ABSTRACTS

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Poster Presentations

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Adaptive radiation in the multidimensional phenotype

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Adaptive radiations are considered a special case of evolutionary diversification in which a clade displays extraordinary ecological and phenotypic diversity. A common feature that unites studies of adaptive radiation is that the ecology-phenotype connection has been almost exclusively described in terms of morphology. For example, the adaptive radiation of Caribbean anoles is known for the evolution of distinct ecomorphs,, which are so-named based on the tight association between structural habitat use and morphological traits in these lizards. Despite all the of the disproportionate attention that morphological traits have received, it has also been well-recognized that physiological evolution, along a thermal gradient, is also a key aspect of the adaptive radiation of anoles. Here we test how morphological and physiological disparity compare by examining the morphology and thermal physiology of Hispaniolan anoles. Elucidating that physiological patterns of evolution do not mirror morphological patterns of evolutionary divergence. We propose that thermoregulatory behavior may be guiding these macroevolutionary patterns revealed by this study.

The invasive tree-of-heaven's (*Ailanthus altissima*) relationship with understory and seedbank plant species

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Ailanthus altissima (Mill.) Swingle (Sapindales: Simaroubaceae), commonly known as the tree-of-heaven, was introduced to Pennsylvania in 1784 from China. Since then, this tree has spread to over 40 states. In Virginia, it is found ubiquitously in urban areas, along road ways, bordering agricultural lands, and in forests. Though *Ailanthus* has been shown to be associated with decreased levels of above-ground plant species richness and native species diversity in a few studies, this relationship has not been consistently found. Additionally, its impact to the seedbank (viable seeds or vegetative propagules present in the soil) has yet to be studied. To further understand this invasive tree's impact, ten paired invaded-uninvaded sites were identified in Montgomery, Giles, and Pulaski Counties. The established canopy and understory for each plot was measured, and soil samples were collected and grown out for 5.5 months in a greenhouse. All germinating plants were identified to the highest taxonomic level possible. In total, 96 species of understory plants and 77 species of seedbank germinants were identified. Furthermore, stand size and age of each invaded plot was estimated, ranging from 2-53 years and 3-4,200m2 respectively. A preliminary analysis of the relationship between *Ailanthus* presence, the understory, and the seedbank is presented, followed by a discussion of its future implications.

Fish assemblage impacts of reef fisheries in tropical Brazil

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Tropical marine environments are threatened by high fishing pressure and use of nonselective fishing gears that cause the decline and even ecological extirpation of key fish populations. Such declines have the potential to change species community composition, and associated energy fluxes for whole marine communities. The goal of this research is to identify fishing gears that harm the ecosystem because they catch disproportionate amounts of non-target species and/or undersized individuals. The project will take place in the "Marine Protected Area Coast of Corals", an area where over 100 species are regularly harvested. This includes the iconic and endangered Atlantic goliath grouper (*Epinephelus itajara*), which is often caught as bycatch. The data collection involves interviews with local fishers during the moment of the landing in fishing ports. An effort will be made to record the total catch per species, besides the size of each individual caught. The specific characteristics of the gears used (e.g. traps, beach seines, bottom trawlers, hand lines, spears and gill nets) will also be registered such as the length and mesh sizes of nets, size and number of hooks, etc. By identifying "harmful" gears, this project will help reverse current degradation trends by providing recommendations of gear restrictions. By evaluating our results in the context of ongoing fishing practices, our research will have direct application to fisheries management and ecosystem conservation

Predictability in the Evolution of Tetrodotoxin Resistance in Reptiles

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Predicting the presence or magnitude of traits based on genome sequences is a major challenge in modern evolutionary research, and improving our understanding of the relationships between genotypes and phenotypes can help us to more accurately forecast how populations will respond to changing environmental conditions. Cases of convergent evolution, in which the same trait has evolved independently in different lineages, are particularly useful in addressing this challenge. We used comparative genomics to investigate the molecular basis of tetrodotoxin (TTX) resistance, which has evolved independently in multiple snake species that consume TTX-bearing amphibians. We found evidence for a predictable, stepwise pattern of nucleotide substitution occurring in the genes targeted by TTX (members of the voltage-gated sodium channel gene family). We also found evidence for positive selection within the TTX-binding regions of these genes. In addition to selective pressure, changes in genetic structure and increased mutation rates may have contributed to the evolution of resistance in select colubrid snake species. These results shed light on the molecular underpinnings of complex trait evolution, and provide a basis to search for similar patterns in other taxa that encounter TTX, such as the toxic amphibians themselves.

