ABSTRACTS

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Poster Presentations

The influence of social behavior and stability on disease transmission in a songbird host

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Human wildlife provisioning has long been overlooked as a major ecological factor, but in the last ten years it has been shown to be an important factor on the social behavior and physiology of wildlife and, consequently, disease. A prime example is among house finches (Haemorhous mexicanus) who, since the mid-1990s, have been subject to infection with a highly contagious bacterium, Mycoplasma gallisepticum, which causes debilitating conjunctival pathology. House finches congregate at bird feeders in social flocks, where most transmission takes place, making it an ideal system for testing hypotheses regarding how human provisioning influences social behavior, physiology, and disease transmission. To test the impact of bird feeders, I altered feeder density across several sites on the Virginia Tech campus while using radio-frequency identification to track social networks and individual behavior. By altering the density of feeders, my results should be able to show the effects of human feeding via bird feeders on this disease system by seeing changes in the social networks of house finches, individual behavior and physiology, and the prevalence of disease.

Loblolly pine and switchgrass: A year of eddy flux measurements in Virginia

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How do land-use transitions affect climate? Land-use is a large component of human emissions of CO2 to the atmosphere. But these transitions have immediate, local, biophysical impacts on surface climate as well. As climate change continues the market for biophysical effects and other climate services will continue to grow. What land-types provide the greatest climate services in the southeastern United States?

We have been gathering data from the eddy flux covariance systems at Sweet Briar College in central Virginia for the past year. These two towers measure fluxes of water, carbon and energy as well as relevant meteorological measurements over a switchgrass field and a loblolly pine stand respectively. These measurements allow us to make assessments of the exchange of carbon and the biophysical effects on climate.

After a year of data, the switchgrass field shows the most biophysical benefit. This is mostly due to its high albedo. In addition, the switchgrass has a higher rate of carbon absorption than loblolly pine during peak growth. However, this must be contrasted with the large amount of CO2 emitted by the grass system during non-peak growth, ultimately making it a net source of carbon. The Pine system continues to be a carbon sink all year, but what fluxes may emerge after a harvest event remains unknown.

Identifying local strains of Nile tilapia *Oreochromis niloticus* that are adapted to future climate conditions

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This study was conducted to synthesize information on the ambient water quality (temperature, dissolve oxygen and salinity) for the Nile tilapia, an important commercial species, compare wild populations in the Volta basin and the selectively bred Akosombo strain from the basin used in fish farming in Ghana under current and future climate conditions, and

develop predictive models delineating the boundaries of the species' range. A combination of literature survey, field and laboratory methods provided data for meta-analysis, growth and genetic analysis, as well as distribution models. We found variations in water temperature along the latitudinal gradient in Ghana; and temperature was the most informative variable in terms of characterizing the adaptive range and ambient water quality for the species. The results of the growth studies showed no evidence of superior performance of the Akosombo strain over the wild strains under current or predicted future climatic conditions of temperature, dissolved oxygen, or salinity. Significant *F*st values from the genetic analysis suggested that the Akosombo strain was well differentiated from all the wild populations (Aframso, Sabare and Binaba) studied. The combined results of the field, growth and genetic studies show that at least one wild population from the Oti River (Sabare) may possess the traits for superior performance under high temperature and low DO conditions. Further studies should concentrate on comparing the Sabare strain with the Akosombo strain under different experimental conditions and increase replications to confirm the suggested differences and the heritability of those performance traits for selective breeding.

