Graduate Student Symposium

February 11-12, 2022

Welcome to the 28th annual Graduate Student Symposium (GSS) at the Odum School of Ecology! GSS is organized by graduate students and serves as a forum to showcase student research at all stages of development. The goals of GSS are to provide opportunities for graduate students to give professional presentations and stimulate communication and camaraderie between students and faculty throughout the Odum School of Ecology and the broader UGA community. This year more than ever GSS serves as a crucial event for graduate students to reconnect with one another or make new friendships across cohorts.

This year's symposium could not have happened without the time and effort of numerous graduate student volunteers. We thank all of you for helping us plan our first virtual GSS!

Program Committee: J. Beauvais, A. Briggs, D. Cryan, E. Walther
Undergraduate Poster Committee: J. Blaze, K. Schroeder, A. Mital, S. Rajagopal
Feedback Committee: D. Gokhale, E. Kelsick, L. Naslund, C. Smaga, D. Suh
Souvenir Committee: C. Aikins, I. Ragonese, I. Wargowsky, A. Willoughby
Prospective Student Committee: C. Cummins, M. Pierce, C. Wilson
A/V: S. Bauer, D. Chaussadas, M .Kelly, R. Park
John Spencer 5K: A. Baynes, N. Tomczyk

Many undergraduate and graduate students also volunteered to present posters and give presentations. Furthermore, faculty, post-docs, and graduate students all contributed to provide feedback on presentations. Constructive, friendly feedback obtained from these judges is one of the most beneficial elements of GSS. Thank you all!

The staff of the Odum School of Ecology provides administrative and technical support throughout the event and have been especially important for this year's hybrid symposium. In particular we want to thank Julie Gunby, Beth Gavrilles, Tyler Ingram, Brian Perkins, Mica Turner, Joanne Greenway, Benjamin Taylor, Amanda Rugenski, Leslie Sitz, and Allison Walters for their assistance and work to keep Odum running! Additionally, we would like to thank the generous support from the Eugene and Will Odum Ecology Fund.

Finally, we thank you for taking time to attend the event. We hope this GSS will help kick off a hopeful 2022 and give you the space to see old friends, make new ones, and foster a welcoming community here at the Odum School. Please enjoy the talks, provide constructive feedback to the student participants, and consider contributing next year!

Sincerely,
Megan Tomamichel and Andrew Nagy
2022 Graduate Student Symposium Coordinators

History of the Graduate Student Symposium

Year	GSS Organizer(s)	Keynote Speaker	Affiliation at the time
1995	Janice Sand, Liz Kramer, Bob Hall, Anne Dix	NA	NA
1996	Janice Sand, Patty Saunders, Karen Bushaw, Elaine Hardwick, Jen Tougas	Rebecca Sharitz	Savannah River Ecology Laboratory
1997	Larkin Powell	Ronald Pulliam	National Biological Service
1998	Unknown	Unknown	Unknown
1999	Alice Miller	Karen Holbrook	Provost, University of Georgia
2000	Theresa Thom	Karen Kind Eckert	Wider Caribbean Sea Turtle Conservation Network
2001	Laura England	H. Kay Austin	International Joint Commission
2002	Unknown	Jack Webster	Virginia Polytechnic Institute
2003	Dawn Drumtra, Stephanie Madson	Jianguo (Jack) Liu	Department of Fisheries and Wildlife, Michigan State University
2004	Gretchen L. Peltier	Peter Groffman	Cary Institute of Ecosystem Studies
2005	John Kominoski, Caralyn Zehnder	Carol Couch	Georgia Department of Natural Resources
2006	Chrissa Carlson, Carol Flaute	William Cale	University of North Alabama
2007	Andrew Mehring, Sonia Hernandez	Johnathan Ambrose	Georgia Wildlife Resources Division
2008	Ching-Yu Huang, Chip Small	Nick Haddad	North Carolina State University
2009	Dean Hardy, Jamie Winternitz	Evelyn Gaiser	Florida International University
2010	Jessica Joyner, Shafkat Khan	Elizabeth Anderson	Field Museum of Natural History
2011	Peter Baas, Megan Machmuller	Ned Gardiner	National Oceanic and Atmospheric Administration
2012	Kimberly Kellett, Kyle McKay	Matt Whiles	Southern Illinois University – Carbondale
2013	Courtney Collins, Ethan Epps	Wyatt Cross	Montana State University
2014	Carly Phillips, Sam Woolford	Bob Hall	University of Wyoming
2015	Katie Brownson, Elise Krueger	Mike Strickland	Virginia Tech
2016	Jessica Chappell, Rachel Smith	Doug Parsons	Society for Conservation Biology
2017	Caitlin Conn, Kelsey Solomon	Elizabeth Sudduth	Georgia Gwinnett College
2018	Daniel Harris, Talia Levine	Dave Walters	U.S. Geological Survey
2019	Michelle Evans, Claire Teitelbaum	Virginia Schutte	Louisiana Universities Marine Consortium (LUMCON)
2020	Kaylee Arnold, David Vasquez Jr.	Rebeca de Jesús Crespo	Louisiana State University

2021	Jeffrey Beauvais and Nate Tomczyk	Ethell Vereen	Morehouse College
2022	Andrew Nagy, Megan Tomamichel	Marcelo Ardón	North Carolina State

The Institute of Ecology Graduate Student Symposium was founded in 1995 by Janice Sand, Liz Kramer, Bob Hall, and Anne Dix as an outlet for graduate students to give oral presentations in preparation for national and international meetings. The first symposium involved approximately 10 student presentations on rotary slide trays from 35mm film developed in Ecology's dark room! Presentations were followed by a convivial potluck dinner. The success of GSS was immediately apparent with all involved having a great time and students winning presentation awards at national meetings! Other academic units at the university soon followed suit by establishing their own student symposia.

The event has grown in popularity and size over the years as the Institute has morphed into the Odum School of Ecology. In 1996, a keynote lecturer was invited to the event, and soon thereafter it was decided that the keynote should be an alumna or alumnus of the UGA ecology program. Faculty, post-doctoral researchers, and graduate peers were enlisted to provide friendly feedback on presentations. An undergraduate poster session was established after ecology began a bachelor's degree program. Meals and coffee breaks were catered by local eateries to keep bellies full and attendees alert. Prospective students were soon invited the week of GSS to "get a feel for what ecology is all about." Additional administrative roles were needed to adjust to a growing symposium, and conference committees were organized to take care of invited speakers, program and scheduling, judging, food and drink, prospective student housing, and souvenirs. The table above lists *some* of the people who have been instrumentally involved in GSS.

This year marks the 28th annual Graduate Student Symposium, and we hope the tradition continues well into the future.

A note on talk formats and accessibility

Talks are scheduled to start every 15 minutes with the expectation that the presenter will speak for a maximum of 12 minutes. The remaining 3 minutes are allocated for questions and for participants to transition to the next recording. Additionally, this year there will be two Rapid Fire Sessions, in which each presenter will have 5 minutes to speak. During presentation transitions there will be time to ask a single short question. Longer, more detailed questions should be raised at the Q & A period at the end of the session where all presenters will be available to address questions. Moderators will attempt to ensure that all speakers receive questions during this time.

Keynote Speaker

Marcelo Ardón

Associate Professor

Department of Forestry and Environmental Resources, North Carolina State University

Biogeochemical signals in tropical streams and temperate coastal wetlands

Water is life, and aquatic ecosystems are the core of the ecological infrastructure that regulate water quantity and quality. However, aquatic ecosystems are being impaired due to land use change, altered precipitation regimes, increasing temperatures, and sea level rise. In our lab group, we have been studying long-term changes in tropical streams in Costa Rica and coastal wetlands in North Carolina. In Costa Rica, we have seen changes in extreme precipitation events, which have consequences for acidification, nutrient export, and carbon processing. In North Carolina, both droughts and storms have led to saltwater intrusion, which can lead to ecosystem transitions. Beyond documenting declines, we seek to understand mechanisms of change to help inform restoration and mitigation strategies. In this talk, I will share some of the lessons we have learned as we combine long-term monitoring, field and lab experiments, remote sensing, citizen science, and kindness in an effort to forecast and adapt to the synergistic and non-linear effects of an uncertain future.

