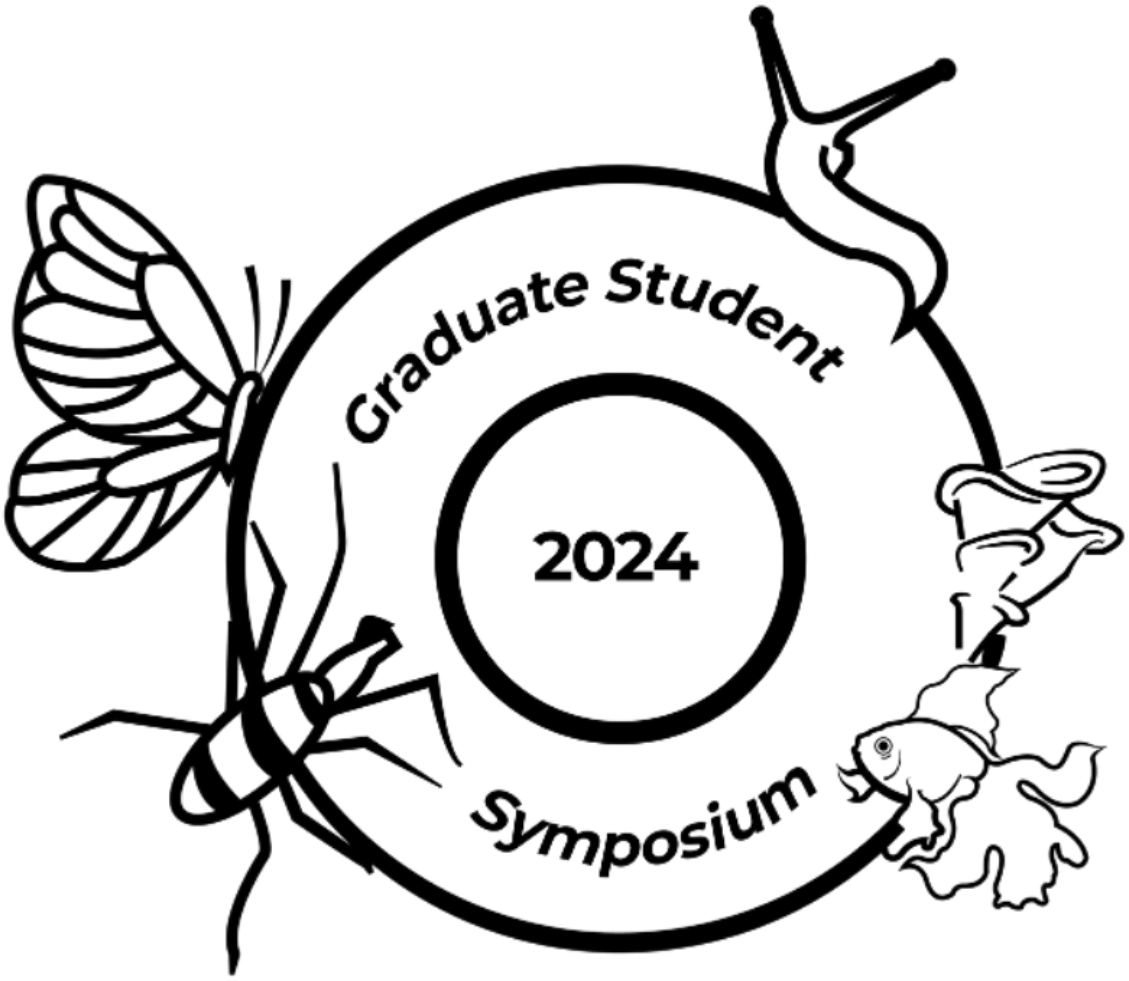
30th Annual

Odum School of Ecology

Graduate Student Symposium

February 9 – 10, 2024



Welcome and Acknowledgements

Welcome to the 30th 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. GSS serves as a crucial event for graduate students to connect with one another and the broader Odum community.

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 this year's event!

Program Committee: C.Hovland, J.Hoyos, E. Walther, A. Harrod, N. Vargas López
Undergraduate Poster Committee: K. Schroeder, B. Frick, C. Molinero, M. Hoyle
Food and Beverage Committee: A. Quan, B. Haile, N. Ashley, L. Rack
Feedback Committee: J. Argrett, J, Parrish, K. Mayes, D. Suh
Souvenir Committee: K. Vaughn, G. Demehin
A/V Committee: A. Blinn, C. Hanns, H. Davie
Prospective Student Committee: J. Sharapi, M. Pierce, K. Bonilla
John Spencer 5K: J. Longmire, C. Hanns, C. Vargas, J. Parrish

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 symposium. In particular we want to thank Julie Gunby, Tyler Ingram, Joshua Fonseca, Allyson Mann, Ashley Weed, Alex Pearson, Joanne Greenway, Amanda Rugenski, and Leslie Sitz 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 an amazing 2024 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,
Christian Brown and Kelsey Vaughn
2024 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
2023	Supraja Rajagopal, Eric Walther	Jacob Allgeier	University of Michigan
2024	Christian Brown, Kelsey Vaughn	Cecilia Sánchez	EcoHealth Alliance

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. Local eateries were enlisted to cater meals and coffee breaks.

Prospective students were soon invited to 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 30th annual Graduate Student Symposium, and we hope the tradition continues well into the future. This GSS marks the largest in Odum history with 36 graduate and 30 undergraduate students presenting their research!

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

Dr. Cecilia Sánchez
Senior Research Scientist
EcoHealth Alliance

Dr. Sánchez received a Bachelor of Science *intensive* in Ecology and Evolutionary Biology from Yale University. She earned her Ph.D. in Ecology from the Odum School in 2019 where she worked with Dr. Sonia Altizer on urban landscapes on wildlife behavior, health, and disease in Australia. She then continued her research at the Odum School where she worked as a postdoc with Dr. John Drake studying pathogen spillover from bats, rodents, and primates to humans before moving into her current position as a Research Scientist with the EcoHealth Alliance. Her interests span zoonotic disease, movement ecology, urban wildlife, flying foxes, and ecotoxicology.

Connections between animal, human, and environmental health: Lessons from bats, rats, and more

In this talk I will provide an overview of main themes in my research, including how and why microbes spill over from animals to humans, the role of changing landscapes in our shared health, and the interplays between contaminant exposure and infection. I will also discuss my efforts to promote equity and inclusion in science, particularly with women in science organizations. Finally, I will share my path thus far as an early career researcher and offer some advice for current students as they navigate grad school and look ahead to what comes next.

Friday,
February 9

9:00-9:15	Dean Mark Hunter, Christian Brown, Kelset Vaughn	Welcoming remark

Session I: Aquatic/Watershed Ecology and Biogeography

9:15-9:30	Andrew J. Blinn	Urban Harmonies? Metabolic Rhythms in the Jordan River Network, Utah
9:30-9:45	Laura C. Naslund	Short burps, tall trees: trajectories of landscape carbon balance after dam removal
9:45-10:00	Christopher R. Smaga	Testing the influence of natural nest thermal environments on alligator hatchling traits and survival
10:00-10:15	Eric Walther	Are rivers ecological islands? Implications for the conservation of lotic systems
10:15-10:30	Christian Brown	Life on the edge: Differential community dynamics at opposing latitudinal boundaries may explain species distribution limits
10:30-10:45	Benjamin Frick	Wetland Plants in a Warming World: Implications of Climate-Driven Shifts in North American Habitat Suitability for the Purple Pitcher Plant (Sarraceniaceae) Species Complex
10:45-11:00	**Break**	

Session II: Movement and Behavioral Ecology

11:00-11:15	Christian Swartzbaugh	Mixed Species Aggregations Lead to Changes in Movement and Behavior of Two Coastal Plain Minnows
11:15-11:30	Kelsey Vaughn	Predator-specific hunting strategies may alter landscapes of fear

11:30-11:45	Anna R. Willoughby	Ecological and anthropogenic predictors of diet breadth in a common omnivore, the ringtail (*Bassariscus astutus*)
11:45-12:00	Alexander Primo	Coral Couch Potatoes: Sex Differences of Symbionts in a Coral Cleaning Mutualism
12:00-12:15	Supraja Rajagopal	Investigating how infection of group members affect collective performance using an agent based modelling approach
12:15-12:30	Kiersten Nelson	Comparison of Release Techniques on Movement, Behavior, and Survival of Head-started Gopher Frogs (*Rana capito*)
12:30-1:30	**Lunch**	

Session III: Rapid Talks #1

1:30-1:35	Matt Pierce	Understanding the role of creek bank slumps as ephemeral refugia
1:35-1:40	Anna G. Bushong	Understanding the influence of water chemistry on developmental abnormalities in imperiled Gopher Frog (*Rana capito*)
1:40-1:45	Henry Davie	Adaptation and osmoregulatory balance associated with chronic copper exposure in Southern toads (*Anaxyrus terrestris*)
1:45-1:50	Natalia Vargas López	The Interconnected Environmental Dynamics of Lake Atitlán: Land cover change, riparian zones, and perennial river water quality
1:50-2:00	Q&A	

Session IV: Rapid Talks #2

2:00-2:05	Emily Chalfin	Geomorphic and Ecological Responses of a Small Dam Removal
2:05-2:10	Charlotte Hovland	Coupled Pathogen Dynamics Between Migratory and Resident Host Populations
2:10-2:15	Michael Belovitch	Characterizing soil to leaf drought vulnerability in southern African savannas
2:15-2:20	Angie Romano	Production and turnover of ectomycorrhizal fungi in a frequently burned longleaf pine forest