Microbiome mediated plant-pollinator interactions in non-agricultural systems

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Plant-pollinator interactions are one of the most widely recognized coevolutionary relationships. Darwin attributed the rapid diversification of flowering plants to this close association with their insect partners and these partners often depend on plants for pollen and nectar as a food source. Woven into this relationship are microorganisms that form close relationships with their hosts forming the microbiome. The microbiome is intricately associated with the organismal health through processes such as nutrient acquisition and disease suppression. This suggests that flowers and their pollinators could have reciprocal influences on their associated microbes that have been shaped over evolutionary time. Few studies have

examined the impact of this reciprocal interaction on microbial community structure, eco-evolutionary dynamics, or plant health. This study aims to fill this gap through characterizing the floral and pollinator microbiome across several natural populations of Solanum carolinense and Solanum dulcamara (an introduced species) and their pollinator Bombus spp. Eighty samples from the first year of the study were sequenced which resulted in 1475 unique OTUs before filtering. Preliminary results from these samples indicate that the floral microbiome changes throughout the developmental stage of the flower and that OTUs were differentially abundant on caged versus uncaged flowers. This suggests that pollinators introduce particular microbes to flowers during their visits, therein shifting the floral microbiome. Future studies aim to determine the similarities between the pollinator microbiome (gut and pollen baskets) and the flowers they visit. These studies will contribute to the body of knowledge on plant-pollinator interactions at the microbial level.

The influence of extra-pair activity on the cloacal microbiome of a free-living bird

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Socially monogamous females that engage in extra-pair activity (e.g., solicitations, copulations, fertilizations) face potential fitness trade-offs including, but not limited to, good genes and genetic diversity in offspring, but also loss of paternal care and increased harassment by their social partner. Sexually transmitted (pathogenic) microbes have been suggested to be a cost of extra-pair activity for female birds for nearly five decades, but this hypothesis has not yet been adequately tested. To determine how extra-pair activity is related to the composition of the cloacal microbiome, we performed an observational study on free-living female tree swallows (*Tachycineta bicolor*) during the breeding season in southwestern Virginia. Tree swallows are a socially monogamous, box-nesting species that exhibit high rates of extra-pair activity, with high variation both within and between populations, and thus are an appropriate system for this study. First, we characterized the cloacal microbiome of females by collecting cloacal swabs and determining the taxonomic composition of cloacal bacteria using 16s rRNA gene amplicon sequencing. Then, we used nestling paternity as a conservative proxy to estimate the frequency and success of extra-pair copulations, and to determine the minimum number of sexual partners per female. This study increases our understanding of how sexual activity, specifically extra-pair copulations, influences the presence, prevalence, and potential pathogenicity of cloacal microbial communities in wild birds. Additionally, this study broadens our understanding of the potential costs of different solutions to common life-history tradeoffs faced by free-living animals.

Implications of a changing climate on bird development

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Our changing climate may pose a threat to the early developmental environment of animals. The effect of climate change on developing reptiles is well-studied, and there is evidence that changes in incubation temperature can have substantial effects on offspring. In contrast, the effects of temperature changes on bird phenotypes have been historically overlooked because parents regulate incubation temperature. However, studies have shown that changes in the environment can affect avian parental incubation behavior, and that small changes in incubation temperature can affect avian offspring phenotypes. Yet, few studies have investigated how environmental changes may directly and indirectly influence incubation temperature, or how incubation temperature influences avian offspring behavior. We used wood ducks as a model system to address these questions. Our results show that wood duck nests with the largest clutch sizes and the lowest ambient temperatures led to the lowest incubation temperatures. We also found that ducklings incubated at 35.0 and 37.0 C exhibited bolder and more exploratory behaviors than those incubated at 35.8 C, while those incubated at 35.0 C were less successful at exiting the nest (a crucial behavior for wood duck ducklings) than those incubated at the other two temperatures. This research shows that environmental changes influence avian incubation temperature and thus, may influence offspring behaviors that are critical for survival. In this case, warming temperatures may be beneficial to developing birds, but future work should address how extreme weather events or changes in food availability due to climate change affect incubation temperature.