Bio

Marcelo Ardón was born and raised in Costa Rica. He did his undergraduate degree in Biology and Environmental Science at Gettysburg College in Pennsylvania. He got his Ph.D. in the Odum School of Ecology (though back then it was called the Institute of Ecology) in 2006, under the direction of Dr. Cathy Pringle. He then did a postdoc at Duke University under the direction of Dr. Emily Bernhardt. In 2011, he started as an assistant professor in the Department of Biology at East Carolina University. In 2016, he moved to NC State University, where he is currently an Associate professor in the Department of Forestry and Environmental Resources. He has received various awards, including the Mercer award from the Ecological Society of America, for an outstanding paper by a young author. In 2015, he received the prestigious NSF CAREER award. In 2019, he received the Outstanding Graduate Mentor Award from the NC State Graduate School. He enjoys hiking and kayaking with his two kiddos.

February 11th, 2022

10:30-10:45	Dean Sonia Altizer, Andrew Nagy, Megan Tomamichel	Welcoming remarks

Session I

10:45-11:00	Nate Tomczyk	Thermal traits of aquatic macroinvertebrates vary with feeding mode
11:00-11:15	Supraja Rajagopal	Individual and social learning of foraging routes in the rock ant *Temnothorax rugatulus*
11:15-11:30	Ben Taylor	An automated multi-camera tracking system for collective behavior
11:30-11:45	**Break**	

Session II

11:45-12:00	Samantha Bock	The adaptive significance of temperature-dependent sex determination in the American alligator
12:00-12:15	Dessa Dunn-Benson	Multivariate analyses of native and invasive plant community and the effects of deer exclusion in maritime forests
12:15-12:30	Megan Tomamichel	Seasonal effects on shrimp black gill transmission and recovery
12:30–2:00	**Lunch**	

Rapid Fire Session I

2:00-2:45	Kelly M. Ridenhour	The fireflies in our backyards: Engaging communities in firefly conservation

	Emma Kelsick	How precipitation events modify extracellular enzyme export from soils in an agricultural headwater stream
	Jordan Argrett	Plant parasitism and soil microbes: A tripartite interaction driving plant community structure
	Katie Schroeder	Implications of temperature variation and resource availability during diel vertical migration on disease transmission in a zooplankton - fungal parasite system
	Q&A	
2:45–3:00	**Break**	

Session III

3:00-3:15	Emily Bertucci	Life stage specific effects of environmental stressors on epigenetic aging
3:15-3:30	Rebecca Park	Geographic variation and plasticity in red maple (*Acer rubrum*) seedling growth and phenology
3:30-3:45	Anna Willoughby	National park buildings modify species interactions of ringtails (*Bassariscus astutus*) across the food web
3:45-4:00	Kaylee Arnold	The gut microbial diversity of a Chagas disease vector varies across single and coinfection status throughout central Panama

Poster Session

4:00–5:30	**Poster Session**

February 12th, 2022

Session IV

10:00-10:15	Erik Jones	How does soil carbon storage vary within ectomycorrhizal forests?
10:15-10:30	Phillip M. Newberry	Examining the effects of microclimate on mosquito populations across an urban landscape
10:30-10:45	Adam McFall	Developmental abnormalities complicate conservation of the Carolina gopher frog (Rana capito)
10:45-11:00	Anna Baynes	Fish habitat associations in the Conasauga River and implications of climate change effects on species conservation
11:10-11:15	**Break**	

Rapid Fire Session II

11:15-11:45	Alyssa Quan	Impacts of the historical geography of Cherokee towns on ecological interactions between culturally important species
	TJ Odom	Characterizing parasite distribution and invasion risk in climate tracking salamanders
	Tucker Stonecypher	Wetland restoration: A new approach to restoring gopher frog breeding sites
	Anecia Gentles	Understanding Fruit Bat Movement Ecology as a Mechanism of Viral Persistence
	Q&A	
11:45-1:00	**Lunch**	

Session V

1:00-1:15	Cali Wilson	Urbanization, food provisioning, and transmission-relevant behaviors in Florida white ibis
1:15-1:30	Brendan Haile	Resource distribution and availability alter population dynamics of rodents and macroparasites
1:30-1:45	Elise Webb	Characterizing the distributions and bioavailability of per- and polyfluoroalkyl substances on the Savannah River Site, a National Environmental Research Park
1:45-2:00	Josiah M. Johnson	Effect of maternally-transferred mercury on development, behavior, and survival in alligator (Alligator mississippiensis) hatchlings
2:00-2:15	**Break**	

Keynote Address

2:15-2:20	Cathy Pringle	Introduction
2:20-3:30	Marcelo Ardón	Biogeochemical signals in tropical streams and temperate coastal wetlands

Abstracts

Plant parasitism and soil microbes: A tripartite interaction driving plant community structure

Jordan C. Argrett[1], Nina Wurzburger[1], Y.A. Chung[2]

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(2) Department of Plant Biology, University of Georgia

Hemiparasitic plants are common in many natural ecosystems and are known to influence community structure and ecosystem function. They connect to host plants through unique root structures called haustoria to establish a direct connection to its vascular system and form a living physiological bridge by which some nutrients, carbon, and water are extracted. In nutrient-limited ecosystems, hemiparasitic plants influence ecosystem processes and increase productivity through two primary pathways. (1) Hemiparasitic plants produce nutrient-rich and labile litter, stimulating microbial activity and increasing local decomposition rates (litter pathway). (2) Hemiparasitic plants reduce the abundance of dominant species via parasitism, thus facilitating the increase and coexistence of diverse co-occurring species (parasitism pathway). While past work on hemiparasites has focused on the direct impact on aboveground responses like host species and plant diversity, little is known about how these plants affect belowground processes. We aim to investigate the effects of hemiparasitic plants on neighboring plant population and community dynamics, nutrient cycling, and soil microbial communities by assessing their direct and litter-mediated effects. This work will provide a comparison of the two pathways, ultimately contributing to a greater understanding of how hemiparasites impact surrounding plant communities and ecosystem cycling.

The gut microbial diversity of a Chagas disease vector varies across single and coinfection status throughout central Panama

Kaylee M.H. Arnold[1,2], Christina Varian[1,2,3], Troy Kieran[2,4], Azael Saldaña[5], Franklin Samudio[5], Jose Calazada[5], Nicole Gottdenker[1,2,3]

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(3) College of Veterinary Medicine, University of Georgia
(4) Environmental Health Sciences, University of Georgia
(5) Gorgas Memorial Research Institute, Panama City, Panama

Chagas disease is caused by the parasite *Trypanosoma cruzi* that is carried in the guts of blood-feeding triatomine (kissing bug) vectors. Triatomines are often coinfected with the parasite *T. rangeli*, which is non-pathogenic to mammals but can reduce the fitness of their triatomine hosts. This study examined the gut microbial diversity of *T. cruzi* single-infected, coinfected, and uninfected triatomines (n = 288) throughout central Panama. We hypothesized that single and coinfected triatomines would have greater gut microbial diversity than uninfected individuals due to pathogen-microbe interactions within the gut, which may facilitate the proliferation of less dominant bacterial taxa. Coinfections were found in 13% of individuals (40/288), and

there was significantly greater alpha diversity in coinfected individuals when compared to both single and uninfected samples (Dunn's test of multiple comparisons, $p < 0.001$). Furthermore, single *T. cruzi* infections were found in 32% of sampled individuals (91/288) and also displayed significantly greater alpha diversity when compared to uninfected individuals (Kruskal-Wallis H test, $p < 0.001$). Finally, the beta diversity of single and coinfected samples was significantly different to uninfected samples (PERMANOVA: $p = 0.001$). These results highlight triatomine gut microbial diversity patterns that may be influenced by infection status and will be important to consider when developing vector control strategies.

