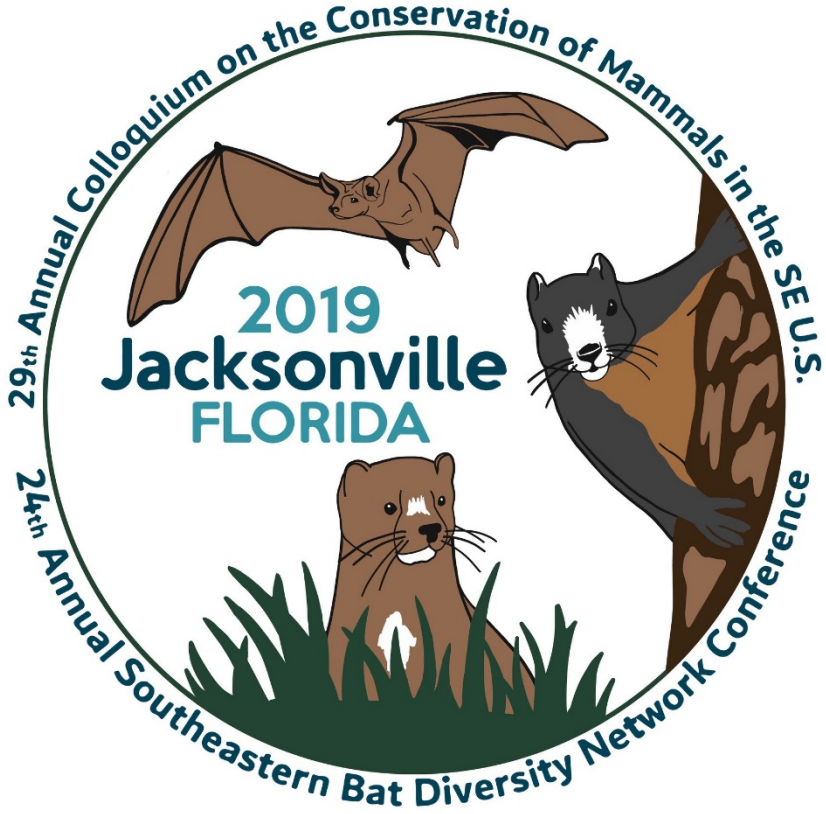
CONTRIBUTED ABSTRACTS



24th Annual Meeting of The Southeastern Bat Diversity Network

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29th Annual Colloquium on the Conservation of Mammals in the Southeastern U.S.

February 21st – 22nd, 2019
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Contents

PLENARY SPEAKERS

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CONSIDERATIONS IN ASSESSING CHANGES IN BAT DISTRIBUTION AND ABUNDANCE

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Bat populations are encountering numerous stressors that are impacting the distribution and abundance of bats on a large scale. These factors are quite varied from factors such as climate change to massive population declines from White Nose syndrome. Efforts to document changes in the bat distribution and abundance are currently being developed/implemented. However, an important aspect of this process is attempting to determine the factor(s) that are causing the observed change. For some factors, such as the direct impacts of WNS, causality is easily determined. However, assessing the impacts of other stressors is more difficult due to the complex inter- and intra-specific relationships determining community structure. Before casualty can be assigned to changes in the distribution and/or abundance, researchers must understand how these factors interact to form the observed bat community structure. This talk will discuss examples of intra and inter-specific factors that influence community structure. In addition, consideration will be given to developing future study efforts to better study and understand the complex interaction of factors that impact bat distribution and abundance.

RANGE EXPANSION OF THE BRAZILIAN FREE-TAILED BAT IN THE EASTERN UNITED STATES

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The distribution patterns of many organisms are changing in directions predicted by climate change. These range expansions will shift as population sizes change by the imposed limits of climatic and other environmental factors. Brazilian free-tailed bats (*Tadarida brasiliensis*) are one of the most abundant and widely distributed mammal species in the Western Hemisphere, with wide-ranging habitat and roost preferences. Based on reports from local wildlife control professionals, wildlife rehabilitators, regional submissions of bats for rabies testing, acoustic monitoring, and the presence of bats in different structures, we document that since ca. 2007, these bats have expanded and established in year-round colonies in multiple locations throughout North Carolina, East Tennessee, and Virginia. Until recently, this species has only been reported as occasional vagrants in the region. We hypothesize that cold tolerant thermal physiology and

the colonization of man-made structures contributes to the ability of *T. brasiliensis* to establish populations outside their distribution range, and their rapid expansion is facilitated by climate change. The reports presented here also emphasize the importance of community outreach and collaborations between researchers and different agencies to document range expansions and their implications. In *T. brasiliensis*, specifically, documenting range expansions could have implications for public health, ecosystem services, and bat conservation.

PREDICTING RANGE EXPANSION OF COMMON VAMPIRE BAT INTO THE UNITED STATES IN RESPONSE TO CHANGING CLIMATE CONDITIONS

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Common vampire bats (*Desmodus rotundus*) feed regularly on the blood of mammals and can transmit rabies to native species and livestock, causing substantial impacts on the health of prey. This species has not been documented in the Unites States, but has been documented within about 50 km of the U.S. state of Texas. This proximity to the U.S. has caused some stakeholders to express concerns about the possible expansion of vampire bats into the southeastern and southwestern U.S. We used 7,094 vampire bat occurrence records from North America and presence-only species distribution modeling (SDM) to map the potential distribution of common vampire bats in North America under current and future climate change scenarios. We analyzed and mapped the distribution of this species using 5 SDM approaches: logistic regression, multivariate adaptive regression splines, boosted regression trees, random forest, and maximum entropy. We then projected these models into 17 future climate scenarios for year 2070 to generate hypotheses about future distribution in North America. We also considered possible biases associated with the data and the relative strengths and weaknesses of these SDM approaches using several metrics. The results suggest two potential future routes of vampire bat range expansion into the U.S., one via southern Texas, and a second into southern Florida. Some of our SDM models support the hypothesis that suitable habitat for vampire bats may currently exist in parts of the México-U.S. borderlands, including extreme southern portions of Texas, as well as in southern Florida. However, this analysis also suggests considerable uncertainty among model predictions, with some approaches disagreeing on whether the future range will expand or contract. We view these distribution models and maps as quantitatively derived geospatial hypotheses of possible distributions and emphasize the importance of careful attention to issues associated with sample selection bias and other data limitations.

AN EMPIRICAL AND MODELING APPROACH TO ASSESS THE IMPACT OF WHITE-NOSE SYNDROME IN WESTERN NORTH AMERICA

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of Microbiology and Immunology, Montana State University, Bozeman USA (CGH, DC, RKP); Department of Biological Sciences, Texas Tech University, Lubbock, USA (NWF, LPM); [m]EpiLab, Hopkirk Research Institute, Massey University, Palmerston North, NZL (DTSH, CRH); Conservation Science Partners, Truckee, USA (MLM); Department of Biology and C-FIR, University of Winnipeg, Winnipeg, Canada (YAD, CKRW, ELK); Wildlife Conservation Society Canada, Kaslo, BC, Canada (CLL)

Understudied bat species and populations are now facing the arrival of white-nose syndrome (WNS) in western North America. WNS is a fungal disease affecting hibernating bats that has already killed millions of bats in eastern North America. There is limited time to collect baseline empirical data on pre-WNS bat hibernation physiology, behavior, and morphology that can inform our understanding of western bat WNS risk factors and priorities for possible mitigations. We collected data on physiological, behavioral, and morphometric traits paired with measurements of hibernacula microclimates from >1400 western bats, representing 12 species, across sites in Colorado, Montana, Nevada, Oklahoma, Utah, British Columbia, Texas, and Alberta. These data establish valuable pre-WNS reference points for western bats (i.e., insights on hibernation phenotypes of western species). A subset of bats were measured for torpid metabolic rates and evaporative water loss with respirometry and 783 bats scanned for body composition (body fat, lean mass and total body water) with Quantitative Magnetic Resonance. Furthermore, these data provide input to WNS survivability models that previously relied on generalizing parameters based on few species of eastern bats. Our energetic model provides predictions of WNS susceptibility by mechanistically combining fungal growth, hibernation physiology (now including evaporative water loss), and hibernaculum microclimate. Further we are deriving ecological niche models to relate high-resolution landscape attribute data with spatially explicit estimates of winter survival capacity before and after WNS exposure, and we will project these models under future climate conditions. We report on empirical observations and our new modeling tools that we are using to assess WNS susceptibility across the western North American landscape with bioenergetically diverse bat populations. These models will inform conservation management and mitigation activities by identifying specific WNS risk factors as well as susceptible and more resilient western species and populations.

RAPID RANGE EXPANSION OF LASIURUS SEMINOLUS IN THE U.S.

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Bat species are threatened by climate change, large-scale changes in vegetation, wind-power development, and white-nose syndrome. These threats make research on changes in bat communities essential for conservation planning. The Seminole bat (*Lasiurus seminolus*) historically occurred in the Deep South portions of the southeastern United States, but recent evidence suggested they may be expanding their range. I used museum records, publications, and data derived from mist-net surveys conducted by various individuals and organizations to determine changes in the seasonal and historical range of Seminole bats over the past 48 years across the eastern U.S. These data suggest Seminole bats are migratory, spending winter along the Gulf Coast, Carolinas, and southern Arkansas, and migrating as far north as Missouri and

Kentucky during the summer maternity season. During the autumn juvenile-dispersal period, Seminole bats are recorded in unexpected locations outside their range, including the Caribbean, Wisconsin, and New York. Over the past 48 years, their range has expanded northward 521 km, at a rate of 11 km/year, and their range has expanded westward 185 km. These data suggest a recent and rapid shift northward, likely in response to climate change, and an expansion westward possibly due to changes in vegetation communities across historic grassland regions.

WORKING TOWARDS RELIABLE RANGE-WIDE STATUS AND TRENDS ANALYSES USING NABAT MONITORING DATA

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North American bats face unprecedented risks from continuing and emerging threats including white-nose syndrome, wind energy development, and habitat loss. Based on local monitoring efforts, many species of bats are thought to be experiencing unparalleled population declines. However, local observations at known roosting sites or high-quality habitat may not be indicative of species status and trends across larger spatial extents (e.g., across the entire range of a species). The North American Bat Monitoring Program (NABat) aims to provide reliable information on the status (e.g., distribution, activity, local abundance) and trends (changes in these measures) of all 47 species of bats shared by the U.S., Canada, and Mexico. NABat seeks to improve the state of conservation science for bats by providing standardized protocols and facilitating cross-boundary agency coordination and sharing of limited resources. NABat will provide managers and policy makers with information they need to effectively manage bats, detect early warning signs of population declines, assess species vulnerability to potential threats, and measure recovery. Since implementation in 2015, acoustic and colony count data have now been collected in more than 40 states and 10 Canadian provinces. Some of these data are already being used to determine species distributions and population trends.

I will present on the current state of the NABat program including efforts to compile acoustic and colony count monitoring data. I will highlight both ongoing and completed analyses and discuss how NABat plans to share this information with the broader scientific and conservation communities. Recognizing that no single source of data will be sufficient for monitoring status and trends for all species of North American bats, I will also discuss some proposed analytical solutions for predicting future distributions, some of which leverage data collected using more than one monitoring method.

