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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Social interaction in animals has been shown to have lots of fitness benefits, like cooperation in foraging and sharing of resources. However, species that have lots of social interaction are also at a much higher risk of transmitting infectious diseases. Therefore, it is important to study not only social behavior itself, but the structure and stability of social groups as well. Past studies have shown that not only does social stability and behavior change an animal's exposure to disease, but it can impact physiological factors influencing disease susceptibility through both stress responses and changes in hormones as well. A relatively new method for analyzing social behavior and disease transmission is through contact network modeling. Contact networks show the interactions between individuals within a population and can be created using technology like radio-frequency or GPS. These networks can also give information on how interactions are changing over time as well making them a dynamic tool. Since the early 1990s house finches have been subject to a highly infectious bacterium causing conjunctival pathology. Finches form flocks outside of the breeding season and congregate at bird feeders where the majority of transmission takes place, thus they are an ideal system to test hypotheses relating to social behavior, stability, structure and the impacts of those behaviors on disease transmission. I plan to do my dissertation research on this system utilizing RFID technology placed on feeders to see how manipulations of house finch social behavior and stability affects disease transmission, prevalence, and severity.

The Two Towers: An ecosystem story as told by the atmosphere

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How do we combat climate change? One potential solution is to change our source of energy, from fossil fuels to bio-fuels. Biofuels, have a shorter carbon cycle than fossil fuels, allowing for complete reabsorption of burned fuel within a hundred years as opposed to ten thousand. However, sources of biofuel such as Switchgrass and Loblolly pine have other effects on climate besides absorbing carbon. They also affect the planetary energy balance by altering the reflectivity of the Earth's surface, and altering how energy is distributed through the atmosphere. These processes have the ability to affect local and regional temperature and can counteract any benefit derived from reduced CO2 in the atmosphere. We have partnered with Sweet Briar College and the Global Change Center to set up two eddy flux covariance systems on the Sweet Briar campus, one over a loblolly stand, and one over a switchgrass field. These paired systems will independently measure fluxes of carbon and water, as well as incoming and outgoing radiation, photosynthetically active radiation, temperature, humidity, precipitation, soil temperature, soil moisture, and energy absorbed by the ground. These measurements will allow us to compare these systems as potential biofuels in a complete accounting of how they affect climate. In addition, data from these towers can be used to inform and constrain future work investigating the effects of implementing a biofuel program on a regional and global scale.

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.

What's Bugging the Bugs? Commonalities in Benthic Stressors across the United States

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Biological monitoring of invertebrate communities is a key component of stream monitoring under the Clean Water Act in nearly all states, and is one approach used to determine if the biological integrity of state waters is being protected. Monitoring methods, interpretation of field data, and metrics used to evaluate invertebrate communities vary widely across the county, and flexibility in reporting requirements results in inconsistencies in how invertebrate-based impairments are reported to the EPA. Further, states differ in the specific approaches used to determine Total Maximum Daily Loads (TMDLs) to address the stressors associated with impairments. The objective of this research was to determine the pollutants most commonly associated with invertebrate-based stream impairments in the U.S. Through discussions with EPA and state regulators, and evaluation of over 1000 approved TMDL reports written since the initiation of the TMDL program, we confirm a long-thought but formerly undemonstrated assumption that sediment is the most commonly identified stressor associated with invertebrate-based stream impairments nationwide. The variety of approaches used to identify sediment TMDLs are discussed.