Fish habitat associations in the Conasauga River and implications of climate change effects on species conservation

Anna Y. Baynes[1,2], Seth J. Wenger[1,2], Mary C. Freeman[1,2], Kyle S. McKay[1,3]
(1) Odum School of Ecology, University of Georgia
(2) River Basin Center, University of Georgia
(3) U.S. Army Corps of Engineers

Flow is a key determinant of the ecological structure of a riverine ecosystem, but climate change could alter flows to which fishes have evolved. In the Southeastern US, a global hotspot of biodiversity, changing flows are a potential threat to fish communities that have already experienced declines in abundance and richness due to other anthropogenic factors. Our objective was to understand fish relationships with flow-related microhabitat variables such as depth, velocity, Reynolds number and Froude's number, while accounting for the effects of other habitat features such as vegetation, to guide fish conservation in a changing climate. We used a long-term data set of annual fish samples in the highly biodiverse Conasauga River, GA, to estimate occurrence and counts of 21 fish species as a function of habitat variables using generalized linear multiple regression models. Results showed that microhabitat models explained a substantial amount of the variation in counts for some species, although other species were poorly predicted. Associations with depth and velocity varied greatly among species, indicating different flow niches. We found some species had associations with specific habitat features, such as aquatic plants and woody debris, but not all our hypotheses about these associations were supported. The characterization of depths and velocities used by shoal-dwelling fish will allow us to understand the effects of future changes, such as increased frequency and severity of droughts, on populations. A wide variety of habitats need to be maintained in a changing climate to support the large fish diversity in the Conasauga River.

Life stage specific effects of environmental stressors on epigenetic aging

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(2) Savannah River Ecology Laboratory, University of Georgia

Age-associated patterning of DNA methylation ("epigenetic aging") is a strong predictor of biological age as it is correlated with chronological age, the onset of age-related disease, and all-cause mortality. Using measures of epigenetic age to explore the discrepancies between chronological and biological aging offers insight into the molecular determinants of variable life history trajectories. While previous work demonstrates that adverse environmental conditions are associated with accelerated biological aging, it is not clear if some life stages are more sensitive than others to environmental conditions. Given that age-associated methylation patterns are most dynamic during early life, we hypothesized that early life exposures to environmental stress would have disproportionate effects on epigenetic aging relative to adult exposures. We tested this hypothesis by investigating the relative contributions of environmental stressors applied during different life stages of medaka (*Oryzias latipes*). At two distinct life stages (early life: 7-weeks post hatch and adult life: 4-months post hatch) fish were exposed for 21 days to either methylmercury or exogenous cortisol. After exposure, all fish

were reared to a common age of 6-months and assessed for biological age acceleration via several measures - epigenetic age estimates, telomere length, and the degree of epigenetic drift. Our results shed light on life stage sensitivity of epigenetic aging and the potential mechanism by which the epigenome translates environmental stressors into accelerated biological aging trajectories.

The adaptive significance of temperature-dependent sex determination in the American alligator

Samantha Bock[1,2], Yeraldi Loera[3], Thomas Rainwater[4], Benjamin B. Parrott[1,2]
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(3) Department of Ecology & Evolutionary Biology, Princeton University
(4) Belle W. Baruch Institute of Coastal Ecology & Forest Science, Clemson University

Many ectotherms, including all crocodilians, rely on temperature cues experienced during development to determine offspring sex. Ever since the first descriptions of temperature-dependent sex determination (TSD) were made over 50 years ago, an understanding of its adaptive significance has remained elusive, especially in long-lived taxa. One novel hypothesis predicts that TSD should be evolutionarily favored when two criteria are met - (1) incubation temperature influences juvenile survival and (2) sexes mature at different ages. Under these conditions, a sex-dependent effect of temperature on fitness arises through differences in age at sexual maturity, with the sex that matures later benefiting disproportionately from incubation temperatures that promote juvenile survival. Here, we test this hypothesis in the American alligator, a TSD species displaying a stark sex difference in age at first reproduction. By implementing a combination of artificial incubation experiments and mark-recapture methods, we disentangle the effects of incubation temperature and sex on annual survival in alligator hatchlings at two geographically distinct sites. Hatchlings incubated at male-promoting temperatures consistently exhibited higher survival compared to those incubated at female-promoting temperatures. Interestingly, this pattern appears independent of hatchling sex, as females incubated under male-promoting temperatures exhibited similar survival to their male counterparts. These findings support the hypothesis that TSD represents an adaptive sex-allocation strategy in this species. Ongoing work aims to understand the role of temperature-dependent hatchling phenotypes in mediating observed differences in early-life survival.

Multivariate analyses of native and invasive plant community and the effects of deer exclusion in maritime forests

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(1) Odum School of Ecology, University of Georgia
(2) Warnell School of Forestry and Natural Resources, University of Georgia

Many coastal forest ecosystems are experiencing environmental stresses that could alter ecological functions and native plant and tree communities. Two stresses of concern on Jekyll Island, a barrier island in Georgia, are intense herbivory by white-tailed deer (*Odocoileus virginianus*) and introduction of invasive plant species. The camphor tree *(Cinnamomum camphora*) was introduced from Asia to the southeastern United States over 100 years ago, and it has become increasingly abundant in maritime forests on Jekyll Island in recent decades. Native deer populations have also increased during this period. Furthermore, plant and tree communities on Jekyll Island have heterogeneous abiotic microsite conditions that could affect growth and survival. Therefore, we sought to explore how local abiotic and biotic environmental conditions influenced understory native plant and tree abundance and composition. We established 22 6x6m plots in a 40ha area with heavy camphor proliferation, of which 11 were fenced to exclude deer and 11 were not. For two years, we recorded total understory vegetation cover, cover by species, and abundance of hardwood tree seedlings, and

we counted, tagged, and measured height and leaf number of each camphor seedling. We also measured environmental conditions of soil moisture and temperature, elevation, leaf litter depth, adult tree composition, and light availability in each plot. We then used multivariate analyses to observe how plant community composition varied across the heterogeneous landscape, and with deer exclusion. Plant community composition did vary with environmental conditions and deer exclosure, though due to the scale of the study, ecological interpretations of patterns are tentative. Still, our findings point to the value of using environmental conditions to provide helpful contextual information for ecological restoration and invasive species control.

Understanding Fruit Bat Movement Ecology as a Mechanism of Viral Persistence

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Bats are the reservoir hosts of viruses more virulent than those of any other mammal (Guth et al., 2019, 2021). Deadly emergence of zoonotic pathogens in humans (rabies lyssaviruses, SARS-CoV-2, SARS and MERS coronaviruses, Ebola filoviruses) have driven the search for bat reservoir species and investigations into viral transmission dynamics. Although the subject of many studies, much remains unknown about the processes by which bats tolerate viral infections, even less so - how these viruses persist in bat populations. I propose that in order to better answer epidemiological questions regarding bat-virus systems, the movement and foraging ecology of the bats must be better understood - especially in the context of constantly changing habitat due to human activities. Previous studies have shown that populations experiencing anthropogenic pressures such as culling or displacement augments viral transmission, and thus persistence, within and across species. In this study, I will attempt to uncover mechanisms of persistence of henipaviruses in the three endemic fruit bat species of Madagascar (Rousettus madagascariensis, Eidolon dupreanum, and Pteropus rufus) by first determining the home range and resource use of each species. Populations of each species roost approximately 70 kilometers apart in this study system with ample space for overlap since their maximum foraging range is ~60 kilometers. This study will address key questions about home range and resource partitioning amongst bats that may occupy the similar niches in a geographically defined area in order to better understand viral persistence.

