungal activity against *Pd*, as well as correlate differences in the bat cutaneous microbiota with the presence/absence of *Pd*. We hypothesized that the cutaneous microbiota of bats has anti-fungal bacterial members, and that these members are found more frequently on negative bats. To test this, we sampled the microbiota of tri-colored bats, adjacent roost surface, and soil from *Pd* positive caves to infer possible overlap of antifungal taxa, we tested these bacteria for bioactivity *in vitro,* and lastly compared bacterial assemblages using both amplicon and shotgun high-throughput DNA sequencing. Results suggest that the presence of *Pd* has an inconsistent influence on the bat cutaneous microbial assemblage across sites. Operational taxonomic units (OTUs) that corresponded with cultured antifungal bacteria were present within all sample types but were significantly more abundant on bat skin when compared to the cave environment. Additionally, the microbial assemblage of *Pd* negative bats was found to have more OTUs that corresponded to antifungal taxa than positive bats, suggesting that the host microbial assemblage may play a role in host defense against fungal pathogenesis.

Winter Foraging Activity of Two Cave-Hibernating Bat Species in Tennessee

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During winter in the southeastern U.S., individuals of cave hibernating bat species susceptible to white-nose syndrome (WNS) will often arouse from torpor. During arousals, some individuals may leave hibernacula to forage on the landscape. We deployed VHF radio transmitters on individuals of two bat species (*Myotis grisescens* [n = 8] and *M. leibii* [n = 2]) captured outside cave hibernacula during winter and used aerial radio telemetry to explore their foraging activity. Bats were tracked from release at the hibernacula until their transmitter signal was lost or they remained stationary for $\geq$15 minutes. To understand which landscape features influence foraging area selection, we mapped foraging points in ArcGIS and compared them to random points using Welch's t-tests. *Myotis leibii* were tracked 1.20 $\pm$ 0.32 kilometers and *M. grisescens* 4.14 $\pm$ 0.58 kilometers from hibernacula. Both species selected to forage along streams ($P \leq 0.01$), with all foraging points located within 0.57 km of water features. *Myotis leibii* also selected to forage along roads ($P < 0.01$). Management for these important landscape features, particularly streams, may benefit *M. leibii* and *M. grisescens* populations, especially during winter when prey resources are low and bats are stressed by the rigors of hibernation and WNS. Similar data collection is recommended for other bat species affected by WNS that have seen high over-winter mortality.

Identification of Feeding Buzzes Using Deep Learning

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Bats provide many ecosystem services and are considered valuable indicators of ecosystem health. Currently, bioacoustic recording technology and associated call analysis software allows for the generation and analysis of large datasets with relative ease. These methods of assessing bat activity focus on metrics such as seconds recorded per hour deployed or number of passes per night. While effectively indicating the presence or absence of bats at a given site, these metrics do not tell us about habitat use. Feeding buzzes may elucidate this knowledge gap, however no automated method of counting feeding buzzes currently exists. With the rise of Deep Learning, I propose a method using transfer learning and artificial intelligence to automate this process by building on open-source deep neural networks. Using a retrained model based on Inception-V3 developed by Google, we were able to identify files containing a feeding buzz with an accuracy of 85.7%. With a very small training dataset, this lags behind what is considered "state-ofthe-art," but should improve drastically as more training data is collected and properly labeled.

Right under our noses- endangered gray bats in western North Carolina

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Until recently, federally endangered gray bats (*Myotis grisescens*) were considered rare visitors to western North Carolina; summer captures were assumed to be on foraging excursions from maternity sites in Tennessee. However, we detected gray bats roosting in 7 bridges and 1 culvert in the French Broad River (FBR) basin in NC in 2016–2017. Thus, in 2018, we began a 2.5-year study of the distribution and roosting/foraging ecology of gray bats in the FBR basin. We surveyed 291 bridges, 24 culverts, and used radio telemetry (by car and via telemetry towers) to track 189 bats (132 female, 57 male) to find new roosts and foraging sites. We deployed acoustic monitoring stations along 15 large streams and rivers in the FBR basin. New roosts included 10 bridges, 7 culverts, 3 buildings, 2 sycamore (*Platanus occidentalis*) trees, and 2 known cave roosts in TN; most were along major waterways in the FBR basin. Tracked bats tended to move along the N-S axis of the FBR while foraging. However, acoustic data show gray bats are distributed across the basin. Applying a combination of methods and focusing on major waterways, we significantly advanced our understanding of the distribution of these endangered bats in western North Carolina.

