Cary Institute of Ecosystem Studies

UNDERGRADUATE RESEARCH SYMPOSIUM

August 6, 2020
12 – 2:30 pm

12:00 Welcome and Introductions: Dr. Alan R. Berkowitz, Head of Education

12:05 **Julianna Adler-Colvin (**Marist College): The effect invasive species have on the natural ecohydrology

12:15 **Michael Moubarak (Hamilton College):** A spatially explicit risk assessment of salamander populations to *Batrachochytrium salamandrivorans* in the US for directing conservation actions

12:25 **Cassandra Roberts (Elizabethtown College):** Thermal layering and variable resistance to changing weather patterns in small aquatic systems

12:35 **MyKenna Zettle (University of Pittsburgh)**: The effects of Urbanization of landscapes on mosquito populations

12:45 **Annabelle McCarthy (Cal State University)**: Turbidity in Relation to High Flow Events in the Hudson River Estuary

12:55 **Emma Castiblanco (Haverford College)**: You Wouldn't Eat 3 Pounds of Salt, So Why Should Our Watersheds?

1:05 **Break**

1:15 **John Nguyen (Columbia University)**: Nutrient Effects on Leaf Biomass Allocation Across Tropical Forest Succession

1:25 **Carissa Moore (Rider University)**: Modeling the effects of nitrogen deposition and nitrogen fixation by *Robinia pseudoacacia* on northeastern U.S. forests

1:35 **Sara Herrejon Chavez (Portland State University)**: Evaluating growth and survivorship of afforestation plots in NY, and potential impacts of climate change

1:45 **Abigail Williams (Salem College)**: Road salt in Drinking Water Wells in Southwest Virginia and Southeast New York

1:55 **Victoria Martinez (Barry University)**: Exploring the Effects of The Clean Air Act on Stream Invertebrate Communities

2:05 **Elizabeth Jurado (University of Georgia)**: Cultivating a Sense of Belonging: The Impact of Undergraduate Research Experiences

2:15 **Closing remarks**

Cary Institute of Ecosystem Studies

Research Experiences for Undergraduates

2020 Student Abstracts

Julianna Alder-Colvin (Marist College): The effect invasive species have on the natural ecohydrology

This summer I worked on the effect invasive species have on the ecohydrology of an area. I did this by looking at three case studies. The first project I completed was a manuscript on Japanese knotweed's effect on soil properties along with the geologic features that allow an invasion. The next study used data from LTER regarding the invasive rusty crayfish (*Orconectes rusticus*) and how their presence has affected native virile crayfish (*Orconectes virilis*) populations over a 10-year period. The final project I completed was a detailed proposal for field-based research to investigate how the location of groundwater flux can be predicted in a lake system, and if the spatial heterogeneity of groundwater influx has a control on macrophyte density distributions.

Michael Moubarak (Hamilton College): A spatially explicit risk assessment of salamander populations to *Batrachochytrium salamandrivorans* in the United States for directing conservation actions

Amphibian populations are threatened globally by anthropogenic environmental change and *Batrachochytrium dendrobatidis (Bd*). A closely related new fungal pathogen of salamanders, *Batrachochytrium salamandrivorans* (*Bsal*), has recently left its native range in Asia and decimated some salamander populations in Europe. *Bsal* has not been detected in the United States, but given the U.S. has the most salamander biodiversity on Earth, predictive assessments of salamander risk are necessary to proactively allocate research and conservation efforts into disease mitigation. The present study mapped the risk of salamander populations to *Bsal* in the US based on the predicted environmental suitability of the *Bsal* pathogen in the US, and the distribution of potentially susceptible species to the pathogen. To predict the environmental suitability of *Bsal*, an ecological niche model was developed based on the pathogen's native range in Asia and validated on the observed invasive range in Europe using bioclimatic, land cover, elevation, soil characteristics, and human modification variables. Potentially susceptible salamander species were determined using a machine learning model that correlated known life history traits of a species with literature derived data on actual and predicted susceptibility to *Bsal* for tested and untested species. Environmental suitability, number of susceptible species, and risk to *Bsal* infection were highest in the Pacific northwest, Gulf and Atlantic coasts, and inland states east of the plains region. The overlap of these three metrics for risk of salamander populations to *Bsal* provides direction for researchers and conservationists in efforts to protect already threatened salamanders from an additional pathogenic disturbance.