Resource distribution and availability alter population dynamics of rodents and macroparasites

Brendan B. Haile[1], Richard Hall[1]
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Historically, macroparasite infections have been shown to chronically infect many organisms including rodents. This project uses mathematical modeling to determine how differences in resource availability and distribution affect the population dynamics of rodents and their macroparasites. How resources are distributed in the environment can influence the behavior of foraging rodents which in turn alters the likelihood of encountering macroparasites. Resource availability is used to scale the impact of the two resource distribution scenarios (clustered and evenly distributed) on rodent and macroparasite populations. When resources are clustered together, one might expect an increase in likelihood of infection by macroparasites due to rodents gathering at feeding sites. In contrast, when resources are evenly distributed throughout the environment there may be a lower risk of infection by macroparasites because rodents are less likely to utilize the same space. It is apparent that resource distribution can impact the behavior of rodents but is unlikely to affect the rodent's immune system for this we rely on resource availability. Elevated levels of resource availability are assumed to increase the rodent's ability to tolerate and pass the macroparasite. Combinations of resource availability and

distribution create some interesting effects on the population dynamics of rodents and macroparasites.

Effect of maternally-transferred mercury on development, behavior, and survival in alligator (*Alligator mississippiensis*) hatchlings

Josiah M. Johsnon[1,2], Samantha L. Bock[1,2], Christopher R. Smaga[1,2], Benjamin B. Parrott[1,2]
(1) Odum School of Ecology, University of Georgia
(2) Savannah River Ecology Laboratory, University of Georgia

Interactions between developing embryos and their environment determine a broad range of organismal traits with consequences for survival and reproductive success. The widespread and highly toxic contaminant mercury is now widely recognized for its potential to be maternally transferred to offspring during sensitive stages of development, but the sub-lethal and long-term impacts of maternal mercury exposure have seldom been studied. Using the American alligator (*Alligator mississippiensis*) as our study species, we seek to answer three main questions: (1.) what is the immediate impact of mercury contamination on reproductive success and hatchling morphology, (2.) what is the impact of maternally-derived mercury on hatchling behavior, and (3.) what is the compounding impact of maternally-derived mercury and its sub-lethal effects on long-term hatchling survival? Nine alligator clutches were collected from Par Pond, a former industrial reservoir with a history of mercury contamination on the Savannah River Site, South Carolina, and evenly split between male- and female-promoting temperature groups. Clutch viability, egg morphometrics, and hatchling morphometrics were measured to assess reproductive success, and a subset of hatchlings underwent behavioral trials to assess predator avoidance behavior. Clutch-averaged mercury measured in egg yolk ranged from 248-554 ppb, compared to 18-52 ppb for a reference site. Hatchlings were released 10 days post-hatch at three sites on Par Pond, and monthly recapture surveys will assess hatchling survival and growth. Results from the analysis on reproductive effort and hatchling morphology will be presented here, and preliminary data from the ongoing behavioral trial analyses and survival study will be discussed.

How does soil carbon storage vary within ectomycorrhizal forests?

Erik Jones[1], Nina Wurzburger[1]
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The mycorrhizal association between plants and fungi is an important determinant of terrestrial nutrient cycling. Soils in ecosystems dominated by ectomycorrhizal (EM) plants are believed to have higher ratios of carbon to nitrogen compared to ecosystems dominated by arbuscular mycorrhizal (AM) plants as well as differential distribution of their soil carbon: EM-dominated soils have more carbon in their organic horizons and more carbon in the form of particulate organic matter (POM), while AM-dominated soils store more carbon deeper down, in the form of mineral-associated organic matter (MAOM). Since MAOM is better protected from disturbance than POM, this distinction is important to soil carbon storage. Preliminary evidence from four gradients of EM dominance across the eastern temperate forest suggests that the relationship between ectomycorrhizae and soil organic matter varies between sites, apparently due to tree identity. Pines and oaks represent two major, evolutionarily distant EM plant lineages, the Pinaceae and the Fagales. Soils of co-occurring pine and oak forests will be sampled across the eastern US to test how soil organic matter varies between EM tree lineages. Since oaks and pines are both fire-adapted and fire affects soil greatly, forests with and without the recent presence of fire will be assessed. Data will be collected on litter quality and fungal

community to test two contrasting hypotheses: differences between oak and pine forests in soil organic matter are driven by litter traits, or they are driven by differences in the ectomycorrhizal associates of these two lineages of tree.

How precipitation events modify extracellular enzyme export from soils in an agricultural headwater stream

Emma N. Kelsick[1,2], Raven Bier[2], Diana Oviedo Vargas[3], Jinjun Kan[3]
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(2) Savannah River Ecology Laboratory, University of Georgia
(3) Stroud Water Research Center

Microorganisms use extracellular enzymes to regulate the breakdown of soil organic matter and, correspondingly, the bioavailability of nutrients in organic matter. Extracellular enzyme activity represents microbial investments towards the uptake of carbon, nitrogen, and energy sources. To identify how different precipitation events can drive enzyme loss from soils, a stream surrounded by agricultural fields in Southeastern Pennsylvania, USA, was monitored for changes in extracellular enzymes during ten storms over a one-year period. Three enzymes, β-glucosidase, alkaline phosphatase, and β-acetylglucosaminidase, were used to measure the potential for organic macromolecule hydrolysis to produce bioavailable substrates. Extracellular enzyme activity analysis will show if there is a shift in potentially active enzymes during increased precipitation. Here I test the hypothesis that there will be an increase in enzyme activity following heavy precipitation as enzymes are exported from soils. This research aims to describe how microbial resource allocation in soils can be modified by changes in precipitation where there is the potential of nutrient leaching from agricultural fields. The export in extracellular enzymes indicates changes of soil enzyme distribution and potential decomposition rates.

Developmental abnormalities complicate conservation of the Carolina gopher frog (*Rana capito*)

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(2) Savannah River Ecology Laboratory, University of Georgia

Amphibians are declining faster than any other vertebrate group. In response to declines, conservation groups have turned to headstarting, a technique used to bolster populations by taking eggs from the wild, rearing them to a juvenile or adult stage in a protected environment, then releasing them back into the wild. The headstarting of gopher frogs (Rana capito) has become a common practice for their conservation in response to declines across the southeast. Survival of released juveniles is extremely low. Thus, we investigated how larval rearing conditions may impact juvenile survival. However, nearly 100% of the frogs we raised emerged with developmental abnormalities and were deemed unreleasable by South Carolina DNR. We have since learned that beginning in 2017 headstarting facilities across several states noticed that small proportions of metamorphic frogs were emerging with developmental abnormalities. These included skin, eye, and jaw abnormalities. We are working to understand the underlying cause of these abnormalities–which may be related to plant substrates, cyanobacteria and retinoids leading to endocrine disruption. Interestingly, our observations have been met with mixed concern by the gopher frog headstarting community. Perception of this problem appears to be driven by the priorities of the headstarting organization, which brings up a debate of quantity versus quality in headstarting. We believe these findings emphasize the need to investigate

underlying factors that might be responsible for these abnormalities and to what extent they are occurring in captivity and the wild so that future headstarting efforts for gopher frogs are not wasted.

Examining the effects of microclimate on mosquito populations across an urban landscape

Philip M. Newberry[1] , Sonia M. Altizer[1], Courtney C. Murdock[2]
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Urban landscapes present a wide range of microclimates that mosquito species are sensitive to regarding their potential to transmit pathogens. Urbanization alters the canopy cover and impervious surfaces of a landscape while also altering temperature characteristics through the heat island effect. This study is motivated by the diverse fine scale heterogeneities present across landscapes, to include differing levels of canopy cover, impervious surfaces, and temperature. Mosquito populations were surveyed across the metro-Atlanta area from summer to fall 2021 to examine the effects of microclimate on mosquito populations. Of particular interest are the *Aedes albopictus* populations, which in other regions of the world serve as an important arbovirus vector. Adult mosquito populations were surveyed using BG-Sentinel traps, and larval populations were surveyed through on the ground larval habitat surveys and specimen collection. This study found a significant relationship between the number of larval habitats at a survey site and the mosquito abundance at that location. The relationship between mosquito species richness and impervious surfaces was found to be negative and species richness and canopy cover to be positive, but not significantly so in both cases. The specimens collected during this survey will also serve as the basis of future genomic analysis to examine population structuring across an urbanized area. Understanding the effect of human development on the populations of disease vectors is important for public health interventions, and unraveling the effects of temperature, canopy cover, and impervious surfaces is key to measuring human impact on landscapes.