ORAL PRESENTATIONS

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

GENETIC EVIDENCE OF ISOLATION IN INSULAR COTTON RATS

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The insular cotton rat (*Sigmodon hispidus insulicola*) has been petitioned for conservation listing, however, there has been no concerted effort to determine the degree of isolation of this island rodent subspecies. Our objective was to quantify the degree of genetic isolation of Sanibel and Pine island populations of *H. s. insulicola* from adjacent mainland populations. We used 13 microsatellite loci (SSRs) and the cytochrome b mitochondrial gene (mtDNA) to 1) characterize population structure, 2) quantify gene flow, and 3) estimate the timing of demographic isolation of island populations. Results indicate that *H. s. insulicola* itself has consisted of discrete island populations (Sanibel and Pine islands are as differentiated from one another as either are from the mainland). Furthermore, maternal gene flow has been effectively zero among islands and mainland, whereas nuclear SSRs support limited historical migration from mainland to islands. Estimates of divergence based on the Bayesian isolation-with-migration model supports a time of divergence (based on mtDNA) of the mid-Holocene, which corresponds to a period of relatively low sea level. Our genetic results illustrate that mainland cotton rats represent a large well-mixed population across the peninsula, whereas Sanibel and Pine islands are discrete units. In addition to the neutral genetic information, more detailed information on morphological, ecological, demographic or behavioral differences should be used to confirm distinction

LOST IN TRANSLATION? DIFFERENCES IN BAT ACOUSTIC DETECTORS

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Although there are a plethora of available full spectrum and zero-crossing acoustic bat detectors, performance comparisons and the implications to managers thereof are limited. To assess this, we compared five styles of acoustic detectors (Pettersson D500X, Anabat Swift, and Wildlife Acoustics SM3 in full spectrum and Wildlife Acoustics SM3 and Anabat SD2 in zero-crossing) during the summer of 2017 at Fort Knox, Kentucky where the endangered Indiana bat (*Myotis sodalis*), endangered gray bat (*M. griscesens*) and threatened northern long-eared bat (*M. septentrionalis*) occur. In a replicated upland forest (3), forest-field edge (3) and riparian area

(3) design, we operated all detector types concurrently for 60 sample nights. All acoustic data was analyzed using Kaleidoscope Pro. We assessed levels of agreement between detectors using generalized linear models and pairwise comparisons of species-specific nightly activity and maximum likelihood estimates (MLE). Overall, activity patterns followed similar trends across time and habitat conditions. However, actual numerical nightly agreement between detectors for all species was low, with activity levels often varying in levels of magnitude. For common bat species, there was a high rate of nightly agreement for simple occupancy metrics derived from MLE values. This rate dropped significantly for rarer species, including listed *myotid* bats. Our findings suggest that each of the type tested would suffice for most research and monitoring activities, but standardization of detector type and recording method within the scope of a project or study should be encouraged.

EVIDENCE OF RESOURCE-DEFENSE POLYGYNY IN FLORIDA BONNETED BATS

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Endangered Florida bonneted bats (*Eumops floridanus*) are thought to form harems with a nearly year-round reproductive season, but our understanding of their social structure, reproduction and activity patterns is rudimentary. We hypothesized that Florida bonneted bats exhibit resource-defense polygyny, where the largest males defend limited suitable roost sites from competing males trying to gain access to females. To test this, we used a robust three-year dataset of 341 individuals uniquely marked with Passive Integrated Transponders (PIT tags), coupled with tri-annual capture records, to track activity patterns of bats at 5 roosts outfitted with PIT tag readers. We assessed differences among sex, reproductive categories, and seasons in the following metrics: nightly emergence times, activity (number of tag detections), duration of foraging bouts, and total time spent away from the roost per night. We found that males identified as the dominant males in each roost had the earliest emergence times, highest activity at roosts, and spent the least amount of time away from roosts. Subordinate males had slightly later emergence times, were slightly less active at roosts, and spent slightly more time away from roosts, suggesting roost defense and male competition. Reproductive and non-reproductive females spent the most time away from roosts and behaved very similarly, suggesting that females may forage together regardless of reproductive status. Activity metrics varied seasonally, likely related to reproductive cycles and climate. Our findings provide strong evidence that Florida bonneted bats exhibit resource-defense polygyny, with the largest reproductively active males expending time and energy in roost defense rather than defending females while foraging. Male-male competition may intensify as roost sites become more limited across the landscape. Finally, our study provides critical ecological information on activity patterns and foraging behavior that will inform monitoring and conservation recommendations for this endangered species.

NORTHERN LONG-EARED BAT SUMMER ROOST SELECTION AND BEHAVIOR ON COASTAL PLAIN SOUTH CAROLINA, YEAR TWO

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Historically, in South Carolina (SC?), northern long-eared bats (*Myotis septentrionalis*) were considered common in the Appalachian Mountains and had only been documented in three counties in the northwestern portion of the state. Since the first coastal documentation in 2016, twenty additional northern long-eared bats have been captured and tracked to over 58 roost trees in coastal SC. In 2017, a population of this bat species was discovered within the Francis Marion National Forest (FMNF) while conducting a research project for Central Electric Power Cooperative Inc. Nine northern long-eared bats were captured and tracked to 30 roost trees in 2017. In 2018, additional surveys were conducted where eleven northern long-eared bats were captured and tracked to 28 roosts. The majority of the roost trees were located within intensively managed, open forests that are not typically associated with northern long-eared bats as preferred roosting or foraging habitat; however, within the FMNF, the majority of the transmitted northern long-eared bats were tracked to this habitat type and roosted in live pine trees. Of the 58 roost trees documented, 95% were pine species including loblolly pine (*Pinus taeda*), longleaf yellow pine (*Pinus palustris*), and shortleaf pine (*Pinus echinate*). In addition, observations suggest maternity colonies may establish earlier than the typical timelines in the northern and western regions for this species. Current forest management practices may need to consider these differences in the seasonal movements and roost selection of protected bat species found in these southern, coastal areas. Observations of this population's behavior could support changes in the approved timelines for activities such as tree cutting and prescribed fires.

CHARACTERISTICS OF NORTHERN YELLOW BAT ROOSTS ON GEORGIA BARRIER ISLANDS

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In the southeastern U.S., northern yellow bats (*Dasypterus intermedius*) primarily roost in Spanish moss (*Tillandsia usneoides*) but are also known to roost under cabbage palm (*Sabal palmetto*) fronds. Although hardwood habitats are thought to be important in roost site selection, specific habitat components that provide optimal roosting conditions are unknown. Therefore, we examined northern yellow bat roosting habitat selection on two Georgia barrier islands. Sapelo Island has a history of extensive anthropogenic disturbance and is dominated by pine forests; Little Saint Simons Island has a limited disturbance history with maritime hardwood forest as the dominant cover type. In summers of 2012 and 2013, we radiotagged 35 adult male, 2 adult female and 2 juvenile female northern yellow bats which were tracked daily to diurnal roosts. We quantified and modeled roost characteristics at the plot and landscape scales. In total, we located 413 unique roosts, of which 97% were located in Spanish moss on hardwood trees; 3% were located under palm fronds. At the plot scale, yellow bats selected larger roost trees and

roost locations with greater open flight space (i.e., low midstory clutter) under the roost on both islands. At the landscape scale, yellow bats selected roosts in oak forest on both islands despite the difference in amount of oak forests between islands. Roosts were located closer to fresh water on Little Saint Simons and farther from open habitat on Sapelo compared to random locations. Our results indicate that mature hardwood forests with low midstory clutter are important in northern yellow bat roost selection on Georgia barrier islands, but landscape-level features have varying influences on roost selection, likely as a result of differences in disturbance history.

PRESCRIBED FIRE EFFECTS ON SUMMER HABITAT USE BY BATS IN THE CUMBERLAND PLATEAU

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Forests of the Cumberland Plateau and Appalachian Mountains are often managed with prescribed fire. Several declining bat species including the federally protected Indiana bat (*Myotis sodalis*) and northern long-eared bat (*Myotis septentrionalis*), as well as the little brown bat (*Myotis lucifugus*) and tri-colored bat (Perimyotis subflavus) use these forests. While recent studies suggest prescribed fire improves bat foraging habitat, more information is needed on effects of time since last burn and fire severity on the summer ecology of these bats. Our objective was to determine how these factors influenced summer foraging habitat use of bats on Big South Fork National River and Recreation Area in Tennessee and Kentucky. From May to August 2018 we used Anabat SD2 detectors to measure activity in 27 prescribed fire sites for 3 nights each with varying combinations of time since last burn (0-2, 3-4, 5-7, and >8 years), burn severity (high, medium or low), and forest habitat type (hemlock-hardwood cove, mixed-oak hardwood, and Appalachian pine-oak forests). We also recorded basal area and percent canopy closure for each site. We recorded 2,722 bat passes and identified 6 species groups. Time since last burn did not significantly affect activity of any species or species group. Eastern red bats (*Lasiurus borealis*) were more active in medium severity burned sites and in mixed-oak hardwood forest than other forest types while Myotis spp. were significantly more active in high severity burned sites than medium and low severity sites. Tri-colored bat, big brown bat (*Eptesicus fuscus*), silver-haired bat (*Lasionycteris noctivagans*), and evening bat (*Nycticeius humeralis*) activity was not significantly affected by habitat, time since last burn, nor burn severity although evening bat activity was negatively correlated with percent canopy closure. Our findings suggest that burn severity and forest type may influence bat species composition and activity in our study sites.

ARE WE MAXIMIZING OUR CONSERVATION OPPORTUNITIES AT THE ANNUAL SBDN-CCMSE MEETINGS?

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Attendees of the annual combined meetings of the Southeastern Bat Diversity Network (SBDN) and the Colloquium on the Conservation of Mammals in the Southeastern U.S. (CCMSE) work for various organizations or institutions and often are not able to collaborate or coordinate regularly on conservation issues. As a result, during the meetings attendees regularly acknowledge the need for effective collaboration, either during organized sessions or ad hoc discussions. However, it is unclear whether the annual meetings are providing sufficient opportunities to facilitate that collaboration. The annual SBDN-CCMSE meeting is a good forum for presenting results of recent conservation work and exchanging information among state, federal, and private organizations across the Southeast. The meetings are less effective mechanisms for taking advantage of this collective expertise to expand conservation actions or develop new projects to address mammal conservation needs throughout the year. The SBDN-CCMSE provides a limited framework to actively promote the implementation of mammal conservation actions outside the meetings. The few taxa- or issue-focused working groups affiliated with SBDN-CCMSE work independently and not all of them meet regularly. During this presentation we will use an audience participation process to begin a discussion about whether members want to maintain a primary emphasis on information exchange at these meetings and see if are there potential ways to improve that process. Or, are members interested in having an increased emphasis on collaboration and implementing conservation actions outside the meeting. The goal is to determine whether further discussion is warranted on the role of SBDN-CCMSE in mammal conservation activities across the Southeast and, if so, identify people who want to participate in that discussion.

USING DYNAMIC OCCUPANCY MODELS TO DETERMINE THE DISTRIBUTION OF *MYOTIS SEPTENTRIONALIS* IN NORTH GEORGIA

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Mortality from white-nose syndrome has led to *Myotis septentrionalis* becoming a management priority. Developing conservation strategies for this species in Georgia is difficult due to limited knowledge regarding their distribution and habitat associations in the state. Our objective was to determine the summer distribution and habitat use of *M. septentrionalis* in northern Georgia to guide land use decisions, such as highway development, that minimize impacts to bats in the region. To address this paucity of knowledge, we developed distribution models associating the composition and arrangement of landscape features to capture records of *M. septentrionalis*. We utilized mist-netting records on public and private lands from 2007 through 2017 to determine how distribution is changing with white-nose syndrome. Distributions were derived using dynamic occupancy models, with covariates including land cover, aspect, elevation, landscape arrangement, Julian date, and square meters of net used. Landscape variables were derived at the home range (65 ha) and potential movement (490 ha) scales. Preliminary results suggest percent deciduous forest and elevation at the home range scale were the best predictors of occurrence pre-white-nose syndrome. Post-white-nose, the ability to persist at a site seems to be associated with the largest patch of deciduous forest at the potential movement scale. While these findings

show the distribution of the species is contracting, it does not mean that suitable habitat has diminished. However, it may allow for land managers to better target areas for conservation and give us a better understanding of what quality habitat looks like for *M. septentrionalis*.