Cassandra Roberts (Elizabethtown College): Thermal layering and variable resistance to changing weather patterns in small aquatic systems

Temperature is a defining factor to an aquatic ecosystem and many climates are now experiencing temperature changes, therefore the resilience of pond temperature against these climate changes should take precedence. This research allows us to build on known climate reactions within lakes and examine their consistency when scaled down. I will also investigate if the sediment layer of these ecosystems acts as a resilient temperature refuge. This temperature refugee could aid organisms in avoiding the thermal stressors brought on by climate change. I will examine these temperature changes by placing sensors at three depths: water surface (~0.2m), deep water (~0.5-0.8m), and sediment layer (~0.8-1.2m). The data was collected from five ponds throughout the US (North Dakota, Maine, New York). I asked three

research questions: How do pond temperatures change in response to air temperature fluctuations and precipitation? Are these changes evenly experienced throughout the depth of the pond? Is the variability of water temperature different at different depths? I found that the sediment layer has both a significantly lower variability and daily average water temperature than the surface water. The general trend through all ponds studied was that daily average temperature and variability of daily average temperature lowered with depth. Overall, the surface layer responded quickly with temperature exhibiting day-night cycling and effects from heat waves, the sediment layer showed only muted effects heat waves. The sediment layer in all ponds showed higher resistance to temperature than surface water but lower resilience taking longer than surface water to recover after a heat wave. This research shows evidence for thermal layering in small, shallow aquatic systems which creates a temperature refugee with potential to aid organisms against climate change.

MyKenna Zettle (University of Pittsburgh): The effects of temperature and urbanization gradient on Aedes and Culex mosquitos

Mosquitos are an aggressive vector species that transmit diseases that lead to millions of human deaths every year. Species presence and population abundance is influenced by several environmental characteristics, such as temperature and precipitation. Human land modifications can alter these characteristics, thereby making them more optimal for some mosquito species. Mosquito abundance and diversity can be monitored at the juvenile stage and then compared between environment types. We used standardized ovitrap and iButton data collected across five years (2011-2015) to examine how mosquito composition and abundance are influenced by temperature variation along an urbanization gradient in the Baltimore. Our results focus on the four most commonly observed species, which include two *Culex* (*restuans* and *pipiens*) and two *Aedes* (*albopictus* and *japonicus*) species. All species were highly abundant at sites with both high impervious surface and vegetation cover (urban green sites), while *Ae. japonicus* and *Cx. restuans* were also highly distributed in rural sites, and *Ae. albopictus* and *Cx. pipiens* were more exclusive to urban sites. *Ae. albopictus* and *Cx. pipiens* were positively correlated with impervious surface. All four species were positively affected by temperature, but with varying degrees of magnitude. Species that feed on humans, *Ae. albopictus* and *Cx. pipiens*, were more likely to be found in warm, urban areas, which will likely lead to an increase in population in these species due to future growth of urbanization and climate change.

Annabelle McCarthy (Cal State University): Turbidity in Relation to High Flow Events in the Hudson River Estuary

In 2011, Tropical Storms Irene and Lee made their impact on the Hudson River: sediment input was five times the annual average. Following these storms, one of the Hudson's most common underwater plants, *Vallisneria americana* (water celery), experienced a 90% decline in distribution. Research shows that the storms caused changes linked to increased turbidity. This study aims to expand our understanding of the relationship between high flow events and turbidity in the Hudson. By examining a wider range of high flow events – not limited to Tropical Storms and Hurricanes – the model resulted in a strong, exponential relationship between high flow and turbidity. The results suggest high flow events have the potential to increase turbidity in the Hudson River, with higher flow leading to increasingly greater turbidity. The increased turbidity from flow events we examined would cause an ecologically significant decline in light penetration with negative implications for plant growth. Efforts to reduce sediments loading would be strategic as severe storms are likely to become more frequent in the future as a result of climate change.

Emma Castiblanco (Haverford College): Long term trends in nitrate and chloride in streams in an exurban watershed

The lines between natural areas and human habitats have blurred as urbanization continues, creating a need for the study of ecosystems at all levels of development. This need is particularly acute for exurban

environments which are located outside of the suburbs and have low population density but are changing rapidly and have a dynamic mix of natural and human-dominated features. The "watershed approach" which integrates biophysical and human factors is useful for the study of these areas. Two sites in Baltimore County; Pond Branch (a forested watershed) and Baisman Run (an exurban watershed) were used to examine long term trends in chloride and nitrate (two critically important water pollutants) levels in streams using data collected by the National Science Foundation-funded Baltimore Ecosystem Study since 1998. Sources of chloride from human involvement come from the use of road salts for deicing, while sources of nitrate include fertilizers and atmospheric deposition. Long term stream data were combined with data on climate, road salt, and fertilizer use, and atmospheric deposition to explore the factors driving pollutant trends and ways to improve water quality in increasingly common exurban areas.