Characterizing parasite distribution and invasion risk in climate tracking salamanders

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Anthropogenic climate change is one of the greatest threats to global biodiversity and human health. In response to changing temperature and moisture, and associated changes in habitat and resources, many animal ranges are shifting in latitude, altitude, or both. Populations moving into new habitats can create novel interactions between climate trackers, their parasites, and the recipient host and parasite communities, much in the way that exotic invasive species have both escaped from and introduced new pathogens into recipient host communities in their introduced ranges. *Plethadon shermani* and *Plethadon teyahalee*, lungless salamanders present in the southern Appalachians, are two such species experiencing shifts in elevational distribution and hybridizing in the Nantahala Mountains in North Carolina where their distributions overlap at intermediate elevations. Although studies have investigated the drivers of the distribution of hybrid zones between these two species, none have investigated the potential role of parasite infections as a driver of the occurrence of hybridization zones between *P. shermani* and *P. teyahalee*. This work seeks to investigate if the parasite communities found in each host group and across climatic gradients differ in richness (the number of different parasite taxa present), parasite infection prevalence, and host specificity of individual parasite species by collecting individuals from localities containing exclusively *P. shermani*, exclusively *P. teyahalee*, and localities containing hybrids of both species. Beyond host species hybridization, this study system provides a unique opportunity to study the distribution and diversity of parasite communities in populations of climate

tracking host species on the move.

Geographic variation and plasticity in red maple (*Acer rubrum*) seedling growth and phenology

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Species with broad geographical ranges exhibit specific adaptations to local climates, which may result in diverging responses among populations to changing conditions. Climate warming has shifted species distributions and advanced spring phenology worldwide, but questions remain how responses to warming differ among populations across the species' natural range. In this 2-year study, I examine intraspecific variation in survival, growth, and leaf-out phenology by red maple (*Acer rubrum*) seedlings in response to experimental forest soil warming. *A. rubrum* is the most widely distributed and abundant tree species in eastern North America, displaying high genetic and phenotypic variation among and within populations. In April 2020, 2-year-old red maple seedlings sourced from 3 physiographic regions (Coastal Plain, Piedmont, and Mountains) were transplanted into experimental soil warming plots at Whitehall Forest. The seedlings were measured for size and survivorship in Fall 2020 and Fall 2021, and the leaf-out timing was recorded in Spring 2021. Overall, the results showed that although there was not a strong effect of temperature alone on survival, growth, and timing of leaf-out, there were regional differences in response. Moreover, provenances showed different magnitudes of response to increases in temperature, indicating a genetic-by-environment interaction effect. These findings support the premise that locally adapted populations respond to ecosystem-level changes differently, and climate warming experiments need to consider individuals arising from multiple regions in order to forecast the response of a species.

Impacts of the historical geography of Cherokee towns on ecological interactions between culturally important species

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Traditional ecological knowledge (TEK) holds a deep understanding of complex relationships within socio-ecological systems. The Eastern Band of Cherokee Indians (EBCI) are an indigenous people group residing on the Qualla Boundary in western North Carolina. The rivers in the local watershed form not only the lifeblood of local ecosystems, but also the cultural foundations of the EBCI. River cane (Arundinaria gigantea), a bamboo plant culturally important to the EBCI, plays a major role in sustaining habitat for various riverine species. In co-production with the EBCI, my research will explore the effects of EBCI spatial geographies on culturally important freshwater species by incorporating the role of TEK in township decision-making. Understanding TEK alongside mainstream scientific approaches is key to fully grasping the mechanisms behind river cane's impact on the watershed ecosystem. I plan to investigate 1) the spatial correlative patterns between Cherokee towns, fish weirs, and the patch size of river cane stands; 2) the relationships between these patterns and canebrake conditions; 3) how canebrakes affect the diversity of culturally important fish species in local rivers. Using field observations and ArcGIS, I will map historical Cherokee town sites and river cane patches along the river. I hypothesize that there will be a positive relationship between the spatial presence of town sites and the sizes of cane stands, which in turn will have an effect on the water quality and biodiversity of fishes. This study will reveal how TEK might influence the stability of watershed ecosystem dynamics.

Individual and social learning of foraging routes in the rock ant *Temnothorax rugatulus*

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Animals can learn their environment and improve their performance over time. Social animals can also achieve higher performance by pooling information from group members. However, it is still not clear if and how group members integrate individual and social information and generate new information as a group, known as collective learning. In the ant *Temnothorax rugatulus*, colony members individually learn routes and develop idiosyncratic routes during foraging bouts. They also transfer information about their foraging routes to their nestmates via tandem runs, by which a single member is led to the new food source one by one. By attaching a micro tag to every colony member, we are able to track the routes of all foraging trips, including tandem runs. These detailed data allows us to investigate how foraging routes change over time as the route information is passed from one individual to another, shedding light on how collective learning takes place in a colony.

The fireflies in our backyards: Engaging communities in firefly conservation

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Fireflies or lightning bugs are globally distributed bioluminescent beetles in the *Lampyridae* family, well known for sparking wonder and curiosity in people around the world. Despite many anecdotal reports of population declines in North American *Lampyridae* species, we lack long-term population data for most firefly species. The top conservation threats to *Lampyridae* are habitat loss and degradation, artificial light at night, and climate change - all anthropogenically driven and greatest in areas undergoing rapid urbanization. Atlanta, Georgia, a growing metropolitan area rich in *Lampyridae* species, is an excellent city for studying firefly threats, and with (61%) of Atlanta zoned single-family residential, individual land management decisions might significantly affect the local abundance of *Photinus pyralis* (the big dipper firefly), a common species. In this study, I used a community science approach to collect *Lampyridae* abundance and land management data across multiple residences and municipalities. Digital educational and training resources were custom-built to organize and instruct volunteers. Participants were recruited through a network of NGOs, neighborhood organizations, and local press sources. I will present the community response to the project design and recruitment scheme and describe ongoing work to analyze how land management affects *P. pyralis* abundance locally. The results of this research are useful to 1) *Lampyridae* conservation and outreach efforts, 2) inform residential and municipal land management, and 3) serve as baseline abundance data of *P. pyralis* in Atlanta, Georgia.

Implications of temperature variation and resource availability during diel vertical migration on disease transmission in a zooplankton - fungal parasite system

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Diel vertical migration is the daily migration of aquatic animals from deeper, colder waters with poor

food quality during the day to shallow, warmer water with richer food quality at night. This behavior is widespread in both freshwater and marine systems among zooplankton and fish. *Daphnia*, the dominant zooplankton genus and grazer in many freshwater lakes, commonly exhibit this behavior. In stratified lakes, this movement often results in large changes in temperature and resource availability for migrating individuals. Variation in temperature is likely to result in metabolic rates that differ from those at a mean temperature due to nonlinear relationships between temperature and host and parasite traits. These temperature responses also depend on resource availability. Many *Daphnia* species are infected by various parasites, and these parasites are also affected by temperature and host foraging behavior. However, the effects of variation in temperature and resource availability on host-parasite interactions are poorly characterized. The proposed study tests how increasing deviations from the mean temperature affect both host and parasite in this system and aims to determine i) whether varying temperatures result in transmission dynamics that differ from the mean temperature, ii) how increasing deviations from the mean temperature affect disease transmission, and iii) how resource availability interacts with temperature variation to affect disease transmission.