Tree-of-Heaven (*Ailanthus altissima*) biocontrol

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Abstract: *Ailanthus altissima,* commonly known as the tree-of-heaven, has been successfully invading the North American landscape since its introduction from China over 200 years ago. Today, it is found in over 40 states along transportation corridors, on agricultural fields, within urban areas, and in forest stands displacing native species. Long-term and wide-spread control using chemical and mechanical methods have been ineffective in containing this tree. Recently, two strains of naturally occurring fungi (*Verticillium nonalfalfae* and *V. dahliae*) have caused entire *Ailanthus* stands in Ohio, Pennsylvania, and Virginia to decline and die, effectively removing the invasive species from the area. Preliminary work from Pennsylvania shows that *V. nonalfalfae* has the potential to become a cheap, effective, and safe biocontrol agent. This summer, we will determine if these two fungal pathogens also have the potential to become effective control agents in Virginia. *Ailanthus* stands throughout Virginia have been identified and mapped, and conidia suspensions of one or both species will be injected into the trees in May. Disease progression and spread will be monitored monthly and analyzed to compare differences between hardiness zones. Has our environment given us an effective tool to fight this aggressive invader?

Hypoxia-induced trade-offs on zooplankton vertical distribution and community structure in reservoirs

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Because of global change, lakes and reservoirs worldwide are increasingly experiencing low dissolved oxygen concentrations (hypoxia). Although the effects of hypoxia on internal nutrient loading have been well-studied, less is known about how hypoxia impacts plankton communities, especially zooplankton. Typically, zooplankton migrate to the dark bottom waters (hypolimnion) during the day to escape visual fish predation in the well-lit surface waters (epilimnion). However, due to the physiologically-stressful conditions of hypoxic hypolimnia, zooplankton may remain in the epilimnion during daylight, trading oxic stress for increased predation risk. We sampled five reservoirs weekly to biweekly during the daytime in southwestern Virginia, USA over three summers to examine how hypolimnetic oxygen concentrations impact the vertical distribution, density, biomass, and community composition of macrozooplankton and rotifers. These reservoirs varied on a gradient of hypolimnetic oxygen concentrations, from no oxygen to high oxygen during the sampling period. In addition, we also conducted ten 24-h sampling campaigns on reservoirs across this same oxygen gradient to examine how zooplankton were vertically distributed over day-night periods. Under hypoxic conditions, zooplankton were predominately found in the epilimnion during the day *and* night, did not exhibit diel vertical migration, and had overall lower densities and biomass than in reservoirs that exhibited oxic hypolimnia. Only two zooplankton taxa were found predominately in hypoxic zones. Zooplankton play a critical role in lakes and reservoirs as the dominant grazers of phytoplankton, and our results suggest that hypolimnetic hypoxia may alter zooplankton vertical distribution and densities, which may in turn exacerbate water quality degradation.

Mathematical modeling of cyanobacterial dynamics in a chemostat

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We present a mathematical model that describes how cyanobacterial communities use natural light as a source of energy and water as a source of electrons to perform photosynthesis and therefore, grow and co-survive together with other bacterial species. The purpose of our model is to explain interactions between bacteria. In particular, we apply our model to a phototrophic population of bacteria, namely, cyanobacteria. Our model involves the use of light as a source of energy and inorganic carbon as a source of nutrients. First, we study a single species model involving only cyanobacteria, then we include heterotrophs in the two species model. A stability analysis is done and the obtained results show that adding heterotrophs increase the level of inorganic carbon in the medium which allows cyanobacteria, on one hand, to perform more photosynthesis, therefore increase their growth and on the other hand delay the excess of light damage which also benefits cyanobacterial growth.

Temporal variation of the skin microbiome in lowland amphibians and its implications for conservation

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The amphibian skin microbiome has been the focus of recent studies aiming to better understand its role in host defense against disease. However, host-associated microbial communities can be dynamic, and changes in their composition can influence their function. Understanding temporal variation of bacterial communities on amphibian skin is critical for establishing baselines from which to improve the development of mitigation techniques based on probiotic therapy and provide long-term host protection in a changing environment. Here, we investigated whether microbial communities on amphibian skin change over time across seasons and years at a single pond. To examine this, we collected skin swabs from two pond-breeding species of treefrogs (*Agalychnis callidryas* and *Dendropsophus ebraccatus)* for four years in a single lowland tropical pond in Panama. Relative abundance of OTUs based on 16S

rRNA gene amplicon sequencing was used to quantify bacterial community diversity on the skin. We found variation between the two species within the same pond. In addition, we found significant variation in bacterial community structure across years for both species. We also found significant changes across seasons, but this was stronger in *D. ebraccatus*. Lowland amphibians species persist despite the presence of a fungal skin pathogen, *Batrachochytrium dendrobatidis*, which has caused declines in highland populations. These preliminary findings suggest that skin-associated microbiomes vary across time, but more research is necessary to elucidate the significance of temporal variation in bacterial skin communities and their maintenance for amphibian conservation efforts.