EXTENT OF HURRICANE DAMAGE TO HABITAT FOR THE IMPERILED BIG CYPRESS FOX SQUIRREL

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Climate change has led to an increase in hurricane intensity for regions within and surrounding the Gulf of Mexico. Environmental damage caused by these storms can be particularly harmful to wetland habitat and associated wildlife species, however, few studies have measured how high intensity hurricanes may be impacting these unique ecosystems. In the fall of 2017, we investigated how Hurricane Irma affected habitat for the Big Cypress fox squirrel (*Sciurus niger avicennia*), a threatened arboreal species endemic to slash pine and cypress mosaic communities in southwest Florida. *S. n. avicennia* are geographically isolated by extensive anthropogenic landscape alteration and are sensitive to change that may result in lowered habitat quality. The focus of our study was to determine the level of acute degradation to habitat for *S. n. avicennia* caused by high intensity hurricane activity and how that degradation may impact occupancy of *S. n. avicennia* throughout its range. We used a combination of direct vegetation measurements one month post-hurricane, remote sensing, repeat photography, and data from pre-hurricane occupancy analysis to assess changes to habitat structure and composition and potential impact to *S. n. avicennia* occupancy. Results indicate hurricane maximum sustained wind speed, vegetative species, vegetative structure, and distance to fragmented edge were significant predictors of extent of damage to habitat for *S. n. avicennia*. Continued monitoring of these sites is necessary to determine long-term ecosystem resilience, changes in space use of *S. n. avicennia*, and potential compounded effects of multiple high intensity storms over consecutive hurricane seasons.

DOES HABITUATION AFFECT TRANSLOCATED WHITE-TAILED DEER (*ODOCOILEUS VIRGINIANUS*) SURVIVAL IN THE SOUTHERN APPALACHIANS?

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When animals habituate to humans, predators become more dangerous or herbivores cause damage. However, many animals become successful despite the dangers that humans may pose, such as through poaching or road mortality. White-tailed deer (*Odocoileus virginianus*) can become very habituated to human environments, especially if humans facilitate food availability. Without initial fear to guide animals away from dangerous situations, we asked whether habituated deer would be more susceptible to mortality. Following a translocation of white-tailed

deer from a state park to a soft-release facility, we evaluated the behavior and survival of habituated and non-habituated deer. We scored twenty-four deer as habituated, and thirteen with a healthy fear of people. Following a four-week captive period, we released animals into a reserve land where we could track movement and survival as they moved into human residential areas and major highways. Although mortality was high within the first few weeks, there was no statistical indication that habituated animals are more at risk of mortality than non-habituated animals. These results may provide more insight for why white-tailed deer are successful in human-altered environments.

PATTERNS OF INFECTION AND SEVERITY OF SKUNK CRANIAL WORM IN SPOTTED SKUNKS

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Eastern and western spotted skunks (*Spilogale putorius* and *S. gracilis*) serve as definitive hosts for skunk cranial worm (*Skrjabingylus* spp.), a metastrongylid nematode that spends its adult stage inhabiting the host nasal cavities and cranium. Skunk cranial worm can cause severe damage to the skull in spotted skunks, and this damage is identifiable in preserved specimens. We used spotted skunk skull specimens from six mammal collections to identify patterns in infection and severity of infection by skunk cranial worm in spotted skunks across the U.S. and since the late 1800s. We divided specimens into four genetic clades based on specimen origin and recent genetic analyses. We hypothesized that the Midwestern genetic clade (*S. putorius interrupta*), which experienced a range-wide population decline in the mid1900s, experienced higher infection rates than other spotted skunk populations. We also tested for effects of precipitation and sex, hypothesizing that precipitation, but not sex, would influence infection and severity rates. Our top models indicated that specimen collection year, precipitation in the year prior to specimen collection, and genetic clade were the most important factors in predicting infection and severity in spotted skunks. Contrary to our hypothesis, the Midwestern genetic clade experienced significantly lower infection and severity rates relative to other spotted skunk populations, with the western genetic clade experiencing the highest infection and severity rates. We suggest that precipitation in the year prior to the specimen collection year may influence the local availability of gastropods, the obligate intermediate host for skunk cranial worm, resulting in higher infection rates being manifested the following year.

THE LUXURY EFFECT BEYOND CITIES: BATS RESPONDED TO SOCIOECONOMIC VARIATIONS ACROSS LANDSCAPES

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The luxury effect describes the positive relationship between affluence and biodiversity, activity, or presence probability of organisms in urban landscapes. Driven by difference in human actions, the luxury effect should potentially scale up and be found across different landscapes. Previously the luxury effect has been found in two bat species, the red bat (*Lasiurus borealis*) and the evening bat (*Nycticeius humeralis*), in an urban landscape. We examined bat activity distribution patterns across landscapes, including both urban and non-urban areas, for 7 common bat species to test for the luxury effect. We also identified bat – land cover associations for each species. Across the state of North Carolina, USA, we used the North American Bat Monitoring Program mobile transect survey protocol to collect bat activity data for 7 species at 43 sites from 2015 to 2018. We collected land cover data from the 2011 National Land Cover Database and income data from the 2016 American Community Survey. We constructed generalized linear mixed models to identify bat-land cover/bat-income relationships. We found that across landscapes, activity of *Lasiurus borealis* and *Nycticeius humeralis* was positively correlated to income, independent of land cover, consistent with previous results from an urban landscape. We also found that hoary bat (*Lasiurus cinereus*) activity decreased with income. All 7 species had specific land cover habitat associations. Our results demonstrate that the luxury effect in urban landscapes can be found beyond cities and is an ecological pattern that can be scaled up across different landscapes. We suggest multi-scale roosting and foraging studies to identify the mechanism underlying the luxury effect. We also suggest that the luxury effect could cause inequity in ecological services provided by bats.

ASSESSMENT OF BRIDGES AND CULVERTS AS ROOSTING HABITAT FOR TRI-COLORED BATS (*PERIMYOTIS SUBFLAVUS*) AND DISEASE TRANSMISSION CORRIDORS FOR *PSEUDOGYMNOASCUS DESTRUCTANS* IN COASTAL GEORGIA

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Pseudogymnoascus destructans is an emerging fungal pathogen causing precipitous declines in North American bats due to the development of white-nose syndrome. Since 2006, 34 U.S. states and 7 Canadian provinces have confirmed the presence of *P. destructans*. Due to the rapid spread of *P. destructans* across the eastern United States, habitat characterization and disease monitoring has become vital to conserving remnant populations. Bats have been observed in multiple states using non-traditional habitat, such as interstate culverts, for roosting. To investigate their use of anthropogenic structures in coastal Georgia, an area where *P. destructans* has yet-to-be detected, comprehensive bridge and culvert surveys were conducted during the hibernation season. Over 140 swabs of bats and substrates were collected and analyzed for fungal presence using qPCR. Monthly culvert surveys are ongoing to assess bat presence and collect culvert temperature data. Seasonal data will further characterize optimal tri-colored bat habitat and, along with WNS surveys, identify suitable habitat for developing WNS. This data will address the knowledge gap regarding the seasonality of bat use of bridges and culverts in

coastal Georgia, *P. destructans* presence and burden, and the potential role bridge and culvert roosts play in disease transmission.

HOME RANGE AND HABITAT OF NORTHERN LONG-EARED AND TRI-COLORED BATS DURING FALL SWARM

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Fall swarm is an essential period in the annual life-cycle of bats. Foraging during this period is under-studied in comparison to the summer maternity season. We completed a study to describe landscape-use during fall swarm and create a resource for managers tasked with decisions about the future viability of northern long-eared (*Myotis septentrionalis*) and tri-colored (*Perimytois sublfavus*) bats on their conservation or management lands. In 2018, we conducted a ground-based foraging study during autumn on these two species in the Boston Mountain ecoregion of northeastern Oklahoma. Four northern long-eared and 13 tri-colored bats were radio tagged and synchronized azimuths were gathered from five stations for five nights. Mean home range of northern long-eared bats was 196.0 ± 83.7 ha, and mean location distance (n=84) from the swarm site was 1,337.8 ± 192.3 m. Mean home range for the tri-colored bat was 91.6 ± 11.8 ha, and mean location distance (n=103) from the swarm site was 609.0 ± 76.6 m. Field surveys provided finer-scale habitat data than available from the National Land Cover Dataset'; compositional analysis and linear regression showed that both species use breaks in the forested landscape, such as trails, to a greater degree than those habitats are available on the landscape. Both species used second-order and larger streams more than first-order streams, wetlands, ponds, or lakes.

FAT, HAPPY BATS AND POOL NOODLES: A CASE STUDY FOR COMPLETING MAINTENANCE ON A BRIDGE WITH YEAR-ROUND BAT USE

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Bats regularly use bridges and other transportation structures for roosting in the United States, especially in warmer climates like the southeast. Recent surveys in Georgia suggest that roughly 10% of bridges have some evidence of bat use. During a survey for a large interstate maintenance project in 2015, the largest known bridge roost in Georgia was discovered. Thousands of big brown bats (*Eptesicus fuscus*) and Brazilian free-tailed bats (*Tadarida brasiliensis*) are found year-round on this bridge located in northwest Georgia. Because of the structure of the bridge and the large numbers of bats in the joints, the presence of federally protected species could not be ruled out. Georgia Department of Natural Resources biologists worked with the US Fish and Wildlife Service and the Georgia Department of Transportation to develop a plan for completing necessary maintenance on this bridge without harming the bats. Using special provisions, hands-on assistance and small changes to the normal maintenance plan

the project was completed without any evidence of harm to the roosting bats. This project provided an opportunity for engineers and biologists to test the effectiveness of using backer rod for protecting bats still present in the expansion joints while completing bridge resurfacing and joint replacement. These small changes did not add significant costs or extra time to the project and no injuries or mortality was observed during the process.

AMBIENT TEMPERATURE INFLUENCES WINTER TORPOR PATTERNS OF ALTERNATE ROOSTING TRI-COLORED BATS

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Cave and mine hibernating tri-colored bats (*Perimyotis subflavus*) have experienced precipitous declines from white-nose syndrome (WNS). The stable temperatures of cave and mine hibernacula are ideal for extended torpor bouts and unfortunately, fungal infection and disease progression. However, tri-colored bats use alternate roosts (e.g., tree cavities, bridges, foliage) during winter throughout parts of their range. Bats in alternate roosts experience variable roost temperatures which may influence their torpor patterns and WNS susceptibility. Our objective was to determine the winter torpor patterns and skin temperatures (Tsk) of tri-colored bats using alternate roosts and relate them to WNS susceptibility. From November 2017 to March 2018 and November to December 2018, we measured Tsk of tri-colored bats at the Savannah River Site in south-central South Carolina, an area devoid of caves or mines, using temperature-sensitive radio transmitters. In addition to three bridge roosts, we tracked individuals to 20 tree roosts. The median torpid Tsk of seven bats ranged from 12.8°C to 18.8°C. Bats in alternate roosts often passively rewarmed, occasionally even to normothermic Tsk. Torpid bout duration varied from 3.5 hours to 9.6 days and decreased as mean ambient temperature (Ta) increased above 5°C. Normothermic bout duration varied from 15 minutes to 10.6 hours and increased as mean Ta increased above 10°C. The continuous duration of time a bat's Tsk fell below the Pd growth threshold (19.5°C) varied from 15 minutes to 8.9 days and decreased as mean Ta increased above 10°C. Preliminary results indicate exposure to daily fluctuations of Ta in tree, bridge, and foliage roosts influences torpid and normothermic bout duration. Therefore, tri-colored bats using alternate roosts may be less susceptible to WNS than cave and mine populations because of altered torpor patterns.

"BATS IN BRIDGES" INSPECTION TRAINING AS A TOOL FOR IMPACT AVOIDANCE DURING TRANSPORTATION STRUCTURE PROJECTS

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Transportation structures are an increasing focus in bat research as potentially vital resources on the landscape. Many species of bats are known to use bridges and culverts as refugia at various

times of the year. However, until recently, little was known about the scope of bat use in these structures across the state of Georgia. In an effort to minimize impacts to bats during maintenance and construction activities on transportation structures, the Georgia Department of Transportation (GDOT) began inspecting bridges scheduled for these activities across the state in 2015. Subsequently, the Georgia Department of Natural Resources developed a "Bats in Bridges" training course to teach transportation ecologists, consultants, agency personnel, and other interested parties to conduct thorough inspections of bridges and culverts for bats and signs of bat use. Since the first offering of the Bats in Bridges training course in 2016, over 80 students from the public and private sectors have attended. Transportation structure inspections associated with GDOT projects, as well as other research projects, have revealed important roosting sites for bats across the state of Georgia. Without consistent training, surveyors may lack the skills and tools to properly identify signs of bat use leading to loss of roost structures and potential harm to bats. In many cases, proper inspections have resulted in minimization and avoidance measures to protect bats during scheduled activities. Topics of this presentation will include survey methodology, impact avoidance, developing research, and future training opportunities.

