# MEETING PROGRAM

## 27th Annual Meeting of the Southeastern Bat Diversity Network

## and the

## 32nd Annual Colloquium on the Conservation of Mammals in the Southeastern U.S

**SBDN Virtual Meeting**
**March 9 – 10th, 2022**
**10 am – 5 pm EST**

## PROGRAM OVERVIEW

This two-day virtual meeting will bring together biologists, private and public land managers, private consultation organizations, educational institutions, and citizen scientists from across the Southeast. It will begin with working group meetings and early viewing of posters on Wed, March 9. The morning of Thurs, March 10 will include the plenary session and updates, followed by an afternoon for the SBDN Business Meeting, oral presentations from students, poster session, awards ceremony, and opportunities to socialize informally. We will conduct the meeting through a combination of Zoom and Gathertown **(Password: SBDN)** platforms. All aspects of the meeting other than the poster session can be accessed two ways: either by entering Gathertown and navigating through the virtual venue to the room described below and typing 'x', or using the direct Zoom link. We recommend using Gathertown to allow for networking opportunities

| **WEDNESDAY, MARCH 9, 2022** | | |
|---|---|---|
| **Time** | **Event** | **Location** |
| 10:00 am – 12:00 pm EST | Bat Marking Working Group | Zoom (Wed) or Gathertown (Working Group Room) |
| 12:00 – 12:30 pm EST | Break | Zoom (Wed) or Gathertown (Working Group Room) |
| 12:30 – 1:00 pm EST | Training for Judges | Gathertown (Posters A Room) |
| 1:00 – 3:00 pm EST | Bats in Transportation Structures Working Group | Zoom (Wed) or Gathertown (Working Group Room) |
| 3:00 – 5:00 pm EST | Eastern Spotted Skunk Working Group | Zoom (Wed) or Gathertown (Working Group Room) |

| **THURSDAY, MARCH 10, 2022** | | |
|---|---|---|
| **Time** | **Event** | **Location** |
| 10:00 – 11:30 am EST | Plenary and Updates | Zoom (Thurs) or Gathertown (Plenary/Business/Student Talks Room) |
| 11:30 am – 12:30 pm EST | Break | |
| 12:30 – 1:30 pm EST | SBDN Business Meeting | Zoom (Thurs) or Gathertown (Plenary/Business/Student Talks Room) |
| 1:30 – 3:30 pm EST | Student Oral Presentations | Zoom (Thurs) or Gathertown (Plenary/Business/Student Talks Room) |
| 3:30 – 4:45 pm EST | Poster Session | Gathertown (Posters A and Posters B) |
| 4:45 – 5:00 pm EST | Awards | Zoom (Thurs) or Gathertown (Plenary/Business/Student Talks Room) |

## GATHERTOWN PLATFORM INFORMATION

**Link: Gathertown**

**Password: SBDN**

**NOTE: we are calling the platform "Gathertown" in this document, but it is technically "gather.town".**

### Virtual Meeting Etiquette

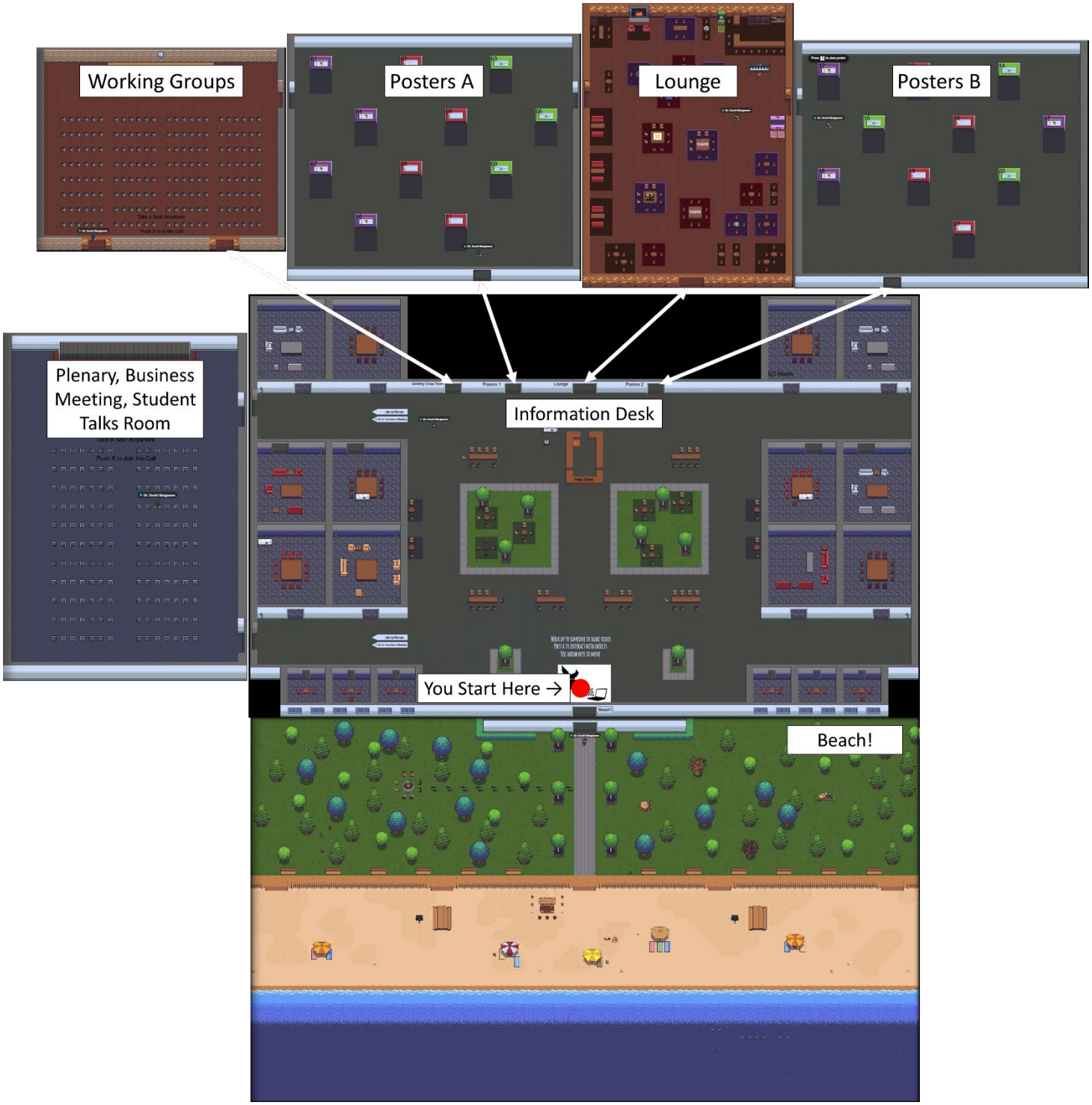
1) Please use your full name when naming your avatar. You can also add your affiliation (see video tutorial linked below)
2) Please mute yourself when you are not talking. This will help reduce echo and ensure conversations are understandable
3) Please keep your video on whenever you are active in Gathertown. This will help us simulate an actual conference as best possible!
4) Please don't stop your avatar (or logout) in front of doorways to ensure that everyone has access in and out of rooms.

### Gathertown Help

Check out the video tutorial for using Gathertown linked below. If you have any problems and need help, please visit the virtual information desk in the main lobby of the conference hall or contact Dr. Scott Bergeson (bergesos@pfw.edu; office phone: 260-481-6317). You can also ask anyone with an asterisk after their name (the SBDN executive committee) for help.

**VIDEO TUTORIAL - https://youtu.be/2e0ZlXrCm5U**

## SBDN Gathertown Map



## WEDNESDAY, MARCH 9, 2022

### Working Group Meetings

Location: Zoom (Wed) or Gathertown (Working Group Room)

**10:00 am – 12:00 pm EST**

Bat Marking Working Group

If you are a bat researcher, agency biologist, or oversee bat marking data or decisions, please attend this Bat Marking Working Group session to share your insights and experience with bat marking practices, management and uses of bat marking data, and observed adverse effects of marking on bats. Our working group is engaging with respondents across Canada, Mexico, and the United States with the aim of identifying inconsistencies across jurisdictions and, ultimately, providing guidance on best bat marking practices.

**12:00 – 12:30 pm EST - Break**

**12:30 – 1:00 pm EST**

Training for Judges

Location: Posters A Room

**1:00 – 3:00 pm EST**

Bats in Transportation Structures Working Group

Our Quarterly Call for the SBDN Bats in Transportation Structures Working Group will occur in conjunction with the SBDN Annual Meeting and Mammal Colloquium! If you're a practitioner in transportation, bat biology, or both, this group may interest you. During this meeting we will have a presentation by Andrew Logsdon of the Kentucky Transportation Cabinet focusing on a recent bridge replacement project with gray bat presence. We will also have plenty of time for open discussion on any and all topics related to bats in transportation structures. We hope you'll join us!

**3:00 – 5:00 pm EST**

Eastern Spotted Skunk Working Group

During the meeting of the Eastern Spotted Skunk Cooperative Study Group, we will have updates on our activities and discuss future priorities and coordination. Our group's goals are conservation of the eastern spotted skunk across their distribution through (1) enhancing communication about the species, (2) identifying management and resource priorities, and (3) facilitating collaborative planning, funding, outreach, monitoring, and research opportunities. We encourage the attendance of anyone interested in this species or our group's efforts.