The role of biotic and abiotic factors in the distribution limits of an invasive grass

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Since before the time of Darwin, there has been an interest in species distributions and why species are found where they are. Range limits are strongly associated with both abiotic factors (e.g., temperature, precipitation) and biotic factors (e.g., competition, predation), but it is still unclear how much each of these factors influence species' ranges. Recently, in light of global change, there has been a resurgence of interest in species distributions as the need to accurately predict how species will respond to climate change becomes ever more important. This need is especially important when considering invasive species, as evidence indicates that some invasive species may be expanding their ranges in response to climate change. The invasive Johnsongrass (*Sorghum halepense*) is a highly damaging weed and invader of natural ecosystems that has a wide, global distribution; however, there is evidence that climate may play an important role in limiting its range. We are investigating the influence of climate and competition on the range limits of Johnsongrass through the use of reciprocal common gardens in 5 locations–New York, Virginia, Georgia, Texas, and New Mexico–that represent the peripheral, edge, and core of Johnsongrass' US distribution along both a temperature (NYàVAàGA) and precipitation (GAàTXàNM) gradient. Each common garden will have a no competition and a competition treatment. This design enables us to investigate the potential biotic and climate drivers of Johnsongrass' distribution limits. Our work will advance our understanding of the factors that influence the distribution and abundance of invasive species.

Global change impacts on microbiome mediated plant-pollinator interactions.

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Pollinators form the cornerstone of ecosystem stability and agricultural production and they are under threat from multiple global change factors which lead to precipitous declines in pollinator health. Recent declines in bee health have been associated with changes in gut microbial communities. Additionally, bee gut microbiomes leave a 'footprint' on flower microbiomes, however, little is known about the reciprocal effects of the floral microbiome on bee gut microbial communities, nor the impacts of global change factors in shaping these interactions. Here we compare reciprocal microbiome responses in pollinators and flowers across a latitudinal gradient (a surrogate for elevated temperature) and between native and non-native *Solanum* species. First, we will assess the structure of the floral microbiome during floral development and assess how they correspond with changes in pollinator gut microbial communities. Next, flowers on both species will be caged to exclude pollinators to determine how pollinators are impacting the floral microbiome in each species. The analysis of microbial communities in both plant species and their pollinators will be conducted through sequencing the 16s rRNA gene and ITS region as appropriate. Plant fitness will be assessed and determined how it relates to floral microbiome. This study will provide information regarding differences between native and non-native species microbial communities, how changes in floral microbiome structure impact pollinators, and how changes in environmental factors shape plant-pollinator microbiome interactions.

Sexually transmitted microbes as a cost of extra-pair activity in female tree swallows

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Up until the 1980s, most avian species were considered to be truly monogamous. It was not until the recent advent of revolutionary genetic approaches that the opposite pattern was shown to be true of avian mating systems. Species that were previously recognized to be truly monogamous were found to have extra-pair young, thus exhibiting evidence for extra-pair copulations. Fundamental questions in biology center around understanding the advantages

and disadvantages of monogamy versus polygamy, particularly with regards to females and polyandry. While females face numerous potential fitness trade-offs (e.g., benefits: good genes, genetic diversity in offspring; costs: loss of paternal care, de novo deleterious mutations), I will focus on the sexual transmission of pathogenic microbes, which has been suggested to be a cost of extra-pair copulations to females since as early as the 1970s, but has not yet been adequately tested. For my dissertation, I will study a free-living, box-nesting population of polyandrous female tree swallows (Tachycineta bicolor) that form a social pair bond with a male throughout the breeding season, yet also engage in extra-pair copulations. Through observational and experimental studies, this project will help elucidate the relationship between extra-pair copulations and the presence, prevalence, and pathogenicity of sexually transmitted cloacal microbiota, with respect to fitness, in a wild avian population. Overall, such research is essential since host fitness consequences of sexually transmitted microbes likely influence sexual selection and the evolution of mating systems.