USE OF AN ACOUSTIC DETERRENT SYSTEM FOR RESIDENT BAT COLONIES IN BRIDGES

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Eco-Tech Consultants, in partnership with NRG Systems and Georgia Department of Transportation, is implementing a new approach to managing bat colonies in bridges. Building upon current technologies being developed in the wind industry, high-output acoustic bat deterrence units have been deployed at several bridge pilot study sites to study behavior and effectiveness as a non-maternity season temporary exclusion methodology. Bat deterrent units emit an ultrasonic acoustic field in the same range as a bat's natural calling frequencies, effectively "jamming" the bat's ability to hear its own return call. While bats rely so heavily on echolocation, they know to avoid any airspace that compromises this capability, thus allowing the temporarily exclusion of roost areas. The BDUs are typically deployed prior to sundown and activated after visually confirming complete emergence of the colony. They remain in operation until sunrise. Three pilot studies have been performed with proven deterrent success, one showing 98.5% successful deterrence of a colony of 887 bats consisting of big brown bats (*Eptesicus fuscus*) and Brazilian free-tailed bats (*Tadarida brasiliensis*).

MOVEMENTS OF TRANSLOCATED SOUTHEASTERN POCKET GOPHERS (*GEOMYS PINETIS*) IN GEORGIA

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Southeastern pocket gophers (*Geomys pinetis*) are endemic to southeastern open pine forests and are ecologically important because they aerate soils by tunneling and mounding, provide shelter for commensal species, and perform selective herbivory. Pocket gophers have been extirpated from much of their original range and with the recent increase in open pine community restoration may be candidates for translocation. Therefore, we assessed translocation methodologies to develop a relocation protocol. We present results from soft and hard releases of 8 individuals (3 female, 5 male). For soft releases, we used a custom plow to establish a tunnel system, whereas for hard releases, individuals were released into a shallow (100-cm wide by 20-cm deep) hole. Pocket gophers were radiotagged and tracked for 0.5-3.5 months. Translocated pocket gophers averaged 5 new mounds built per week and hard- and soft-released individuals made frequent above-ground movements. Mean distance moved by all gophers was 49.2 m (SE=7.50 m) which is greater than estimates from non-translocated individuals in other studies. There was no difference (p=0.930) in mean movement distance between soft- (51.1 m, SE=8.92 m) and hard-released (47.4, SE=7.09 m) individuals. At the end of 3.5 months, 5 pocket gophers were still alive and 3 individuals were deceased, 2 from predation. Soft- and hard-released pocket gophers were each predated at a rate of 25% (1 out of 4). Although we hypothesized that above-ground movements would expose translocated pocket gophers to greater predation risk, only 2 of 8 pocket gophers (25%) were predated. There is little evidence that providing starter burrows contributes to site fidelity. Our results are consistent with studies on other pocket gopher species that translocation is likely a viable method for re-establishing populations in open pine communities.

ASSESSING INDIANA BAT REPRODUCTIVE CONDITION ON KENTUCKY'S POST-WNS LANDSCAPE

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White-nose syndrome (WNS) (*Pseudogymnoascus destructans*) is responsible for extensive declines of Indiana bat (*Myotis sodalis*) populations across eastern North America. We are evaluating this bat species' ability to reproduce in Kentucky despite exposure to the fungus, a key factor in determining recovery potential. Using mass as a measure of fitness, we hypothesize that individuals captured during the maternal season will exhibit decreased mass over the course of our surveys and in comparison to historical records. Additionally, we considered relative reproductive rates of female bats (%) in relation WNS to better understand potential shifts in population structure. We captured adult female bats in mist nets during the reproductive season

of 2017 and 2018 from maternity colonies using artificial roosts. Records collected prior to these field efforts were retrieved from a collective database managed by the Kentucky Department of Fish and Wildlife Resources. While adult female mass has remained relatively consistent over a decadal timescale, trends within pregnant, lactating, and post-lactating classes suggest reproductive females are of slightly lower masses since detection of WNS in Kentucky. Data from 2017-2018 field efforts suggest over 90% of adult females captured were reproductively active within the two-year period. Additionally, reproductive rates and observed mass of bats within reproductive classes remain consistent across our five survey locations. Data collection will continue at these artificial roost sites in 2019, with the ultimate goal focused on analysis of reproductive success, roost climate and changes in usage throughout the maternity season. With the impacts of WNS continuing to be realized in Kentucky, *M. sodalis* maternity colonies should continue to be monitored to assess recovery potential of the species.

FIELD IDENTIFICATION OF GRAY BATS AND SOUTHEASTERN BATS

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The gray bat (*Myotis grisescens*) and southeastern bat (*Myotis austroriparius*) are found throughout the southeast with the gray bat usually roosting in caves in karst areas while the southeastern bat inhabits bottomland forests. However, in some parts of its range the southeastern bat utilizes caves and has been found roosting in the same caves, and sometimes the same cluster, as the gray bat. Field guides offer conflicting and incomplete advice on distinguishing the two similar species and in order to clarify these discrepancies we gathered data on key characteristics from museum specimens from throughout the southeast and on live animals captured in Arkansas. Due to the difficulty of discernment under field conditions, varying descriptions in the literature, and lack of an objective method of measurement we recommend that dorsal hair coloration not be utilized as a primary method of identification between these species. While the wings of both species almost always attach at the ankle or between the ankle and the base of the toe this is too inconsistent to be used for distinguishing the two, but may be helpful in telling them apart from other North American *Myotis*. Although gray bats have significantly longer forearms and few southeastern bats exceed the 40 mm length that was the minimum observed in gray bats, there is enough overlap that forearm length alone should not be used to separate the two. Rather, the presence of notches in the toes and claws of gray bats serves as the best objective method for identifying this species and for separating it from southeastern bats in particular and should be incorporated into future North American mammal identification manuals.

EVIDENCE FOR GEOGRAPHICAL DIALECTS IN NORTHERN AND SOUTHERN FLYING SQUIRRELS (*GLAUCOMYS SABRINUS* AND *G. VOLANS*)

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Geographical dialects have been well documented in birds and humans. Dialects in these taxa have been used extensively to study the evolution and systematic learning of social behaviors by way of acoustic communication. Despite the fact that most mammalian taxa vocally or acoustically communicate, relatively little is known about dialects in mammals. For example, evidence of regional dialects has been found in bats, seals, prairie dogs, and most recently whales. The purpose of this study was to determine if northern and southern flying squirrels (*Glaucomys sabrinus* and *G. volans*) exhibit geographical variation in their trill-type calls. We hypothesized that populations separated by the greatest distance (i.e., trills emitted by *G. sabrinus* from Idaho and Alaska versus North Carolina) would exhibit significantly greater differences in dialects versus populations separated by shorter distances (i.e., trills emitted by *G. volans* from Alabama/Georgia versus North Carolina). One-way ANOVA tests were used to analyze call variation in duration, entropy, bandwidth, and frequency at maximum amplitude (Fmax). Results showed that regional dialects for trill-type calls exist in both species and that distance between populations did not influence those differences. Additionally, *G. sabrinus* trills remained easily distinguishable from *G. volans* trills irrespective of degree of allopatry.

SEASONAL VARIATION IN HABITAT USE BY BATS IN COASTAL SOUTH CAROLINA

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The southeastern Coastal Plain is projected to have one of the largest urban expansions in the United States. This region also marks the northeastern range limit of the northern yellow bat (*Dasypterus intermedius*), a species of special concern. Given the mild winter conditions of this region, bats may continue to forage throughout cooler months. Our objective was to determine seasonal habitat use of bats in this region with a focus on northern yellow bats. During February-March 2018 we placed Anabat Express acoustic detectors at 36 sites for 6-10 nights in Beaufort County, SC. During May-August 2018 we placed detectors at the 36 sites we surveyed in winter and an additional 28 sites. We placed detectors in upland forests, bottomland forests, fields, salt marshes, and ponds, and characterized habitat and forest structure within a 0.05 ha plot surrounding each detector. Additionally, we measured distance to nearest road, freshwater pond, and residential area. In summer, overall bat activity was significantly lower in upland forests than all other habitat types ($P < 0.001$), and higher at sites closer to roads ($P = 0.008$). In winter, overall bat activity was lower in salt marshes ($P < 0.001$) and upland forest ($P = 0.001$) than all other habitat types. Northern yellow bat activity in summer was higher at non-forested sites than forested sites ($P < 0.001$) whereas northern yellow bat activity was not significantly different

between non-forested and forested sites ($P = 0.75$) in winter. Our results suggest that bats may exhibit different habitat use patterns across seasons, and that northern yellow bats may exploit forested areas in winter which were not used in the summer. Understanding differences in habitat use between seasons is important so critical habitat features important to foraging during both summer and winter are retained on the landscape.

HIGH INCIDENCE OF PIEBALD MARKS IN THE ENDANGERED FLORIDA BONNETED BAT

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Aberrant patches of white skin or fur, known as piebald marks, have been observed in many mammal species worldwide, but they are typically limited to only a few individuals in a population. Piebald marks were documented in only two museum specimens of the federally endangered Florida bonneted bat (*Eumops floridanus*) as early as 1950, but recent observations suggest that piebald marks may be more common in this species than previously believed. We investigated the occurrence of piebald marks in a population of Florida bonneted bats located at Babcock–Webb Wildlife Management Area (BWWMA) in Charlotte County, Florida, from 2014 through 2017. We observed piebald marks on 172 (80.8%) of 213 Florida bonneted bats captured at BWWMA, the highest incidence ever reported in a bat population. The proportion of piebald marks did not differ with sex, age at first capture, or reproductive status. We also found no difference in survival or capture probability between piebald and solid-colored individuals. We assessed the proportion of Florida bonneted bats with piebald marks across the species range and also compared the proportion between recently captured bats (post-2004) and historical museum specimens (pre-1965). The proportion of piebald bats was highest in Charlotte County but was not significantly different from that of the other northern county surveyed, Polk County. However, bats from Collier and Miami-Dade counties, in southeastern Florida, had a significantly lower proportion of piebald individuals. Although few piebald Florida bonneted bats had been reported previously, we found no significant difference between the proportion of piebald bats captured recently in Miami-Dade County and that of museum specimens from the same county. We suspect that the high rate of piebald markings in Florida bonneted bats at BWWMA is due to restricted gene flow and inbreeding associated with a small population. Further study is required to understand the mechanism underlying the high incidence of piebald marks and to determine whether piebaldism indicates low genetic diversity that could threaten populations of Florida bonneted bats.

I SHALL BE RELEASED! CLEMENCY FROM THE WNS PAROLE BOARD

M. J. St. Germain, S. P. Bombaci, D. S. Jachowski, W. M. Ford, R. E. Russell, and S. C. Loeb

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Emerging infectious diseases present a major perturbation with apparent direct effects such as reduced population density, extirpation and/or extinction. Comparatively less is known about the potential indirect effects of disease that likely alter community structure and larger ecosystem function. Recent research by the authors have shown dramatically altered spatial and temporal niche structure following White-nosed syndrome (WNS) in the northeastern United States. We expanded this investigation evaluating the broader extent of alterations to bat community structure and impacts on remnant bat population ecology throughout much of the WNS-affected region of the eastern US. We analyzed pre and post-WNS acoustic data collected across five study sites from 2003 to 2017. We examined pair-wise interspecific comparisons of niche overlap and temporal kernel density estimates between combined WNS impacted myotis (*Myotis lucifugus, M. sodalis, M. septentrionalis*) and non-impacted species within each site over time. Activity patterns of forest bats (*Lasiurus borealis* and *Lasionycteris noctivagans*) exhibited temporal release with reduced myotis activity, *Eptesicus fuscus* exhibited temporal release in some locations but was limited in others, and *Nycticeius humeralis* did not respond to myotis reduction on the landscape. An additional finding of interest was the reduction of *Lasiurus borealis* activity from the Wisconsin landscape in 2015. Relaxation of temporal niche partition is tied to geographic location, time since WNS, and the differences among bat community membership.