Female aggression in song sparrows is higher in urban habitats

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Urban adapters are animals that are able to live in human-impacted areas, such as suburbs and cities. It has been hypothesized that urban adapters have behavioral phenotypes that permit

them to persist in human-impacted environments. Indeed, song sparrows (*Melospiza melodia*) live and breed in both urban and rural habitats and previous research has shown that urban males of this species show greater territorial aggression. However, little attention has been given to female behavior across urban and rural habitats. To determine if living in urban habitats is associated with elevated aggression in female song sparrows, we simulated the intrusion of a conspecific female onto the social territory of females at two rural and two urban study sites in Blacksburg, VA. We placed a model bird 5 to 10 m of the focal bird's nest and played one of 6 exemplars of recorded female vocalizations. For 3 minutes without the model and 6 minutes after model exposure, we measured the focal female's distance from the speaker and the duration of vocalizations produced by the female as a measure of aggression. Female song sparrows nesting in urban habitats were more likely to respond to a simulated female intruder and showed a greater behavioral response to conspecific intrusions than did females in rural habitats. This pattern of greater female aggression in urban habitats parallels previous reports of greater territorial aggression in males and raises the hypothesis that resource competition may increase in urban environments, driving increased territorial aggression in both sexes of song sparrows.

Water quality at the point of use in San Rafael Las Flores, Guatemala

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Limited information is available describing point of use water quality in rural Guatemala, particularly with respect to geologic contaminants, such as arsenic, associated with chronic health risk. This effort aimed to characterize drinking water in San Rafael Las Flores, a Guatemalan community directly adjacent to a large silver mine, to identify key contaminants of health concern. Surveys on water use and perception were conducted in 31 households, with water samples concurrently collected and analyzed for *E. coli*, pH, conductivity, and metals. Survey results indicated widespread distrust and dissatisfaction with in-home piped water. The majority (77%) of participants perceived their tap water to be unsafe and preferred drinking bottled water or from community springs. The majority (84%) also identified at least one aesthetic issue with their tap water (e.g. color, particulates) and only 25% of homes had continuous water service. Concerns predominantly revolved around potential health risks from arsenic and bacteria with widespread perceptions of contamination, most commonly attributed to the nearby mine. Though only two samples exceeded the 10 ppb arsenic standard, 45% were above 9 ppb. In addition, 13% of samples were positive for *E. coli.* Continued research is

recommended to quantify potential arsenic biomarkers and critical exposure pathways. The establishment of a baseline water quality profile, confirmation of field test kit potential, and understanding local water quality concerns will permit the design of future interventions and citizen science efforts to engage the local community in discussions of potential infrastructure and land use development.

Ecological patterns and significance of secondary metabolites in a Neotropical shrub, *Piper sancti-felicis*

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Rooted in place, plants often rely on secondary metabolites to mediate interactions with other organisms. Both attraction of mutualists and defense against antagonists are thought to be mediated by secondary metabolites. *Piper* is one of the largest genera of flowering plants, containing about 1,000 species. This study describes the secondary metabolites occurring in the infructescences of *Piper sancti-felicis* and their functional significance in ecological interactions. We focused on one group of compounds: alkenylphenols. We had three specific objectives: 1) to elucidate the structures of the major alkenylphenol compounds present in *P. sancti-felicis*; 2) to describe the natural variation in alkenylphenol composition throughout reproductive tissue development and across individual plants; and 3) to test the ecological significance of the alkenylphenols in plant defense against fungi. Results suggest that alkenlyphenol concentration in infructescences significantly differed among individual plants, developmental stages, and individual compounds. Alkenylphenol concentration was higher in ripe and unripe infructescences compared to inflorescences with high interspecific variation. Results from the microdilution bioassays revealed that as alkenylphenol concentration increases, fungal absorbance decreases. This is the first study to describe alkenylphenols in *P. sancti-felicis* and their ecological function as defensive secondary metabolites, possessing anti-fungal properties.