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, and no studies have investigated 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 and 37°C exhibited bolder and more exploratory behaviors than those incubated at 35.8°C, while those incubated at 35°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.

A Division of the Crown: using novel tracking devices to examine behavioral responses to fragmentation and habitat heterogeneity in crowned lemurs (*Eulemur coronatus*)

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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. Crowned lemurs (*Eulemur coronatus*), listed as endangered on the IUCN red list, are frugivorous, group living, cathemeral primates endemic to forests of northern Madagascar. Crowned lemurs 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 in this species. However, studying primates when groups are constantly fluctuating in size and composition is nearly impossible due to logistical challenges and the high cost of commercially available tracking equipment. To address this issue, we propose to design a modular, open-source tracking collar. Our monitoring device, nicknamed FitPET ("FITness, Proximity, Energetics, and Tracking"), will be capable of capturing data on lemur social and spatial behavior. The tracking devices will be specialized to collect precise measurements of proximity between group members, grooming frequency, locomotion, and heart rate. The outcome of the project will be the development of technology, synergizing the fields of biology and engineering, to better understand crowned lemur social interactions and transform the ways in which wildlife species are studied.

Urbanization and parental care: Are parents able to compensate for changing ecological conditions?

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Phenotypic plasticity is an organism's ability to adjust its phenotype in response to habitat variation. Such plasticity has been proposed to help organisms cope with changing environmental conditions. Additionally, parental care is a mechanism that could buffer developing young from environmental variation with consequences for their mature phenotype. For my dissertation, I will compare phenotypic outcomes of free-living, urban and rural song sparrows to better understand how variation in habitat quality affects growth and development. I will use observational and experimental approaches to study the following objectives: 1) To determine the level of developmental stress offspring experience, I will measure nestling growth and stress hormone levels through development. I predict that offspring's in urban habitats will experience pathological stress during development. I predict that urban habitats will be of lower quality due to food restriction and anthropogenic stressors. 2) To determine the extent to which parental care may mitigate ecological variation, I will use video recordings of the nest to measure feeding rates and food load. I predict that parents in urban environments will increase parental care when possible but prioritize territorial behaviors. Collectively, these studies will resolve how urbanization affects the phenotype and fitness of developing birds. Urbanization represents a dramatic and relatively quick change in environment. Understanding how environmental factors impact birds' phenotypes, if parental care provides a buffer to ecological change, and the fitness consequences of urbanization will inform conservation efforts.

Advancing equity: Comparing water violations in rural versus urban Virginia

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The Safe Drinking Water Act (SDWA) of 1974 and its subsequent amendments have revolutionized the way that drinking water is protected in the United States. However, high profile failures, such as the lead crisis in Flint, Michigan, have cast doubt on the equity and reliability of these regulatory mechanisms. Previous studies using publically available compliance data have found that regulatory inequities regarding water quality and availability do exist based on system size, race, ethnicity, and low socioeconomic status of the community served. However, the effects of urbanity and rurality on drinking water system integrity has only been cursorily characterized. This work seeks to identify and describe primary differences in drinking water challenges in urban and rural American landscapes. The work to be presented

is an illustrative case study comparing drinking water violation patterns in distressed rural Appalachia counties versus coastal Virginia cities designated as environmental justice hotspots. Initial comparisons suggest that rural Virginia counties are served by five to twelve times the number of water systems as the two independent cities, despite serving less than twenty-five percent of these cities' population. More notably, over one hundred times the number of SDWA violations were reported within the rural region as compared to the independent cities within the last ten years. Ongoing work is expected to expand this case study method to the entire southeast region of the United States. This study has implications for the way that public water systems are managed and regulated across disparate regions of the United States. This work also has value for rapidly urbanizing developing nations who must manage their drinking water infrastructure for a growing urban and peri-urban population.