2:20-2:30	Q&A	
2:30-2:45	**Break**	

Session V: Infectious Disease Ecology

2:45-3:00	Juliana Hoyos	Spatial occurrence and infection rates of *Rhodnius pallescens* in response to deforestation and land reversion
3:00-3:15	Maria L. Müller Theissen	Documenting the geography and host range of neogregarine parasites in milkweed butterflies using museum specimens
3:15-3:30	Carlos Molinero	Effects of phylogeny, range overlap, and ecological traits on parasite sharing in birds
3:30-3:45	Daniel Suh	Patterns in parasite species richness across host pace-of-life
3:45-4:00	TJ Odom	Host introgression and environment predict parasite prevalence and abundance in two hybridizing Appalachian salamanders

Poster Session – Ecology Building Lobby

4:00-4:45	**Poster Group A**
4:45-5:30	**Poster Group B**

Saturday, February 10

Session VI: Fungus, Parasites, and Evolution

10:30-10:45	Abigail Bickle McKittrick	Does epigenetic aging underlie trade-offs between development rate and aging rate?
10:45-11:00	Julia Sharapi	Assessing the failure risk and associated socioeconomic characteristics of septic system infrastructure in Athens-Clarke County, Georgia
11:00-11:15	Nathan Ashley	Experimental soil warming suggests a potential for shifts in future southeastern forest community compositions
11:15-11:30	Jordan Argrett	Plant parasitism in alpine communities
11:30-11:45	Katie M. Shroeder	Thermal fluctuations increase disease transmission of a fungal parasite in a zooplankton host at the individual and population scale
11:45-12:00	S. Kane Moser	Environmental, ecological, and sociodemographic factors associated with emerging fungal pathogens
12:00-1:00	**Lunch**	

Session VII: Rapid Talks #3

1:00-1:05	Colin Peterson	Avian Conservation and Ecology in Rice Fields in Madagascar
1:05-1:10	Jonathan T. Parrish	Stormwater Management Around the World: A Systematic Literature Review of Stormwater Policies and Modeling Stormwater Utility Fees
1:10-1:15	Gbenga O. Demehin	Predicting Thermal Performance of *Littoraria irrorata* in Varying Environmental Conditions in Salt Marshes
1:15-1:20	Marilee C. Hoyle	Investigating the Impact of Environmental Conditions on Metal-Microbe Dynamics in Wetlands

1:20-1:25	Kelly Mayes	Do changes in nutrient input affect seasonal infections of microsporidians in midges?
1:25-1:35	Q&A	
1:35-1:45	**Break**	

Keynote Address

1:45-1:50	Sonia Altizer	Introduction
1:50-3:00	Cecilia Sánchez	

Abstracts

Urban Harmonies? Metabolic Rhythms in the Jordan River Network, Utah

Andrew J. Blinn[1], Rebecca L. Hale[2] & Krista A. Capps[1,3]

[1]Odum School of Ecology, University of Georgia
[2]Smithsonian Environmental Research Center
[3]Savannah River Ecology Laboratory, University of Georgia

Urban watersheds experience altered flow patterns due to an increase in impermeable surfaces and infrastructure altering flow paths. Manipulation of the landscape and engineered flow channels add complexity to the biology and chemistry in those systems. While the paths water takes through human-built structures are complex and not typically monitored, ecological consequences are measurable once water is returned to the river. Monitoring stations located on these reaches of the river provide continuous temporal resolution adequate for modeling gross primary production and ecosystem respiration (together referred to as stream metabolism). Modeled rates of metabolism and their temporal patterns are directly influenced by the biogeochemical environment created by the path of the water. Urban centers such as Salt Lake County, Utah establish long-term monitoring stations at these locations to ensure legal management of the human impacts on the Jordan River. These rich sources of high-resolution water chemistry and hydrology data have been leveraged to model daily estimates of stream metabolism. I explore the modeled results of ecosystem modeling at nine sites among the Jordan River drainage basin and share attempts of applying clustering techniques to annual patterns in urban streams. By summarizing large data sets into annual metabolic regimes allows for comparisons both among the Salt Lake sites and to existing metabolic regime data. This initial exploration of public data provides context to an ongoing investigation of temporal and spatial patterns of ecosystem processes in the Jordan River network.

Short burps, tall trees: trajectories of landscape carbon balance after dam removal

Laura C. Naslund[1,2], Amy D. Rosemond[1,2], S. Kyle McKay[3], Andrew S. Mehring[4] & Seth J. Wenger[1,2]

[1]Odum School of Ecology, University of Georgia,
[2]River Basin Center, University of Georgia
[3]U.S. Army Corps of Engineers, Engineer Research and Development Center
[4]University of Louisville

Dams can facilitate high emissions of carbon dioxide and methane from their reservoirs by flooding terrestrial soils and concentrating organic matter under hypoxic conditions. Dam removal has been proposed as a strategy to reduce emissions while restoring aquatic ecosystems; however, the carbon balance of formerly impounded landscapes depends on multiple pathways of gas exchange. For example, buried organic matter can be rapidly mineralized when exposed to air after reservoir drawdown (resulting in 'burps' of carbon emissions), but newly forming terrestrial vegetation and soils in the reservoir footprint can store carbon. The relative contribution of these and other pathways of carbon emissions and storage following dam removal, and thus, the viability of dam removal as a natural climate solution, is unknown. We combine empirical models of surface gas exchange, reservoir sedimentation, and forest regeneration to estimate and characterize the uncertainty in relevant carbon fluxes before, during, and after dam removal. We apply this model to completed dam removals on the Elwha River, WA and the Penobscot River,

ME. We find that the fate of previously inundated reservoir sediments is a major determinant of the magnitude and dominant pathways of carbon emissions during dam removal. Regrowing vegetation can eventually offset carbon emissions during dam removal and compensate for lost carbon storage with reduced sediment burial; however, the time to reach this compensation point after dam removal depends greatly on reservoir, dam, and basin characteristics, suggesting that removal of some, but not all, dams may be a beneficial climate solution.

Assessing the failure risk and associated socioeconomic characteristics of septic system infrastructure in Athens-Clarke County, Georgia

Julia Sharapi[1], Krista A. Capps[1,2,] Nandita Gaur[3] & Jacob Bateman McDonald[4]

[1]Odum School of Ecology, University of Georgia
[2]Savannah River Ecology Laboratory, University of Georgia
[3]Crop and Soil Sciences, University of Georgia
[4]University of North Georgia

Municipal septic systems are used widely for wastewater treatment in the United States (US). Approximately 25% of households, and 33% of new housing and commercial developments use septic systems for wastewater treatment. In many areas of the US, septic systems are not monitored by local governments, so regular maintenance is typically the responsibility of individual landowners. This can be problematic, as those in charge of systems may not provide sufficient servicing or upkeep of their systems until after system failure. The subsequent pollution from septic failure events increases community exposure to fecal waste and associated pathogens, which poses a serious threat to public health. Several studies have also shown a correlation between low-income communities and poorer local wastewater infrastructure functionality, which has concerning environmental justice implications. The purpose of this work is to model and assess the current potential septic system failure risk based on system specific and environmental factors and analyze the relationship between septic failure risk and sociodemographic characteristics in Athens-Clarke County (ACC), Georgia, at two local scales (parcel and block group level).

Are rivers ecological islands? Implications for the conservation of lotic systems

Eric Walther[1,2], Mary Freeman[3], & Seth Wenger[1,2]

[1]Odum School of Ecology, University of Georgia
[2]River Basin Center, University of Georgia
[3]U.S. Geological Survey, Eastern Ecological Science Center

Ecologists have been attracted to islands as model systems to examine how ecological and evolutionary processes shape community structure given their isolated, insular characteristics and ostensibly discrete nature that allows for considering an island as an ecological unit for ‘natural’ experiments. The conceptual framework that has emerged from studying island systems–most notably MacArthur & Wilson’s theory of island biogeography–has been expanded to other ‘island-like systems’ that are thought to behave similarly to ‘true’ islands and provided much of the theoretical basis for the design of natural protected areas. There have been few direct conservation applications of island biogeography theory to freshwater lotic systems, in part because of the limited inclusion of streams and river ecosystems as primary targets for protection. Despite the lack of use of island biogeography theory and species-area relationships to inform stream conservation, it has frequently been used as the conceptual framework for studies examining patterns in species richness. In addition, these theories could help researchers predict how the ecological structure of systems have changed in response to increased fragmentation and habitat loss. Given the common comparison of streams to ecological islands, a rigorous

review of how well-suited stream systems are for being considered island-like systems is needed. In this talk, I will discuss the extent to which lotic systems express characteristics of island-like systems (e.g., isolation, insularity), and the utility of considering rivers as ecological islands as a conceptual framework for freshwater conservation. The ability to integrate macroecological principles to help guide conservation planning in the extensively fragmented river networks across the Southeastern United States could help identify watersheds where there is high risk of extirpation.

Life on the edge: Differential community dynamics at opposing latitudinal boundaries may explain species distribution limits

Christian H. Brown[1], Jacqueline E. Mohan[1]

[1]Odum School of Ecology, University of Georgia

Range limit theory seeks to describe the mechanisms causing species distribution limits. Originating with Darwin, a central theme in contemporary range limit hypotheses is that different factors limit species distributions at their different geographical edges. Specifically, the Species Interaction Abiotic Stress Hypothesis (SIASH) proposes that biotic interactions are more important for limiting distributions where there is low abiotic stress and vice versa. Although range limit hypotheses abound, much of the variation seen across species distribution responses to climate change remains unexplained. Here, a novel application of joint species distribution models (JSDMs) was used to determine how community level responses to both the abiotic and biotic environment shift along a community's distribution gradient. JSDMs use a hierarchical multivariate generalized linear mixed model framework to simultaneously explain species and community level environmental relationships. Importantly, JSDMs enable inference of the direction (positive or negative) and strength of biotic interactions via residual species to species associations; a feature lacking in traditional distribution models. Three JSDMs were constructed to represent different parts of a southeastern plant community's distribution: 1) Full-range community 2) North edge of the community 3) South edge of the community, with the full-range model used as a control. Across the three models, species responses to the environment and each other were compared in order to assess the likely mechanisms of species distribution limits.