2019 Kentucky Bat Working Group Bat Blitz Results

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The Kentucky Bat Working Group (KBWG) hosted its 4th annual Bat Blitz from August 22 – 24, 2019. It was centered around Little South Fork Cumberland River and Rock Creek in Wayne and McCreary Counties, Kentucky. A total of 33 participants attended the event. Three people scouted sites and harp trapped at a cave entrance on August 22nd. Twenty-nine (29) and 31 individuals conducted surveys for bats on Friday the 23rd and Saturday the 24th, respectively. A total of 10 sites were selected for the blitz. Both mist nets and harp traps were used to capture bats. As a result of 44 net nights of effort, three hundred and eighty-seven (387) bats representing 7 species were captured. The eastern red bat [*Lasiurus borealis* (n=302)] was the most frequently captured species representing 78% of captures. Other species captured included the Rafinesque's big-eared bat [*Corynorhinus rafinesquii* (n=41)], tri-colored bat [*Perimyotis subflavus* (n=22)], big brown bat [*Eptesicus fuscus* (n=16)], eastern small-footed bat [*Myotis leibii* (n=2)], gray bat [*M. grisescens* (n=2)], and evening bat [*Nycticeius humeralis* (n=2)]. A single gray bat captured over Rock Creek in McCreary County represented a new county for the endangered species.

Winter Torpor and Arousal Activity of Four Cave-hibernating Bat Species in the Southeastern United States

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In the southeastern U.S., bats susceptible to white-nose syndrome (WNS) frequently arouse from torpor during winter and are often active outside hibernacula. We investigated the torpor and arousal activity of four WNS affected species, two with relatively low (*Myotis grisescens*, and *M. leibii*) and two with relatively high (*M. sodalis* and *Perimyotis subflavus*) WNS susceptibility. We deployed temperature-sensitive radio-transmitters on bats captured outside cave hibernacula during winter to monitor torpor and arousal profiles (n = 21) and recorded activity of others at cave entrances by implanting them with passive integrated transponder (PIT) tags (n = 1,349). *Myoits leibii* had a higher torpor skin temperature (18.57 $\pm$ 0.20 °C) than *M. grisescens* (13.72 $\pm$ 0.60 °C) and *P. subflavus* (14.62 ± 0.49 °C*; P* <0.048). *Myotis leibii* also had a higher arousal skin temperature (32.29 $\pm$ 0.67 °C) than *M. grisescens* (29.01 $\pm$ 0.64 °C) and *M. sodalis* (28.59 ± 0.38 °C; $P \leq 0.016$). *Myotis leibii* had the highest activity frequency throughout the hibernation period (November–February), with 74.22 + 10.62% of tagged individuals detected at cave entrances each month compared to <30% of tagged individuals from other focal species. Of the 531 PIT-tagged bats active during winter, only 12.60% (n = 67), the majority of which were *M. leibii*, were detected at a cave entrance more than once/night. For this species, the time between detections in the same night was 0.87 $\pm$ 0.09 hrs. Understanding these differences in torpor and arousal activity will help inform WNS management strategies.

Gray Bat Movement and Migrations in Tennessee

Cory Holliday
The Nature Conservancy of Tennessee

Due to their gregarious nature and endangered status, considerable research and management has been focused on gray bats in Tennessee. The majority of work to date has focused on their cave roost sites. Biologists are now making attempts to better understand the full spectrum of life history for multiple bat species, including Tennessee's gray bat. The Nature Conservancy is working with multiple partners in Tennessee and beyond to better understand and define gray bat behaviors and actions above ground. This includes foraging, migrating, and general habitat use outside of the cave environment. The Nature Conservancy will present preliminary results of their gray bat model and the results of active gray bat tracking efforts in Tennessee.