## THURSDAY, MARCH 10, 2022

## Plenary, Business Meeting, Oral Presentations, Poster Session, Awards

Location: Zoom (Thurs) or Gathertown (Plenary/Business/Student Talks Room)

**10:00 – 11:30 am EST**

Plenary Session and Updates

### Plenary: Applications of New Technology and Approaches to Bat Conservation and Management

### An Open Science Vision for Bat Conservation

Cheng, Tina L.[1], Reichert, Brian[2], Frick, Winifred F.[1,3]

[1]*Bat Conservation International*

[2]*USGS North American Bat Monitoring Program*

[3]*University of California, Santa Cruz*

Bat conservation faces multiple and sometimes compounding stressors. Some stressors require long-term timelines for action (e.g., climate change) while others require rapid responses (e.g., emerging infectious diseases, such as white-nose syndrome). Data-driven conservation planning, both in the long and short-term, can be challenging given the lack of open availability of long-term data. However, where long-term data exist, additional barriers of data sharing to support reproducible analyses add compounded difficulties to achieving both consistent and rapid assessments that aid conservation decision-making. To overcome these challenges, we propose an open science vision for bat conservation that promotes a shared scientific and conservation culture toward community-based open data-sharing over propriety data privacy. I will share the use of open-source software in producing reproducible pipelines for data collation, data processing, data analysis, and data sharing. Ultimately, the adoption of open science practices in the bat community will support the ability to produce consistent (annual) and rapid assessments relevant to the timescale of conservation needs, while also connecting members of the bat conservation community together to work cohesively across borders relevant to the spatial scales

Dr. Tina Cheng is a data scientist at Bat Conservation International. She received a PhD from UC Santa Cruz; her dissertation examined various conservation-related solutions for conserving bats affected by the disease white-nose syndrome.

## New Approaches to Aid in our Understanding of Bat Migration

Wieringa, J.
*The Ohio State University*

Our understanding of bat migration has been limited by the amount and types of data we are able to collect. This is especially true when we compare our current understanding of bat migration to other flying species, such as birds. As a result, new techniques are needed to understand bat migration. One such approach is via the use of modeling species distributions and habitat suitability to determine least-cost-paths that predict the most likely migratory pathways used by these bats. I should note that the decision of where to migrate is a wholly individual choice for each bat, whereas this approach predicts the general patterns we would expect. My research suggests that *L. borealis* and *L. cinereus* likely follow linear features, while *L. noctivagans* is potentially a partially migratory species and more individuals may overwinter than previously thought. Another area where we can improve upon our understanding of bat migration is by determining the origin of individual bats after migration. Historically, researchers have used hydrogen isotopes to inform our understanding of these migrations, but other biomarkers are available. Trace elements are one such avenue and I show that they are a viable tool for determining the origin of migratory bats but are likely best served by combining trace elements with isotopes for better spatial resolution. When I combine multiple biomarkers, I find that we improve our spatial resolution to predict the origin of migratory bats for both *L. cinereus* and *L. borealis* but do not find the same to be true for *L. noctivagans*. Overall, the approaches highlighted offer new ways to inform our understanding of bat migration and could aid in their conservation.

Jamin Wieringa is currently at PhD candidate at The Ohio State University advised by H. Lisle Gibbs and Bryan C. Carstens. He has focused on the conservation of bats and developing approaches that can aid in our understanding of bat migration in the hopes of reducing wind farm mortality.

## Technologies to Monitor and Minimize Bat Mortality at Wind Energy Facilities

C. D. Hein
*National Renewable Energy Laboratory, Arvada, CO 80007*

Two decades of research indicates that certain species of bats are attracted to wind turbines. Several hypotheses as to why bats approach and interact with wind turbines exist, but the specific attractant(s) remain unknown. It is possible that attraction occurs at multiple scales, varies by species, and differs based on habitat. Understanding this behavioral aspect is key to reducing mortality. Monitoring bat behavior with wind turbines requires a suite of technologies. Acoustic detectors, thermal cameras, and strike indicators can provide real-time data at the turbine-scale, whereas radar and GPS tags or radio-transmitters can track facility-wide movements. Each technology has strengths and weaknesses, and it is often best to combine technologies to answer research questions. Strategies to minimize bat mortality include curtailing wind turbines during times when bats are at risk or using deterrents to reduce the bat activity near wind turbine. Historically, curtailment strategies incorporated wind speed and time (e.g., curtail above 5.0 m/s wind speed from mid-July to mid-August). Although proven effective, curtailment is not widely implemented because it impacts energy generation. New approaches use acoustic detectors to factor in real-time bat activity, which allows for greater energy production, while still reducing bat mortality. Acoustic deterrents are devices installed on the wind turbine that emit ultrasound within the minimum frequency range of most North American bats (i.e., 20–50 kHz). Although deterrents do not impact energy production, their effectiveness varies by species and location. One limitation of deterrents is the rapid attenuation of ultrasound. Given modern turbine blades range from 50–90 m in length, it can be difficult to extend the signal beyond the rotor-swept area to deter bats. Research on deterrents continues to better understand specific-species responses to different frequencies and patterns, and where to install the devices on wind turbines to maximize the ensonified airspace.

Dr. Cris Hein is the Senior Project Leader for the Environmental Portfolio at the National Renewable Energy Laboratory. Cris received his Ph.D. in Forestry and Natural Resources from the University of Georgia in 2008. Cris has studied bat behavior and ecology for 24 years, with the last 15 years focused on bats and wind energy interactions.

## Updates

- **USFWS survey guidance & listing decisions** – Mike Armstrong
- **WNS updates** – Pete Pattavina
- **NABat updates** – Bethany Straw

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**11:30 – 12:30 pm EST – Break**

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**12:30 – 1:30 pm EST**

Location: Zoom (Thurs) or Gathertown (Plenary/Business/Student Talks Room)

## SBDN Business Meeting

12:30 pm - Call to Order, Introductory Remarks – Holly Ober

12:35 pm - Treasurer's Report – Luke Dodd

12:40 pm - Committee Reports

- Website Committee – Jason Robinson
- NASBR and State Agency Rep Committee – Trina Morris
- Bat Blitz Committee – Pete Pattavina
- Membership Committee – Rada Petric

1:05 pm - Future Meetings – Scott Bergeson

1:15 pm - Other Business Membership

- Southeastern Bat Hub – Susan Loeb

**1:30 – 3:30 pm EST**

Student Oral Presentations

Location: Zoom (Thurs) or Gathertown (Plenary/Business/Student Talks Room)

*Underline indicates presenting author*
*Asterisk (*) indicates student author*
*Complete abstracts located at the end of the program (starting at pg. 14)*

| Time | Presentation |
|---|---|
| 1:35 – 1:45 pm | **USING PASSIVE ACOUSTIC MONITORING TO ESTIMATE INDIANA BAT (*MYOTIS SODALIS*) POPULATION SIZE**<br>M. L. Hoggatt*, C. A. Starbuck, and J. M. O'Keefe |
| 1:45 – 1:55 pm | **TRI-COLORED BAT MICROSITE USE THROUGHOUT HIBERNATION IN THE SOUTHERN BLUERIDGE MOUNTAINS**<br>R. L. Brown*, S.C. Loeb, and S.L. Rodriguez |
| 1:55 – 2:05 pm | **SEASONAL AND SEX-SPECIFIC CHANGES IN THE GASTROINTESTINAL TRACT OF *PEROMYSCUS MANICULATUS***<br>O. S. Chapman*, B. S. McLean |
| 2:05 – 2:15 pm | **VARIATION IN TRI-COLORED BAT BODY MASS IN RESPONSE TO WINTER HIBERNACULUM ROOST SELECTION IN GEORGIA, U.S.A.**<br>Emily Ferrall*, Brian Irwin, Katrina Morris, Jeffrey Hepinstall-Cymerman, Steven Castleberry |
| 2:15 – 2:25 pm | **SOUTHEASTERN FOX SQUIRREL OCCUPANCY AND HABITAT ASSOCIATIONS OF THE PIEDMONT AND COASTAL PLAIN REGIONS OF VIRGINIA**<br>Marissa H. Guill***,** W. Mark Ford, Jesse De La Cruz, Marc Puckett, Scott D. Klopfer, and Brandon Martin |
| 2:25 – 2:35 pm | **TO TREE OR NOT TO TREE: FACTORS INFLUENCING SELECTION OF ROOST TYPE BY FEMALE INDIANA BATS IN THE BLUEGRASS REGION OF KENTUCKY**<br>S. K. Howe*, J. M. O'Keefe, and L. E. Dodd |
| 2:35 – 2:45 pm | **NORTHERN LONG-EARED BATS IN THE CENTRAL APPALACHIANS FOLLOWING WHITE-NOSE SYDROME: FAILED MATERNITY COLONIES?**<br>N. J. Kalen*, M.S. Muthersbaugh, J. B. Johnson, A. Silvis, and W. M. Ford |

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|---|---|
| 2:45 -2:55 pm | **A COMPARISON OF BAT DETECTIONS RECORDED BY TWO ACOUSTIC MONITORS**<br>Jane M. Kunberger* and Ashley M. Long |
| 2:55 – 3:05 pm | **INFLUENCE OF URBANIZATION AND WATER QUALITY ON SOUTHERN APPALACHIAN INSECTIVOROUS BATS AND ARTHROPODS**<br>R. Maunus*, N.E. Meiri*, and R. Petric |
| 3:05 – 3:15 pm | **WATER-WORKS? EFFECTS OF HYDROLOGIC RESTORATION ON THE FORAGING BEHAVIOR OF THE ENDANGERED FLORIDA BONNETED BAT**<br>L. P. Nicholson*, E. C. Braun de Torrez, and H. K. Ober |
| 3:15 – 3:25 pm | **TRI-COLORED BAT FORAGING SITE USE AND SELECTION DURING THE SPRING AND FALL IN NORTHWESTERN SOUTH CAROLINA**<br>E. Rosales*, S. C. Loeb, and D. S. Jachowski |