Wetland Plants in a Warming World: Implications of Climate-Driven Shifts in North American Habitat Suitability for the Purple Pitcher Plant (Sarraceniaceae) Species Complex

Benjamin Frick[1], Christian H. Brown[1], Jacqueline E. Mohan[1]

[1]Odum School of Ecology, University of Georgia

Over the past several decades significant hydrological shifts have been observed in peatland systems throughout North America as a result of changing temperature and precipitation regimes. These climate-driven shifts have profound impacts on the survival, reproduction, and dispersal of wetland specialist plants. The purple pitcher plant species complex (Sarraceniaceae) is one such group, and is intimately connected with historical wetland dynamics in North America. Habitat suitability for the purple pitcher plant is shown to shift considerably under multiple climate change scenarios, with high suitability habitat consistently moving northeast by 2100. Further, large losses in suitable habitat throughout the southeastern United States imply future extirpations and support the potential movement of local populations. Conservation implications for these trends are considered further, and recommendations for future management are explored.

Mixed Species Aggregations Lead to Changes in Movement and Behavior of Two Coastal Plain Minnows

Christian Swartzbaugh[1,2], Krista A. Capps[1,2] & Stacey Lance[1,2]

[1]Odum School of Ecology, University of Georgia
[2]Savannah River Ecology Laboratory, University of Georgia

The formation of mixed species groups in freshwater fish communities is a well-documented phenomenon, particularly reproductive associations between many Leuciscids. While these reproductive associations have received considerable attention, significantly less attention has been dedicated to understanding the processes guiding the formation of mixed-species groups outside of the breeding season. *Notropis lutipinnis* and *Notropis cummingsae* are two small-bodied, morphologically similar Leuciscids native to the Middle Savannah River Basin that occur both sympatrically and allopatrically across the Savannah River Site in Aiken County, SC. In their sympatric locations, they have been observed to aggregate together in the water column, potentially indicating a positive association between the two species. We are currently investigating the factors that may influence this aggregating behavior in captivity, specifically how body size and species present influence organization of individuals and how this may change under different conditions. The findings from this study will help to further our understanding of the factors that influence the formation and maintenance of mixed species groups in lotic Leuciscid communities as well as their potential adaptive significance.

Predator-specific hunting strategies may alter landscapes of fear

Kelsey M. Vaughn[1]

[1]Odum School of Ecology, University of Georgia

Variability in predator hunting strategies affect prey populations through both direct (consumption) and indirect (behavioural change) interactions. Fear-mediated behavioural responses and habitat shifts of prey can heavily alter benthic communities and the ecological functionality of coral reefs. The magnitude of these responses may be dependent on both the prey and predator species and size. Predators employ a range of hunting strategies such as sit-and-wait, sit-and-pursue, and active pursuit, where each tactic may create a different landscape of fear by altering how prey perceive predation risk. Some predators demonstrate multiple hunting strategies and even shift their strategy depending on the time of day. Moray eels are opportunistic predators deploying a sit-and-wait strategy during daytime hours then shift to active pursuit of prey at night. This study examined the influence of a top predator, the giant Moray eel (Gymnothorax javanicus), on the perception of predation risk in prey fishes. Visual transect surveys as well as baited remote underwater videos (BRUVs) were employed at six sites on the northern shore of Moorea, French Polynesia to assess the overall predator and prey community as well as the abundance and distribution of G. javanicus. Herbivory assays using turf algae were placed at varying distances outside of Moray eel dens during morning and evening hours to assess changes in foraging behaviour of prey as a function of perceived predation risk and time of day. Species specific size structure and foraging rate were documented by a camera placed at each assay. This study highlights the importance of indirect interactions in predator-prey dynamics and subsequent effects on the ecological functioning of coral reef ecosystems.

Ecological and anthropogenic predictors of diet breadth in a common omnivore, the ringtail (*Bassariscus astutus*)

Anna R. Willoughby[1,2], Sydney Speir, John M. Drake[1,2] & Sonia M. Altizer[1,2]

[1]Odum School of Ecology, University of Georgia

[2]Center for the Ecology of Infectious Diseases, University of Georgia

Like many generalist species, ringtails (*Bassariscus astutus*) use diverse foraging strategies to survive across a wide range of natural and human-modified habitats across North America. Ringtails are the ultimate omnivore, known to eat plants, insects, vertebrates, and human-provided foods such as wrapped candies and littered apple cores. While ringtail diet is expansive, at the population-level, ringtails exhibit distinct dietary phenotypes on the herbivory-carnivory spectrum. Here, we ask how local habitat variables, such as resource availability and the presence of competing species, influence ringtail diet composition. From a review of ringtail diets in the literature (n = 65 studies) we compiled a population-level dataset of more than 600 food items, their taxonomic identity, relative abundance in the diet, study method, sample size, and location. From this dataset, we calculated metrics to assess diet generalism, based on the rank-abundance of each food item, and omnivory, based on the evenness of each consumed phylum, for each ringtail population. Lastly, we used existing global datasets to assess resource availability and competitor diversity for each ringtail population. Owing to correlations among environmental variables, we use Elastic-Net regression to construct a model to predict ringtail diet metrics. This study provides a framework to assess diet composition in a major generalist mesocarnivore and brings new insight into how animals respond to naturally-occurring resources, overlap with people, and competition.

Coral Couch Potatoes: Sex Differences of Symbionts in a Coral Cleaning Mutualism

Alexander Primo[1], Adrian C. Stier[2] & Craig W. Osenberg[1]

[1]Odum School of Ecology, University of Georgia
[2]Department of Ecology, Evolution, and Marine Biology, University of California, Santa Barbara

Hosting multiple mutualist species within a guild can result in additive, synergistic, or antagonistic interactions for the host. However, the interactive effects of conspecific mutualists of different sexes are not well understood. This study used the cleaning mutualism between the branching coral (*Pocillopora*) and coral guard crab (*Trapezia serenei*) as a study system to explore the interactive effects of different symbiont sexes on their host. Corals actively remove sediments from their tissue, and this sediment removal increases when they host guard crabs. These crabs commonly occur in male-female pairs on their host coral and will clean the coral surface in exchange for food and refuge. Using a laboratory experiment, we quantified each of the solo effects and the interactive effect of male and female guard crabs on sediment removal from host tissue. Coral colonies containing one of four crab treatments (zero crabs, solo female, solo male, or male-female pair) were each exposed to a discrete gradient of sedimentation to determine cleaning efficacy. Our results show that female singletons do increase the amount of sediment cleared from a coral, but male singletons do not – meaning corals hosting no crabs removed more sediments than corals hosting only a male. Despite this, male-female pairs removed the most amount of sediment of all treatments indicating a synergistic effect between males and females. This study underscores the importance of considering the number and identity of apparent mutualists and emphasizes that such symbiont variation can yield different outcomes for the host.

Investigating how infection of group members affect collective performance using an agent based modelling approach

Supraja Rajagopal[1], Takao Sasaki[1] & Richard Hall[1]

[1]Odum School of Ecology, University of Georgia

While group living confers benefits like higher efficiency of foraging, brood care and defense against predators, social animals are also susceptible to an increased risk of parasitism. Past research has mainly focused on the effect of pathogen exposure on individual behavior and the

disease transmission within a group. However, it has been little explored how the individual-level effects of pathogens can scale up to affect colony-level performance. We developed an agent-based simulation model to investigate how when disease effects different behaviours of an individual that could affect collective outcomes. We simulated foraging behaviour of an ant colony based on the model organism *Temnothorax rugatulus*, where the presence of disease in an individual could affect different parameters like her walk speed, ability to find food, willingness to leave the nest and forage and willingness to recruit new individuals to the food source. Our simulations allow us to investigate how these different parameters affect the colony's ability to collect food and how important different behaviours are to colony success.

Comparison of Release Techniques on Movement, Behavior, and Survival of Head-started Gopher Frogs (*Rana capito*)

Kiersten Nelson[1,2], Sophia Zaslow[2], Tucker Stonecypher[2], Padraic Robinson[2], Sydney Ward[3] & Stacey Lance[2]

[1]Odum School of Ecology, University of Georgia
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Implementing head-starting programs for the at-risk Gopher Frog (*Rana capito*) throughout the species range is the primary conservation strategy to assist with population augmentation and reintroduction efforts. However, current head-starting efforts for the Gopher Frog consistently report low survival of released juveniles. Population models identify juvenile survival as one of the most important parameters affecting long-term persistence of amphibian populations. Thus, there is a critical need to identify alternative conservation strategies that will increase juvenile survival to improve the likelihood that head-starting programs result in self-sustaining populations. Previous efforts to improve post-release survival focused on reducing post-release dispersal, because frogs that spend more time aboveground have a higher risk of predation. Our research examines the effects of alternative release strategies on post-release performance of juvenile head-started Gopher Frogs. We constructed artificial burrows and conducted a radio-telemetry study to experimentally evaluated the effects of altering the timing of and age at release, as well as the size of the release burrow on juvenile movement, behavior, and survival. Preliminary results have shown that the release time of day, date, and burrow size effect burrow occupancy. Burrow occupancy was increased by releasing frogs in the morning and into a smaller sized burrow. Additionally, we documented site fidelity to a release burrow as multiple radio-tracked frogs return to their same release burrows several days after abandoning them. Our results will provide managers and conservation practitioners with recommendations for release strategies that will improve juvenile survival of head-started Gopher Frogs.