TEMPORAL CHANGES OF BAT ACTIVITY FOLLOWING THE ARRIVAL OF WHITE-NOSE SYNDROME IN NORTHWESTERN SOUTH CAROLINA

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Highly diverse bat communities are often structured by niche partitioning. Sympatric bat species partition niches in several ways, including time of activity. White-nose syndrome (WNS) has changed the pattern of niche partitioning in some bat communities by differentially impacting WNS-resistant and -susceptible species. Our objective was to compare temporal niche partitioning by bats pre- and post-WNS in northwestern South Carolina. We hypothesized that post-WNS, there would be a relaxation of niche partitioning among WNS-resistant and -susceptible species, as WNS-susceptible species have suffered population declines due to WNS. We conducted echolocation surveys in the Andrew Pickens District of Sumter National Forest, a WNS-positive site. In summer 2004 and 2005, we surveyed bats using Anabat II bat detectors and collected 1,555 call files. In summer 2016 and 2017, we surveyed bats using Anabat Express detectors and collected 2,684 call files. Calls were grouped into five species groups according to call frequencies. Using two-tailed t-tests, we found a significant increase in the number of low

frequency bat call files collected post-WNS. Using kernel density estimation, we generated a probability density distribution of each species' activity throughout the night during both sampling periods and used the overlap term to quantify the amount of temporal overlap that occurred between sampling periods and species. We found that all species changed their peak activity periods pre- to post-WNS, though the degree of change differed among species. We also found that the level of overlap between species changed, with evening bats and Myotis using opposite foraging times post-WNS. We conclude that WNS has affected temporal niche partitioning in South Carolina. Overall, our findings lend additional support to the results of other studies suggesting that changes in niche partitioning is widespread among communities affected by WNS.

DIET CHARACTERIZATION OF THE FLORIDA BONNETED BAT, WITH ANALYSIS OF SEASONAL AND GEOGRAPHIC VARIATION

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Understanding the prey base of federally endangered species such as *Eumops floridanus* is important: Examining diet variation among populations of the species and across seasons can help determine if it is rigid or flexible in selecting prey species. Also, identifying ecosystem services provided by *E. floridanus* could provide an important tool in promoting conservation of these bats among the general public. The increased sophistication of molecular techniques allows for results of higher resolution than the lone published study of *E. floridanus* diet, which relied on manual dissection. We used passive and active methods to collect guano from *E. floridanus*. We collected guano beneath roosts one night per month for a year at Babcock-Webb Wildlife Management Area in Punta Gorda, FL to assess seasonal variation in diet. We also collected guano from individuals captured using an acoustic lure at Avon Park Air Force Range and metropolitan Miami to assess geographic variation in diet. We used a metabarcoding approach with two sets of primer pairs to extract and amplify the insect DNA within the guano; the DNA was sequenced using the Illumina MiSeq platform. After filtering the results by quality and known insects of Florida, 355 unique insect taxa were identified, representing 10 orders and 73 families. Moths were highly prevalent and diverse, spanning 28 families. Moths, beetles, and grasshoppers appeared in every or nearly every guano sample. More than two dozen pest taxa were identified. PERMANOVA analyses identified seasonal and geographic groupings of prey taxa as highly significant. Diet overlap was greatest between winter and spring, and least between winter and summer. Diet overlap between Avon Park and Miami was greater than diet overlap between winter and summer within a single location, suggesting that conservation efforts should take into account temporal variation in prey availability.

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 113 bridges and used radio telemetry (by car and via telemetry towers) to track 90 bats (62 female, 28 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 3 bridges, 2 buildings, a sycamore (*Platanus occidentalis*) tree, and a known cave roost in Newport, TN; all 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 and most active (>7 calls/night) along the E-W axis that includes the Pigeon and Swannanoa rivers. 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.

RANGE-WIDE POPULATION GENETIC STRUCTURE OF RAFINESQUE'S BIG-EARED BAT (*CORYNORHINUS RAFINESQUII*) AND SOUTHEASTERN MYOTIS (*MYOTIS AUSTRORIPARIUS*)

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Population genetic structure can provide pertinent and essential information for the conservation and management of rare species. *Corynorhinus rafinesquii* (Rafinesque's Big-eared Bat) and *Myotis austroriparius* (Southeastern Myotis) are two rare bat species with overlapping ranges across much of the southeastern United States. At the state level, both species are regarded as threatened, endangered, or of greatest conservation need across nearly all of their range, mostly due to loss of habitat and population decline. The overall objective of this study is to understand the population genetic structure of *C. rafinesquii* and *M. austroriparius* to determine population connectivity and determine if there is sufficient gene flow to maintain a high level of genetic diversity among populations. In 2016 and 2017, I collected tissue samples from both species across their range and extracted and sequenced mitochondrial DNA through Sanger sequencing and nuclear DNA and mitochondrial DNA through genotyping-by-sequencing (GBS). Thanks to the collaborative efforts of many researchers, I collected more than 800 tissue samples from 14 different states. As population decline and habitat fragmentation continues, understanding the population genetic structure of these two rare species will provide much-needed information, such as gene flow and population connectivity, genetic diversity within and among populations, and needs for management of both species based on these population characteristics. Some

populations may be disjunct and may need to be considered as separate evolutionarily significant units (ESUs) or management units (MUs), and it may be beneficial to create wildlife corridors to reconnect these populations for proper mixing of the gene pool, while lessening the impacts of genetic drift and the risk of a population bottleneck. Results from this study will be made available to improve long-term protection and management protocols for these two bat species.

A COMPARISON STUDY OF SELECT TENNESSEE DEPARTMENT OF TRANSPORTATION (TDOT) BAT SURVEY PROJECTS CONDUCTED IN THE FOUR GEOGRAPHICAL REGIONS OF TENNESSEE

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As our infrastructure continues to grow and develop the need for improvements continue to increase. Therefore, individual departments of transportation will continue to need bat surveys as these projects are developed and implemented. This growth continues to be the case for the Tennessee Department of Transportation (TDOT) as well. Having done numerous bat surveys for several years, Civil & Environmental Consultants, Inc. decided to take a look at several projects that we have surveyed on multiple occasions. Four projects were chosen that were located in each of the DOT's four geographical regions of the state. All projects were road improvement projects that required either widening or extensions of existing roads and triggered bat survey requirements. Variables that were evaluated include; number of bats captured, number of species, sample location (habitat type), survey effort, and first occurrence of White-nose syndrome in the project county.

POSTER PRESENTATIONS

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

NONINVASIVE COLOR MARKING TO EXAMINE MOVEMENT PATTERNS IN LOUISIANA CULVERTS

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Examining fine scale movements of bats in transportation structures can be difficult with traditional techniques. For example, when bats are wedged in cracks, reading PIT tags and wing bands may require disturbance. Noninvasive marking techniques have been used on a variety of taxa such as bees, crayfish, hummingbirds, lizards, and snails; however bat-specific literature is limited. To noninvasively examine Perimyotis subflavus movements within and between culvert sites we used a combination of standard and ultraviolet florescent fingernail polish to mark individuals. Pelage was marked on the top of the head between the ears of 348 bats in 14 culverts. At two sites, 95 males and 35 females were marked to determine if differences in movement occur between sexes. Bats were marked January 2019 and will be checked weekly until mid-April or until migration begins. Temperature, light, and water level loggers were deployed at all sites containing marked individuals. Preliminary results indicate fingernail polish is a viable option for noninvasive marking and movement results will be available at the meeting.

WINTER USE OF CULVERTS IN LOUISIANA

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Louisiana has limited data on distribution and abundance of bat species throughout the state. Positive detections in all three bordering states; Arkansas, Mississippi, and Texas, increases the potential of disease spread into the state. In Louisiana, cave dwelling species typically roost in culverts and man-made structures due to a lack of available cave hibernacula. Collecting statewide data prior to disease arrival will allow Louisiana to monitor population impacts and track spread. We examined seasonal use of culverts as roost or hibernaculum sites. We surveyed 718 culvert sites, over 1,200 individual culverts, from November 2017 to February 2018. One hundred thirty-three (18.5%) culverts contained bats, 89 (67%) of those 133 contained a single species and 44 (33%) contained two or more species. In total, we identified 2,628 individuals representing five species; *Eptesicus fuscus*, *Perimyotis subflavus*, *Myotis austroriparius*, *Corynorhinus rafinesquii*, and *Tadarida brasiliensis*. This project increased our WNS

surveillance efforts from three sites, one species, and 75 samples the previous year to 13 sites, 5 species, and 275 samples. In order to determine if patterns of species distribution and abundance are constant, culvert surveys are currently being repeated.

OBSERVATIONS OF EASTERN SPOTTED SKUNKS IN SOUTHERN ALABAMA AND THE USE OF CROWD SOURCED INFORMATION IN LOCATING A CRYPTIC SPECIES

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Eastern spotted skunks (*Spilogale putorius*) have experienced dramatic range wide population declines in recent years due to unknown causes, with the species currently listed as vulnerable to extinction by the IUCN Red List. Within the southeast, numerous research projects are studying the species via camera surveys, habitat surveys, and telemetry studies. A current project located in Conecuh National Forest in southern Alabama is attempting to assess fine scale landscape use of eastern spotted skunks, and has caught one individual during its 12 month duration. This study site was chosen due to little knowledge on the status of populations in the southern coastal plain region, relative to the greater depth on knowledge on populations in the more northern regions of the state. In hopes of increasing the number of collared individuals, the Conecuh project will be shifting focus to areas with recent Eastern spotted skunk sightings. These sightings are a result of crowd sourcing efforts, which have shown that eastern spotted skunks are evenly distributed across the state, and have been sighted in 34% of counties in Alabama.

EFFECTS OF PRESCRIBED FIRE INTERVAL ON THE QUALITY OF SNAG HABITAT IN THE SOUTHERN APPALACHIANS

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Snags, or standing dead trees, are an influential part of forest ecosystems and provide habitat for many species of birds and bats. Alabama alone is within the ranges of 45 species of birds and 8 species of bats that utilize snags at some point in their life histories. Alabama is also within the historical range of longleaf pine (*Pinus palustris*) which requires frequent, low intensity fires to maintain its open-canopy structure. Current restoration efforts in the southeastern U.S. use mechanical thinning and prescribed fire to promote longleaf pine and its associated species. The effects on snags preferred by wildlife within a prescribed fire regime is not well documented in the southeast. Our objective is to evaluate how different fire intervals, or times between fire events, affect the density and characteristics of snags. Over the summer of 2018 we surveyed 80 sites spanning four different ranges of prescribed fire intervals using belt transects placed on the ridge, mid-slope and valley of the site. We measured 256 snags and found that snag density was lower in heavily managed stands with frequent fire. Those stands also had significantly less snags per hectare that met the minimum size requirement for the majority of bird species. The

density of the highest quality snags for bats was significantly higher in the stands with the most frequent fire, and the highest quality snags for birds was not significantly different across fire intervals. Management with prescribed fire may reduce the total number of snags on the landscape, but can actually promote snag characteristics preferred by native imperiled bat species. Prescribed fire management also may not reduce the density of the highest quality snags for cavity nesting and perching birds as has been previously shown. This emphasizes the benefits of managing a landscape with prescribed fire in regards to improving the quality of habitat for snag-dependent wildlife.

HURRICANE IRMA'S IMPACTS ON FLORIDA PANTHERS

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High water levels have been shown to influence the movements of Florida panthers (*Puma concolor coryi*), so with the impending arrival of Hurricane Irma in September 2017, we were interested to see how panthers might be affected. To that end, we increased the fix acquisition rate on an adult male panther fitted with an Iridium GPS Collar to assess the response to the storm. The panther sought shelter while the winds were greatest, but resumed movements within 8 hours. Concurrently during the storm, a trail camera grid that had been deployed on a private ranch to measure panther population densities, was also collecting data. Photos of panthers and their prey captured pre- during and post-Irma demonstrated the drastic landscape changes during the hurricane. High water levels likely restrict or slow movement rates. Flooding probably has the greatest impact on dependent aged kittens, the most vulnerable segment of the population. Fine scale movement patterns of deer during the storm were also delineated via GPS collar data collected in a separate study on public lands. Those data revealed deer moved toward higher ground during Irma. Observations of GPS location data during this hurricane and flight data collected during previous named storms have shown adult panthers to be resilient to danger and habitat alterations that can be caused by these severe weather events.