Terminal electron acceptor processes in metalimnetic oxygen minima changes the annual methane budget in a eutrophic freshwater reservoir

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Freshwater reservoirs are heavily influenced by humans and commonly develop Metalimnetic Oxygen Minima (MOM) in their water columns because of different water management practices. MOM are also known to accumulate large quantities of methane (CH4) in them and change the seasonal CH4 efflux phenology. While the causes of MOM are known, less is known about their effects on CH4 production and the depletion of terminal electron acceptors (TEA) that precedes methanogenesis. MOM create distinct redox gradients in the water column that changes the distribution of CH4, but whether the CH4 is derived from methanogenesis in the MOM or from laterally entrained CH4 from methanogenesis occurring in the sediments remains unclear. We monitored profiles of CH4 and the TEAs that precede methanogenesis at five sites from the inflow to the dam in a eutrophic reservoir that develops a MOM as a result of the operation of water quality engineering systems. We observed large fluctuations in the TEA availability in the MOM and little fluctuation in TEAs at other depths in the water column that remained oxygenated. We also observed lateral entrainment of CH4 from upstream depths that coincided with the MOM. This suggests that the CH4 that is observed in MOM is from TEA depletion followed by methanogenesis in both upstream sediments and in MOM that have become anoxic. This poses new uncertainties to annual CH4 budgets in freshwater reservoirs if TEA processes that normally occur in the sediments are also occurring directly in the water column.

Do good neighbors make up for poor conditions? Case study on a mixed-flocking habitat specialist

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Birds are known to form foraging flocks in numerous systems, many of which are mixed-species flocks. Individuals may choose to a mixed-flock in order to increase foraging efficiency, limit intraspecific competition, or reduce predation. In the longleaf pine system of the southeastern United States, brown-headed nuthatch (*Sitta pusilla*) mixed-flock during the nonbreeding season, but are subject to variable predator presence and food availability throughout this period. Furthermore, it is unknown whether this species forgoes the boundaries of its small breeding territories in order to follow mixed-species flocks. Thus, I am recording mixed-flocking behavior of brown-headed nuthatch at Marine Corps Base Camp Lejeune. Nuthatch behavior and mixed-flock interactions will be recorded. Individual nuthatches will be color banded in

order to locate breeding territories and track individual movement. Additionally, I will experimentally manipulate food availability by placing feeding stations in portions of the field site. I will then record station recruitment rates and flocking behavior surrounding these stations. I expect that tendency to forage in mixed flocks is inversely correlated to food availability and individual territory quality. As food becomes scarce in winter, flock foraging reduces the predator vigilance required by each individual, increasing foraging efficiency. Determining how these factors impact nuthatch behavior will inform habitat management strategies for improved winter survival.

Resource Use and Interspecific Interactions in a Namibian Cavity-nesting Community

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Cavity-nesting guilds are diverse communities of animals found in forest ecosystems worldwide. Due to their dependence on tree holes for nesting, populations of these species are highly susceptible to forms of disturbance that diminish cavity availability. Namibia is the driest country in sub-Saharan Africa, with a landscape largely depauperate of large trees, the most common harborers of cavities. This community is threatened by numerous anthropogenic disturbances, including charcoal production, altered grazing and fire regimes, and increasingly frequent and severe droughts caused by climate change. To aid the conservation of this threatened community, we have embarked on a multi-year nest-web analysis to quantify community structure. Through this analysis, we seek to describe the type of nest cavities available in the landscape, species-specific resource use preferences, and direct and indirect interactions between community members. Quantifying community structure willprovide important information for land use managers who want to mitigate impacts of anthropogenic disturbance on this community. To aid conservation of this community, we have alsoembarked on a sociological study to identify a potential flagship species. By using emotional prompts to identify wildlife perceptions of local communities, we hope to identify a potential flagship species that will effectively bring awareness to the plights facing this community, and to encourage behavior change in the form of preserving large, cavity-bearing trees. By combining ecological and sociological research, we hope to generate recommendations for both ecological management as well as sociological strategies to generate local support for a conservation campaign.