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## 3:30 – 4:45 pm EST

Poster Session

Location: Gathertown (Posters A room: 1- 11; and Posters B room: 12-21)

*Number beside the title indicates the poster number in the poster session. Posters 1-11 will be in room Posters A; Posters 12-21 will be in room Posters B.*
*Posters Listed alphabetically by first author*
*Underline indicates presenting author*
*Asterisk (*) indicates student author*
*Complete abstracts located at the end of the program (starting at pg. 23)*

1. **EFFECTS OF GATE INSTALLATION ON CAVE INTERNAL MICROCLIMATE**
   J. R. Anderson*, C. T. Cornelison, S. C. Loeb, T. C. McElroy, and A. J. Edelman

2. **PATTERNS OF SMALL MAMMAL ABUNDANCE ACROSS MICROHABITATS OF PINE MOUNTAIN**
   S. E. Baker* and L. E. Dodd

3. **CAMERA SURVEYS FOR ALLEGHENY WOODRAT ALONG THE PINE MOUNTAIN WILDLANDS CORRIDOR**
   M. E. Beckner*, H. F. Blevins, L. E. Dodd

4. **ROOST SELECTION BY A MATERNITY COLONY OF NORTHERN LONG-EARED BATS (*MYOTIS SEPTENTRIONALIS*) IN AN URBAN-ADJACENT WETLAND**
   G. Burrell*,* and S.M. Bergeson

5. **EVALUATION OF SURVEY METHODS USED TO DETERMINE SEMI-AQUATIC MAMMAL OCCUPANCY IN NORTHEASTERN INDIANA**
   E. L. Di Girolamo*, G. Albers, M. A. Jordan, B. A. Kingsbury, and S. M. Bergeson

6. **FORAGING AND ROOSTING ECOLOGY OF *LASIURUS BOREALIS*, *NYCTICEIUS HUMERALIS*, AND *EPTESICUS FUSCUS* ON ARNOLD AIR FORCE BASE, TENNESSEE**
   M. R. Evans and S.T. Samoray

7. **THE BAT-SIGNAL: USE OF AN ULTRAVIOLET LURE TO INCREASE ACOUSTIC DETECTION OF BATS**
   Samuel R. Freeze*, Sabrina Deeley, and W. Mark Ford

8. **SUMMER DAY-ROOST SELECTION BY SEMINOLE BATS IN COASTAL SOUTH CAROLINA**
   S. J. Holst and L. H. Moore

9. **EVALUATING BAT ROOST ABUNDANCE: A COMPARISON OF DRONE-ACQUIRED THERMAL IMAGERY AND ACOUSTIC RECORDINGS WITH HUMAN OBSERVERS**
   K. Jaffe*, R. Carter, A. Corcoran, and G. Arceo-Gómez

10. **COMPARING EFFECTIVENESS OF AHDRIFT SYSTEMS AND SHERMAN TRAPS FOR SURVEYING SMALL MAMMALS IN NORTHEASTERN INDIANA**
    C.L. White, L.J. Jenkins*, T.L. Proctor, M.A. Jordan, and S.M. Bergeson

11. **SURVEYS OF TRICOLORED BAT WINTER-ROOST STRUCTURES ON EGLIN AFB AND HURLBURT FIELD, 2019-2022**
    L. Ketzler

12. **TRICOLORED BATS OVERWINTER IN CULVERTS IN CAVELESS SOUTHERN ARKANSAS**
    A. Lamb*, R.W. Perry, and V. Rolland

13. **COMMUNITY SCIENCE HELPS REVEAL SPECIES-SPECIFIC EFFECTS IN BAT ROAD ECOLOGY**
    H. Li, K. Etchison, and K. Clark

14. **BATS OF THE WACCAMAW NATIONAL WILDLIFE REFUGE**
    S. C. Loeb, E. A. Winters, and D. M. Wells

15. **CHANGES IN THE FOREST BAT COMMUNITY AFTER ARRIVAL OF WHITE-NOSE SYNDROME IN THE OUACHITA MOUNTAINS OF ARKANSAS**
    Roger W. Perry, and Phillip N. Jordan

16. **BAT FORAGING ACTIVITY IN RESPONSE TO SHIFTS IN INSECT AVAILABILITY CAUSE BY PRESCRIBED FIRE MANAGEMENT IN THE SOUTHERN APPALACHIANS**
    Andrew Pitt*, Jonathan Stober, Joseph Johnson and Andrew Edelman

17. **HAS THE ENDEMIC OZARK POCKET GOPHER (*GEOMYS BURSARIUS OZARKENSIS)* EXPANDED ITS DISTRIBUTION?**
    Monica Reusche*, Ronald Johnson, and Virginie Rolland

18. **THE RESPONSE OF BATS AND THEIR INSECT PREY TO DIFFERENT COASTAL UPLAND HABITAT MANAGEMENT TECHNIQUES**
    Mandy Sartain*, Eric Sparks, Scott Rush, and Jonathan Pitchford

19. **TEMPORAL VARIATION IN BAT USE OF CULVERTS IN NORTH FLORIDA**
    Lisa M. Smith, Terry J. Doonan, and Jeffery A. Gore

20. **DISTRIBUTION AND DISEASE SURVEYS OF NINE-BANDED ARMADILLO IN TENNESSEE USING ROADKILL AND COMMUNITY SCIENCE DATA**
    C. M. Turner*, T. P. Wilson, W. J. Loughry, and T. J. Gaudin

21. **THE LONG WAY HOME: ONE GRAY BAT'S JOURNEY THROUGH MIDDLE TENNESSEE**
    T. A. N. Wetzel and S. T. Samoray

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## 4:45 – 5:00 pm EST

Awards

Location: Zoom (Thurs) or Gathertown (Plenary/Business/Student Talks Room)

Student Awards will be given for Best Bat and Best Overall Posters, and Best Bat and Best Overall Oral Presentations.

## STUDENT ORAL PRESENTATION ABSTRACTS

*Underline indicates presenting author*
*Asterisk (*) indicates student author*

**TRI-COLORED BAT MICROSITE USE THROUGHOUT HIBERNATION IN THE SOUTHERN BLUERIDGE MOUNTAINS**

R. L. Brown*, S.C. Loeb, and S.L. Rodriguez
*Clemson University, Clemson, SC 29634 (RLB, SLR); Southern Research Station, USFS, Clemson, SC 29634 (SCL).*

Tri-colored Bat (*Perimyotis subflavus*) populations have plummeted at hibernacula infected with *Pseudogymonascus destructans.* The number of Tri-colored Bats hibernating in Stumphouse Tunnel (Walhalla, SC) declined by more than 90% in the years following the arrival of white-nose syndrome (WNS). The population appears to be stabilizing and slightly increasing in the last several years, which has been associated with a significant increase in the proportion of bats using the colder, front and publicly accessible section of the tunnel during the annual February census. Our objectives were to determine whether Tri-colored Bats use the front tunnel section throughout hibernation or if they move forward toward the end of hibernation, and how this relates to roost microclimate. We conducted monthly censuses of bats in the tunnel November 2020 - March 2021. For each bat we recorded species, distance from the entrance, wall temperature, and relative height on the wall. There were no significant differences in use of tunnel sections between months, but the proportion of bats using the front of the tunnel remained higher than pre-WNS. For all months, temperatures at roost sites were significantly colder in the front section of the tunnel. Use of the upper third of the wall (~4.7-7 m) was significantly higher in the front section than the back section. There was a significant interaction between relative wall height and tunnel section on roost temperatures; temperatures at roost sites were warmest on the upper third of the wall in the front and back sections, but the difference was much greater in the front section. Whether bats were using higher roosts to avoid colder temperatures, human disturbance, predators, or a combination is unclear. It is important to consider how to better manage this site and protect the bat population from human activity in the front section of the tunnel.

**SEASONAL AND SEX-SPECIFIC CHANGES IN THE GASTROINTESTINAL TRACT OF *PEROMYSCUS MANICULATUS***

O. S. Chapman*, B. S. McLean
*Department of Biology, University of North Carolina at Greensboro, Greensboro, NC, 27413 (OSC and BSM).*

Functional traits are critical parameters that help explain how species persist in varied environments. In mammals, categorical and quantitative functional traits derived from skeletal tissues have been extensively utilized, but there has been a lesser focus on continuous functional measurements of soft tissues. This is particularly true for the digestive system, which plays a major role in the dietary ecology of species. To guide more effective utilization of gastrointestinal (GI) morphology as a functional trait in small mammals, we examined how GI tracts (lengths and masses of four GI sections) vary within a population of deer mice (*Peromyscus maniculatus*) in the Southern Appalachian Mountains of North Carolina, USA. We collected monthly samples of adult *P. maniculatus* during 2021 and measured these GI traits to determine the variation with seasonality and food availability, providing insight into how this soft tissue trait varies over time within this population. We found that both season and reproductive activity had a significant effect on the total length of the GI tract, and season had a significant effect on the wet mass of the GI tract. GI lengths and wet masses varied over the course of the year such that January mice had the longest GI tracts and lengths decreased into the summer, before rising again in the fall and the beginning of winter. Mice that were reproductively active (pregnant, lactating, or scrotal) had significantly longer GI tracts than those that were not reproductively active. Our study provides proof-of-concept for how rarely-collected soft tissue traits might be used to understand community assembly across ecological gradients, and that they provide an important functional dietary proxy that is complementary to standard craniodental measurements.