Millipedes Under Our Feet: Taxonomic Revisions of the Common North American Millipede Genera *Pseudopolydesmus*(Polydesmida: Polydesmidae) and *Nannaria* (Polydesmida: Xystodesmidae)

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Much progress in North American millipede taxonomy has been made over the past three decades, stabilizing nomenclature and providing identification resources. However, much work remains, particularly with regards to alpha-taxonomy and revisions of poorly-understood groups. In eastern North America, the two genera *Pseudopolydesmus* (Polydesmida: Polydesmidae) and Nannaria (Polydesmida: Xystodesmidae) are among the most commonly encountered millipedes, with 12 and 23 described species, respectively. However, species level classification in *Pseudopolydesmus* is fuzzy and in need of revision. *Nannaria* has many undescribed species represented in museum collections, and may even double the number of currently known species. To remedy this, molecular and morphological studies are being conducted to revise the genera and describe new species. Collecting is being done in areas throughout the eastern United States to obtain fresh specimens for molecular analysis and to search for new species, and museum specimens are being examined for morphological analysis. As a result of these studies, photographs and identification keys will be produced, and new species and their ranges will be described.

Effects of social environment on the development and maintenance of behavioral strategies for coping with stress.

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Coping styles are consistent behavioral differences in how individuals respond to stressful conditions. Proactive individuals are more likely to engage with potential dangers, while reactive individuals tend to avoid a threatening stimuli. Understanding the proximate mechanisms behind these contrasting strategies is an active area of research. In this dissertation project, we will explore one aspect of these proximate processes: mediating role of social environment on the development and expression of coping styles in a model species, the Zebra Finch (*Taeniopygia guttata*). Using behavioral responses in three different assays to characterize coping styles in our population, we will investigate how exposure to social stress in early development impact the emergence of coping styles later in life, and how social position within a group influence the expression of coping styles in adulthood. We predict that, exposure to stressful social conditions during development, as simulated by artificial injection of stress hormones in egg and hatchling stages (i.e. CORT), causes differential expression of two types of stress hormone receptors in the brain, which leads to a more reactive response later in life. In adulthood, we predict that individuals with strong associations within a flock, and higher

dominance status, will be buffered from potential risks in an environment, resulting in a more proactive response even though their coping style is strongly shaped with early life social conditions. This study will have important implications on understanding the emergence of coping with stress as an interplay between epigenetic effects in early life and social conditions in adulthood.

Impacts of mining effluent on fishes in the Clinch River and Powell River watersheds

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Mining coal in Appalachia has profoundly changed landscapes and impacted >1,900 km of headwater streams. Mining activities can increase instream sedimentation and elevate concentrations of total dissolved solids and trace elements (e.g. selenium) above tolerances of stream fishes. We are evaluating the fish response to mining effluent across a mining-intensity gradient in 16 headwater streams in the upper Powell River and the upper Clinch River watersheds. We expected conductivity, fine sediments, major ion concentrations and [Se] to be elevated in streams on the high-impact end of the gradient. Further, we expected to find fish responses such as shifts in community assemblage, reduced spawning performance, and reduced individual-level health at high-impact sites. Water quality, physical habitat, fish community, and fish tissue samples were collected August – October 2015. There were strong correlations between our mining gradient and measured specific conductivity and concentrations of HCO3–, Ca, Mg, Na, K, and SO42-. Seventeen fish species were collected and individual-fish data were gathered on two species, *Etheostoma flabellare* and *Rhinichthys obtusus*. A hierarchical cluster analysis characterizing species composition at sites identified two groups: widespread species (*Campostoma anomalum*, *Rhinichthys obtusus*, *Etheostoma flabellare*, and *Semotilus atromaculatus*) and patchily distributed species (all others). Although *E. flabellare* was widespread, it was absent from assemblages at four high-impact sites. Future interpretation of community data will be paired with physical habitat and water quality data. This spring we are also processing fish tissue samples to describe changes in individual-level health and conducting spawning surveys of *E. flabellare* across our mining-impact gradient.