USE OF BRANDENBARK™ BY BATS IN WESTERN KENTUCKY: OCCUPANCY AND HABITAT CHARACTERISTICS

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Maintenance of habitat with suitable roost trees is a key component of conservation efforts for the endangered Indiana bat (*Myotis sodalis*). BrandenBark™, an artificial bark designed specifically for long-term habitat improvement for bark-roosting bats such as the Indiana bat, is being used as a mitigation/habitat enhancement tool in several states. We monitored 18 roost poles on which Brandenbark™ was installed for occupancy by bats at three sites in western KY where Indiana bats were known or likely to occur, in the summers of 2017 and 2018. We examined the relationship between roost occupancy and macro- and microclimate variables. Sites

were visited weekly and ambient conditions, presence of guano in a guano trap at the base of each pole, audible bat calls, and canopy cover were documented. Roost temperature was recorded every 30 min using iButtons that were placed between the roost pole and the surrounding BrandenBark. At Clark's River National Wildlife Refuge (CRNWR) and Audubon State Park (ASP), none of the roost poles were occupied by bat in 2017. In 2018, 3 of 9 poles (33%) were occupied for 8 days at CRNWR and 3 of 5 poles (60%) were occupied for 1-4 days at ASP. At the Trigg Co. site, 2 of 4 poles were occupied in 2017 (42-78 days in late May or June – early September) and 2018 (117-123 days in early April – late August). There was no significant difference between ambient and roost temperature at any site. There was also no significant difference in canopy cover and distance to forest between occupied and unoccupied roost poles. Our results indicated that use of BrandenBark roost poles takes time, with use tending to increase in the second summer after the poles are installed. We did not find any obvious habitat correlates that indicated use of specific roost poles but our sample size was small.

USE OF LONG TERM ACOUSTIC MONITORING TO STUDY BAT COMMUNITY CHANGES IN GEORGIA

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The Georgia Department of Natural Resources (GADNR) began conducting annual mobile acoustic routes in the summer of 2010 to gather data before the expected arrival of White-nose Syndrome (WNS) to the state. This mobile acoustic survey data will provide estimates of bat activity, relative abundance, and species richness over large survey areas. As was anticipated, WNS arrived in Georgia in 2013 and cave bat populations quickly declined. Since this acoustic monitoring project began, almost 300 nights of data have been collected, mostly through the use of volunteers. Data is collected from 34 routes around the state, driven on the same roads and for the same distance and direction during each survey night. Routes are driven with a Titley Anabat SD1 or SD2 detector with a roof-mounted microphone and GPS to record calls. Routes are ideally completed once in June and July each year on nights when weather conditions are favorable. GADNR employees use Kaleidoscope Pro software to conduct analysis. We are interested in monitoring Tri-colored bat (*Perimyotis subflavus*) populations to determine if acoustic results match species declines observed from summer mist-netting and winter cave survey data. Other WNS-susceptible species are also being monitored. Further analysis will investigate bat community response habitat changes, as well as overall activity in relation to weather conditions on survey nights.

PREVALENCE OF HANTAVIRUS IN WILD POPULATIONS OF MICE IN THE GREATER MUNCIE AREA

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Biologists have an increasing interest in hantavirus throughout the Midwestern United States due to its potential negative implications on humans. Understanding the prevalence of this zoonotic virus throughout the environment is a priority for the safety of biologists that work with small mammals but also represents concerns for public health in general. *Peromyscus sp*. are the main vector for the spread of the virus in the Midwest US. Recently high prevalence rates of hantavirus were documented in one location in Indiana. It is unclear if these prevalence rates are localized or wide spread. We plan to look at the presence of hantavirus in the east-central Indiana area in hope of gaining a better understanding to the extent of hantavirus prevalence on the landscape. During the month of November 2017, we deployed Sherman traps to catch mice on a single property at Ball State University. Efforts were focused on a 50-acre restored prairie using 60-meter grids established throughout 15 prairie management plots to sample the presence of hantavirus in *Peromyscus sp*. throughout the prairie. Traps were checked daily and general morphological characteristics were collected on captured individuals. We also collected blood samples from captured individuals to determine the presence of hantavirus within the community. Our first trapping efforts yielded 23 *Peromyscus sp*. and our second trapping effort yielded 178 *Peromyscus sp*. throughout the study. A total of 54 blood samples were collected from captured individuals. All 54 samples collected were negative for hantavirus. We plan to increase our sampling effort and continue to collect data in the spring of 2019 in various habitat types. The results of this research may guide management decisions for future hantavirus surveying.

EVALUATING AN ACOUSTIC LURE TO INCREASE CAPTURES OF IMPERILED BAT SPECIES AT MARINE CORPS BASE QUANTICO AND PRINCE WILLIAM FOREST PARK

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Ultrasonic acoustic lures may help increase captures of rare, net-shy, or high-flying bats during mist-net surveys. However; studies testing the effectiveness of acoustic lures are lacking in North America. Research in Europe and to a lesser extent North America, suggests bats respond to social and distress calls of conspecifics and therefore may serve as auditory attractants for interior forest *Myotis*, and high-flying species such as *Eumops floridanus* and *Lasiurus cinereus*. We performed a pilot study in summer of 2018 at Marine Corps Base Quantico and Prince William Forest Park to test acoustic lure effectiveness using a combination of mist-nets and a low-cost infrared camera system "captures" as our observable metric. Although analysis is ongoing, our preliminary results suggest largely equivocal responses for most bat species, although some positive trends in captures with lures was recorded.

A COLLABORATION BETWEEN THE US FISH AND WILDLIFE SERVICE AND THREE FLORIDA ZOOS

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The USFWS has the responsibility of recovering federally listed species pursuant to the Endangered Species Act (ESA). The Perdido Key Beach Mouse (PKBM) is an endangered species living in the far western reaches of the Florida panhandle on a barrier island approximately 17 miles long. The population was so low in 2005 following a robust few years of active hurricane seasons. A captive breeding program aimed at recovering the PKBM was established with three Florida zoos (Santa Fe Teaching Zoo, Brevard Zoo, Palm Beach Zoo). Overtime this program developed into more than a traditional captive breeding program, whereby zoo staff became an integral part of the field projects involving trapping and surveying PKBM. Zoo staff was trained in field techniques to trap, tag, collect data and samples, becoming some of the few individuals in Florida experienced in handling these endangered mice. Further efforts have included zoo staff creating and conducting outreach to the public where the USFWS was falling short. Future endeavors involve zoo staff assisting with other beach mouse field projects needing experienced individuals.

LASIURINE FORAGING TELEMETRY IN IOWA

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In late summer and early fall of 2018 Western EcoSystems Technology, Inc. (WEST) conducted mist-net surveys at 16 sites in central Iowa with the objective to capture and attach radio-transmitters to Lasiurine species to identify foraging habitat utilized during the summer and fall. The main objectives of the bat surveys were to identify areas that *Lasiurus* bats are using for foraging particularly in areas of perceived low quality bat habitat, such as high agriculture and development areas. Four *Lasiurus borealis* and one *Lasiurus cinereus* were captured and tracked using crews of three to five people. Bat foraging habitat was estimated using Lenth's (1981) maximum likelihood estimation procedure and for locations with acceptable precision kernel smoothing was applied provided a non-parametric estimate of the foraging area. WEST presents the initial findings on the foraging habitat use of those bats and the differences between tracking *Myotis* species and *Lasiurus* species.

BAT USE OF UPLAND PONDS WITHIN THE HARDWOORD FOREST ECOSYSTEM OF SOUTHERN INDIANA

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The watershed systems of the Morgan-Monroe and Yellowwood State Forests (MMYSF) of southern Indiana are largely composed of ephemeral streams. The Indiana Department of Natural Resources (DNR) created man-made ponds within the state forests for the benefit of game species. The DNR would like to determine how these ponds might be affecting bat species living within state forest boundaries. During the summer months of 2018, we conducted acoustic surveys at a sample of ponds within the MMYSF boundaries to determine bat activity levels for the season. Mid forest vegetation surveys were conducted at each pond to determine vegetation density, which may limit bat accessibility to ponds based on body size morphology. These activity and vegetation density levels will provide the preliminary results to determine what ponds are more actively used for bat communities living in managed hardwood forest ecosystems.

ASSESSING RIVERS AS BARRIERS TO EASTERN SPOTTED SKUNK (*SPILOGALE PUTORIUS*) MOVEMENT IN WEST VIRGINIA

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Eastern spotted skunks (ESSK; *Spilogale putorius*) were once thought common throughout the midwestern and southeastern United States but have experienced a range-wide decline since the 1940's. Extensive surveillance in Maryland and Pennsylvania, the northeastern extent of the species' range, suggest that viable populations may no longer exist. Seemingly viable populations have persisted along shared mountain ranges in Virginia and West Virginia, but these populations are separated by the Potomac River, a possible barrier to future expansion into the historic range. Relatively little is known about the effects aquatic habitats and landscape features may have on the dispersal of ESSK. We are currently assessing movement, home range, and habitat use of ESSK (3 males, 2 females) in West Virginia. We present evidence of at least 5 crossings of the South Branch of the Potomac River (SBPR; Pendleton County, WV) by 2 radio-collared male ESSK. The width of SBPR typically ranges 9 m – 55 m at areas where the 2 ESSK are suspected to have crossed. It is unclear if females will cross the SBPR. Although our sample size is small and more information is needed, medium-sized rivers do not appear to be movement barriers for male ESSK. Future research will involve using GPS-enabled UHF collars to determine if movement across the river is random or restricted to certain stretches of the river.

WILDLIFE ACTIVITY AT MAKER'S MARK DISTILLERY

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Healthy ecosystems are characterized by complex networks of predator and prey interactions. The global decline of apex predators has likely caused mesopredator populations (predators in

the middle of food chains) to shift, a phenomenon described by the mesopredator release hypothesis (MRH). We conducted baited camera trap surveys to inventory the wildlife community and assess peak times of mesopredator activity on the 623-acre property of Maker's Mark Distillery in Loretto, Kentucky. Cameras were deployed on tree trunks ca. 0.5 m off the ground facing a bait station 2-3 m away. Camera traps were deployed from March to April 2018 and were placed near edges and corridors, landscape features generally associated with mesopredator presence. We surveyed 4 locations and ultimately surveyed 208 trap days and collected 3560 images of 14 different species. White-tailed deer (*Odocoileus virginianus*), eastern cottontails (*Sylvilagus floridanus*), and tree squirrels (*Sciurus* spp.) were the most commonly recorded species and comprised 73% of total detections. Mesopredators detected include Virginia opossums (*Didelphis virginiana*), raccoons (*Procyon lotor*), coyotes (*Canis latrans*), gray foxes (*Urocyon cinereoargenteus*), and red foxes (*Vulpes vulpes*) and comprised 23% of total detections. Mesopredator activity was highest (33 mesopredators detected) around the average sunset time for the study period (approximately 8:00 pm), and lowest (0-1 mesopredators detected) from 2:00 pm – 5:00 pm. Our data suggests mesopredators comprise a large portion of the wildlife community at Maker's Mark Distillery, are mostly active after sunset, and are therefore more elusive than other wildlife more commonly seen on the distillery grounds. Images and results from these surveys are being used for environmental outreach at Maker's Mark Distillery to facilitate education to visitors about wildlife found on the property and the importance of a healthy ecosystem.

ASSESSMENT OF THE PRE- AND POST-WHITE NOSED SYNDROME BAT COMMUNITIES ON CHEROKEE TRIBAL LANDS

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By 2012, biologists throughout the eastern United States were evaluating impacts of white-nosed syndrome on bats. However, few researchers were continuously monitoring bat populations before white-nosed syndrome had taken a large toll. Because of federal regulatory actions coupled with residential growth, the Eastern Band of Cherokee Indians has continually evaluated bat communities since 2004. In this presentation, we examine the loss of *Myotis* and changes in bat communities from three long-term mist-net sites on the Cherokee tribal boundary located in the southern Appalachians.