Understanding the role of creek bank slumps as ephemeral refugia

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Refugia is a critical component in predator-prey dynamics. Understanding how prey organisms interact with refugia is necessary to understand what influences their population density. In highly dynamic environments, refugia may not always be accessible throughout an organism's daily life. However, ephemeral structures can be used as a secondary refuge during these vulnerable periods of time. Thus, populations with access to ephemeral structures may experience less predation and greater access to available resources. To understand the mechanisms that control the behaviors of prey organisms and how they interact with ephemeral structures, I propose three experiments focused on slump blocks (detached vegetated pieces of salt marsh creekbank) and three resident prey species: the mummichog *Fundulus heteroclitus*, mud crabs in the genus

Panopeus, and grass shrimp *Palaemontes vulgaris*. To accomplish this proposed work, I will perform an observational field study, a manipulative field experiment, and an aquaria study that manipulates prey density, predator presence, and access to refugia to assess aggregation patterns of the prey species around the ephemeral structure. The goal of this study is to elucidate how slump blocks are used by key prey species and how the utilization could affect predator-prey dynamics.

Understanding the influence of water chemistry on developmental abnormalities in imperiled Gopher Frog (*Rana capito*)

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population-level declines of thousands of species. 'Head-starting' is a conservation technique employed to bolster populations of imperiled amphibians, which involves rearing wild-caught individuals for release to aid juvenile recruitment. In 2021, our head-starting program for the at-risk Gopher Frog (*Rana capito*) at the Savannah River Ecology Laboratory resulted in developmental abnormalities in nearly 100% of captive-reared metamorphs, including severe edema, skin, jaw, skeletal, and eye abnormalities. After ruling out several common causes of abnormalities, we suspected that plant material used to stock head-starting mesocosms facilitated abnormal development. During 2023 head-starting efforts, we obtained experimental evidence that a native wetland grass, maidencane (*Panicum hemitomon*), can be deleterious to the development of larval Gopher Frogs. Nearly 100% of individuals reared in the *P. hemitomon* treatment developed abnormalities, while none were observed in other plant treatments. We hypothesize these abnormalities result from endocrine disruption elicited by environmental retinoids produced from cyanobacteria associated with plant material. Given that carryover effects of atypical development on juvenile fitness are not well understood, we must clarify mechanisms underlying these abnormalities to identify strategies to minimize them. Our central objective is to investigate whether abnormal larvae experienced endocrine disruption indicative of excess retinoid exposure using an RNA-seq approach to generate organ-specific transcriptome profiles for analyzing gene expression. We expect our data to not only inform refinement of Gopher Frog head-starting, but also improve basic understanding for the teratogenic potential of environmental retinoids to amphibians.

Adaptation and osmoregulatory balance associated with chronic copper exposure in Southern toads (*Anaxyrus terrestris*)

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Constructed surface flow treatment wetlands process industrial effluent via contaminant sequestration into the sediment. Constructed wetlands are inhabited by many taxa, however, elevated contaminant exposure can cause lethal and sub-lethal effects. This is especially true for amphibians that develop in constructed wetlands contaminated with heavy metals, like copper (Cu). On the Savannah River Site, the A-01 and H-02 constructed wetlands were built to mitigate Cu in 2000 and 2006, respectively. Southern toad populations (*Anaxyrus terrestris*) in A-01 have developed tolerance to Cu exposure in only 16 years. Previously, the H-02 toad population showed low survivorship in response to Cu, suggesting no local adaptation. The H-02 toad population has now been exposed to Cu for 17 years, and may have had time to adapt. While Cu tolerance mechanisms are unknown, maintaining osmoregulatory balance has been suggested, but not investigated. This study will 1) investigate the adaptive response of toads in Cu

contaminated wetlands and non-contaminated wetlands and 2) investigate osmoregulatory balance as a mechanism of Cu tolerance. I will conduct a laboratory experiment using southern toad clutches from A-01, H-02, and three reference wetlands. I will expose embryos to four Cu treatments until either death or free-swimming larval stage to assess survival. Surviving larvae will continue their respective treatments until either death or metamorphosis, and a subset of larvae will be examined with elemental analysis to assess osmoregulatory competence. Results from this study will inform amphibian resilience to environmental degradation and identify a potential mechanism contributing to local adaptation.

The Interconnected Environmental Dynamics of Lake Atitlán: Land cover change, riparian zones, and perennial river water quality

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Some of the most significant threats to lakes include land cover change, nutrient input, and accelerated eutrophication. Situated in the Guatemalan highlands, Lake Atitlán is an endorheic basin that formed 85,000 ya within a volcano's caldera, and it is known for being the deepest lake in Central America. Over the past few decades, the lake has been subject to heightened anthropogenic pressures, including land conversion. Permanent rivers drain into the lake in the northern part of the basin, but long-term changes in water quality in these rivers have not been examined. My research aims to (i) uncover the historical patterns of land cover change in the basin, with a specific emphasis on the riparian zones, and (ii) analyze the water quality in the rivers, exploring relationships between water quality and changes in land cover, especially in riparian areas. I will integrate remote sensing techniques with long-term environmental data gathered from the river networks in the lake basin. The importance of this research lies in its ability to offer a comprehensive understanding of the Lake Atitlán environment by incorporating changes in land cover, alterations in the riparian zone, and variations in river water quality. Moreover, this research holds significance as the Lake Atitlán basin is home to 400,000 individuals from the Mayan Tz'utujil, Kaqchikel, and Q'eqchi' communities. Therefore, gaining insight into the long-term dynamics of land cover change and the rivers can impact the management strategies for the well-being of the aquatic ecosystem and human populations within the Lake Atitlán basin.

Geomorphic and Ecological Responses of a Small Dam Removal

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Many small dams have outlived their design lifespan and are both potential hazards and barriers to passage for aquatic organisms. However, removal of small dams may have negative short-term impacts due to the release of stored sediments, which can degrade downstream habitat. This study will evaluate the effects of removing a small dam and impoundment on the geomorphology and biota of a small mountain tributary to the Upper Etowah River in Georgia, USA. We will sample biota in the tributary containing the dam and the mainstem of the Etowah River prior to the removal of the dam in order to determine the presence of any imperiled species. We will also measure geomorphologic characteristics in the impoundment, the tributary, and the Etowah River. After the dam is removed in the summer of 2024, we will repeat biotic and geomorphic sampling to assess differences in community composition and abundance of organisms before and after

dam removal, as well as geomorphic changes. This study will be a comprehensive review of hydrology, geomorphology, sedimentation, and biota pre- and post-dam removal, including some biota that are understudied such as crayfish. The results will be useful for informing decisions and methods for future small dam removals in the Etowah River and nearby watersheds.

Coupled Pathogen Dynamics Between Migratory and Resident Host Populations

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Migratory animals, including monarch butterflies, are forming novel resident populations. Residents take advantage of resources and favorable habitats that are newly available year-round due to anthropogenic resource provisioning and climate change. However, they lose the population-level benefits of migration for pathogen control, leading to high pathogen prevalence for some resident populations. I plan to conduct research using monarch butterflies and their specialized parasite, *Ophryocystis elekroschirrha*, as a study system to inform understanding of how resident populations and their pathogens affect the population dynamics of migratory conspecifics.

The first aim of my research is to assess the impact of migrant/resident breeding range overlap during the Spring return migration. I predict that areas in which residents and migrants share milkweed habitat while breeding will support higher infection prevalence relative to areas where only migrants are present. I will use observations from Journey North, a longstanding volunteer science project, to track the spring migration in real time, and select sites and dates during Mar-Jun from which to sample adult monarchs. I will use cardenolide assays and stable isotopic signatures from wings of each adult sampled to assign them as residents vs migrants. I will also assess the infection prevalence in residents and migrants.

The second aim of my research is to develop a mechanistic model, parameterized for the monarch-OE system, to determine the conditions under which resident/migrant host interactions threaten the persistence of migration in the presence of a specialist parasite.

Characterizing soil to leaf drought vulnerability in southern African savannas

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As soil water availability decreases, plants typically respond by limiting the loss of water vapor through their stomata. This mitigates drops in internal pressure through the plant's vascular system that can otherwise lead to xylem cavitation or loss of leaf turgor. Among tree and grass species in African savannas, it is poorly understood how their capacity to transport water changes in situ due to differences in internal pressures. This relationship is commonly called a vulnerability curve, defining the percentage loss of conductivity for a given tissue as the pressure potential decreases. For this study, we set out to construct vulnerability curves for twelve common tree and grass species of southern Africa across the entire root to leaf pathway. Across three field seasons, we measured predawn and midday pressure potentials in mature trees and grasses, pairing these measurements with stomatal conductance to calculate theoretical whole plant conductivities at given pressures. These vulnerability curves were split into two components, the xylem segment and leaf segment. These segments are defined by their respective resistances in the xylem vessels and the mesophyll-atmosphere pathway. We found significantly higher magnitudes of conductivity for both segments within our tree species, owing to their physiology. Grasses showed significantly greater sensitivity to drops in internal pressure as compared to trees

for both xylem and leaf vulnerability curves. Theses empirically derived models of drought vulnerability, highlights a surprisingly conservative strategy from savanna grasses that may explain their ability to dominate in regions with lower water availability.

Production and turnover of ectomycorrhizal fungi in a frequently burned longleaf pine forest

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Prescribed burns are frequently used as a tool for ecosystem management and rehabilitation. However, there are gaps in our knowledge as to how repeated burns affect soil carbon storage, especially with respect to ectomycorrhizal fungi. When ectomycorrhizal (ECM) fungi take up carbon from their associated plants, it is distributed through the rhizosphere via the production of extramatrical mycelium. To assess the effect of frequent fire on hyphal biomass, we will measure the production and turnover of mycelia in soils with a four year fire return interval in a longleaf pine savanna ecosystem, as well as unburned soils in the same system. To quantify turnover and production of ECM fungi, we will deploy hyphal ingrowth bags at four distinct depth increments in timed intervals and, following incubation, quantify fungal biomass in the bags via ergosterol extraction. This study will provide insights into the role ECM fungi play in nutrient cycling in the face of frequent fire and contribute to our ability to manage and conserve fire-adapted ecosystems.

Spatial occurrence and infection rates of *Rhodnius pallescens* in response to deforestation and land reversion.