Metalimnetic oxygen minimum zones decouple diffusive CH4 and CO2 fluxes from seasonal turnover in a eutrophic reservoir

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Diffusion of greenhouse gases (GHGs) from freshwater ecosystems into the atmosphere can contribute a large fraction of total GHG efflux. In temperate waterbodies, annual peak diffusive flux generally occurs during fall turnover when methane (CH4) and carbon dioxide (CO2) in the anoxic bottom layer (the hypolimnion) mix to the surface. However, when thermal stratification develops, some waterbodies become anoxic in the middle of the water (the metalimnion), not the hypolimnion. This can change the distribution of *p*CH4 and *p*CO2 in the water column and alter diffusive CH4 and CO2 efflux phenology. As a part of water quality management in a local reservoir, an anoxic metalimnion (OMZ) has developed since 2013. We measured depth profiles of dissolved CH4 and carbon dioxide (CO2) concentrations since 2015, and estimated CH4 and CO2 atmospheric gas exchange with multiple gas flux models. We observed substantial accumulation of CH4 within the OMZ of the local reservoir in summers 2015 and 2016. Regardless the gas flux model, the largest efflux of CH4 into the atmosphere was decoupled from turnover both years, while peak CO2 efflux from the hypolimnion occurred during turnover. Thus, timing and magnitude of GHG fluxes may be dependent on the depth of the gases in the water column, and that the efflux of gases in the metalimnion may be sensitive to extreme events that are decoupled from turnover. If OMZs increase as a result of global

change, waterbodies may accumulate substantial concentrations of CH4 in their water columns, thereby altering the GHG efflux phenology.

Resource use and interspecific interactions in a cavity-nesting guild in central Namibia

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Cavity-nesting guilds are hierarchical communities of vertebrates and invertebrates that interact through competition for nest sites. Some species in these communities, known as primary excavators, are able to create their own nest cavities. Other species, known as secondary nesters, rely on pre-existing cavities to breed, be they cavities made by excavating species or by other natural processes. Due to their dependence on pre-existing cavities, secondary nesters are highly susceptible to forms of disturbance that diminish the availability of suitable nest cavities, including anthropogenic management and natural disasters. Quantifying the entirety of a cavity guild's structure is critical to understanding how to conserve that community. To inform land managers on how to preserve Namibia's threatened cavity-nesting guild, we have embarked on a nest-web analysis outside Otjiwarongo in central Namibia. We are two years into a study that aims to evaluate the availability of the central resource (tree cavities), primary forms of cavity creation, species-specific cavity preferences, and interactions between cavity-nesters, including direct competition for nest sites and indirect interactions as cavities are used over time. Preliminary results suggest that cavity density overall is low, with natural cavities (12.4/ hectare) 15 times more abundant than excavated cavities (0.8/hectare), and that large cavities are in particularly low supply. Some small-bodied secondary nesters readily use excavated cavities, suggesting that excavating species, though in low densities, may act as ecosystem engineers in this ecosystem. Large-bodied secondary nesters, of which there are over a half dozen species, are particularly likely to be restricted by cavity availability, as they utilize a limit supply of naturally formed cavities. Already facing intense competitive pressures, cavity-nesting populations could face declines due to pressures resulting from common management practices, such as charcoal production, as well as from climate change induced droughts, which may hinder floral growth, and thus the replacement of large, cavity-bearing trees. Results of this study will inform management plans and aid local conservation efforts targeting cavity-nesting species, some of which may risk extirpation from Namibian forests.