Wetland restoration: A new approach to restoring gopher frog breeding sites

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The southeastern US is one of the most biodiverse regions in North America, largely due to fire-maintained landscapes, where species across many taxa have evolved in the presence of regular fire disturbance. The imperiled gopher frog (*Rana capito*) is one among many pond breeding amphibian species that have seen precipitous declines due to anthropogenic alterations of the natural fire regime. Gopher frogs migrate once a year from sandy uplands to breed in ephemeral open canopied wetlands with lush herbaceous understories. These wetlands are maintained through periodic fires, killing trees and shrubs that would otherwise block sunlight, accumulate non-pyrogenic leaf litter, and reduce wetland hydroperiods through excessive evapotranspiration. One hundred years of fire suppression has caused many of these wetlands to become overgrown with woody vegetation, thus inhibiting herbaceous growth. Practitioners have recently prioritized restoring these wetlands by removing trees, however this technique alone is unpredictable and supported by few published studies. I am currently conducting research on the Savannah River Site to test the combined effects of tree removal and duff treatments on vegetation growth. Treatments include duff removal, duff disturbance, prescribed fire, and a control. Duff removal was raked by hand to the soil surface, disturbance was performed with a garden tiller, and fire was applied using a blow/drip torch combination. I will compare post-treatment vegetation responses to pre-treatment conditions, quantifying any additive effect these restoration practices may have. If successful, these treatments could potentially arm practitioners with new tools for wetland restoration in the southeast.

An automated multi-camera tracking system for collective behavior

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Quantifying and understanding the behavior of animal collectives is often limited by the ability to track individuals - a task that becomes increasingly difficult as group size, frequency of overlap, and similarity of individual appearance increase. Here, we present a robust method for capturing the movement of multiple small animals across relatively large spaces. This novel system will provide insight into the collective learning strategies utilized by highly coordinated animal groups.

Seasonal effects on shrimp black gill transmission and recovery

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Infectious diseases in marine fishery systems can cause mass mortality events in fished species that threaten the livelihoods of coastal communities. Because both marine hosts and parasites are sensitive to temperature, ocean warming could exacerbate this problem. One demonstrative system is the ciliate *Hyalophysa lynni* that infects the gills of commercial shrimp in the southeastern United States. We experimentally measured parasite transmission and shrimp recovery between June 2020 and February 2021. We first treated shrimp with anti-parasitic medications to remove *H. lynni* infections. We placed individually caged medicated shrimp into the Skidaway River, Georgia for 10 days. As a control, we held medicated shrimp in artificial seawater for the same length of time. Seasonal changes were detected in both the transmission of and recovery from *H. lynni*. Baseline prevalence of H. lynni was positively correlated with water temperatures: winter yielded the lowest prevalence (25%) while the summer yielded the highest prevalence (80% and 83%). We measured significant recovery from *H. lynni* in all seasons except for winter, where prevalence remained at 25%. *H. lynni* was transmitted to 83% and 100% of deployed shrimp during the two summer deployments compared to the 7% and 18% prevalence in unexposed control shrimp. During fall and winter, only 27% and 20% of shrimp deployed in the estuary were infected with *H. lynni*, while control shrimp had 6% and 33% prevalence, respectively. Together, these experiments demonstrate that season strongly affects the ability of *H. lynni* to transmit and for white shrimp to recover.

Thermal traits of aquatic macroinvertebrates vary with feeding mode

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Functional traits mediate how organisms interact with their environment, and feeding traits in particular can determine how organisms facilitate ecosystem processes. In stream ecosystems, macroinvertebrates are important drivers of ecosystem processes and their roles are mediated by their feeding traits. As climate change continues to increase stream temperatures, any shifts in the composition of feeding traits within aquatic macroinvertebrate communities may have impacts on ecosystem processes. However, it is unclear whether the thermal preferences of macroinvertebrates vary systematically across feeding groups. We evaluate relationships between thermal traits and feeding traits across hundreds of macroinvertebrate taxa, and evaluate whether patterns we observe are related to evolutionary history. Across several thermal parameters we find that organisms that consume leaves, commonly called “Shredders”, are more sensitive to temperature and have lower optimal temperatures than other feeding groups. Furthermore, we found a strong phylogenetic signal in both feeding traits and thermal traits across taxa, suggesting that the eco-evolutionary dynamics may have favored shredders with preferences for lower temperature.

Characterizing the distributions and bioavailability of per- and polyfluoroalkyl substances on the Savannah River Site, a National Environmental Research Park

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The Anthropocene is characterized by radical global changes that includes the near ubiquity of environmental contaminants across terrestrial and aquatic systems. Per- and polyfluoroalkyl substances (PFAS) are a family of anthropogenic chemicals widely used since the 1940s for commercial and industrial purposes to create heat, grease, and water-resistant products. Subsequent to their broad-scale use, studies have reported that exposure to PFAS is associated with a spectrum of consequences to vertebrate health including alterations to immune, metabolic, and reproductive function. Given the potential health risks to people and wildlife, there is a growing concern for these environmental contaminants because PFAS are highly mobile, recalcitrant, and ubiquitous. Aqueous Film Forming Foam (AFFF) are used in firefighting training and operations on military bases and airports and are thought to be a major contributor to PFAS contamination in the environment. The South Carolina Department of Health & Environmental Control (SC DHEC) in January 2020 released the first report on the issues and concerns of PFAS in South Carolina, and specifically indicated that AFFF had been used at the Savannah River Site (SRS). However, the extent, duration, and frequency of those activities are not known, and raise critical questions as to their overall distribution and bioavailability of these contaminants. The overarching goal of the study is to provide an initial characterization of the spatial distribution of abiotic and biotic contamination levels of PFASs on the SRS. In addition, the study will investigate potential trophic biomagnification of PFASs in identified hot spots and identify the bioaccumulative congeners in biotic samples.

National park buildings modify species interactions of ringtails (*Bassariscus astutus*) across the food web

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Built structures are rapidly expanding and encroaching on wildlife territories. Urbanization at broad scales generally decreases biodiversity, yet at fine scales architectural features can attract wildlife and alter their individual movements to allow access to anthropogenic resources and interactions with people. Here, I study the impacts of built structures on ringtails (*Bassariscus asutus*), a raccoon-related mesocarnivore, in developed areas of two natural parks. Using camera traps, I explore the presence and timing of ringtail building-use in conjunction with seasonal weather events. I expect ringtails to be more likely to seek refuge in buildings during times of winter snows or extreme heat. Further, cameras capture the vertebrate community that ringtails share habitat with. I expect indoor sites to house less species and a more homogenized community than outdoor sites as a result of environmental filtering. These community shifts might scale to impact other trophic levels; as such, I assess the diet and parasite diversity of ringtails non-invasively through analysis of their scat. While I expect building resident ringtails to expand their diet to include human food items, their consumption of natural foods like plants and insects may decrease. Lastly, I discuss how changes

to vertebrate communities affect ringtail parasites of varying life history traits. Historic park structures offer a unique study system to assess how even small, managed buildings can have long-term impacts on wildlife communities and their food web dynamics, with relevance to sprawling new construction near natural lands, abandoned buildings in rural areas, or natural structures like caves.