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In tropical countries, Royal palms (*Attalea butyracea*) constitute the most important element in the common arrangement defining the ecological niche of *Rhodnius* species. Landscape disturbances modulate the presence of palm-dwelling bugs and palm infestation, serving as indicators of transmission risk in rural areas. In this study, we assessed the impact of land use changes and palm characteristics on the occurrence, abundance, and infection state of *Rhodnius pallescens*, the primary vector of Chagas Disease in Panama, across a landscape gradient. Bugs were collected from 46 Royal palms located in 12 communities across different habitat types, including secondary forest, grassland, and successional forest. Genomic DNA was extracted from whole bodies, and real-time PCR (RT-PCR) assays were performed using probes targeting the 28S ribosomal RNA (rRNA) genes of *Trypanosoma* parasites. We developed occupancy models using 10 m resolution land cover data at 100 and 300 buffers, as well as specific palm traits. To address potential spatial autocorrelation, we ran spatial occupancy model versions of the top-performing models and compared the outputs. We tested infection in populations of *R. pallescens* (N=82) in central Panama and found prevalence to be over 70%. We confirmed that elevation, amount of infructescence, and successional forest cover are important habitat features for *R. pallescens*. Our models with quadratic effects outperformed those with linear effects for landscape metrics, indicating that predicted occupancy peaks at optimal amounts of these cover types and palm features. Our findings suggest that, in rural areas of Panama, anthropogenic landscape alterations, mainly forest regeneration, are associated with higher probabilities of palm infestation by Chagas disease vectors and with higher vector population densities.

Documenting the geography and host range of neogregarine parasites in milkweed butterflies using museum specimens

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The debilitating protozoan parasite *Ophryocystis elektroscirrha* (OE, Neogregarinorida: Ophryocystidae) was described as a parasite of monarchs (*Danaus plexippus*) and queens (*D. gilippus*) in 1970. Parasites similar in morphology and life cycles (*Ophryocystis* sp. or "OE-like") were recently documented in other *Danus* species. However, the wider host range and geographical distribution of *Ophryocystis* infection in milkweed butterflies (Lepidoptera: Nymphalidae: Danainae) has not been examined. We used museum collections to advance the host range and geographic distribution of the milkweed butterfly-OE/OE-like parasites global associations. We sampled and collected data from 2,726 museum specimens from 85 countries to describe the distribution of parasites. Specimens represent 10 out of the 12 described genera of milkweed butterflies and at least 57 out of 160 species of milkweed butterflies described to date. Our results indicate that infection is restricted to *Danaus* butterflies, but it spans the five continents of this group's distribution. Oocysts from different hosts differed in size and may represent different parasite lineages or species. Parasite percent positivity in the six identified hosts was 12% in lesser wanderers (*D. petilia*), 10% in monarchs, 9% in plain tigers (*D. chrysippus*), 3% in queens, and 2% in Jamaican monarchs (*D. chleophile*). Because OE in monarchs are known to cause negative fitness that impacts their size, longevity, and mating probabilities, among others, infection in other susceptible milkweed butterflies may also have impacts at the individual and population levels. This work establishes baseline infection data for a group of insect pollinators as a model system to study macroecological patterns of host-parasite associations.

Effects of phylogeny, range overlap, and ecological traits on parasite sharing in birds

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1. Disentangling what factors promote parasite transmission between different host species holds significant importance within disease ecology. Previous studies have indicated that parasite sharing is mainly influenced by host phylogenetic relationships and range overlap. Nonetheless, these research projects have been mainly carried out in mammals, other animal groups such as birds have been understudied and their biological traits make them suitable vectors of parasites and zoonotic diseases.
2. In our study, we used the Global Bird Parasite Database to unravel the determinants of parasite sharing across host species. This is the first study using this promising disease database which includes more than 11,000 host-parasite interactions formed by 506 and 2,677 bird and parasite species, respectively.
3. For this, we ran two GLM models for all the parasites together and for each parasite group individually (arthropoda, bacteria, helminth, protozoa and virus).
4. The results of this paper showed that range overlap, diet, foraging stratum and phylogenetic distance are significant factors promoting parasite sharing in birds. We also found that phylogenetic distance and range overlap are significant in all the parasite groups.

Patterns in parasite species richness across host pace-of-life

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It has been notoriously difficult to understand the determinants of parasite diversity across host taxa. Traditional patterns used for understanding host diversity, such as latitudinal diversity gradients, have not been as reliable for understanding parasite diversity. However, incorporating a wider breadth of host data, such as host life history traits and traits related to host ecology, in addition to geographical traits, may yield more informative results.

We used GMPD, the Global Mammal Parasite Database, a host-parasite association database to estimate parasite species richness. Life history characteristics were gathered from existing host trait databases such as PanTHERIA which includes data on host life history, ecology, and geography. Using these data, we used Boosted Regression Trees to predict parasite species richness according to host traits. The results of this analysis allowed for detection of patterns between host traits and parasite species richness in total and across parasite types.

Preliminary results show that certain host traits related to host life history, ecology, and geography are all important for predicting parasite species richness. When broken down according to parasite type, we see consistency among some host traits as well as variation in the relative importance of these predictors. These results emphasize the need to consider the multiplicity of factors that determine parasite diversity.

Host introgression and environment predict parasite prevalence and abundance in two hybridizing Appalachian salamanders

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Plethodon shermani and *Plethodon teyahalee*, lungless salamanders found in the southern Appalachians, occupy dynamic elevational distributions and hybridize where their distributions overlap at intermediate elevations. Studies have investigated the environmental and competitive drivers of the distribution of hybrid zones between these taxa, but quantification of the roles of parasites in shaping the extent of hybrid zones and competitive interactions between *P. shermani* and *P. teyahalee* is needed. Salamanders from the Georgia Museum of Natural History herpetology collection with localities from within the Coweeta basin were selected based on their identity as *P. shermani*, *P. teyahalee*, or hybrids. Individuals were dissected under a dissecting microscope and were visually surveyed for endoparasites to determine if the parasite communities found across salamander genetic identities and climate gradients differ in parasite richness, infection prevalence, and host specificity of individual parasite species. Our results reveal trends of host specificity as well as aggregation of parasite richness and infection intensity of gastrointestinal helminths found in salamanders of both species and hybrids. Salamanders with genetic identities more closely aligned with *P. shermani* as well as those of hybrid ancestry contained richer parasite communities and greater infection intensity and prevalence of some helminth taxa when compared to *P. teyahalee*. These results further our understanding of the roles that parasites play in their communities as mediators of species range boundaries as well as highlight the utility of museum natural history collections for studying host-parasite interactions.

Does epigenetic aging underlie trade-offs between development rate and aging rate?

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Across vertebrate taxa, the rate of development is fundamentally linked to subsequent rates of aging - slower development is associated with slower aging and vice versa. This trend has been observed between species, populations, and individuals. Despite the apparent universality of this relationship, the underlying biological mechanisms that connect development and aging are unresolved. We hypothesize epigenetic aging serves as a molecular bridge connecting developmental rate to aging rate on individual, population, and species levels. Using newly developed epigenetic clocks for medaka fish, we aim to investigate the effect of individual developmental rates on epigenetic age and other life-history traits. We induced disparate developmental rates in medaka (*Oryzias latipes*) embryos using three temperature treatments: 31.0C, 25.0C, and 18.5C. Individual embryo stages were tracked daily until hatch. Hatched fry were kept individually housed at room temperature, measured monthly, and checked weekly for markers of sexual maturity until sacrifice at approx. 5 months post-hatch. Here we report the effects of temperature treatments on rates of development, and also identify a significant relationship between days-to-hatch (developmental rate) and age at maturity in females. Hepatic DNA was isolated from the tissue and DNA methylation patterns are currently being resolved for each individual. Future work will assess measures of epigenetic aging to test the hypothesis that faster developing individuals will demonstrate higher epigenetic age than expected for their chronological age.

Testing the influence of natural nest thermal environments on alligator hatchling traits and survival

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Incubation temperature is a major determinant of hatchling traits in reptiles, including sex in many species. In American alligators (*Alligator mississippiensis*), which utilize temperature-dependent sex determination (TSD), incubation temperature influences hatchling sex, morphology, and behavior. Additionally, recent work from our lab has shown that hatchling survival during the first year of life is strongly temperature dependent: animals incubated at intermediate, male-promoting temperatures display enhanced survival in the field relative to those incubated at high and low female-promoting temperatures, supporting the Survival to Maturity hypothesis for the adaptive value of TSD. However, most of the work examining the influence of incubation temperature has utilized constant temperatures in the lab. Few studies have attempted to incorporate the thermal complexity observed in natural nests, where temperatures fluctuate within and across days, weeks and months. Thus, the extent to which constant temperature experiments represent natural incubation conditions is mostly unknown, yet critical for understanding the role incubation temperature plays in driving phenotypic variation and sex in nature and its implications for the evolution of TSD. In the present study, using a cross-clutch fostering design to limit confounding maternal effects, we incubate alligator eggs in natural nests, collecting eggs just prior to hatch. Upon hatching, we measure several phenotypic traits, mark and release individuals, and subsequently conduct regular recapture efforts to assess survivorship. Using data collected from temperature loggers placed within nests during incubation, we investigate the relationship between natural nest temperatures and hatchling phenotypes and survival, comparing results to those reported under constant, laboratory incubations.