Behavior and Impact of *Spathius galinae* and *Spathius agrili* on Emerald Ash Borer in Virginia

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Emerald ash borer (EAB), *Agrilus planipennis* Fairemaire (Coleoptera: Buprestidae) is a wood-boring beetle native to Asia introduced to Michigan in 2002. In both its native range and in North America, EAB primarily feeds on ash trees (*Fraxinus* sp.). In North America, ash tree stands suffer complete mortality within 6 years of infestation, and it is estimated to kill 38 million ash trees by 2019. EAB larvae are frequently predated by native woodpeckers (*Picidae*), accounting for up to 39% of all EAB larvae in some areas. Four hymenopteran parasitoids have been identified in Asia and introduced to the U.S. as biological control agents against EAB. This study will focus on two larval parasitoids, *Spathius agrili* Yang (Hymenoptera: Braconidae), and *Spathius galinae* Belokobylskij and Strazenac (Hymenoptera: Braconidae). Neither parasitoid is established in Virginia. We plan to study competitive interactions between both parasitoid species, including multiparasitism and adult competition to determine the best course of action for establishment. We will release both parasitoids across Virginia at a variety of ash dense forest locations, and monitor their activity using a variety of methods including sentinel logs and total larval counts. Once establishment occurs, we will exclude woodpeckers from infested ash trees in order to determine the effect of woodpecker predation on the parasitoids.

Climate Change, Coups, and Critically Endangered Species: First Aerial Drone Surveys of Madagascar's Lemurs

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Lemurs are found only in Madagascar and are earth's most threatened mammals. Hunting, habitat loss, government instability, and climate change all pose serious threats to lemur species. Establishing baseline population estimates and enacting long-term population and habitat monitoring efforts to guide conservation strategies are critical to their survival. However, traditional survey methods are labor intensive, expensive, and can facilitate resource extraction. Novel technologies, such as aerial drones, will help to overcome these obstacles. Population estimates and threat quantification for diurnal species in northern Madagascar will be obtained summer 2016, including critically endangered golden-crowned sifakas (*Propithecus tattersalli*) and endangered crowned (*Eulemur coronatus*) and Sanford's brown (*E. sanfordi*)

lemurs. Prior to conducting drone surveys, lemur behavioral responses to their presence will be assessed so that surveys are performed in a way that minimizes animal stress. A cost-benefit analysis comparing line transects and aerial drone surveys will be conducted, fragments with extirpated lemur populations will be identified for future translocation, and land cover change will be mapped to aid in conservation prioritization and to establish a habitat baseline for future climate change studies. Partnering with Malagasy conservation initiatives will ensure continued long-term monitoring. Pilot data will facilitate my doctoral work investigating how lemurs in this region will respond to climate change-induced environmental change and aid in local conservation efforts in a global biodiversity hotspot. Results will be broadly applicable to wildlife management and conservation around the world.

Modeling Freshwater Salinity for Aquatic Biodiversity Management

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Human activities like agriculture and resource extraction can increase the dissolved inorganic ion concentration (i.e., salinity) in waterbodies, creating toxic conditions for life adapted to dilute freshwater. This salinization of freshwaters is a global threat to aquatic biodiversity. In the USA, mountaintop coal mining contributes to salinization of headwater streams in the Appalachian region, a biodiversity hotspot. Recently, water quality managers have sought to mitigate the biotic effects of salinization by determining the limits of salinity tolerable to freshwater organisms. To date, limits have been based on salinity-biota relationships observed in field surveys that measured salinity only once per year. However, because salinity can vary with seasonal stream flow, effective management will require understanding the temporal patterns. Toward that end, we measured the salinity surrogate electrical conductivity continuously for three years in 25 minimally-disturbed headwater streams across a gradient of salinity in the Appalachian coalfields of Virginia and West Virginia. We found that salinity changed throughout the year, in a distinct seasonal pattern in nearly all streams, regardless of mean annual salinity level. We modeled the pattern using a sine-cosine linear model and found moderate to strong fits. The models indicated that annual minimum salinity occurred in spring and annual maximum salinity occurred in autumn. Averaged across all sites, seasonal deviations from mean annual salinity reached approximately 20% in spring and autumn. Our models indicate substantial, yet predictable seasonal variation in salinity, which should improve salinity management to achieve aquatic biodiversity goals.