**VARIATION IN TRI-COLORED BAT BODY MASS IN RESPONSE TO WINTER HIBERNACULUM ROOST SELECTION IN GEORGIA, U.S.A.**

Emily Ferrall*[1,2], Brian Irwin [1,3], Katrina Morris[2], Jeffrey Hepinstall-Cymerman[1], Steven Castleberry[1]
[1] *Warnell School of Forestry & Natural Resources, University of Georgia, Athens, GA, 30602, USA*
[2] *Wildlife Conservation Section, Wildlife Resources Division, Georgia Department of Natural Resources, Social Circle, GA, 30025, USA*
[3] *U.S. Geological Survey, Georgia Cooperative Fish & Wildlife Unit, Athens, GA 30602, USA*

White-nose syndrome (WNS) has led to the death of millions of cave-dwelling bats by causing them to lose vital fat reserves from repeated arousals during hibernation. The tri-colored bat (*Perimyotis subflavus*) was once a common species in the eastern U.S. but has suffered high mortality due to WNS in the core of its range where it primarily hibernates in caves. In areas

without caves, tri-colored bats are known to use road culverts as roosts. *Pseudogymnoascus destructans* (*Pd*), the fungal pathogen that causes WNS, has been detected in culverts in Georgia, but WNS has not been observed. Given that prior research has shown bat survival is highly dependent on body mass entering hibernation, our objective was to determine if tri-colored bat body mass varied by gender, survey site, roost location, seasonal survey timing, site latitude, and WNS status. We surveyed 32 culvert and 4 cave roosts in winter 2019-2021 and measured mass, forearm length, and assigned a WNS wing damage score for 711 individuals in early and late hibernation. We used linear mixed models to determine how body mass was influenced by our covariates. We found that mass was lower during late season than early season surveys and bats at *Pd* negative sites weighed less than at WNS and *Pd* positive sites. Additionally, female tri-colored bats weighed more on average than males regardless of roost type and survey timing. The results of this study highlight variations in tri-colored bat body mass throughout Georgia, which may alter their susceptibility to WNS. Understanding which tri-colored bats are most at-risk can guide managers on where to focus winter monitoring efforts and potential WNS-treatment trials.

**SOUTHEASTERN FOX SQUIRREL OCCUPANCY AND HABITAT ASSOCIATIONS OF THE PIEDMONT AND COASTAL PLAIN REGIONS OF VIRGINIA**

Marissa H. Guill***,** W. Mark Ford, Jesse De La Cruz, Marc Puckett, Scott D. Klopfer, and Brandon Martin

*Department of Fish and Wildlife Conservation, Virginia Tech, Blacksburg, VA 24060 (MHG)*
*U.S. Geological Survey, Virginia Cooperative Fish and Wildlife Research Unit, Blacksburg, VA 24060 (WMF); Conservation Management Institute, Virginia Tech, Blacksburg, VA 24060 (JDLC and SDK)*
*Virginia Department of Wildlife Resources, Farmville, VA 23901 (MP); Environmental and Natural Resources Management Division of Public Works, Fort Pickett, Blackstone, VA 23824 (BM)*

In Virginia, fox squirrel (*Sciurus niger*) populations are still present in the Delmarva Peninsula and west of the Piedmont in the Appalachians. However east of mountains particularly in the lower Piedmont and Coastal Plain, fox squirrels are rare and patchily distributed, especially the Southeastern subspecies *S. n. niger*. Regionally, suitable habitat has been subjected to fragmentation and degradation of mixed pine-hardwood forests and bottomland hardwoods by conversion to agriculture and plantation forestry, as well as decades of fire suppression. From fall 2019 to the present, we conducted continual camera-trapping and nest box grid surveys for fox squirrels on the Big Woods/Piney Grove complex in the Coastal Plain and at Fort Pickett in the lower Piedmont. These areas contain among the largest and most intact pine savanna and mixed pine-hardwood forest patches remaining in southeastern Virginia. Our results indicated a low level of site occupancy and daily detection probability of southeastern fox squirrels at the Big Woods/Piney Grove complex, $\Psi = 0.23$, $\rho = 0.06$ across pine savanna, pine plantations, mixed pine-hardwood and bottomland habitats. Fox squirrels appear to be absent from Fort Pickett. Our top models explaining fox squirrel occupancy and detection at the Big Woods/Piney Grove complex

highlight the importance of the fall season, pine dominated habitats, and decreased basal area. Results from occupancy and detection also reflect competitive exclusion of fox squirrels from hardwood bottomlands where gray squirrels *(Sciurus carolinensis*) were detected over fox squirrels. Data from our pilot survey will be used to conduct future focal live-trapping to catch and radio-collar fox squirrels for home range and habitat use analyses at Big Woods/Piney Grove complex.

**USING PASSIVE ACOUSTIC MONITORING TO ESTIMATE INDIANA BAT (*MYOTIS SODALIS*) POPULATION SIZE**

M. L. Hoggatt*, C. A. Starbuck, and J. M. O'Keefe
*Department of Natural Resources and Environmental Sciences, University of Illinois at Urbana-Champaign, Urbana, IL 61801 (AMM and CAD).*

Surveys to estimate bat populations are typically conducted during the winter, though this is only feasible for bats that aggregate during winter. While it is essential to measure summer bat population sizes for management, we have not identified a reliable method. Acoustic surveys have promise, as this is a are less expensive and more efficient method than mist-net surveys. Passive acoustic monitoring is often used to gather data for population indices such as distribution, activity, and occupancy. We assessed the application of generalized random encounter models for estimating Indiana bat population density. We conducted summer acoustic surveys at six conservation areas in northeast Missouri over a period of three years (2019—2021). We investigated the effects of year, volancy period, and conservation area. Our density estimates were greater overall than either mist-net capture counts or roost exit counts. While we captured a maximum of 17 Indiana bats and observed a maximum of 234 bats emerging from roosts for any one of the six conservation areas, we estimated population sizes ranging from 0—2,228 for each conservation area. We will use these models to assess factors affecting Indiana bat density estimates and to validate the use of acoustics as a means of estimating population size.

**TO TREE OR NOT TO TREE: FACTORS INFLUENCING SELECTION OF ROOST TYPE BY FEMALE INDIANA BATS IN THE BLUEGRASS REGION OF KENTUCKY**

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In addition to using natural roosts, Indiana bats (*Myotis sodalis*) form maternity colonies in artificial roosts such as bat boxes and bark-mimic structures. However, few Indiana bat study systems contain multiple artificial roost types alongside natural roosting options. Our research

focuses on determining biotic and abiotic factors that influence the selection of roost type and roost characteristics. Our field site in the Bluegrass Region of Kentucky (Veterans Memorial Wildlife Management Area) contains 12 rocket box roosts and 19 bark-mimic roosts across various positions in a forested landscape. From April through September 2021, we radio-tagged and tracked 12 female Indiana bats to day roosts, collecting DBH, roost structure height, decay stage, and canopy closure measurements. We also collected hourly temperature and humidity measurements at some artificial roosts using iButtons, daily wind speed using a Kestrel weather meter, and precipitation from the US National Weather Service. We surveyed for potential natural roost availability within fifty 50×50-m plots stratified across the entire 1010-ha ownership. Despite finding a wide range of natural roosting options, Indiana bats were tracked more often to artificial roosts (24 of 27 recorded roosts were artificial, and 72 of 75 roost-days were in artificial structures). Of artificial roosts, bark mimic roosts were recorded more often than bat boxes (14 of 24 artificial roosts were bark-mimic structures, and 40 of 72 roost-days were in bark-mimic roosts). Further analyses will exam the role of reproductive status and weather on roost habitat selection.

**NORTHERN LONG-EARED BATS IN THE CENTRAL APPALACHIANS FOLLOWING WHITE-NOSE SYDROME: FAILED MATERNITY COLONIES?**

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Northern long-eared bat (*Myotis septentrionalis*) populations have experienced severe declines in eastern North America from white-nose syndrome (WNS), yet potential secondary effects on maternity roosting and recruitment remain largely unknown. We documented female day-roosting at two locations in the central Appalachians of Virginia, Back Creek Mountain (BCM) and Rapidan Camp (RC) during 2015-2016, approximately six years after the regional onset of WNS. We compared roost characteristics with available trees and roosts recorded prior to WNS at the Fernow Experimental Forest (FEF), West Virginia in 2007 and 2008. Roosts at BCM were smaller than pre-WNS roosts but were otherwise similar in terms of stand condition and species use, though bats selected for red maple (*Acer rubrum*) at BCM rather than black locust (*Robinia pseudoacacia*) as at FEF. At RC, bats roosted almost exclusively in large eastern hemlock (*Tsuga canadensis*) snags (dbh = 50.13 ± 23.1 cm) with high solar exposure that had recently been killed by the hemlock woolly adelgid (*Adelges tsugae*). These two strategies correspond with pre-WNS observations of female northern long-eared bat roost use. However, our results suggest reliance

on smaller roosts and canopy-dominant positions that better accommodate solitary individuals and small groups associated with smaller post-WNS colonies in terms of space and thermoregulatory benefits. Despite some observations of pregnant and lactating individuals, all three post-WNS colonies vacated roost networks in early June, and we observed no juveniles. Potential colony failure at BCM and RC are consistent with predicted secondary physiological effects from WNS-induced population collapses, suggesting, if recruitment failed, northern long-eared bats may already be functionally extirpated in portions of the central Appalachians.