DISTRIBUTION AND REST SITE OBSERVATIONS OF EASTERN SPOTTED SKUNKS IN NORTH CAROLINA

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The eastern spotted skunk (*Spilogale putorius*) is categorized as a priority mammal species in North Carolina, because the current distribution, status, and habitat requirements of this species are largely unknown. Since 2016, we have been coordinating with wildlife managers to conduct an annual camera trap survey in the mountain ecoregion of North Carolina to assess spotted skunk distribution and factors influencing the species' detection and occupancy probability. Additionally, in 2018 we initiated a multi-year radio-telemetry study of spotted skunks in South Mountains State Park (SMSP) and adjacent protected areas to investigate the factors influencing fine-scale habitat selection, reproductive success, and survival. Initial results of these ongoing studies offer promising insight into the ecology of spotted skunks in North Carolina. We surveyed 177 locations during the 2016-2018 camera surveys, detecting spotted skunks at 26 locations dispersed across the mountain ecoregion. In the radio-telemetry study near SMSP, we collared and tracked nine spotted skunks (7 males, 2 females) and observed 53 diurnal rest sites for these individuals. We present initial findings regarding the regional distribution of camera detections and local rest site observations of the nine radio-collared skunks in and around SMSP, with discussion of upcoming occupancy and habitat selection analyses planned for these data.

DIETARY OVERLAP AND PEST CONSUMPTION OF THREE COMMON BAT SPECIES IN THE SOUTHEAST US.

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Ecological theory and research suggest that niche partitioning among generalists allows the coexistence of sympatric species. In bats, direct observation of food consumption is infeasible, and thus morphological variation among species (i.e. wing loading, body size etc.) is often used as a proxy to make predictions regarding the expected degree of dietary overlap. This approach often ignores intraspecific variation and offers an incomplete view into the dynamics of resource partitioning which can vary across time and space. To overcome these shortcomings, we are using metabarcoding techniques to compare dietary overlap across species, reproductive conditions, age, region, and seasons. In addition, we are determining the site conditions and bat characteristics which influence the consumption of key insect pest species. These insights promise to reveal increased resolution in our understanding of the interactions between *Nycticeius humeralis, Lasiurus seminolus, Myotis austroriparius* and their prey in the Coastal Plain of the Southeast US.

CORRELATION OF BAT SPECIES RICHNESS AND BAT ACTIVITY WITH HABITAT TYPE, INSECT DIVERSITY, AND INSECT BIOMASS AT REELFOOT LAKE

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We examined the correlation between bat activity with habitat type, insect diversity, and insect biomass at Reelfoot Lake, June 20 – August 15, 2018. We simultaneously sampled three habitat types (two sampling sites each located in bottomland hardwood forest, lakeshore habitat, and cropland) located within 0.5 miles of Reelfoot Lake each week. Due to the structural complexity of the bottomland hardwood habitat, we hypothesized that bat activity would be highest in bottomland forest as would insect diversity and insect biomass. Two nights a week at each site, we collected insects using black light traps, and subsequently identified insects to order and family (where possible). In addition, we determined insect biomass by gaining both a wet and dry weight of subsamples from the insect samples. Finally, we sampled bat activity by using a Wildlife Acoustics SM4Bat Full Spectrum detector to record bat passes. We visualized bat passes using SonoBat North America 4.2.2 software with the western Kentucky-Tennessee regional classifier to count bat passes (after files were scrubbed for non-bat noise) and to identify species when possible. Subsequently, we manually vetted bat passes that had been identified to species by SonoBat. Bat activity was significantly different between habitat types and dates, with no consistent habitat type being correlated to the highest amount of bat activity. There was no significant correlation between insect abundance and bat activity among the three habitat types. Given the abundance of insects at Reelfoot Lake in general, other factors most likely influenced the variation in bat activity during the study.

A NEW METHOD TO MONITOR TRENDS IN POPULATIONS OF EASTERN SMALL-FOOTED BATS ON TALUS SLOPES

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Hibernacula surveys have been the primary method to monitor status of bat populations in eastern North America, but such data may be less useful for assessing population status of Eastern Small-footed Bat (*Myotis leibii*) compared to some other species of cave hibernators. Counts of this species in winter are often low and have high variance, perhaps due to their cryptic hibernating habits. To augment winter datasets and reduce uncertainty over status of this species in Virginia, we conducted annual visual surveys for bats roosting on talus slopes during summers, 2013 to 2018. Because this is a novel and untested survey method we also assessed factors affecting detection and error. Negative binomial model estimates varied substantially among sites, with densities ranging from 17 (95% CI:15 to 21) to 269 (95% CI: 248 to 291) bats per ha. Population sizes ranged from 11 (95% CI: 9 to 13) to 286 (95% CI: 274 to 299) bats, depending on the size of talus slopes. Detection error trials suggested visual surveys are relatively effective. Observers detected 67% of radio-tagged bats; half of false negatives were caused by observers overlooking visible bats and half were due to bats roosting in hidden recesses of crevices. Our monitoring results suggest site specific trends in abundance, with some sites exhibiting declines, but overall changes in abundance were negligible (-1.3% net change). Researchers in other regions with talus slopes should consider using this method to improve monitoring of Eastern Small-footed Bats, or other species of bats with similar habits, especially where hibernacula data are limited.

A FOUR-YEAR WHITE NOSE SYNDROME MITIGATION EFFORT AT BLACK DIAMOND TUNNEL

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Black Diamond Tunnel is an abandoned railway tunnel in Clayton, GA which housed the largest recorded tri-colored bat (*Perimyotis subflavus*) population in the state prior to the arrival of white nose syndrome (WNS). Since the first detection of WNS at Black Diamond Tunnel in 2013, the bat population, once exceeding 5,000, has experienced a 95% decline. In an effort to mitigate the effects of WNS on the population of bats hibernating in Black Diamond Tunnel, a multi-year mitigation project was implemented at the site. A formulation of volatile organic compounds known to exhibit anti-fungal properties was developed to inhibit the growth of *Pseudogymnoascus destructans*. Flavorzon 185B (or B-23), is a synthetic mixture of volatile organic compounds produced by *Muscodor crispans*, a fungal endophyte of the wild Bolivian pineapple (*Ananas ananassoides*), and decanal, a naturally occurring volatile organic compound found in many natural products and flavorings. To treat the tunnel with this formulation, an automated dispersal system was created to aerosolize the formulation at a constant rate, effectively distributing the solution over the entirety of the tunnel and facilitating evaporation. These treatments were conducted three times each winter hibernation season. Bat population surveys were recorded pre- and post-treatment season. The data collected from the post-treatment surveys thus far suggest there have been no negative impacts as well as potentially contributing to increased survivorship. However, continued treatments and surveys are necessary to strengthen our conclusions.

BAT ACTIVITY AT UPLAND-EMBEDDED WETLANDS IN THE DANIEL BOONE NATIONAL FOREST, KENTUCKY

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The Daniel Boone National Forest (DBNF) in eastern Kentucky has more than 500 known upland-embedded wetlands (UEWs), many of which have been the focus of ecological studies over the past decade. While bats are well-known to use streams and wetlands across eastern North America as a water source and for foraging, their use of UEWs is relatively understudied. We conducted acoustic surveys of bat activity across a variety of natural and constructed UEWs in the DBNF. We hypothesized bat activity would differ between natural and constructed UEWs, and that clutter-adapted species would be more likely to use natural wetlands given the denser canopy structure expected at these features. Full-spectrum acoustic detectors were deployed across twenty-eight randomly selected wetlands during June–August of 2018. Each wetland was monitored by a single detector, and each monitoring event for a single wetland lasted ≥5

continuous nights. In total, we conducted acoustic surveys across 205 detector-nights, resulting in identification of 18,891 bat passes. While our acoustic surveys suggest that overall bat activity per detector-night was greater at constructed wetlands vs. natural wetlands ($P \leq 0.05$), fewer pulses identified as belonging to *Myotis* species were recorded per detector-night at constructed wetlands vs. natural wetlands ($P \leq 0.05$). Given the abundance of UEWs on the DBNF, this research is broadly important for understanding wetland use by various organisms, and for informing management practices and wetland restoration efforts to specifically benefit bat species. This is especially critical for those species negatively impacted by White Nose Syndrome.

RESPONSE OF ANASTASIA ISLAND BEACH MOUSE POPULATIONS TO HABITAT LOSS

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In 2016 and 2017, multiple hurricanes struck Anastasia Island, on the Atlantic coast of Florida, destroying dune habitats necessary for the survival of the endangered Anastasia Island beach mouse (AIBM; *Peromyscus polionotus phasma).* Starting in January 2018, we monitored AIBM populations for 12 months to better understand impacts from the hurricanes and improve recovery efforts. We installed 131 track tube stations in Anastasia State Park (ASP) and Fort Matanzas National Monument (FMNM), where most habitat potentially suitable for AIBM occurs. Additionally, we placed track tubes in 4 St. Johns County (SJC) parks between ASP and FMNM to assess habitat connectivity for AIBM. We supplemented the track tube monitoring with live-trapping conducted along transects in suitable habitats at ASP (4 transects) and FMNM (3 transects) in June, September, and December to confirm species identification. We trapped opportunistically on the SJC properties. Initial track tube detection rates for AIBM were 32% at ASP and 36% at FMNM. Detection rates reached highs of 91% at ASP and 68% at FMNM in March, then declined through November before increasing again in December. Overall, AIBM detections were most frequent in dune habitats with open sand areas and high plant diversity. Detections declined in dune habitats when the vegetation grew too dense in summer and fall. Trapping data confirmed that AIBM was the only rodent species present in dune habitats at all sites and showed that AIBM population sizes were similar in June and September, then increased in December at both ASP and FMNM. Our results indicate that AIBM populations and the habitats they depend upon have been recovering. However, further habitat restoration is needed, and ongoing population monitoring is recommended to determine how AIBM populations respond to storms or other unanticipated threats.

GRAY BAT DIET IN WESTERN NORTH CAROLINA

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To date, no specific diet data are available for the federally endangered gray bat (*Myotis grisescens*). Because gray bats often forage over water, past work has speculated on a preference for Ephemeroptera (mayflies), but because these soft-bodied insects degrade quickly in bat stomachs, there are few data to support this hypothesis. Gray bats were recently discovered roosting in manmade structures in the French Broad River Basin of western North Carolina. We conducted capture surveys at these roost sites during spring, summer, and fall 2018. We conducted a next-generation sequencing analysis using 79 guano samples collected from gray bats captured at roost sites. We extracted DNA from 1–3 fecal pellets per bat and amplified the COI minibarcode region with insect-specific primers (Zeale et al. 2011), using the two-step PCR method for Illumina MiSeq outlined in Divoll et al. (2018). We also followed the bioinformatics process outlined in Divoll et al. (2018), comparing resulting sequences to the BOLD database and filtering viable operational taxonomic units at a 98.5% similarity threshold. Here, we will present preliminary data on the diets of six individuals (3 AM and 3 AF), two each from capture surveys in April, July–Aug, and Sept–Oct. It is especially important to study gray bat diet because this is one of the few cave-dwelling bats not experiencing significant declines from white-nose syndrome. Though federally endangered, this species may eventually become one of the more abundant bats in the southern Appalachian Mountains. Therefore, it is crucial to understand this species' dietary requirements and the ecosystem services these bats provide in terms of insect control, in order to make a better case for their conservation.

SOUTHEASTERN FOX SQUIRREL (*SCIURUS NIGER*) OCCUPANCY PATTERNS IN FRAGMENTED MONTANE LONGLEAF PINE FORESTS IN ALABAMA

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Southeastern fox squirrels (*Sciurus niger*) have received little study within the montane longleaf pine (*Pinus palustris*) ecosystem, but are considered an indicator species within other longleaf forest types. To better understand southeastern fox squirrel abundance and habitat needs in montane longleaf pine forests, we conducted an occupancy study to determine habitat associations and preliminary population estimates for southeastern fox squirrels in Talladega National Forest, AL. Using 73 camera trapping sites, we collected detection data, conducted vegetation surveys at the local scale, and used remotely sensed data to quantify habitat at the landscape scale. Influential occupancy models included several groundcover variables, slope, basal area (BA) of pines, and frequency of prescribed fire as predictor variables. Fox squirrels in montane longleaf system are negatively associated with dense woody groundcover and steep slopes, but are positively associated with pine BA and frequent fires. This study improves knowledge of fox squirrel habitat by adding information about occupancy in the understudied montane longleaf system and aids in management of the species.