John Nguyen (Columbia University): Nutrient Effects on Leaf Biomass Allocation Across Tropical Forest Succession

Biomass allocation is a technique used by plants to overcome nutrient constraints. Plants can change the amount of biomass available in fine roots and wood, but it is unclear if biomass can be allocated to leaves. To determine if tropical trees can adjust their leaf biomass in response to nutrient additions over forest succession, we analyzed hemispherical tree photos and leaf scans from a 5-year fertilization experiment in Agua Salud, Panama. Image processing software Hemisfer and ImageJ were used to quantify LAI and LMA, respectively, and estimate leaf biomass. Data was analyzed using generalized linear mixed models (GLMM) to determine the effects of nutrient conditions, forest age, and the forest landscape on LMA, LAI, leaf herbivory and leaf biomass. GLMMs revealed no significant trends or effects of treatment and forest age on LMA, LAI, leaf herbivory, and leaf biomass ($Pr(>F)$ and $p > .05$). Our findings are consistent with studies that suggest allocation is focused in roots and wood and remains relatively constant in leaves. To better predict how forests will respond to nutrient limitation, a better understanding of plasticity of biomass allocation to leaves is needed. Our study suggests areas for productive research including an assessment of wood, root, and leaf biomass ratios and observing nutrient concentrations in leaves.

Carissa Moore (Rider University): Modeling the effects of nitrogen deposition and nitrogen fixation by *Robinia pseudoacacia* on northeastern U.S. forests

Biological nitrogen fixation provides the main source of new nitrogen into historically nitrogen-limited temperate forest ecosystems, increasing soil nitrogen levels and stimulating forest biomass productivity and carbon storage. Symbiotic nitrogen-fixing trees in particular can supply large amounts of new nitrogen relative to asymbiotic and non-biological sources due to their access to light energy. Across the United States, *Robinia pseudoacacia* is the dominant symbiotic nitrogen-fixing tree species and is mostly found in eastern forests. Over the past few decades, nitrogen deposition from anthropogenic sources has brought in large amounts of new nitrogen to eastern forests, potentially shifting the soil nutrient status away from nitrogen limitation. However, it is unclear how this increased nitrogen deposition has affected the role of *Robinia pseudoacacia* within eastern forest ecosystems, including its effect on soil nitrogen and forest biomass productivity and carbon. On the one hand, we may expect that *Robinia pseudoacacia's* role will decline due to nitrogen deposition because of negative effects of soil nitrogen on the benefit of symbiotic nitrogen fixation activity. On the other hand, we may expect no change or an increase in the importance of *Robinia pseudoacacia* following recent findings that nitrogen deposition stimulates the growth of *Robinia pseudoacacia*. To test these alternative hypotheses, we modified the SPE-CN model to include *Robinia pseudoacacia* and examine different scenarios of Robinia abundances and nitrogen deposition rates (historic, peak, and current). The model indicates that both nitrogen deposition and Robinia abundances increase ecosystem productivity, carbon storage and soil nitrogen, supporting the second hypothesis. In order to test this further, future focus will be on a more complex test using the Spe-CN model as well as comparisons of our results to current literature.

Sara Herrejon Chavez (Portland State University): Evaluating growth and survivorship of afforestation plots in NY, and potential impacts of climate change

As we experience gradual changes in climate patterns, it is important to understand how city forests will respond to New York's changing urban environments. Major cities around the globe are expected to undergo extreme transformations of temperature and precipitation. NYC in this same manner is expected to see patterns of higher precipitation, hotter climate, and rising sea levels. To mitigate this, NYC is one of many cities in the United States that has turned to green based solutions such as urban forests to aid infrastructure and create sustainable urban environments. However, climate change could prove impactful to the many native tree species that live within these urbanized areas. Studies have suggested that there is a concern within sustaining urban forests, as there are trending losses of city canopy cover over major cities, including NYC. As well as predictions for rising temperatures that may prove stressful for native urban forest populations. This study focuses on the analysis of tree survivorship and growth of afforestation plots planted by the Million Trees Initiative in NYC. With the purpose of exploring potential impacts that climate change may have on urban tree populations. This was done by examining selected niches of tolerance to waterlogging and heat, and cross examining that with species survivorship and growth on a case by case basis. Findings suggest that there is no certainty that heat and waterlogging tolerance are traits that can determine survivorship and growth within this afforestation community. Furthermore, species that are waterlog tolerant marginally outperform non tolerant species in growth, but it is uncertain if this is due to their tolerance. Moving forward, more research must be conducted on other tree traits i.e. drought tolerance, to determine which niches in trees may prove most beneficial in light of climate change. By doing so, we may have a better understanding of what species will be most successful in changing urban environments, and therefore beneficial for urban forests.