**A COMPARISON OF BAT DETECTIONS RECORDED BY TWO ACOUSTIC MONITORS**

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Recent advances in low-cost automated recording unit (ARU) technology have made large-scale bat monitoring projects more practical than ever, but several key features of ARUs (e.g., microphone quality, triggering thresholds) can influence an ARUs ability to detect and record bats. As such, it is important to quantify and report variation in ARU performance as new recording systems become available. We used automated classification software—SonoBat—to compare the number of call files, echolocation pulses, and species recorded by a commonly used, full-spectrum bat detector—the Song Meter SM4BAT-FS—and a less expensive, open source ARU that can detect ultrasound—the AudioMoth. We deployed paired monitors at several study sites in Louisiana during breeding (June–August) and non-breeding (December–February) periods in 2020 and 2021. We found that SonoBat detected bat activity on more nights from SM4BAT recordings compared to AudioMoth recordings. Further, SonoBat identified more call files to species, call files with high frequency bat calls, echolocation pulses, and species from SM4BAT recordings compared to AudioMoth recordings during all of our sampling periods. Conversely, we found that SonoBat identified a similar number of call files with low frequency bat calls between monitors during three of the four sampling periods, and that SonoBat identified more call files identified as hoary bats (*Lasiurus cinereus*) from AudioMoth recordings compared to SM4BAT recordings. Our results likely reflected differences in microphone sensitivities, recording specifications, and housing units, and reiterate that researchers should consider all factors (e.g., cost, recording quality, detectability) when they select an ARU, compare data sets obtained using different systems, or use ARU data to inform management or policy decisions.

**INFLUENCE OF URBANIZATION AND WATER QUALITY ON SOUTHERN APPALACHIAN INSECTIVOROUS BATS AND ARTHROPODS**

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As urbanization and concomitant pollutants rise in conjunction with the human population, freshwater sources are increasingly becoming compromised by urban development and chemical contamination. Degraded water quality reshapes the diversity and abundance of arthropod communities, which may in turn influence the composition of insectivorous bat communities. Bat populations are similarly sensitive to changes in water quality and urbanization, making it essential to understand how changing land cover and land use influences freshwater resources, aquatic arthropods, and bat community dynamics. In this study, we investigated nocturnal arthropods and insectivorous bats at 32 water bodies along a rural-exurban-urban gradient using light traps and acoustic recorders in the southern Appalachian Mountains of western North Carolina, USA. We took temperature, turbidity, and dissolved oxygen measurements at each site to assess water quality. We found no correlation between urbanization level and the water quality metrics we used. Total bat activity was the highest in areas with a medium disturbance level; however, individual species responded uniquely, and sometimes oppositely, to disturbance. Moreover, arthropod biomass was highest in areas of low disturbance, demonstrating that both bat activity and arthropod biomass are affected by disturbance, but there was no significant correlation between activity and biomass at varying disturbances. The results of this study highlight the importance of a species-specific approach to bat conservation and point to the need for future research on the intricacies of the relationship between bat activity, arthropods, water quality, and anthropogenic disturbance.

**WATER-WORKS? EFFECTS OF HYDROLOGIC RESTORATION ON THE FORAGING BEHAVIOR OF THE ENDANGERED FLORIDA BONNETED BAT**

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Wetlands provide critical foraging habitat for bats, but over half of wetlands worldwide have been degraded or destroyed. Although wetland restoration efforts have recently become more common, little is known about the effects of such efforts on bats. Understanding the potential impact of these landscape changes is particularly important for the endangered Florida bonneted bat (*Eumops floridanus*), given that much of the species' geographic range is covered in

wetlands that face increasing threats from development and sea level rise. We investigated the impacts of a large-scale hydrologic restoration project expected to affect over 2.5 million acres of wetlands and estuaries in the Florida Everglades. We conducted acoustic surveys at 194 detector sites in 2020 and 2021. Detectors recorded at each site for 16 total nights during 4 distinct sample periods spanning the dry and wet seasons. Sites were randomly stratified across a restoration gradient (unrestored, partially restored, restored) and compared with reference areas. Hydrologic and vegetation metrics were measured at each site to investigate drivers of bat activity in the context of wetland restoration. Acoustic files were classified in Kaleidoscope Pro and all Florida bonneted bat calls were manually verified. We describe patterns of bat activity relative to restoration categories and the relative importance of hydrologic and vegetative characteristics in driving habitat selection by Florida bonneted bats. Insights from this study will inform immediate management decisions for this endangered species and contribute to our understanding of how bats more broadly are influenced by hydrologic and subsequent vegetative changes in wetlands.

**TRI-COLORED BAT FORAGING SITE USE AND SELECTION DURING THE SPRING AND FALL IN NORTHWESTERN SOUTH CAROLINA**

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Recent studies focusing on factors affecting bat survival and population recovery from WNS suggest the importance of fat reserves pre- (fall) and post- (spring) winter hibernation. Tricolored bats (*Perimyotis subflavus*) have received very little study but are one of the four most impacted bat species by WNS and have experienced some of the largest population declines. Our goal was to determine suitable foraging habitat of tricolored bats in northwestern South Carolina during the spring (March-May) and fall (September-November). We determined occupancy at the same 68 sites during spring and fall using acoustic detectors, and related tricolored bat occupancy to season, past forest management, forest structure, and forest composition. We stratified stands on the Andrew Pickens Ranger District (APD) of the Sumter National Forest using forest type and past forest management, and selected sites using the spatially balanced Generalized Random Tessellation Stratified sampling design. We placed acoustic detectors at selected sites for 3 nights and recorded vegetation along with landscape data from each site. We identified bat calls using Kaleidoscope Pro software, and calls identified as tricolored bats were manually vetted. We ran single season occupancy models to assess habitat use. During spring, occupancy was greater at sites with less canopy cover. During fall, occupancy was greater at sites with less basal area and at sites with less canopy cover. Our results suggest the importance of open habitat for suitable foraging sites pre- and post- winter hibernation in northwestern South Carolina. Because access to open habitat likely minimizes energy expenditure and enhances fat reserves, forest management

that increases open habitat may provide tricolored bats greater chances of survival and recovery of WNS.

# POSTER ABSTRACTS

*Posters Listed alphabetically by first author*
*Underline indicates presenting author*
*Asterisk (*) indicates student author*

## 1. EFFECTS OF GATE INSTALLATION ON CAVE INTERNAL MICROCLIMATE

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North American bats are threatened by factors such as land use, habitat destruction, and habitat disruption. Gate installation at entrances to subterranean sites (caves and mines) reduces anthropogenic activity and protects bats from the spread of diseases such as white-nose syndrome. Internal climate conditions such as temperature and humidity may change post gate construction depending on gate type. We examined how entrance gates impacted microclimatic conditions at Weaver Cave, Alabama. To determine if gates caused significant changes in cave microclimate, we compared the difference between ambient and cave conditions for temperature and relative humidity pre-installation of gates during the 2020-2021 winter season and are continuing to monitor post-installation during the 2021-2022 winter season to evaluate potential changes to internal conditions. The internal average temperature within the cave ranged from 17.1°C - 10.2°C during the first year and 12.0 °C - 17.3°C during the second year and was dependent on location within the cave. Average humidity ranged from 82.9% - 102.7% during the first year and 103.3% - 99.4% during the second year. Broader implications of studying effects of gate construction on internal microclimates will contribute to monitoring efforts to understanding the effects of gate installation as well as understanding hibernacula selection among bats.

## 2. PATTERNS OF SMALL MAMMAL ABUNDANCE ACROSS MICROHABITATS OF PINE MOUNTAIN

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Surveys for cryptic small mammals are challenging due to their reclusive behavior and low trap success. Pine Mountain, located along the Virginia border, possesses a variety of forest types and stand conditions uncommon in other parts of Kentucky. The most recent organized records for small mammals on Pine Mountain date to the 1990's. The objective of our investigation was to assess variation in patterns of small mammal abundance at the microscale along this unique

physiographic region. We deployed pitfall traps across sites in Harlan and Letcher counties (14 plots across four nature preserves, for 140 pitfall traps total). Plots within study areas ranged across the elevational gradient of Pine Mountain (ca. 450-800 m above sea level), and trap locations within plots were selected to maximize trap success. Traps were left open continuously from May 2021 through November 2021. Concurrent with checking traps at least monthly, we measured microhabitat conditions at trap locations, including soil moisture and temperature, leaf litter and duff depth, canopy closure (%), and cover (%) of mountain laurel (*Kalmia latifolia*) and rhododendron (*Rhododendron spp.*). Standard measurements (hind foot length, tail length, total length, ear length, and weight) were taken for each small mammal collected. We skeletonized and identified all small mammals collected in traps, and will use principal components analyses to identify which microhabitat characteristics explain the most variation in patterns of small mammal abundance. In total, we have accessioned 93 skeletons from three genera to the Eastern Kentucky University Mammal Collection. Data from our analyses will inform land management along Pine Mountain, and help identify important habitat conditions for a species group in need of greater attention.