Subtle variation in incubation temperature may have long-term effects on immune function and sexually-selected traits of an altricial model, the zebra finch

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Avian incubation temperature plays an important role in offspring development and is affected by the interaction between parental behavior and environmental variables. Numerous studies have indicated its importance to a suite of phenotypic traits in offspring, yet we have a fairly limited understanding of how variation in incubation temperature affects individuals throughout adulthood. The literature has identified numerous traits that are affected in altricial nestlings prior to fledging and in precocial birds (chickens and ducks), but whether or not incubation temperature has long-lasting impacts on individuals, possibly affecting their lifetime phenotypic trajectory, is unknown. We investigated how growth, immune function, and ornamental plumage was influenced by variation in incubation temperature by incubating eggs at two biologically-relevant temperatures (36.5 and 37.5°C) and measuring endpoints on nestlings and adults. We found no differences in growth or immune function in young birds across the two incubation temperatures. However, compared with 37.5°C individuals, those incubated at 36.5°C had a lower cell-mediated immune response as adults (40 days post-hatch) and males had lower brightness and intensity ornamental plumage coloration at sexual maturity (~100 days post-hatch). This study demonstrates how subtle differences in the conditions experienced during embryonic development may have a crucial and long-lasting influence on individual phenotype.

A Comparison of Intraspecific Aggression in Populations of the Lizard, *Anolis sagrei,* at Varying Stages of Species Invasion

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It is important to asses how invasive species are able to thrive in novel environments in order to predict and prevent future invasions. Additionally, the study of invasive species allows a unique opportunity to assess how species adapt to novel conditions, which are often created by current global changes. Invasive species often undergo phenotypic divergence from their native counterparts because they must adjust to novel conditions to persist outside of their native range. Behavior is a key determinant of success for invasive animals because it can facilitate rapid responses to novel conditions, so it is likely that behavioral divergence occurs in species invasions. *Anolis sagrei* is an invasive territorial lizard in the Southeast United States that is native to the Caribbean. For *A. sagrei* and other territorial species, increased territorial aggression may be selected for when their ranges expand into areas that contain closely related species. This study investigates the differences in aggressive behavior between populations of *A. sagrei* at different stages of invasion. One-on-one aggressive encounters were staged between males in order to assess differences in aggressive behavior between different populations. We had two competing hypotheses: 1. lizards at the front of the range are more aggressive than other populations because aggression allows them to outcompete species in their new range, and 2. lizards at the front of the range are less aggressive than other populations because there is lower population density there, thus less competition.

Population biology, life history, and ecology of the Bahama Swallow (*Tachycineta cyaneoviridis*): informing conservation of an endangered bird in the northern Bahamas

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The Bahama Swallow (*Tachycineta cyaneoviridis*) is an endangered bird species that is endemic to the northern Bahamas. This doctoral research project focuses on three central questions:

- What are the features of the current Bahama Swallow population biology? Available population estimates indicate a sharp decline in population abundance, and there is currently no information regarding distribution and dispersal. I am conducting surveys and using capture-recapture to estimate abundance and distribution, and taking genetic samples to assess the dispersal of populations between islands.

- What are the life history characteristics of the Bahama Swallow? The life history data for this species are limited, and I am expanding these data by monitoring active nests during several consecutive breeding seasons.
- What are the potential agents of decline of Bahama Swallow populations? (A) Habitat loss and degradation: Bahamian pine forests were heavily logged, and continued loss and degradation of pine forests poses an ongoing threat. I am conducting habitat surveys to assess the availability of suitable breeding habitat. (B) Competition for nesting cavities: The Bahama Swallow may face competition for cavities with other cavity-nesting bird species. I am identifying the species that excavate and utilize the same types of nesting cavities as Bahama Swallows, and designing a cavity nest web illustrating the interactions of these species. (C) Predation: Increased abundance of nest predators could pose a threat to the Bahama Swallow. I am monitoring active nests to determine whether the rates of depredation are sufficiently high to contribute significantly to population declines.

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.