EFFECT OF ASPECT ON THE MICROCLIMATE OF THREE-CHAMBERED BAT BOXES

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Bat boxes are important conservation tools that can provide roosting habitat for bats in altered or suboptimal habitats. However, while some bat box designs can be beneficial, many designs and placement conditions can result in microclimates that are harmful to bats (e.g., $T_{MAX} > 40^{o}C$, $T_{MIN} < 0^{o}C$). Of the few designs and placements that have been tested, many experience suboptimal temperatures which renders these boxes largely unusable by most species. We conducted a pilot study analyzing the microclimate of a common three-chambered bat box design from August 23rd to September 5th, 2018 at Taylor Fork Ecological Area, an early-successional field station in the Outer Bluegrass region of Kentucky. Our objective was to develop a temperature profile for bat boxes in this area and, further, to investigate the impact of aspect on the microclimate of this common type of bat box. We deployed a total of 6 bat boxes, with an east-facing aspect randomly assigned to 3 of these boxes, and the remaining 3 were assigned north-facing aspects. We collected temperature data points hourly via Thermochron iButtons placed in the middle of each roosting chamber (n=3/box, n=18 iButtons total). No bat boxes overheated during the two week study period ($T_{MAX} = 38.0^{o}C$). Both box orientations had a mean daily temperature variation of ~12ºC. East aspect boxes generally supported warmer microclimates than north aspect boxes ($\bar{x}$ ± SE of 24.1 ± 0.09ºC and 23.7 ± 0.09ºC, respectively). East aspect boxes typically reached maximum temperatures later in the afternoon (ca. 60 min), and retained more heat over the course of the night when compared to the north aspect boxes. Our results suggest that greater heat retention through the overnight by east aspect boxes could be important to facilitate pup development and reduce energetic expenditure associated with thermoregulation.

CONSERVATION METHODS OF CAROLINA NORTHERN-FLYING SQUIRRELS ON CHEROKEE LANDS AND FUTURE DIRECTIONS OF POPULATION ASSESSMENTS

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Successful conservation of mammals is achieved through optimal monitoring methods. However, the current method of monitoring the endangered Carolina Northern-Flying Squirrel (*Glaucomys sabrinus*) via artificial nest box surveys has proven to be inadequate. Nest box surveys for this species has provided few captures and even fewer re-captures, lending to poor population assessments. The Eastern Band of Cherokee Indians is currently attempting new methods to determine population size of the Carolina Northern-Flying Squirrel on tribal reserve lands. Our methods include acoustic detection devices and searching for natural nest sites.

BATS OF THE FLORIDA KEYS

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Staff at the Florida Keys Wildlife and Environmental Area began a survey in 2018 to collect baseline acoustic data from Key Largo to Key West. Prior to this work, velvety free-tailed bats (*Molossus molossus*) were thought to be the only resident species, with colonies discovered in buildings in the 1990s. Several neotropical species have been documented but are considered incidental. SM3BAT detectors have been placed at each of 12 sites for 4 nights. Recording has and will occur during each season over the course of a year. Preliminary analysis indicates the presence of several species at multiple sites. Results of the survey will provide greater understanding of the bat community in a freshwater-limited area.

TEMPERATURE PROFILES OF THREE-CHAMBERED BAT HOUSES AT TAYLOR FORK ECOLOGICAL AREA

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Bats are a crucial component of Kentucky's wildlife community and are currently under threat from habitat loss and White-nose Syndrome (WNS). In order to lay the groundwork for expanded research, an experiment was conducted at Taylor Fork Ecological Area, an early-successional field station managed by Eastern Kentucky University in the Outer Bluegrass region of Kentucky. We sought to investigate the variance of daily temperature profiles within three-chambered bat houses, and to gain a better understanding of how thermal variance might affect bat preference of chamber location within a roost. The bat houses were deployed 10 ft above ground at regular 100-meter increments in a systematic formation. Temperature data was collected hourly over a 28-day long period ranging from 18 July – 14 August in 2018.While mean temperatures on a daily basis do not appear to vary according to chamber location, temperatures within boxes varied greatly with middle and western-most chambers tending to warm later in the day versus the eastern-most chamber of the box. This study is beneficial, as it has laid the groundwork for long-term studies of roost microclimates at our institution's on-campus field station.

LONGEST DOCUMENTED SPRING MIGRATION TRACK OF A TRI-COLORED BAT (*PERIMYOTIS SUBFLAVUS*)

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The tri-colored bat (*Perimyotis subflavus*) was once considered a common species throughout its range and therefore research efforts in the eastern United States have historically focused more on endangered species such as Indiana bats (*Myotis sodalis*) or Gray bats (*M. grisescens*). However, populations of tri-colored bats have declined significantly since the discovery of white-nose syndrome, a deadly disease caused by the fungus *Pseudogymnoascus destructans* and the species is currently petitioned for listing under the Endangered Species Act. Researchers are now attempting to answer many life-history questions about tri-colored bats including questions of migration behavior. Copperhead Environmental Consulting, Inc. conducted a spring migration and roosting ecology study of tri-colored bats on and near Arnold Air Force Base, Tennessee in April 2018. On the nights of 27, 28, and 29 April 2018, we used aerial radio-telemetry to track a female tri-colored bat as she migrated a straight-line distance of 243 km from Wet Cave in southern Tennessee to a roost tree in Peachtree City, GA. The roost was located in a leaf clump 13 m high on a 68.8 cm diameter at breast height short-leaf pine (*Pinus echinata*). To our knowledge, this represents the first complete and longest spring migration track recorded for this species.

CROWD-SOURCING SPOTTED SKUNKS: CITIZEN SCIENCE IMPROVES EFFORTS TO IDENTIFY CONTEMPORARY RANGE BOUNDARY OF A RARE AND ELUSIVE SPECIES IN VIRGINIA

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Identification of spatial distribution is vital for the conservation of a rare and declining species, such as the eastern spotted skunk (*Spilogale putorius*). The elusive and nocturnal nature of this species creates logistical difficulties for researchers attempting to identify extant populations and contemporary range boundaries. The use of remote-sensing cameras in wildlife conservation has greatly increased the ability to detect species while minimizing time and resource use particularly if volunteer citizen scientists can participate. Our objective was to develop a state-wide citizen science camera survey to identify extant populations of eastern spotted skunks in Virginia. From our perspective, citizen science benefits include 1) greatly increased study area coverage and broader land-use sampling with little increase in project expenses; 2) increased awareness and interest in the conservation of an uncommon, cryptic species; and 3) active involvement of the lay community in wildlife conservation research and management. During the winter months, 2016-2019, > 30 volunteers throughout Virginia have donated time and resources to assist us in establishing baited, remote-sensing camera stations in an attempt to more fully describing the contemporary range of spotted skunks. Through the development of this project, we have increased the number of surveyed counties from seven in 2015 to > 30counties in 2019, spanning from the Appalachian Mountains to the Eastern Shore. Although data collection is ongoing, to date, spotted skunks have been detected in nine counties in the Appalachians south from the North Carolina border to as far north as the City of Harrisonburg. Further results to be discussed.

SYMBIOTIC REGULATIONS AND BAT MONITORING: THE ENDANGERED SPECIES ACT, MONITORING ON TRUST LANDS, AND STANDARDIZED METHODS

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The need for federal protections of white-nose syndrome affected bat species continues to increase as WNS spreads across the U.S. Currently, organizations in the east tied to federal funding must follow the USFWS Indiana bat range-wide guidelines to conduct presence/absence surveys prior to the removal of critical habitat. The USFWS requires the Eastern Band of Cherokee Indians to follow USFWS regulations prior to habitat removal, but the tribe has also welcomed researchers to conduct surveys for over 15 years. However, these surveys have come at a great financial cost and methods vary greatly each year, which may result in discrepancies in management decisions. Many papers suggest various protocols which are suitable for experimentally driven projects, but often federally funded organizations are tied to guidelines developed by and commented on by experts in the field. As one such organization, we followed the USFWS protocols and were able to develop cost-effective long-term monitoring protocols to address federal and tribal needs. To follow USFWS approved methods, we used SM4BAT FS (Wildlife Acoustics) acoustic detectors using factory recommended settings and sampled the recommended area (123 acres) and detector nights (8 detector nights/123 acres) across tribally owned land. We analyzed our acoustic data by converting full-spectrum to zero crossing calls using Kaleidoscope Pro version 4.2.0, sensitivity setting 0, and reporting calls with a p-value <0.05 as present. We hope that by using these methods we will be able to share data across species ranges where similar surveys on trust land are conducted and accurately monitor population trends in a changing landscape. Researchers may also be able to leverage such data to answer research questions over time.

ROUND-TAILED MUSKRATS (*NEOFIBER ALLENI)* IN NORTH CENTRAL FLORIDA: UPDATING PRESENCE DATA AND REFINING SURVEY METHODS

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Round-tailed muskrats are small nocturnal rodents found in shallow wetlands, restricted to southeastern Georgia and peninsular Florida. Their cryptic behavior poses challenges in assessing population status, which are believed to be declining due to wetland habitat loss throughout their range. Techniques have been developed to survey for occupancy, yet the literature lacks methodology to estimate abundance. We aimed to confirm presence of muskrats at historical locations in north central Florida to assess their continued persistence. We also

evaluated three survey methods: time to first den, double observer plots, and line transect distance surveys to determine if less intensive survey methods can accurately reflect abundance at a site. Lastly, we evaluated the effect of habitat variables on round-tailed muskrat occupancy and abundance. Preliminary results show that muskrats have persisted in some historical locations and not in others. Additionally, we have documented muskrats at one previously undocumented location outside of their known range. Our study is imperative for promoting successful long-term monitoring and management of a rare, cryptic Florida mammal.

FAMILY FEUD: TEMPORAL PARTITIONING BETWEEN TWO MAMMALIAN PREDATORS

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Despite often being labeled a mesopredator, coyotes (*Canis latrans*) may function as an apex predator in the absence of larger predators. This, coupled with their increased range across North America, are points of concern for many wildlife managers. Simply their presence may impact the activity patterns of prey and other predator species. While most of the research done on the effect of coyotes focuses on their impact on deer, coyotes also function as a major predator of gray foxes (*Urocyon cinereoargenteus*). These two species also compete for prey and habitat. Spatial partitioning, temporal partitioning, and other niche partitioning (such as diet) may promote coexistence among competing species. We analyzed camera trap data from about 200 sites across Alabama public lands to determine if temporal partitioning exists between various southeastern mammalian species, particularly in relation to the gray fox and the coyote. Our results indicated that coyote, white-tailed deer (*Odocoileus virginianus*), and eastern cottontail (*Sylvilagus floridanus*) shared similar temporal patterns. However, gray foxes and *Peromyscus* mice showed highly nocturnal patterns which may indicate a strong predator-prey interaction, and therefore influence partitioning by diet between the coyote and gray fox. The gray fox was also most likely to be active on nights with low moon illumination, which may be in part driven by prey specialization and/or predation risk. Because of its specialization to particular prey, nocturnality, and an arboreal lifestyle, the gray fox may be able to coexist with the coyote, despite moderate temporal and spatial overlap.

VARIATION IN BAT SPECIES DIVERSITY AND ACTIVITY AT THE BEECH RIDGE UNIT OF THE OBION RIVER WILDLIFE MANAGEMENT AREA

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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 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 during the study period. Simultaneously, we used a Wildlife Acoustics SM4BAT full-spectrum bat detector near the net survey site to record bat activity and species richness for at least two weeks after almost all net nights. SonoBat 4.2.2 North America software with western Kentucky-Tennessee regional classifier was used to assess bat activity (after files were scrubbed for non-bat noise) and to initially identify bat passes to species, where possible. 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. Eight 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 one species was 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.

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