**3. CAMERA SURVEYS FOR ALLEGHENY WOODRAT ALONG THE PINE MOUNTAIN WILDLANDS CORRIDOR**

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The Allegheny woodrat (*Neotoma magister*) has shown significant population declines and a narrowing distribution since the early 1900's. Declines have been attributed to numerous reasons, but are historically associated with the species' habitat requirements specific to high elevation rocky outcrops. Further, rugged terrain limits the ability of researchers to access these isolated habitat fragments, which can result in low detection rates and high costs of effort. While the species has been recorded in Kentucky, expanded survey efforts are needed. Our objective was to survey for the presence of Allegheny woodrat along the Pine Mountain Wildlands Corridor near the Virginia border where contemporary data for the species exist. We deployed camera traps across three study areas on the south side of Pine Mountain in Harlan and Letcher counties during the summer of 2021. In total, 93% of our 15 camera traps recorded the Allegheny woodrat across 277 total trap nights. Additionally, camera traps were deployed at Lilley Cornett Woods, a field station to the north of Pine Mountain where 61% of our 18 camera traps recorded presence across 236 total trap nights. These data suggest widespread presence of the species in counties adjacent to Virginia. For 2022, anticipated field efforts will include expanded camera surveys along Pine Mountain concurrent with surveys for raccoon latrines. Contemporary assessment of woodrat populations coincident with the prevalence of a pathogenic threat (raccoon roundworm) in

eastern Kentucky is critical for actionable conservation efforts for the species; our data provide an important first step towards addressing this need.

**4. ROOST SELECTION BY A MATERNITY COLONY OF NORTHERN LONG-EARED BATS (*MYOTIS SEPTENTRIONALIS*) IN AN URBAN-ADJACENT WETLAND**

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Throughout the Midwestern United States, shifts in land use towards agriculture and urban development have reduced undisturbed natural areas, with a disproportionate effect on forests and wetlands. The compounding effects of this habitat loss and the spread of white-nose syndrome have resulted in precipitous population declines of several forest obligate bat species. We studied the roost selection of a small maternity colony (≤ 8 bats based on emergence counts) of state endangered, federally threatened northern long-eared bats (*Myotis septentrionalis*) in a wetland adjacent to Fort Wayne, IN. We attached radio transmitters to juvenile and adult female northern long-eared bats during the summers of 2019-2021. We tracked bats back to roosts where we measured roost characteristics and performed emergence counts. For each new roost observed, we randomly selected another available tree within the flight distance to the original capture location and measured the same roost characteristics. Over the course of 70 net nights, we tracked 4 individuals (1 juvenile male, 1 post-lactating female, and 2 lactating females) to 12 different roosts. The majority of roosts (83.3%) were located in a severely flooded stretch of forest with a large number of snags. Roost trees (primarily silver maple snags) were an average of 5.5% wider in diameter, 30.4% taller, and had 23.0% more remaining bark compared to other available trees. However, both roosts and available trees had roughly equal amounts of canopy closure. Snags were 3.5 times more abundant and live trees were 4 times less abundant within 18 meters of roost trees. Bats in this maternity colony seem to select more for forest plots that contain high roost availability than trees with specific roost characteristics (except for tree height). By describing roosts within this landscape, we can provide insight into how this threatened species might persist in urban-agricultural landscapes like Fort Wayne.

**5. EVALUATION OF SURVEY METHODS USED TO DETERMINE SEMI-AQUATIC MAMMAL OCCUPANCY IN NORTHEASTERN INDIANA**

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The American mink (*Neogale vison*) is a semi-aquatic mammal in the Mustelidae family. Their elusive and cryptic nature makes determining occupancy difficult. Thus, little is known about their distribution in Indiana. Environmental DNA (eDNA) has been an effective tool for surveying cryptic species (e.g., eastern hellbender, Kirtland's snake). Our objective is to evaluate the effectiveness of eDNA as a method for determining American mink occupancy. We sampled 7 bodies of water around Fort Wayne, Indiana that are surrounded by both rural and urban land cover. We collected ten 1L water samples from each site, once a week, for 3 weeks. We filtered 500mL from each sample and stored the filtrate in a −20℃. We also monitored each body of water with multiple camera traps for a minimum of 5 consecutive days prior to collecting the water samples. We collected 117,772 photos total (16,824±5,130 per site; photos were taken in triplicate), 17 of which contained mink (0.01% of total photos; 2±2 per site). Specifically, we determined presence of mink at four sites and over six survey weeks (1 survey week = 1 week of camera surveys at 1 site). Quantitative PCR analyses of eDNA samples are still underway. We will present preliminary analyses comparing the results of the eDNA sampling to the camera trap data to determine which method, or if a combination of both, yield the best results. This research will contribute additional information about American mink occupancy in Indiana, as well as insight into a more cost- and time-effective method to survey them. By doing so, this research will provide data that will be used to inform the establishment of a state-wide occupancy survey of American mink.

## 6. FORAGING AND ROOSTING ECOLOGY OF *LASIURUS BOREALIS*, *NYCTICEIUS HUMERALIS*, AND *EPTESICUS FUSCUS* ON ARNOLD AIR FORCE BASE, TENNESSEE

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With the decline of species diversity due to white-nose syndrome, the "common" bat species on Arnold Air Force Base (AAFB) including, big brown bats (*Eptesicus fuscus*), eastern red bats (*Lasiurus borealis*), hoary bats (*L. cinereus*), and evening bats (*Nycticeius humeralis*) may be becoming more important to the local ecology. Because previous studies at AAFB have focused on federally endangered or threatened bat species, little is known about the roosting and foraging ecology of these more common bat species. To begin to answer these questions, we conducted mist-net surveys in June and July 2021 and attached radio transmitters to a total of 53 bats of three different species (27 eastern red bats, 18 evening bats, and 8 big brown bats) including both sexes and age classes. Individuals were tracked to diurnal roosts and nightly forging data were collected to determine overall home range locations and sizes. A total of 150 roosts were found and included trees, shrubs, and man-made structures. Foraging data were collected for 45 bats resulting in 1,216 individual foraging points. Home range calculations showed that all three species tracked used small areas of the base and in general did not forage far from roost trees or capture sites. This information will provide land managers at AAFB with the data necessary to make informed decisions to help protect the bats species that remain on the base and will provide

baseline data needed to assess recovery efforts should these species become federally endangered or threatened in the future.

**7. THE BAT-SIGNAL: USE OF AN ULTRAVIOLET LURE TO INCREASE ACOUSTIC DETECTION OF BATS**

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Despite advantages of acoustic bat surveys over traditional capture techniques in the post White-nose syndrome environment, acoustic survey techniques are still reliant on bats flying close to receivers (< 10 m). Baited camera trap surveys have been used for decades to increase detection of rare and elusive terrestrial wildlife but such approaches have rarely been employed for bats. Anecdotal observations of ultraviolet "blacklights" creating artificial insect swarms to attract bats were noted in the literature. To assess if this had practical application, during the summers of 2020 and 2021 we deployed a custom ultraviolet lure at eight sites throughout Prince William Forest Park and Marine Corps Base Quantico in eastern Virginia. We deployed lures along presumed flyways (single track roads and riparian corridors) with bat detectors placed at the lure and on either side of the lure at 10- and 100-meter intervals in a six night before-after-control impact design. Our analysis indicated the lure had a positive effect on overall bat calls recorded, however most of this was attributable to the eastern red bat (*Lasiurus borealis*), with little or no discernable effect for other extant species. Detectors placed 10 meters away from the lure recorded the most bat calls during treatment, possibly due to less interference from insect noise. Ultraviolet lures show some promise for increasing acoustical detection and future investigation is warranted with improvements in lure design making field deployment easier.

**8. SUMMER DAY-ROOST SELECTION BY SEMINOLE BATS IN COASTAL SOUTH CAROLINA**

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Seminole bats (*Lasiurus seminolus*) are a common yet understudied species in the southeastern United States. Little is known about the habitat characteristics at their summer day roosts which are in the foliage of trees. To get a better understanding of summer day-roost selection, we observed roosting habits of Seminole bats at Palmetto Bluff in Bluffton, South Carolina. We radiotracked four adult male and four adult female Seminole bats to roost trees from mid-June to mid-August 2021 and documented 21 male and 27 female roosts. We measured characteristics of the roost tree, as well as the surrounding plot within 10m of the roost tree and repeated these

measurements at two random trees for every roost tree. We compared characteristics of roost trees and plots between males and females to determine whether there were sex-specific differences in selection of day roosts. We also compared the selected day roosts and surrounding plots to random trees and plots. Seminole bats roosted in the foliage of loblolly pine (*Pinus taeda*), slash pine (*Pinus elliottii*), and hickory (*Carya* sp.). Roost tree characteristics did not differ between males and females, but there were significant differences between sexes at the plot level and between used and random trees. Females roosted in areas with higher basal area, plot canopy cover, and number of trees with Spanish moss than males. Tree height and height to the first limb of used trees were higher than random trees, and the proportion of pine trees and average height of trees in used plots were higher than random plots. Our preliminary results show that plot characteristics around the roost tree may be more important for Seminole bat roost site selection than roost tree characteristics.