Experimental soil warming suggests a potential for shifts in future southeastern forest community compositions

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Trees and vines make up the backbone of forests around the world and exhibit different nutrient allocation strategies, evident by their distinct growth habits. Thus, the two groups will inevitably demonstrate different responses to environmental stimuli, such as soil warming. Recent studies have suggested that, in a warmer climate, vines may grow proportionally more rapidly than trees, resulting in a greater level of vine-induced disturbance via tree and branch collapse, as well as a potential shift in the proportional abundance of these growth forms in forest communities. My experiment took place at the Whitehall Forest Soil Warming Facility (WFWF), where we used four levels of soil warming treatments, heated via underground cables. The soil warming chambers were evenly divided between the understory of a late succession forest and the forest's edge, where the canopy was open at the beginning of the experiment and has grown up over the ~13yr duration of the experiment. To determine how trees and vines differ in their responses to soil warming, I measured several leaf size traits, as well as plant size, of four focal native tree and vine species at WFWF. Results indicate some level of species-specific responses, but overall inverse responses of leaf traits to temperature and light availability between trees and vines, the vines typically exhibiting proportionally larger leaves than trees in warmed treatments. This is consistent with similar experiments and may indicate the potential for a shift in forest community composition in areas with increased temperatures due to global change.

Plant parasitism in alpine communities

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Root hemiparasitic plants are found in almost every ecosystem and can profoundly affect surrounding plants in the community. These organisms use unique belowground structures to attach to host plants and extract nutrients and water but maintain the ability to photosynthesize independently. Yet, they remain significantly understudied outside of agricultural environments and thus are often omitted from our understanding of plant population, community, and ecosystem ecology. This is surprising as they have been shown to increase plant community diversity through the direct effect of parasitism on aboveground plant competition, increase litter decomposition, and alter microbial community composition through the belowground effects of increased litter lability and mycorrhizal suppression. My work aims to provide a complete perspective of plant parasitism by investigating the above and belowground impacts of hemiparasitic plants on community structure, nutrient cycling, and biodiversity. In this talk I will discuss our recent observational findings from an ongoing research project at the Rocky Mountain Biological Laboratory.

Thermal fluctuations increase disease transmission of a fungal parasite in a zooplankton host at the individual and population scale

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Thermally fluctuating environments are ubiquitous, and most organisms exhibit many nonlinear responses to temperature. Under these conditions, theory predicts that biological processes, rates, and interactions will all differ compared to those at constant temperatures. Though previous studies have quantified the impacts of thermal fluctuations on organismal level processes, few have considered how different magnitudes of fluctuations alter species interactions or biological processes across scales. We used a *Daphnia* host and fungal parasite system to 1) quantify how three different magnitudes of fluctuating temperatures affected traits of host and parasites at the organismal scale, 2) evaluate whether thermal performance curves generated from a gradient of constant temperatures predicted these responses, and 3) test whether effects of temperature fluctuation at the organismal scale predicted effects of temperature fluctuations at the population scale.

We found that all traits at the organismal level (host birth rate, transmission rate, and spore yield) were elevated under fluctuating temperatures compared to the constant mean temperature, and were qualitatively consistent with theoretical predictions. However, the traits peaked at different magnitudes of fluctuation. Host fitness and spore yield were greatest at moderate magnitudes of temperature fluctuation, whereas transmission rate was highest at the largest magnitude of fluctuation. At the population level, we observed greater mean prevalence of infection under fluctuating temperatures than at a constant mean temperature, but did not observe significantly greater numbers of infected hosts over the course of the epidemics.

Environmental, ecological, and sociodemographic factors associated with emerging fungal pathogens

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Emerging fungal pathogens pose a serious threat to biodiversity, ecosystem function, and human health worldwide. Over 1.5 million people die from fungal diseases annually; however, the ecology of fungal pathogen emergence has been neglected in research relative to bacteria and viruses. Many of the most concerning pathogenic fungi are environmentally ubiquitous; some are opportunistic, while some are carefully adapted to life inside a warm-blooded host. With increasing disease incidence and little known about the underlying ecology and drivers of infection, there is clear need to unravel the factors at play in the fungi themselves, in the environment, and in the human and animal populations affected. The aim of this work was to identify common risk factors associated with emerging fungal pathogens for application in future modeling efforts. To accomplish this, I conducted a review of the variables associated with 21 emerging fungal pathogens in published literature. I sorted pathogens into types based on their functional traits and transmission strategies and quantified their risk factors for comparison. This information can be used to construct spillover risk profiles, which will be essential to future quantitative efforts to predict disease emergence.

Avian Conservation and Ecology in Rice Fields in Madagascar

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Madagascar is a biodiversity hotspot, with high endemism and high levels of threat from multiple anthropogenic pressures, driving rapid species declines. In the country's central highlands, the Lake Alaotra wetland complex provides critical habitat for diverse waterbird species, but is also important for food security as a major rice-growing region. The destruction of natural wetland habitats has driven extinctions of endemic species as recently as 2010, and new waterbird conservation management plans are needed before other species are also lost forever. Ecologically informed management of rice fields as artificial wetlands can deliver win-wins for both wildlife and rural agrarian communities. Understanding the drivers of rice field habitat quality for waterbirds helps determine the conservation value of different agricultural management techniques. My research question is: what are the primary drivers of habitat quality of rice fields to different avian foraging groups in Madagascar? My project aims to support sustainable development in Madagascar, where environmental and socioeconomic conditions are dire. More broadly, it will contribute to community-based biodiversity conservation frameworks relevant for the ubiquitous rice landscapes across similar developing contexts, especially those in the understudied Global South.

Stormwater Management Around the World: A Systematic Literature Review of Stormwater Policies and Modeling Stormwater Utility Fees

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Every city and jurisdiction needs to manage stormwater to prevent cities and developments from becoming inundated with floods. Yet how municipal and regional governments use policy to manage their stormwater systems can vary dramatically around the world. These policies each have documentation and often published works associated with them, but a systematic review of the many stormwater management policies practiced around the world has yet to be attempted. This article analyzes hundreds of documents related to municipal and jurisdictional stormwater policy to measure the outcomes of different stormwater policies. One policy in particular, the Stormwater Utility Fee (SUF), is then modeled to see how different fee structures can have different outcomes for the populace of the city in which the Stormwater Utility Fee is charged.

Predicting Thermal Performance of *Littoraria irrorata* in Salt Marshes

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Anthropogenic climate change threatens ecosystems by increasing mean temperatures and its variability. Additionally, there is variation in temperatures that arise diurnally, seasonally, and at various spatial scales. For example, with a single salt marsh, temperatures at a given site can vary 20-50^{o}C over a single day and 25-35^{o}C among microsites. The performance of organisms varies with temperatures and can be described with a nonlinear function known as the Thermal Performance Curve (TPC). Because of the spatial and temporal variability in temperatures, it's possible that the performance of organisms will be far different than expected given the mean temperature: e.g., short bouts of exposure to extreme temperatures can have devastating effects and non-linear averaging can lead to further deviations from expectations based on the mean. I

will combine monitoring of environmentally relevant temperatures (with biomimics) with an experiment to better understand the performance of salt marsh snails (*Littoraria irrorata)* under variable temperature regimes. Temperature data loggers have been deployed since February 2023 in 6 different marsh microhabitats to repeatedly collect temperature data every thirty minutes. These data will allow me to document natural spatiotemporal variation in temperatures potentially experienced by snails. I conduct a manipulative lab experiment to determine lethal temperature exposures and how long snails can stay exposed to those temperatures before death or recovery.

Investigating the Impact of Environmental Conditions on Metal-Microbe Dynamics in Wetlands

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Wetlands are crucial aquatic ecosystems commonly characterized by the presence of water either seasonally or permanently, where a variety of water-tolerant flora and fauna species inhabit. Wetlands are susceptible to metal contamination which can result in the degradation of the wetland habitat and wildlife metal poisoning. One important role of wetlands is their ability to harbor microbial communities that actively engage in vital interactions with metal contaminants, influencing their fate within the ecosystem. Uncertainties persist regarding the basic microbial controls through which these metals become bioavailable to the wetland ecosystems. Understanding these controls can help conserve, restore, and manage the ecosystem. Nutrient limitations and light are well known to impact microbial processes and shift microbial community composition. Here we pose the question: How do these environmental conditions affect the capability of microbial communities to alter the fate of metals in wetlands? We propose to establish gradients of macronutrient and metal (copper and zinc) concentrations in a microcosm-based study to evaluate this question. We hypothesize that both macronutrient ratios and light exposure will shift microbial community taxonomic and functional composition, indirectly influencing the predominant reactions with metal within the environment. This research will take a significant step towards understanding how to mitigate the detrimental impacts of metal contamination on wetland ecosystems, preserving their ecological integrity for the benefit of both wildlife and the broader environment.

Do changes in nutrient input affect seasonal infections of microsporidians in midges?

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Parasites can have important ecological consequences in aquatic ecosystems. For example, parasites reduce host fitness, potentially causing trophic cascades when hosts are key consumers. Since parasites can respond quickly to abiotic changes in their environment, we must understand their roles in food webs to predict how ecosystems will respond to climate change. Data collected from seven shallow ponds in Georgia identified virulent microsporidian parasites that consistently infect *Daphnia*, key aquatic grazers, in springtime. These outbreaks vary in severity from pond to pond but reasons remain unclear. We hypothesize that one reason could be variation in nutrients, allowing some environments to support more *Daphnia* and chironomids – putative reservoir hosts. We established a pilot mesocosm experiment to test this hypothesis and complement our ongoing field survey. The experiment manipulates trophic states (mesotrophic or eutrophic; 2 replicates each) in 500-gallon mesocosms at Horseshoe Bend. Mesocosms were inoculated in November with phytoplankton and microbes from local ponds. We will add

uninfected zooplankton cultured in the lab. We expect chironomids will colonize the mesocosms on their own and bring parasites with them. Midge emergence traps will be deployed in each mesocosm to collect insects that have established. Mesocosms will be sampled weekly from February - April, collecting all the same responses as in the field survey (zooplankton, YSI data, and insect emergence). We hypothesize that eutrophic mesocosms will support higher densities of *Daphnia* and chironomids and higher infection prevalence of microsporidians in both populations.