Abby Williams (Salem College): Road salt in Drinking Water Wells in Southwest Virginia and Southeast New York

Road salt contamination of natural water supplies is known to have adverse effects on human health, the environment, and other physical structures. A previous study has shown that the concentration of chloride in a Southeastern New York stream increased during the summer. In this study we aimed to see if similar trends occurred in deeper pockets of groundwater that are used by private wells in Southwestern Virginia. We found that there wasn't a trend across all the wells, but two wells increased and two wells decreased in conductivity throughout the summer. This suggests that chloride concentration may increase as well water levels decrease in some areas. The study also determined that one sample is not representative of the contents of a well based upon variation in max and min conductivities measured throughout the summer. This finding is significant in scenarios where well reports are gathered to determine the quality of the water. The second part of this study aimed to analyze the distribution of chloride and lead concentrations throughout the Townships of East Fishkill, Fishkill, and Wappinger, in order to identify regions of high lead and chloride concentrations and to determine if there was an overlap of lead and chloride contamination of groundwater.

Victoria Martinez (Barry University): Exploring the Effects of The Clean Air Act on Stream Invertebrate Communities

Acid deposition in the northeastern United States has been recognized as an environmental problem affecting aquatic and terrestrial ecosystems. In an effort to protect these ecosystems, the Clean Air Act Amendments of 1990 were passed to achieve a national standard of ambient air quality by placing restrictions on emissions of nitrogen and sulfur oxide. Long-term pH data at Hubbard Brook Experimental Forest (HBEF) demonstrate that stream pH has increased, however, there is no comparable examination of stream macroinvertebrate recovery. To explore whether stream invertebrate communities have responded to the Clean Air Act Amendments in New Hampshire, we synthesized data from the United States Geological Survey (USGS) and the New Hampshire Department of

Environmental Services (NHDES) that contain both pH and stream macroinvertebrate measurements. We identified 11 sites containing both biological and water quality data from USGS from the year 2000, and 154 sites from NHDES ranging from 2003-2017 (biological data) and from 1990-2019 (pH data). Of these sites, 99 of them only have one collection date for aquatic macroinvertebrates, thereby limiting the ability to detect change over time. In addition, 80% of the sites did not experience the hypothesized increase in pH as observed at HBEF. Further analysis will evaluate the impacts of pH on aquatic macroinvertebrates using a Threshold Indicator Taxa Analysis (TITAN). Although these data were collected throughout New Hampshire, there is insufficient temporal data to conduct an analysis of the impact of the Clean Air Act Amendments. This study demonstrates that we need to employ ecological monitoring over longer timescales to fully understand how environmental regulations may affect the very ecosystems that they are designed to protect.

Elizabeth Jurado (University of Georgia): Cultivating a Sense of Belonging: The Impact of Undergraduate Research Experiences

In STEM disciplines, the imposter phenomenon and a sense of belonging has been an area of concern for retaining students in science careers. To explore the role undergraduate research experiences (REUs) have on students' perception of imposter feelings and a sense of belonging in science, I conducted a series of 15- to 25-minute interviews (n=27) and surveys (n=70) of the alumni of 33 years of the Cary Institute Summer REU program. Using both the interview and survey data, I sought to answer the following questions: (1) What is the nature of imposter feelings and sense of belonging in science among former REU students? (2) How do you REU programs affect students' sense of belonging in science? (3) Does not having a sense of belonging in science push people off the science career path? Many of those interviewed experience imposter feelings but feel like they belong in science, which suggests the imposter phenomenon is independent from a sense of belonging in science and that that feeling of belonging in science may mitigate the imposter phenomenon. REU programs provide insight into what a career in science and research means and alumni felt that they belong when they were treated as if they already do especially by those who are established. Additionally, I found that those who left science after their REU experience didn't do so because they did not feel they belong – they generally left for a number of other reasons.