**9. EVALUATING BAT ROOST ABUNDANCE: A COMPARISON OF DRONE-ACQUIRED THERMAL IMAGERY AND ACOUSTIC RECORDINGS WITH HUMAN OBSERVERS**

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Population trend analysis is an essential aspect of wildlife conservation and management. Bat roosts provide an opportunity to sample populations while gathered in high concentrations. Roost emergences have been historically surveyed by visual counts in real-time, either with the naked eye or through night-vision goggles. Comparing the efficacy and precision of historically accepted methods with novel methods can provide guidance on the use of new technologies in the field. This project aims to compare the precision of survey methodologies, i.e., drone-acquired thermal imagery, passive acoustic estimates, and visual counts, for counting bats during emergence events. We compared the variation of counts collected by the three methods between survey nights. The comparison result adheres to the rationale that precise methods will have less variation between nights and that less precise methods will have more variation. We conducted three simultaneous emergence count surveys for ten nights at two emergence sites. Surveys were temporally synchronized to compare counts. Visual count tallies were collected throughout the emergence with a handheld counter app. Passive acoustic detectors were stationed at emergence entrances. The generated acoustic files were analyzed for root-mean-square (RMS) pressure and correlated to the emergence counts from the thermal video to estimate population density of emergence. A drone was equipped with a thermal camera and piloted 30m above ground level. Thermal video imagery was captured at nadir view throughout the emergence with landings to replace drone battery. Thermal imagery was manually counted and semi-automatic counted with ThruTracker

(sonarjamming.com) software. Preliminary results show that thermal imagery was able to consistently capture higher counts during emergence.

**10. COMPARING EFFECTIVENESS OF AHDRIFT SYSTEMS AND SHERMAN TRAPS FOR SURVEYING SMALL MAMMALS IN NORTHEASTERN INDIANA**

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Surveying small mammal communities provides insight into the health and continuity of ecosystems. Because funding and time are often limiting resources for ecological research, it's critical to employ the most efficient surveying method available while also maintaining effectiveness. Traditional small mammal survey methods (e.g., Sherman traps) are beneficial in certain conditions but tend to be monetarily/temporally costly. Additionally, these methods can introduce individual/species biases (e.g., trap happy individuals). The recently described AHDrift Camera Trap System (i.e., camera traps combined with drift fences) effectively surveys small terrestrial vertebrates and doesn't require as much time in the field. Our objective was to compare the effectiveness of AHDriFT systems and traditional Sherman traps for small mammal surveys. We installed AHDriFT systems at four sites, of varying land cover, in Eagle Marsh Nature Preserve (Fort Wayne, IN). These cameras were allowed to collect data from February 23 - July 25 in 2020 and May 28 - August 27 in 2021. In addition, Sherman trap surveys (10 traps in a 50m transect, traps spaced 5m apart) were conducted one night a week throughout these periods completing 640 trap nights of Sherman trap surveys and 384 nights of AHDriFT system surveys. We captured 208 small mammals of 3 different species with Sherman traps and obtained 1103 photographs of small mammals of 7 species with the AHDriFT system. AHDriFT systems captured more small mammal activity and species diversity than Sherman traps. Species caught on camera, but not in Sherman traps, included *Neogale frenata*, *Tamias striatus*, *Sorex cinereus*, and *Blarina brevicauda*. These results suggest that AHDriFT systems may be a more efficient and effective method of surveying small mammal communities, at least in landscapes similar to our study area.

**11. SURVEYS OF TRICOLORED BAT WINTER-ROOST STRUCTURES ON EGLIN AFB AND HURLBURT FIELD, 2019-2022**

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Tricolored bats (*Perimyotis subflavus*) were petitioned for federal listing in 2016, and are found on both Eglin AFB and Hurlburt Field, FL. In areas where caves are not available for winter roosting,

this species sometimes uses a variety of human structures instead, such as bridges and culverts. Maintenance, repair, or replacement of these structures could negatively impact tricolored bats if performed during winter. Over three field seasons, we have used bat acoustic detectors and infra-red video cameras to identify winter-roost structures being used by tricolored bats. We have identified a few winter-roost structures, including one that was used by tricolored bats, and we've detected multiple bat species foraging near structures. Identifying these structures as bat roosts assists the military mission by identifying potential wildlife impacts so that alternative strategies can be taken to maintain these structures, promoting conservation and mission success. Our techniques may be helpful for others initiating winter-roost surveys.

**12. TRICOLORED BATS OVERWINTER IN CULVERTS IN CAVELESS SOUTHERN ARKANSAS**

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Tricolored bats (*Perimyotis subflavus*; PESU) are being considered for listing under the Endangered Species Act and are already listed as a Species of Greatest Conservation Need (SGCN) in Arkansas. In southern Arkansas, records of PESU captures exist for summer but not for winter because this region lacks caves where winter surveys for PESU are typically conducted. However, PESU may overwinter in culverts as reported in neighboring states. Therefore, our objective was to determine which (if any) culverts in this region are used as winter roosts by PESU and other bat SGCN. We began winter surveys of road culverts in three southern Arkansas counties in November 2020. In the winter 2021-22, we expanded the study area to include culverts throughout the South Central Plains Ecoregion during ground-truthing efforts (41 culverts) and a three-day culvert blitz (193 culverts). In 2020-21, we found nine culverts being used by 1–2 Rafinesque's big-eared bats (*Corynorhinus rafinesquii*; CORA) and one culvert with one PESU. In 2021-22, we found a solitary PESU in the culvert identified the previous winter, 10 additional culverts being used by PESU, and 17 additional culverts with CORA. Between one and six PESU and 1–5 CORA roosted in a given culvert. In total, we recorded over 500 bats, including not only 23 PESU and 33 CORA, but also four evening bats (*Nycticeius humeralis*), 20 big brown bats (*Eptesicus fuscus*), and over 450 southeastern myotis (*Myotis austroriparius*). These preliminary findings indicate that PESU remain present in the winter in southern Arkansas. We plan to continue monitoring identified culverts used by PESU and CORA in winter 2022-23 along with unoccupied culverts to determine characteristics that make a culvert suitable winter habitat for these SGCN in southern Arkansas.

**13. COMMUNITY SCIENCE HELPS REVEAL SPECIES-SPECIFIC EFFECTS IN BAT ROAD ECOLOGY**

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Since 2019, the North American Bat Monitoring Program (NABat) in North Carolina has been inviting volunteers to participate in mobile transect surveys via a collaborative community science approach. Each year, we train 30 to 50 volunteers to drive NABat transect routes following a standard protocol. While guiding volunteers to collect high quality baseline monitoring data, we also encourage volunteers to make observations in the field and ask questions based on observations. A question posed by many volunteers was where bats were likely to be encountered on roadways. This question reflects the core of bat road ecology. In the existing literature, roads and traffic have been reported to cause bat-vehicle collisions or disrupt bat commuting due to noise and nighttime illumination; however, transportation infrastructures, such as bridges, highway overpasses, and culverts have been found to provide roosting structures for many bat species. Using data collected by community scientists, we investigated whether and how road type, roadside vegetation canopy availability, and bridge and culvert availability affected the probability of bat encounters during mobile transect surveys. We obtained coordinates of species-specific encounters and randomly generated points along transects. Using these coordinates, we extracted spatially explicit variables for road type, roadside vegetation canopy availability, and bridge and culvert availability at multiple scales. We found that road type, roadside vegetation canopy availability, and bridge and culvert availability had species-specific effects. Our results demonstrate that low traffic volume roads lined with trees could provide corridors for certain species and transportation infrastructures designed with the capacity for bat conservation could have significant impacts. Furthermore, we would like to highlight that involving volunteers in community science projects can produce additional meaningful investigations.

**14. BATS OF THE WACCAMAW NATIONAL WILDLIFE REFUGE**

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Knowledge of the bat communities of the South Carolina Coastal Plain (SCCP) is limited. However, the SCCP contains several species of conservation concern including northern long-eared bats (*Myotis septentrionalis*), tricolored bats (*Perimyotis subflavus*), northern yellow bats (*Lasiurus intermedius*), Rafinesque's big-eared bats (*Corynorhinus rafinesquii*), and southeastern myotis (*M. austroriparius*). Our objective was to inventory the bats of Waccamaw National Wildlife Refuge (WNWR) in the SCCP and determine the presence and distribution of species across the refuge. We surveyed bats across WNWR in summer 2019 and 2021 via acoustic detectors and mist-netting, and via tree searches for Rafinesque's big-eared bats and southeastern myotis. We conducted tree searches along 14 linear transects in the Normandy Tract and in the northern part

of Bull Island following the terrain. We examined tree cavities > 150 $dm^3$ and with basal openings for the presence of bats using a light and mirror. We found 62 potential roost trees, of which three contained southeastern myotis (including a maternity colony of > 30 individuals) and four contained Rafinesque's big-eared bats. Mist-net captures documented additional records of Rafinesque's big-eared bats and southeastern myotis as well as a northern yellow bat, big brown bats (*Eptesicus fuscus*), evening bats (*Nycticeius humeralis*), and Seminole bats (*L. seminolus*). The most acoustically detected species were red bats or Seminole bats (67.5%), followed by tricolored bats (13.1%), big brown bats (9.2%), evening bats (7.2%), northern yellow bats (2.0%), *Myotis* spp. including northern long-eared bats, southern myotis and identified *Myotis* (0.95%), and Rafinesque's big-eared bats (0.07%). Activity was greatest in forested and non-forested wetlands and lowest in upland forests. Our results demonstrate that WNWR has a rich bat fauna with rare and sensitive species found in most areas surveyed. The large diversity of habitats on WNWR most likely contributes to maintaining this diverse fauna.