Urbanization, food provisioning, and transmission-relevant behaviors in Florida white ibis

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As urban areas expand and natural habitats shrink, many wildlife species have shifted into cities. In urban areas, animals often aggregate at higher density, move less, encounter anthropogenic stressors, and alter their diets by consuming human-provided food, all of which can affect the transmission of infectious diseases. American white ibis (*Eudocimus albus*) in South Florida are well-suited for studying the consequences of urbanization on pathogen transmission. Ibis naturally reside in wetlands but now commonly forage in urban parks and consume human-provided food. In this study, we investigate how transmission-relevant ibis behaviors change between urban and natural sites, across urban sites along a gradient of provisioning, and when urban ibis are fed. We find that ibis in urban parks spent less time actively foraging relative to those in natural wetlands. Within urban sites, foraging, preening, and vigilance behaviors differed across the sites observed. Ibis at two urban sites foraged less, on average, than those at other sites, but spent significantly more time preening or being vigilant. Lastly, during feeding intervals, ibis density increased by over 20 times each time food was thrown. These results suggest that urbanization and provisioning alter wildlife behavior in ways that can influence exposure to parasites. Specifically, in ibis, food provisioning can increase local density and contact rates for transmission of directly-transmitted parasites, while decreasing exposure to environmentally-transmitted parasites due to lower active foraging time. Further studies of how urbanization and recreational feeding influences wildlife behavior can inform management strategies to benefit both wildlife and human health.

Poster Abstracts

The effect of discharge on leaf litter decomposition in tropical streams

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Leaf litter decomposition is a key component in nutrient cycling and overall health of aquatic ecosystems. Most studies of stream decomposition take place in northern latitudes, so there is still much that we do not know about tropical freshwater ecosystems, especially in intermittent streams. Our study measured decomposition rates between a perennial and intermittent stream to quantify the effects of flow and water depth on decomposition in San Luis de Monteverde, Costa Rica. We also examined aquatic macroinvertebrate communities on the leaf packs after 20 days of incubation. Using leaf litter bags, we found faster decomposition rates in the intermittent stream. Faster decomposition may be caused by the greater aerobic environment provided by the occasionally dry intermittent stream. Further research should be done to understand the importance of duration and frequency in tropical leaf litter decomposition.

Diversity and richness of mosses and liverworts in boulder habitats

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The role of bryophytes within ecosystems ranges from soil formation and plant succession to monitoring pollution. The Neotropics hold a considerable portion of the world's bryophytic diversity, specifically within its forests. We conducted our study assessing bryophyte diversity on boulders in riparian and non-riparian habitats in the cloud forest of Monteverde, Costa Rica. We quantified species richness, evenness, and diversity and then correlated these with numerical boulder and patch measurements. We hypothesized that: (1) liverwort and moss species distribution would differ among non-riparian and riparian sites, (2) species richness would not be affected by boulder size, and (3) species diversity would be affected by boulder size. We randomly selected ten boulders at three sites for a total of 30. We identified bryophytes down to the most specific possible taxonomic group. We identified a total of 148 bryophyte specimens composed of 19 families (7 liverwort, 12 moss) and 23 genera (8 liverwort, 15 moss). We found no correlation between canopy cover and diversity or boulder size and species richness. However, riparian sites exhibited a greater proportion of mosses to liverworts than the non-riparian site. Additionally, the disturbed riparian site had higher species richness and higher evenness than its undisturbed riparian counterpart. Further research on bryophytic diversity, richness, and evenness as it applies to secondary riparian regrowth should be conducted, especially with the increasing climate change and subsequent natural disasters that prompt this regrowth.

Physiological evaluation of newly invasive jorō spiders (*Trichonephila clavata*) in the southeastern U.S. compared to their naturalized cousin, *Trichonephila clavipes*

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A newly-invasive orb-weaver from east Asia, *Trichonephila clavata*, or the jorō spider, is spreading in the southeastern United States. Little is known about the biology or physiology of this species in this new range. Coincidentally, a closely-related species in the same genus, the golden silk spider, *Trichonephila clavipes*, has already successfully established in this same region over the last 160 years. The golden silk spider, which is native to Central and South America, has not expanded its range beyond the southeast, likely because of thermal limitations. This investigation is to determine how the biology and physiology of *T. clavata* compares to *T. clavipes*. We reason that if their physiologies are similar, then *T. clavata* would be similarly confined to the southeast. We examine online records submitted to INaturalist.org to compare seasonal distributions and timing, and we collect females to measure physiological traits that help predict environmental tolerance, including metabolic rates, cardiac functioning (heart rate) during cold-exposure, and survival during brief (5min) below-freezing temperature. Results show the jorō spider has a shorter season than its cousin, indicating it can complete its lifecycle within a protracted period of suitable weather. It has an inherently higher metabolism (twice as high), and has a 77% higher heart rate when exposed to low temperature. Finally, jorō spiders survive better (74% compared to 50%) in a brief freeze. These findings suggest the jorō spider can

exist in a colder climatic region than the southeastern U.S., which can be useful information for management or planning purposes.

How do epiphyllous lichen affect leaf water retention?

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Water shedding on leaves is an important process linked to the leaves' success, as well as the water cycle. Leaves in the tropics have evolved drip tips to facilitate the shedding of water to avoid fungal infection and reduced gas exchange caused by leaf wetness. I wanted to understand how lichen, a common type of epiphyll that grows on the leaves of tropical plants, affected a leaf's ability to shed water. I sampled leaves of two different families (Piperaceae and Rubiaceae) for a range of lichen cover (0-91%) on leaves of similar size. In the lab, I wetted the leaves, let them drain and measured how much water was retained by comparing before and after leaf mass. I found that water retention per leaf area was significantly greater in the Rubiaceae leaves which had broader, shorter drip tips than the Piperaceae leaves (t-test, $p = 0.0004$). There was a significant positive correlation between percent lichen cover and water retention per leaf area (measured in ÂµI/mm2) for the narrow Piperaceae leaves ($r2 = 0.2658$, $p = 0.02$), but no significant relationship was found for the broad Rubiaceae leaves ($r2 = 0.1286$, $p = 0.12$) This result supports the hypothesis that epiphyllous lichen cover affects the ability of leaves to shed water within the Rubiaceae family.

Plant community characteristics in primary and secondary tropical premontane wet forest in Monteverde, Costa Rica

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Increasing rates of deforestation and destruction of primary forests have prompted a newfound focus on the ecological importance of secondary forests amid emerging regeneration efforts. Secondary forests provide essential ecosystem services, such as sequestering CO_2, but the extent of their role is still being studied. This experiment was conducted in the tropical premontane wet forest in Monteverde, Costa Rica near CIEE campus. There were four sites: three in primary forest and four in secondary forest. The primary forest sites were 70+ years old; one secondary forest site was 15 years old and the others were between 50 and 70 years old, providing an age gradient. Data was collected on understory vegetation abundance, diversity of ecomorphs, amount of organic material on the ground, canopy cover, soil moisture and pH, and above-ground biomass (AGB). Soil characteristics, canopy cover, and leaf litter all yielded similar mean values across age classes and forest type. No correlation was found between forest age and percent plant cover, but the mean for secondary forest was twice that of primary. AGB of both primary and secondary were similar with no specific trend besides an increase in AGB with age in secondary forest. Forests, among many essential services, store lots of carbon and can act as a carbon sink. With forest area increasingly being converted from primary to secondary forest, understanding the ecological potential and regenerative success of secondary forests must become a priority.

Social learning in *Columba livia*

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Past research has shown that the left hemisphere (right eye) is dominant for social cues in some bird species. In our experiment, we test if birds have this lateralization for acquiring social cues using homing pigeons, *Columba livia*, as a model system. Homing pigeons have been used as one of major study systems for testing social learning, the process of obtaining new behaviors by watching and imitating peers. We first place pigeons in individual cages and train them to peck through tissue paper to obtain food in a cup. After the training, each of these “demonstrators” is presented to a naive pigeon, and both receive covered cups. One of the eyes of the naive pigeon is covered. We measured the time it takes for the naive pigeons to peck through the cup after their demonstrators do so. We are currently conducting the experiment and analyzing the data. Our results will provide more knowledge of laterized processes in social information use in birds and other animals.