Natal dispersal patterns and behavior in juvenile male Red-cockaded Woodpeckers

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Natal dispersal, the movement of an individual animal from its birth site to its breeding site, is primarily governed by resource quality and availability, and intraspecific competition for that resource. Natal dispersal can be costly, therefore juveniles often use a prospecting strategy to gain knowledge regarding the conditions outside their natal territory before permanently leaving. The Red-cockaded Woodpecker (RCW) is a cooperatively breeding, federally listed, endangered species endemic to open, southern pine savannah of the Atlantic and Gulf Coastal Plains. Juvenile male RCWs employ two natal dispersal strategies to cope with limited availability of resources, mainly cavities: the dominant males delay dispersal and remain on their natal territory as non-breeding helpers and the subordinate males disperse their first year. Juvenile female RCWs usually disperse, but prospect extensively before leaving. It is unknown if dominant and subordinate juvenile males also prospect. In this study, I investigated dispersal behavior, specifically prospecting behavior, in dominant and subordinate juvenile male RCWs in coastal NC. I followed 9 subordinate and 11 dominant juveniles before and during the breeding seasons (February – June) of 2015 and 2016 using radio telemetry and GPS while they prospected alone and while they foraged with their families. I then determined the distance and direction of forays and calculated the likelihood that a juvenile RCW would travel through certain cover types or near other conspecifics. Overall, subordinate males tended to prospect often and avoided other clusters, while dominant males tended to prospect less.

You can't plant generic trees

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It is well established that forests play a major role in global climate. Trees take up ~30% of anthropogenic carbon dioxide, decreasing the warming impact of human emissions. For this reason, forests play a role in many global warming mitigation approaches through reforestation and afforestation. Current global climate models use simplified representations of forests that do not provide information critical to planning actual mitigation efforts. Planting forests is not

a binary decision. You must also determine which species to plant, where, and what if any management to invoke. We are currently working to improve a widely used global earth system model (NCAR's CESM1.2 / CLM5) by incorporating more realistic representations of forest management and tree species. With these improvements, we hope to answer several consequential questions: Does forestry management impact the climate services provided by forests? Which sequester more atmospheric carbon, natural or plantation forests? What management activities might be employed to increase climate benefits? What species should be planted and where to achieve certain climate goals? Are the effects of some management actives, such as fertilization and irrigation, counteracted by downstream ecological effects? The answers to these questions should be directly relevant to decision makers in the climate policy arena.

Individual variation in testosterone and cooperative behavior in a neotropical lekking bird, the Wire-Tailed Manakin

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Manakins of the family Pipridae are known for performing complex courtship displays at leks. These complex displays have evolved in association with strong reproductive skew, suggesting individual differences in courtship behavior exist. By measuring components of hormone regulatory networks, one may be able to elucidate the proximate mediators of individual variation in courtship behavior. To date, however, work documenting the relationship between individual variation in reproductive behavior and circulating steroids in manakins has been inconclusive. Here, using video recordings of male territories and subsequently collecting a blood sample, we quantified the relationship between individual variation in reproductive behavior and circulating testosterone in male wire-tailed manakins (*Pipra filicauda*). In this system, previous research has shown that territory-holding males have higher testosterone than floaters (i.e., non-territory-holding males), implying that testosterone plays a role in territory acquisition and maintenance. Our results show that that males with a higher proportion of cooperative displays (an important predictor of male wire-tailed manakin reproductive success) perform longer displays. However, males with high circulating testosterone engage in fewer cooperative display bouts suggesting that high levels of testosterone may interfere with effective cooperative behavior and result in shorter display bouts. These results suggest that individual differences in circulating testosterone levels play an important role in mediating individual variation in male reproductive behavior and potentially

success. This research ultimately adds to our knowledge about the proximate mechanisms that mediate individual variation in both reproductive and cooperative behavior.