## 15. CHANGES IN THE FOREST BAT COMMUNITY AFTER ARRIVAL OF WHITE-NOSE SYNDROME IN THE OUACHITA MOUNTAINS OF ARKANSAS

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Unprecedented declines in cave-hibernating bats due to the disease white-nose syndrome (WNS) have the potential to change community composition via numerous mechanisms, including competitive release. In areas that contain few caves, such as the Ouachita Mountains of Arkansas and Oklahoma, winter hibernacula for most cave-hibernating species are unknown. Thus, mist netting surveys are one of the few methods available to determine effects of WNS on populations of these bat species. We mist-netted bats for 6 years prior to the arrival of WNS in the Ouachita Mountains of Arkansas and compared capture rates of 7 species to capture rates collected in 2020–2021 after WNS establishment. We found a 98% decline in northern long-eared bats (*Myotis septentrionalis*) and a 77% decline in tricolored bats *Perimyotis subflavus* after WNS became prevalent. Evening bat (*Nycticeius humeralis*) captures increased by 220% after WNS, but no significant differences in captures rates were found for eastern red bat (*Lasiurus borealis*), Seminole bat (*Lasiurus seminolus*), and hoary bat (*Lasiurus cinereus*) after the arrival of WNS. Capture rates of big brown bat (*Eptesicus fuscus*) increased by 100% but this increase was not significant. We found that the forest bat community of the Ouachita Mountains has been significantly altered since the arrival of WNS in 2012 but it is unknown if these changes are permanent or if species will decline further or recover via adaptive or genetic changes in their populations in the future.

**16. BAT FORAGING ACTIVITY IN RESPONSE TO SHIFTS IN INSECT AVAILABILITY CAUSE BY PRESCRIBED FIRE MANAGEMENT IN THE SOUTHERN APPALACHIANS**

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Prescribed burns, specifically in terms of time since last burn (i.e., fire recency) and fire interval, are an effective tool to promote biodiverse vegetative regrowth in the understory. These controlled burns increase plant diversity and cause structural changes to the forest providing more productive foraging habitat for recolonizing insect population which are a prey source for insectivorous bat species. Our research objectives are to evaluate bat responses to low-severity fire management used to restore pine-dominated southeastern forests. We assessed bat foraging activity and insect abundance in responses to fire interval and fire recency, two major components of fire regimes that impact forest vegetation structure. We deployed UV light traps at 73 sites in 2019 and 75 sites in 2021 across the Shoal Creek Ranger District of Talladega National Forest, Alabama. Acoustic monitors were deployed alongside the insect traps to passively analyze bat activity and species composition. Sites were equally distributed according to fire recency (last burned at 0-<1 year, 1-<2 year and 2-<3 year) and fire frequency (1-3 years and >3-8 years). For each site, collected insects were identified to order, counted, and the dry weight measured. Across both survey seasons a total of 14 insect orders were represented. The results of this study will help make informed decisions on how to effectively use prescribed fire to promote insect prey for endangered bat species.

**17. HAS THE ENDEMIC OZARK POCKET GOPHER (*GEOMYS BURSARIUS OZARKENSIS)* EXPANDED ITS DISTRIBUTION?**

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The Ozark pocket gopher (*Geomys bursarius ozarkensis*) is classified in Arkansas as S1 (Critically Imperiled) and is considered a “species of greatest conservation need” because of its small population size, range restricted to one county, and isolation from other subspecies. To provide insight to the possible extinction risk for this subspecies, we proposed to update the distribution data for this subspecies using vehicle surveys. We predicted that this small, isolated population with geographic barriers and limited dispersal may experience range constriction. Through opportunistic (spring and fall 2021) and standardized surveys (December 2021), we drove all passable roads in and surrounding the distribution of *G. b. ozarkensis* as delineated in a previous

survey 13 years ago. We identified 52 new sites, 14 of which fall outside the known distribution; however, no sites were found outside Izard County. Most new sites were found along the north border, primarily northwest, and on the southwest border. The center of the distribution shifted by 635 m and 66°NW; and the range increased by 38.1 $km^2$, a 21% increase. The preliminary results of this survey may suggest a range expansion and that successful dispersal events have been occurring with the establishment of new burrow systems.

**18. THE RESPONSE OF BATS AND THEIR INSECT PREY TO DIFFERENT COASTAL UPLAND HABITAT MANAGEMENT TECHNIQUES**

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Little is known about the presence and activity of forest-dwelling bats on the Mississippi Gulf Coast. As primary predators of nocturnal flying insects, bats play a key role in forested ecosystems aiding in plant reproduction by decreasing insect herbivory. Many forested coastal habitats areas are managed in efforts to improve overall forest habitat quality and increase biodiversity, while possibly altering, eliminating, or reducing bat resources such as roost sites and foraging opportunities. Understanding how bats respond to land management induced changes within forest habitat is necessary for the conservation of these species. This project leverages off a large-scale land management project taking place at the Grand Bay National Estuarine Research Reserve (GNDNERR), in Jackson County, Mississippi. The objectives of this study are to determine if the activity and diversity of bats and their insect prey is affected by different coastal upland land habitat management techniques, such as prescribed fire and mechanical clearing, within the GNDNERR. Analysis of bat diversity and activity will be assessed using acoustic surveys using bat call recorders placed within managed areas. Black light traps will be used to trap night flying insects and flight-intercept traps will be used to trap day flying insects for analysis of abundance and diversity relationships among potential bat prey between the land management techniques. Findings from this study could be used to inform land managers of the potential benefits and impacts of land management practices on forest bats and their insect prey.

**19. TEMPORAL VARIATION IN BAT USE OF CULVERTS IN NORTH FLORIDA**

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Roadway infrastructure can provide important roosting habitat for cave-hibernating bats, but that may place bats in conflict with necessary road maintenance activities. By developing a better understanding of temporal variation in use by bats, we can reduce potential conflicts from routine maintenance operations. We surveyed 102 culverts in four north Florida counties during the winter torpor period (January and March) in 2018 and 2019 and the summer maternity season in 2018 (June to August) to evaluate seasonal variation in occupancy and abundance. Additionally, we surveyed 34 culverts every 2-3 weeks from 6 November 2019 – to 1 April 2020 to determine within-season variation in use during winter. We found that southeastern myotis (*Myotis austroriparius*) and tri-colored bats (*Perimyotis subflavus*) roosted in culverts in both winter and summer, and big brown bats (*Eptesicus fuscus*) in the summer only. Southeastern myotis were the most common species roosting in culverts in both seasons, occupying 55.3% and 29.6% of sites in the winter and summer, respectively. During winter, southeastern myotis were present during every survey period and peaked in abundance in mid-November. Tri-colored bats occupied an average of 13.8% of culverts in winter in small numbers, but summer occupancy dropped to two bats at a single site. Tri-colored bats first began roosting in culverts in mid-November and increased in abundance until late January. No tri-colored bats remained in culverts by 1 April. Surveys of culverts for bats before maintenance activities would be beneficial for reducing disturbance during winter hibernation and summer maternity season when bats are the most vulnerable. Additionally, given the occupancy of culverts by *Pd*-susceptible species in winter, culverts should be included in white-nose syndrome surveillance programs and as potential treatment sites.

**20. DISTRIBUTION AND DISEASE SURVEYS OF NINE-BANDED ARMADILLO IN TENNESSEE USING ROADKILL AND COMMUNITY SCIENCE DATA**

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Nine-banded armadillo (*Dasypus novemcinctus*) sightings continue to increase in quantity and range throughout middle and east Tennessee. We are using community science data collected from 2008 - 2021 to learn more about this adaptable, semi-fossorial mammal. These data plus recent roadkill surveys are being assessed in various geospatial models that integrate soil types, vegetative cover, and climate data to determine which environmental factors may most strongly influence armadillo presence and distribution. Specifically, we are creating Species Distribution Models (SDM) that incorporate climate patterns to better understand how this aligns with the expanding range of the nine-banded armadillo in Tennessee over time. We predict that climate patterns involving less-harsh winters will be one of the main factors allowing nine-banded armadillos to expand their range. Supplemental data from camera traps, used for monitoring the behavior of armadillos at active burrow sites throughout the winter, are also being used to

evaluate the effect of temperatures on armadillo activity. As part of our roadkill surveys to monitor for the presence of armadillos, blood samples from deceased armadillos are being collected and tested for Hansen's Disease (leprosy). No seropositive individuals have been detected in middle or east Tennessee so far (n = 25), but in order to have stronger results we plan on gathering at least thirty more samples from a broader range of sites in 2022.

**21. THE LONG WAY HOME: ONE GRAY BAT'S JOURNEY THROUGH MIDDLE TENNESSEE**

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The gray bat (*Myotis grisescens)* is the only member of the *Myotis* genus in the eastern United States that regularly spends both summer and winter in caves or cave-like structures, using colder roosts during the winter hibernation period and warmer roosts in the summer. The migration between winter hibernacula and summer roost sites has been an emerging topic of interest within the last several years with the potential for wind turbine development coming to areas of Tennessee. Filling knowledge gaps associated with migration pathways used by this endangered species is becoming increasingly important and could help inform developers on turbine placement to better protect the gray bat and its habitat. In April 2021, transmitters were attached to 10 adult female gray bats from Hubbard's Cave. Along with a ground crew, an aerial crew was utilized to document nightly migration using a Cessna Sky Hawk 172 aircraft. While three bats were tracked through the course of the study; one bat, 329, undoubtedly took the long way home. During her six-night migration, she used one cave roost, one tree (shagbark hickory), and one rock quarry. In total, she was tracked for 192 km to Heron Cave, which is approximately 71.9 km straight line distance from Hubbard's Cave.