Male Red-cockaded Woodpecker dispersal habitat analysis

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Natal dispersal is the movement of individuals from a birth site to a breeding site. Juveniles often foray before dispersal, that is explore outside their natal territory to gather information from the environment and conspecifics regarding habitats and conditions. Individuals choose specific habitat characteristics to travel through and explore while foraying. Understanding what habitat characteristics an individual uses while foraying is key for identifying important resources which promote exploration and movement during dispersal, and for creating and implementing effective management strategies especially for endangered species, such as the Red-cockaded Woodpecker (RCW). The cooperatively breeding RCW is a federally listed endangered species endemic to open, southern pine savannah in the Atlantic and Gulf Coastal Plains of the United States. Juvenile male RCWs have two dispersal syndromes: they can either delay dispersal and remain on their natal territory as non-breeding helpers or disperse their first year in search of territories with open breeder positions. Dominance within broods plays an important role in determining which dispersal strategy a juvenile male will use. Dominant males almost always remain as helpers, while subordinate males disperse their first year. Despite understanding dispersal outcomes of male and female RCWs, very little is known about the dispersal process and behavior of males. Therefore, I followed dominant and subordinate juvenile, and adult helper males using radio-telemetry, and recorded GPS coordinates and behavioral observations to determine dispersal behavior and habitat use. Overall, juvenile and helper males tended to use habitats that had high quality foraging resources (older, larger longleaf and loblolly pines) and were hidden from other RCW families, a group of cavity trees (called a cluster), though male RCWs did seek out other RCW clusters if the family group that guarded that cluster was not present.

Predicting golden-crowned sifaka (*Propithecus tattersalli*) density from habitat and nutritional variables

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Understanding relationships between animal populations and nutritional variables is important for effectively managing threatened animal populations in dynamic environments. Madagascar's lemurs are threatened by forest destruction, yet we know very little about how populations will respond to the additional threat posed by climate change. In northeastern Madagascar, critically endangered golden-crowned sifakas (*Propithecus tattersalli*) live in dry, deciduous to humid rain-forests across a unique biogeographic transition zone. This makes them an ideal case study in which to examine the effects of climate-mediated forest type variables and plant nutrition on sifaka population densities. Specifically, we will investigate the relationships between tree species densities, canopy cover, species diversity, normalized difference vegetation index (NDVI), available plant fiber, energy, and protein values on sifaka densities in ten different forest fragments. Results will help us to better understand how forest type and nutritional variables impact lemur populations. This will help conservation managers to protect key forest habitats and to select the most important tree species for ongoing reforestation efforts. Future work will employ climate models to predict future forest cover types and ultimately, future sifaka population abundance across the species' range.

Impact of habitat type and disturbance level on golden-crowned sifaka (Propithecus tattersalli) social cohesion and ranging behavior

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Madagascar, an island off the coast of southeast Africa, is one of the world's richest biodiversity hotspots, yet little is known about how habitat degradation will affect imperiled species. Golden-crowned sifakas (*Propithecus tattersalli*), listed as critically endangered on the IUCN red list, are folivorous, group living primates endemic to forests of northern Madagascar. Golden-crowned sifakas display a flexible behavioral strategy called fission-fusion, which results in individuals periodically separating from group members (fissions) and rejoining after temporal and spatial separation (fusions). We are seeking to examine how fragmentation and landscape heterogeneity influence fission-fusion dynamics, ranging behavior, and overall social cohesion in this species. To do this, we completed 7 full-day behavioral follows for nine groups of golden-crowned sifakas in an array of rainforest and dry forest fragments surrounding Daraina, Madagascar (August-December 2018). Using scans at ten-minute intervals, we recorded activity, height, feeding information, nearest neighbor proximity, and group spread. Overall, we found that fragment type resulted in a significant amount of variance on group spread and territory size; with sifakas displaying decreased group cohesion in rainforest fragments, possibly due to decreased food availability and separating from group members to acquire necessary

nutrients. Now that we have an understanding of *P. tattersalli* behavior we will be employing the use of novel tracking devices to automate our data collection and more effectively collect group cohesion and ranging data.

Scientists' roles in policy-making

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This paper explores scientists' roles in policy-making based on literature review with the aim of gaining insights into how policy processes might be enhanced through better science-policy interactions. Integrating scientific knowledge into policy-making and management processes is challenging because of the inherently different purposes, assumptions, and framing of scientific information and policy information (Innes & Booher, 2010). When it comes to research about environmental issues such as biodiversity and conservation, it is even more difficult to use scientific research to inform policy-making and implementation because these environmental issues are particularly complex in nature, involving uncertainty, complexity, diverse conflicting values and multiple objectives in various sectors; science alone cannot provide simple, optimal solutions (Young et al., 2014). To address these challenges, this paper starts with two paradigms of science-policy interactions which determine scientists' roles required in society: the democratic and technocratic approaches. Further, it examines theories about boundary work at science-policy interfaces, and reviews existing typologies of scientists roles. It concludes with a discussion of future direction for research.