Poster Abstracts

Susceptibility of polychaete species to Lepocreadium setiferoides metacercarial infection in a Georgia salt marsh

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The estuarine trematode *Lepocreadium setiferoides* requires several hosts for the completion of its complex life cycle, the first of which is the eastern mud snail (*Ilyanassa obsoleta*). The identities of *L. setiferoides's* second intermediate hosts are less understood, and an exhaustive list of susceptible host species for the trematode does not exist. Here we investigated the possible identities of additional polychaete intermediate hosts for *L. setiferoides* through a three-part study of prevalence and infection susceptibility on a barrier island off the coast of Georgia, USA. We also refined methodologies for polychaete metacercarial cyst identification and cercarial exposure procedures. Ultimately, the natural prevalence of *L. setiferoides* metacercarial cysts in populations of the polychaete species *Neanthes succinea* exceeded the exceptionally low infection prevalence in populations of *I. obsoleta* at the same locations. In the study's experimental portion, a positive relationship between polychaete length and cyst presence was identified for unexposed polychaetes, although not for exposed polychaetes, suggesting that the relationship between size and infection does not rely upon age and thus time of exposure, but rather on factors such as increased surface area for encystment.

Modeling the Interactive Effects of Backyard Bird Feeding, Predation, and Infection in Wild Bird Populations

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Backyard bird feeding is a globally popular activity, but direct nutritional benefits of bird-feeding could be offset by increased risk of predation or disease outbreaks. Food subsidy effects on predation and infection are typically studied in isolation, but their interactions could have synergistic or antagonistic effects on bird mortality at feeders. Given pervasive declines in bird populations, it is crucial to understand the net effects of feeding that account for both the direct effects of supplemental food and the indirect effects of altered species interactions. We developed a mathematical model to simulate bird-pathogen interactions at bird feeders in the presence of predators, motivated by the House Finch-mycoplasmal conjunctivitis system, where food subsidy can alter host fitness, pathogen transmission, and predation risk. We found that predators are most likely to prevent outbreaks when food subsidies decrease feeder bird susceptibility to infection or when infected birds are preferentially predated, and are least likely to prevent outbreaks when subsidies increase bird abundance at feeders. Highly transmissible, but low virulence, pathogens saw the greatest increase in overall bird mortality at feeders when infected birds were selectively predated. However, less transmissible, but high virulence, pathogens saw a decrease in overall bird mortality at feeders when infected birds were selectively predated. These findings highlight the importance of understanding community interactions around anthropogenic food subsidies, and could inform guidelines for the management of feeders in the presence of predators and pathogens.

Mammalian parasite-sharing in marine and terrestrial environments

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While knowledge of factors governing inter-species parasite sharing has improved in recent years, parasite sharing between animals in marine versus terrestrial environments is less understood. Many animal pairs that span the two environments are more related than pairs that co-occur in the same environment, possibly promoting transboundary parasite sharing. Conversely, ecological opportunity for sharing parasites, differences in animal behaviors and population densities on land and in the sea, and contrasting environmental conditions may limit parasites' ability to thrive in differing environments. To characterize boundaries and bridges regulating parasite sharing between terrestrial and marine environments, we compiled known host-parasite associations from three sources: the Global Mammal Parasite Database, a published complex life-cycle database, and supplemental marine mammal data compiled for this study. Frequency comparisons of parasite type by environment showed clear differences, with bacteria and helminths dominating the set of parasites exclusively infecting marine mammals, while parasites exclusively infecting terrestrial mammals show a more even spread across parasite types. When accounting for relatedness of host species, parasite communities show phylogenetic distance decay profiles. For the most closely related pairs of hosts, those sharing a terrestrial environment have the most similar parasite communities, followed by hosts sharing a marine environment, and hosts with no shared environment have the least similar communities. Terrestrial hosts show the sharpest decay, while marine hosts show more gradual decay. Among hosts with no shared environment, parasite community similarity remains relatively constant across phylogenetic distance, suggesting that the ability to infect across environments is a property of parasites rather than hosts.

Genetic characterization and haplotype analysis of *Ostertagia mossi* in white-tailed deer (*Odocoileus virginianus*) and dikmansi at the COI mtDNA and ITS-2 rDNA gene targets

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Abomasal nematodes commonly infect domestic and wild ruminants across North America, and there is emerging evidence that domestic and wild ruminants can cycle abomasal nematodes and anthelmintic resistance between each other (Hoberg et. al 1993, 2021). One genus that commonly infects domestic and wild ruminants, *Ostertagia*, contains several pairings of "major" and "minor" morphotypes that comprise polyphyletic species, but this designation is based primarily on morphological data. Molecular characterization of these polyphyletic species is poor. To examine the validity of the current taxonomic designation for *O. mossi* and dikmansi, one such polyphyletic pairing, I collected DNA sequences of both morphotypes at the COI and ITS-2 gene targets for haplotype analysis. I collected 17 total sequences, 5 of *O. dikmansi* and 12 of *O. dikmansi*, and sequences are ready for analysis in the coming semester. These samples will undergo haplotype analysis via the randomized minimum-spanning tree (RMST) method to examine whether the base pair distance between haplotypes of each morphotype are consistent with the polyphyletic species hypothesis.

Abiotic effects on pollinator visitaiton to Sphagneticola trilobata in Monteverde, Costa Rica

Reina Scott[1] & Amanda Rugenski[1]

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Pollination rides on the precarious balance of multiple organisms' phenology. An intensification in global abiotic changes such as weather phenomenon, temperature, humidity, and sunlight are likely to affect pollinators and pollination alike until the two are out of synch. It is imperative that we understand how a

change in abiotic factors will affect the behavior and visitation rates of pollinators. This study investigates the abiotic effects (weather, humidity, lux, temperature, and wind speed) on pollinator visitation to the flower *Sphagneticola trilobata* on the CIEE Monteverde campus in San Luis, Costa Rica. Observations were made once a day across 12 bushes, each bush had a high site and a low site (at least 0.6m apart) relative to the general height of the plant off the ground. Various sites were destroyed or deemed unsuitable (due to lack of flowers) and at the end of the observation 14 sites remained among 10 bushes. Height of observation sites were recorded once at the beginning of the investigation and all other abiotic factors were measured at the beginning of every observation period. The general hypothesis was that flowers in higher amounts of sunlight would receive more visitation from pollinators thus there would be a positive correlation between pollinator visitation and lux. This correlation would also be reflected in the height of plants as taller flowers would be able to outcompete others for sunlight.

Studying the Abilities of Tress and Grasses to Exploit Deep Water

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My poster will focus on an experiment in which I am studying the abilities of South African trees and grasses to exploit deep water. I have already begun working alongside Dr.Holdo to construct an experiment that measures the varying root strategies of two tree species (*Scelerocarya birrea* and *Colophospermum mopane*), and two grass species (*Perotis patens* and *Erogrostis superba*). At the UGA Botany Greenhouses, I have sixty PVC tubes containing a randomization of the different species at different depths. By watering the plants at different depths, I will be able to see to what extent the trees and grasses can utilize their roots to access water. Based on my knowledge of the subject thus far, I hypothesize that alterations in shallow vs. deep water will have much more significant effects on grass species than tree species. Thus, I predict that grass species will absorb more water than trees in the upper soil layer due to their inability to extend deeper roots. Moving forward with this experiment, I plan to optimize the growing conditions for the plants by fertilizing, creating a timed watering system, and arranging the grow lights. Given all this information, my poster will be a combination of what I have done thus far and what I plan to do with the rest of the experiment.

Leaf Decomposition and Algal Colonization Rates in Ephemeral and Perennial Neotropical Streams

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Neotropical streams are under-studied compared to their temperate counterparts, especially in the context of quantifying the effects of flow dynamics on ecosystem processes. I studied leaf decomposition and algal colonization in two neotropical streams with different flow dynamics. One perennial stream (Alondra), and one ephemeral stream (Bruja) which only had flowing water during high intensity precipitation events. To quantify the leaf decomposition rates (k) , I placed 5 g leaf packs of Inga punctata in four locations through each stream and recorded the remaining leaf mass at 5, 15, and 19 days. I also quantified leaf respiration rates on day 19 leaves. To quantify algal colonization I set ceramic tiles in Alondra and Bruja and measured chlorophyll-a biomass for the duration of the study. I also collected chlorophyll-a biomass on natural substrates in Alondra.I hypothesized that Bruja would have a lower rate of decomposition due little or no water flow and that Alondra will have higher rates of algal colonization due to the constant flow of water. We found higher decomposition rates and colonization rates in Alondra. Due to 2023 being an El niño year, there were lower rates of precipitation, and therefore Bruja had significantly fewer days with water. Understanding the long-term impacts of these disturbances is important, as their frequency and intensity are expected to increase with climate change.

Survey of herpetofauna among stream, road, and forest habitat types in a tropical premontane wet forest in Costa Rica

Catherine Hanks[1] & Amanda Rugenski[1,2]

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Amphibian populations in Central America have experienced rapid declines, making it essential to monitor and survey herpetofauna populations. Various environmental factors like edge effects, canopy cover, humidity, and temperature can influence herpetofauna abundance and diversity. Throughout this study, I surveyed the herpetofauna on and near the CIEE campus, located in a premontane tropical wet forest in Costa Rica. I conducted visual transect surveys on road, stream, and forest habitat types. I also recorded environmental data such as canopy cover, humidity, soil moisture and pH, leaf litter depth, and temperature. I observed a total of 103 individuals from 8 families and 14 species. There were notable differences in species composition among the three habitat types. Contrary to my hypothesis, the road had the highest diversity, although the richness and evenness values were relatively similar across all habitat types. Comparing this year's survey to previous years, I found fewer species than the 2005 survey but more than both the 2021 and 2022 surveys. In the future, I recommend continuing surveys of this area to establish a long-term data set. Monitoring any fluctuations in herpetofauna populations is especially important to predict how species may shift with climate change.