Migratory behaviors of the Asian needle ant

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Asian needle ants are an invasive species found in most places along the east coast of North America that live in decaying logs. Little research has been conducted on the migration behaviors of the Asian needle ant, *Brachyponera chinensis*, both in wild and laboratory settings. In this research, we tested two questions: “How often do Asian needle ants migrate in the wild?” and “How do Asian needle ants collectively choose a new nest site?”. To study migration in the wild, we identified decaying logs containing colonies of Asian needle ants and tagged them. For a month, we periodically checked if each colony had vacated its log. Our data indicate that Asian needle ants migrate often - roughly a half of the colonies moved out every week and all the tagged logs were vacated by week 4 of the experiment. To understand the migration process, we collected three additional colonies from the field and brought it to the lab. Asian needle ants use tandem carrying, a behavior in which one ant physically picks up and carries another, to share the location of a new nest site. Through painting every ant in the colony with a unique set of colors, we can track each individual throughout the migration process. We completed three experiments in which the data are currently being collected and analyzed. We hope to use these data to add to the field of ecology by learning what makes invasive ants such as Asian needle ants successful.

Abiotic and biotic drivers of detrital decomposition in bromeliads

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Decomposition is the breakdown of organic material into inorganic components such as CO_2 and CH_4. In this study, we assessed the drivers of decomposition within bromeliads (bromeliaceae) which are a group of epiphytes widely characterized throughout the tropics. The water and detritus filled center of the plant is a small ecosystem that varies from the surrounding environment. Anthropogenic disturbances have the potential to alter rates of decomposition within these bromeliads which could affect their ability to store carbon and change the food web structure. We placed a litter bag of slowly decomposing *Melastomataceae* leaves and one of rapidly decomposing *Fabaceae* leaves in 12-14 bromeliads in the open canopy and closed canopy. After 20 days, I measured leaf decomposition, and in a subset of bromeliads in the open and closed canopies I measured insect communities, inundation, and chlorophyll a. We found that decomposition occurred more

rapidly within the open canopy than the closed canopy for the *Fabaceae* leaves while there was no significant difference for *Melastomataceae* leaves. Insect abundance, inundation, and chlorophyll a did not correlate with decomposition. However, contrary to previous results, we found that chlorophyll-a concentrations were significantly higher in the closed canopy than the open canopy. Our results suggest that decomposition within bromeliads is microbially driven and that human disturbance may alter rates of decomposition for rapidly decomposing materials. Further research needs to address how this affects the small-scale food web structure and what is driving microbial decomposition within bromeliads (eg. terminal electron acceptors, temperature).

4 Years after Tropical Storm Nate: The recovery of macroinvertebrate community composition in a neotropical stream in Costa Rica

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The goal of our research is to assess recovery of the macroinvertebrate community in Alondra, a neotropical perennial stream, four years after Tropical Storm Nate in 2017. This major disturbance caused debris flows in San Luis de Monteverde, Costa Rica which led to the loss of the macroinvertebrate community. Our data adds to part of a long-term ongoing study of macroinvertebrate community dynamics in a neotropical stream. Data was collected in 2016, 1- year prior to Tropical Storm Nate, and in 2018, 2019, and 2021. Our results provide data on the four-year recovery of the stream benthic macroinvertebrate community as well as some abiotic indicators of recovery. We collected macroinvertebrate data from Alondra, in October for all years from the same 100-meter reach. All macroinvertebrates were identified down to the lowest possible taxonomic level, usually genus, but for the purposes of this study analysis was limited to the family level. We also measured canopy, stream temperature, pH, turbidity, and conductivity. We found that canopy cover decreased by 35.7% after Nate and in 2021 canopy cover increased to 55.2%. After the initial decrease in family richness in 2018 and 2019, we found that Alondra currently has the same number of families it did before Nate. However, the families and functional feeding groups composition is different than before Nate. Overall our findings indicate that Alondra is recovering from the disturbance in 2017 and may be approaching a new steady state.

Anuran diversity in edge versus forest habitats in San Luis, Costa Rica

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The Neotropics are rich in anuran diversity. I conducted an anuran survey in the cloud forests of San Luis de Monteverde, Costa Rica on the CIEE campus using visual and aural techniques. I compared differences in an edge habitat and a forest habitat to determine the differences in anuran abundance, species diversity, and species richness between edge and forest habitats. I had one 500 m transect in each habitat and sampled each transect multiple times during both the day and the night. Overall, I found that abundance, species diversity, and species richness were all higher in the forest habitat. There was very little overlap in species between each habitat type. The most common species in the forest habitat were *Craugastor stejnegerianus* and *Craugastor underwoodi* and the edge habitat was *Lithobates warszewitschii*. The data gathered in this study not only suggests that undisturbed or minimally disturbed habitats are better for anuran species richness and diversity, but it also lays down a baseline for monitoring the anuran community composition over time.

Inter-individual variability in social interactions of urban-dwelling wading birds

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Urbanization has dramatically altered natural habitats worldwide, having profound effects on wildlife condition, abundance, and behavior. In urban parks and gardens, wildlife are fed intentionally by people which can alter contact patterns within and among species, with implications ranging from individual foraging success to transmission of infectious diseases. Although past studies have investigated how social interactions in wildlife are altered by factors such as group size and density, little is known about how direct hand-feeding of wildlife influences behavioral variation among individuals. In this study, we quantify how aggressive behaviors of individuals and flock-level aggregation are affected by food provisioning in American white ibis (*Eudocimus albus*), a species that has begun infiltrating cities along the southeastern coast of the United States, where they are hand-fed by people in urban parks. We used overhead video data of birds being thrown bread to calculate flock density of ibis at multiple distances from the thrown food, flock position of a focal individual per each bread throw, and the number and score of aggressive interactions initiated by a focal individual. We found that birds clustered into two groups based on their aggressive tendencies, where the majority are less aggressive, and a select few initiate a majority of aggressive interactions. Further, more aggressive individuals spend more time closer to the human-provided food, which also coincides with where flock densities are highest. These results suggest that human-provided food may be fundamentally changing the behavior of individuals, with implications for wildlife health and disease.

Spider response to varying web disturbance?

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Orb weavers are a group of spiders that build suspended, typically circular webs. These webs have a very specific 4-part structure in order to maximize prey capture and minimize destruction of the web. Spiders invest substantial energy and the placement and construction of a web is important for their fitness . In this study, I looked at how spiders assess webs and their location, as well as how much consistent disturbance a spider will tolerate before leaving their web. I tested this with a common Central American orb weaver genus: Alpaida on the CIEE campus in San Luis de Monteverde, Costa Rica. All spiders were found in the slats of a porch railing that were present in 4 cardinal directions around campus bungalows. I located 90 spiders and assigned them to one of five disturbances (control, partial destruction, corn flour, corn flour and partial destruction, and complete destruction) at random. I applied treatments every other day, during the day to avoid harm to the spiders. I recorded spider responses every night over the 14-day experiment as either 1) no reaction, 2) rebuild, or 3) leave. There was no relationship between either the treatments and reaction or the day and whether the spider left. My findings could be a result of the spiders regularly rebuilding webs no matter what treatment was applied. It could also have been caused by outside variables (e.g. other disturbance or weather) affecting the webs or the spiders.

Comparing phenological shifts under climate change using historical and observational datasets

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Phenological shifts are some of the most widely-documented consequences of climate change. Phenological sensitivity, a measure of the change in the timing of a phenological event (e.g., flowering) per degree of warming, is often measured using experimental manipulations, observational studies, or herbarium records. However, observational experiments have several limitations in calculating phenological shifts (Wolkovich et al. 2012). Specifically, they often reflect short-term changes in climate and cover a limited spatial extent. Meanwhile, herbarium records provide documentation of phenology over a broader spatial and temporal range (Matthews and Mazer 2015). In this study, I analyzed over 1100 herbarium records of the alpine plant Silene acaulis across western North America. I then compared phenological sensitivity estimated from herbarium records and from a 5-year observational study in Niwot Ridge, Colorado. Overall, I found that herbarium records underestimated phenological sensitivity compared to observational data. Accurate models of phenological shifts would benefit from comparisons between different methods that estimate phenological sensitivity over a variety of spatial and temporal scales.