Do Roots Bind Soil? Comparing the Physical and Biological Role of Roots in Fluvial Streambank Erosion Resistance

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Today, it is recognized that plant roots affect streambank erosion through various processes, including: 1) physical binding of soil particles by roots, 2) gluing soil particles together due to the release of extracellular polymeric substances (EPS) by soil microorganisms, and 3)

alterations to the streambank fluvial boundary layer. However, the relative importance of these mechanisms is not fully understood. To quantify the effects of roots and soil microbial communities on erosion resistance, laboratory testing was conducted using a jet erosion test device, an erosion measurement tool used measure soil erodibility and critical shear stress. Erosion resistance measurements were also correlated with plant, soil, and microbial parameters, including EPS, aboveground biomass, root length density (RLD), and aggregate stability. The experimental setup included five treatments: 1) sterile soil, 2) sterile soil with synthetic roots, 3) inoculated soil, 4) inoculated soil with synthetic roots, and 5) inoculated soil with live roots. Critical shear stress was significantly increased in Treatments 2, 4, and 5 compared to Treatment 3 by 67%, 75%, and 79%, respectively. As RLD and aggregate stability increased in vegetated samples (Treatment 5), soil critical shear stress significantly increased as well. However, soil erodibility was also significantly increased by 33% in Treatment 4 compared to Treatment 1. In addition, Treatment 5 saw a significant 10% decrease in aggregate stability in samples compared to all other treatments. These results suggest that the physical presence of fibers or the biological activity of microorganisms alone may not significantly impact soil resistance to fluvial erosion.

The Screech Owl Nest Web: A New Opportunity for Citizen Science in Montgomery County, Virginia

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Citizen science projects rely upon the public to assist in the scientific process and these projects are known to have a number of benefits. Citizen science 1) promotes engagements between the public and scientists, 2) increases scientific literacy and 3) expands data collection opportunities to a level beyond what is possible by a single researcher. Birds that nest in artificial nest boxes present a unique opportunity for citizens to engage in the scientific process by providing a nesting cavity on their property and monitoring the nesting progress of the inhabitants. Here, I propose to establish a new citizen science project for Montgomery County that entails establishing and monitoring nest boxes specifically designed for Eastern Screech Owls (*Megascops asio*). Eastern Screech Owls are currently declining in parts of their range, including Virginia, and a lack of nesting cavities is a contributing factor. The owls are known to occupy artificial nest boxes in the suburban and rural habitats present in Montgomery County. With this program, we can monitor the nesting success of this charismatic bird. Additionally, the proposed project can also address questions related to breeding phenology, population demography, dispersal behaviors, and the effects of urbanization on wildlife. Beyond the local level, participants can submit their data to the NestWatch Program established by the Cornell

Lab of Ornithology. Overall, the proposed project can contribute to the conservation of a declining species, establish a new study system for the GCC community, and, most importantly, engage the public in the scientific process.

Estimating Occupational Heat Exposure from Personal Sampling of Public Works Employees in Birmingham, Alabama

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Excessive occupational heat stress has been associated with increased mortality and injury rates. Wet bulb globe temperature (WBGT) index is widely used to assess heat stress and recommend work-rest cycles combined with metabolic rates of workers. Currently, estimates of WBGT use meteorological data from nearby weather stations (WS), but likely do not reflect actual environmental conditions at a specific workplace. This study evaluated whether using thermometers clipped on workers shoes would result in different work-rest schedules compared to using area-level meteorological data alone.

Spatial variability in oligotrophic lake metabolism may indicate trophic state change due to localized stream loading