Identifying early warning indicators of eutrophication to inform real-world management: engaging long-term data, ecosystem modeling, committed citizen scientists, and remote sensing

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Freshwater lakes integrate the cumulative impact of upstream human activities on water quality, and thus early warning indicators (EWIs) of ecosystem change in lakes may be used to understand the impact of environmental changes in their catchment. EWIs are statistical metrics applied to high-temporal frequency data to predict regime shifts. To date, EWIs have been used to retroactively assess observed regime shifts and to reverse algal blooms in lakes, but they have not been widely used to inform real-world management decisions. Here, we explored the use of EWIs in water quality management by addressing the questions: 1) How are land use and climate change interacting to affect water quality in an oligotrophic lake over three decades? and 2) Can we use EWIs to manage water quality in a real-world oligotrophic lake? We used historical and recent GLEON (Global Lakes Ecological Observatory Network) buoy sensor data on Lake Sunapee, New Hampshire (USA), collected primarily by committed citizen scientists, to calibrate a lake ecosystem simulation model (General Lake Model; GLM) run at an hourly time step for three decades. We then tested for EWIs in the model output using a suite of statistical analyses, including breakpoint analysis, rolling standard deviation, and autocorrelation. The EWI assessment and simulated lake response to nutrient loading using GLM provide a suite of alternative scenarios as a tool to assist management. Our next steps are to assess land cover change using Landsat imagery and develop spatially-explicit nutrient loading model scenarios to predict future lake water quality

Ecological effects of livestock antibiotics on agricultural soils

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Antibiotic use is under increased scrutiny due to their declining effectiveness; this includes the use of antibiotics in livestock production, which accounts for 80% of national antibiotic use. Much of this 80% passes through livestock via manure, with high estimates at approximately 14-million kg-yr-1. Studies have shown that additions of manure from cattle treated with antibiotics can have effects on soil microbial community composition, antibiotic resistance gene (ARG) abundance, and ecosystem functioning. However, studies have also shown that additions of manure from cows receiving no antibiotics can also cause increases in ARGs. To better understand the relative contribution of manure and antibiotics, a common garden experiment was established where plots were amended with manure from cattle either treated with one of two types of antibiotics, or untreated cattle. Manure was added monthly for three years. Each spring, plots were pulse-labeled using 13C and 15N. Soils and plant biomass from these plots were collected and analyzed using a range of assays to better understanding how soil microbial communities are impacted by manure as well as antibiotics. We have found that manure type does have an impact on a number of important microbial parameters. For instance, manure from cattle treated with the antibiotic pirlimycin elicited an ~6,000 kg ha-1 y-1 increase in respired carbon compared to manure from cattle treated with cephapirin. Although further analysis needs to be completed, the results from this field study highlight the potential influence antibiotics and the type of antibiotics have on soil and ecosystem processes.

Life history and ecology of the endangered Bahama Swallow (*Tachycineta cyaneoviridis*)

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The Bahama Swallow (*Tachycineta cyaneoviridis*; BAHS) is an endangered species that is endemic to three islands in the northern Bahamas. Very little is known regarding the abundance, distribution or dispersal among islands of BAHS, or the factors responsible for the species' decline. We are assessing the current population biology of BAHS using population surveys and genetic-based methods, and expanding the limited life history data available by locating and monitoring BAHS nests. Preliminary results show that BAHS breed between April and July, laying an average of three eggs in pre-existing cavities, primarily abandoned woodpecker cavities in snags of Caribbean Pine (*Pinus caribaea*) and utility poles, and holes in cell phone towers and buildings. Bahamian pine forests were heavily logged through the early 1970s; work to date suggests availability of nest sites limits populations, and reductions in this resource may be responsible for the species' decline. We are conducting surveys of the pine forest and other habitats to assess the availability of cavity-nesting resources across the landscape and constructing a cavity-nest web illustrating species interactions. BAHS appear to rely on West Indian Woodpeckers (*Melanerpes superciliaris*) and especially Hairy Woodpeckers (*Picoides villosus*) to excavate cavities, and compete with secondary cavity-nesters including the American Kestrel (*Falco sparverius*), La Sagra's Flycatcher (*Myiarchus sagrae*), House Sparrow (*Passer domesticus*) and European Starling (*Sturnus vulgaris*). By working with local organizations to facilitate and promote this work, our ultimate goal is to provide information that can be used develop conservation strategies for BAHS and their breeding habitat.