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Local land-use and global climate change are rapidly degrading oligotrophic lakes. Robust water quality indicators are needed to determine whether oligotrophic lakes are maintaining their low-nutrient state. Lake metabolism, the balance of carbon production and respiration, is an integrated ecosystem metric that may indicate impending ecosystem shifts to a meso- or eutrophic state. Ecosystem metabolism modeled from one deep site within a lake is often assumed to be representative of the entire lake; little is known about the relationship between lake metabolism estimates at near-shore sites and nutrient loading from the nearest inflow. Here, we ask: How do summer lake metabolism estimates at near-shore sites (4-7 m deep) compare to a single deep-site (13 m deep) estimate? We addressed this question in oligotrophic Lake Sunapee, New Hampshire (USA). We used high-frequency measurements of dissolved oxygen, water temperature, and light to estimate metabolism at three near-shore sites and one deep-site. We also measured stream discharge and nutrient concentrations in the closest inflow streams to each near-shore lake site to estimate localized nutrient loading. Net ecosystem metabolism at Lake Sunapee's deep-site was consistently positive (range = 0.01, 0.5 mg-O2/L/day) whereas all three near-shore sites averaged near zero net ecosystem metabolism (range = -0.4 – 0.3 mg-O2/L/day). Localized stream nutrient loading was positively correlated with daily maximum GPP and R rates. Linking spatially variable lake metabolism to heterogeneous nutrient loading provides insight into how lakes integrate catchment land use, providing an indicator of impending shifts in lake trophic state.

How can the cavity nest-web inform conservation of the endangered Bahama Swallow (*Tachycineta cyaneoviridis*)?

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The Bahama Swallow (*Tachycineta cyaneoviridis*) only breeds in the northern Bahamas, and is considered endangered due to decline in its population. However, causes of population decline are unknown. As an obligate secondary cavity nester, the swallow requires other species or processes to create cavities in which to nest. We constructed a cavity nest-web to investigate whether nest site availability and interactions between swallows and other cavity-nesting species could provide insight into causes of decline and the design of conservation strategies. We conducted surveys to assess the availability of cavity-nesting resources in Caribbean Pine (*Pinus caribaea*) forest and other habitats. We also examined potential competition by locating nests of all other cavity-nesting species. We measured reproductive success by monitoring swallow nests in different cavity types. Swallows built nests in several cavity types, primarily those excavated by Hairy Woodpeckers (*Picoides villosus*) and West Indian Woodpeckers (*Melanerpes superciliaris*). La Sagra's Flycatchers (*Myiarchus sagrae*) were the only other

secondary cavity nesters that utilized the sparsely distributed pine snag cavities, which are excavated by Hairy Woodpeckers. Other cavity types were in anthropogenic structures and were concentrated in developed areas, where swallows face potential competition with American Kestrels (*Falco sparverius*), and non-native House Sparrows (*Passer domesticus*) and European Starlings (*Sturnus vulgaris*). Reproductive success was high during all nest stages in pine snags, while success in other cavity types appeared to vary. These findings indicate that managing for pine snags and the presence of Hairy Woodpeckers in the pine forest may be crucial to Bahama Swallow conservation.

Convergent evolution and high cranial disparity in the close relatives of archosaurs as demonstrated in Doswellia sixmilensis (Archosauriformes: Proterochampsia)

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The Triassic Period (252 – 200 Ma) records a great expansion of reptile diversity and disparity, particularly in skull morphology. Close relatives of archosaurs (group including birds and crocodiles) exhibit substantial range in cranial disparity, especially by species shortening or elongating the skull. This disparity is exemplified in North American Late Triassic proterochampsians by short-faced and long-faced *doswelliids*. To investigate skull elongation and character evolution in proterochampsians, we evaluate the taxon, *Doswellia sixmilensis*, from the Late Triassic of New Mexico. We redescribe *D. sixmilensis* based on repreparation of the skull material and reinterpret what was previously regarded as the antorbital fenestra to be the orbit. Because of this, the identification of bones and the taxon diagnosis must be substantially modified. We score *D. sixmilensis* into a phylogeny of archosaurs and their close relatives, consisting of 676 characters and 109 taxa. We recover Doswelliidae as a monophyletic clade nested within the South American Proterochampsidae. This challenges previous interpretations of the Doswelliidae and suggests previously unrecognized cranial disparity within Proterochampsidae. To reconstruct archosauromorph cranial disparity, we place *D. sixmilensis* and other proterochampsians into a similarity analysis of 36 taxa and 42 cranial characters using a non-metric multidimensional scaling ordination plot. We find that early diverging proterochampsians explore regions of morphospace explored only by long-snouted taxa (archosaurs and their close relatives), and are disparate from other skull forms. This indicates that archosaur relatives experimented with the anterior half of their skulls with a combination of unique and convergent characters present in the earliest archosaurs.