Early Warning Systems for Invasive Species

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The Lotka-Volterra (LV) competition equations are a heavily studied and well known method for conducting analysis of two species interactions. By introducing stochasticity to these models and creating parameter sets that describe invasive species populations, we may be able to determine statistical early warning systems (EWSs) for invaders. The model used deviates from the usual LV competition equations by adding an extra term to account for immigration of invasive individuals. By changing the ratio of the endemic and invasive interspecific competition factor to advance it towards a bifurcation point, we are able to simulate an invader becoming a better competitor over time, whether it be via evolution, introducing pathogens, or changing environmental conditions. The calculation of statistics from generated time-series data allows us to determine which statistics serve as the best EWSs by utilizing receiver operator characteristic (ROC) curves. After deciding which statistics prove the most useful and what their respective threshold should be, these results can be communicated to managers. Techniques used are based upon those used in disease forecasting. This project aims to test whether these techniques can be extended to invasive species, as an increase in invader abundance appears similar to an outbreak of a pathogen.

The influence of edge effect and herbivory on tropical terrestrial fern diversity and leaf traits

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Tropical terrestrial ferns are understudied compared to angiosperms and epiphytes, especially regarding herbivory defense and edge effect response. Exposure to harsh edge conditions may impact fern diversity and leaf characteristics like trichome density, leaf size, and water content. Herbivory damage may also influence leaf characteristics, yet the possible relationship between these two stressors has not been investigated. In our study, we investigated how abiotic factors (temperature, soil moisture, wind speed, relative humidity, canopy cover) varied between exposed road edge and forested trail edge sites. We also

investigated differences in fern diversity and community composition, leaf traits, and herbivory between the habitat types. We found that percent fern cover and percent fern leaves with herbivory was similar between sites, but that percent plant cover, number of fern leaves, and number of fern ecomorphs was significantly higher in road sites. Canopy cover and soil moisture were significantly higher in trail sites, and canopy cover was negatively correlated with adaxial trichome density. Water content and per leaf herbivory were relatively similar between habitat types, however we found a strong negative correlation between water content and per leaf herbivory. Trichome density did not vary significantly between damaged and undamaged leaves, but water content was significantly higher in undamaged leaves. Our study suggests habitat factors may influence leaf traits to a greater extent than herbivory and that nuanced differences exist among different edge-impacted habitats. Future investigations should seek to better understand taxa-specific leaf traits and herbivore-fern relationships in the tropics, especially individual-level herbivory-induced plastic responses.

Differences in Syrphid (Syrphidae) Communities Across the Interior and the Edge of Forests

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Hover Flies (Syrphidae, hereafter referred to as syrphids) are increasingly being identified as an important source of pollination services. Therefore, there is an increasing need to understand what governs their population dynamics. This family is of particular interest because of their diversity of larval feeding strategies. This includes the predation of ants, aphids, and feeding on decaying organic matter, each with their own environmental requirements and unique behaviors. This study will identify patterns of syrphid community composition, including diversity, richness, and abundance according to, principally, the location of communities occurring either in the interior or edge of a forest. Other environmental variables that have been collected will be evaluated as well, including the abundance of downed wood, canopy cover, the presence of invasives, and leaf litter depth. Samples were collected from colored pan-traps, either blue, white, or yellow, and blue vane traps as is consistent with other pollinator studies which accounts for variation among trap types. The samples were brought to the lab to be stored in ethanol, and syrphids were separated from the bycatch by hand. In the future, the syrphids will be identified and sorted by feeding strategy. I hypothesize that both the community composition metrics and the proportion of each feeding strategy in the community will change according to its location and the variables comprising it. In this presentation I will summarize relevant background information on syrphids, the methodology of this study, and what I expect to see both in terms of results and future implications.

Individual and social learning of tandem running routes in *Temnothorax rugatulus*

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Collective behavior is defined as how simple local interactions among group members can lead to complex collective outcomes. For this project, we investigate questions on collective behavior using the rock ant, *Temnothorax rugatulus*, as our model. These ants, living in large groups, collectively perform tasks such as foraging and house hunting through a recruitment behavior known as tandem running. This process involves an ant leading a naïve nestmate to a destination, spreading novel route information within the colony. Our study investigates if ants enhance foraging routes by transferring information through chains of tandem runs (e.g., Ant A leads Ant B, and Ant B leads Ant C, and so on). Oftentimes, a few ants lead repeated tandem runs, so the majority of tandem runs are done by only a couple of ants. To encourage these 'chains' in the experiment, we remove the leaders after a successful foraging bout Tracking tandem run chains reveals whether ants improve foraging routes, assessing efficiency as information is transferred. Subsequently, we will complete video analysis using UMA Tracker to calculate route efficiency (route distance) over "generations" in a chain, allowing us to test if ants improve their routes over increasing

generations. Preliminary findings support this hypothesis. This research aligns with observations of group learning and improvement in various species, including humans, primates, and pigeons. Our findings suggest similar behaviors in *Temnothorax rugatulus*, indicating potential social information sharing and improvement within insect groups. This phenomenon emphasizes the significance of group dynamics in knowledge acquisition and application.

How does the bluestreak cleaner wrasse (*Labroides dimidiatus*) affect the feeding behaviors of the striated surgeonfish (*Ctenochaetus striatus*)?

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The bluestreak cleaner wrasse (*Labroides dimidiatus*) participates in cleaning mutualisms, where they remove dead skin and parasites from other fish. The goal of our study is to evaluate potential differences in individual foraging behavior associated with cleaning mutualisms. Specifically, we quantified the overall foraging rates and feeding preferences of striated surgeonfish (*Ctenochaetus striatus*), a common client of the bluestreak cleaner wrasse. This study is a novel one since few studies have looked at trait-mediated effects stemming from mutualisms. Here we show that there are limited tradeoffs in foraging behavior associated with cleaning in *C. striatus*. We found that Bare substrate (dead coral often having detritus on its surface) was the preferred feeding substrate, as opposed to Macroalgae or Stegastes turf algae, according to Ivlev's foraging ratio. A MANOVA test showed that foraging ratios for each type were not significantly different. Furthermore, we found that foraging rates between reefs with and without cleaners were not significantly different (T=-0.39, P=0.70). Our results demonstrate that cleaning mutualisms do not significantly deter C. striatus from foraging. Overall, we observed relatively few cleaning interactions between *C. striatus* and *L. Dimidiatus* and those that did occur were often negative, being characterized by high levels of cheating and chasing. Changes in foraging behavior could drive benthic community patterns, possibly altering coral and algae dynamics. We anticipate that our research could be helpful in achieving a better understanding of the mechanisms by which cleaners influence fish communities and various ecosystem processes.

The Effect of Canopy Cover on Abiotic and Biotic Factors of Tank-Bromeliad Ecosystems in Monteverde, Costa Rica

Amelia Shugart[1] & Amanda Rugenski[1]

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Tank-bromeliads have been extensively studied as model ecosystems to study ecological relationships. Their capacity to hold water and detrital material allows for the colonization of bacteria, arthropods, protozoa, fungi, microalgae, and amphibians. Our study aims to examine the relationships between water volume, detrital dry mass, chlorophyll- α biomass, canopy cover, and arthropod communities in bromeliads located in closed and open canopy habitats over a 6-year period. We found positive correlations between bromeliad tank water volume and total arthropod abundance, bromeliad tank water volume and mosquito abundance, as well as between detrital dry mass and arthropod abundance. We found that families in the order Diptera were the most abundant in both open and closed canopy cover sites. Under the order Diptera, Cuculidae were the most abundant in closed canopy cover while Chironomidae were abundant in both open and closed canopy sites. Studying these relationships allows us to better understand and predict how resilient these communities are in the face of extreme climatic conditions.

A Species Distribution model to Predict MERS-CoV Spillover

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Middle East Respiratory Syndrome (MERS) is a disease caused by coronavirus MERS-CoV, similar to SARS-CoV-2, that spills over from dromedary camels to humans. A species distribution model (SDM) predicts the presence of a species in a region based on environmental conditions. Our project is a species distribution model that uses bagged logistic regression to predict MERS spillover in the Middle East, Horn of Africa, North Africa, West Africa, and South Asia, and maps the spillover likelihood across this region. We use existing case data, livestock population data, and other supporting environmental datasets to train the model. This builds on a previous SDM by incorporating more case data, and expanding the study region beyond the Arabian Peninsula. A camel population density dataset from the Food and Agricultural Organization will be available soon, and we will incorporate this into the model when ready. The previous SDM predicted that spillover was most likely in areas that are the most urban. For this SDM, we predict that spillover is most likely in areas with highest camel population density.

Comparing Local and Site Abiotic Effects on Pollinator Visitation To *Sinclairia polyantha* In Monteverde, Costa Rica

Reina Scott[1] & Amanda Rugenski[1]

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Pollination depends on the precarious balance of multiple organisms' phenology. An intensification in global abiotic changes such as rainfall, temperature, humidity, and sunlight are likely to affect pollinators and pollination alike and could result in a disruption of the synchronized processes. This study investigates abiotic effects (rainfall, humidity, lux, temperature, and wind speed) on pollinator visitation to the flower *Sinclairia polyantha* on the CIEE Monteverde campus in San Luis, Costa Rica. To collect local data, we made observations daily across 23 sites among 12 bushes. Each bush had a high site and a low site (at least 0.6m apart) relative to the general height of the plant off the ground. We recorded the height of observation sites once at the beginning of the investigation and all other abiotic factors were measured at the beginning of every observation period. Daily averages of abiotic data (ambient) were compared to local data. We hypothesized that higher lux and temperature would be associated with higher visitation. Further, higher flowering sites would be exposed to higher amounts of sunlight (lux) and thus would receive more visitations from pollinators than lower flowering sites as taller flowers would be able to outcompete others for sunlight. Lastly, an increase in humidity and rainfall would cause a decrease to pollinator visitations. Overall we found that height and visitations were negatively correlated. However, light intensity was positively correlated with visitation at the ambient level and negatively correlated at the local level. Assessing correlations amongst these abiotic factors can help us to further understand plant-pollinator interactions and prepare for future changes.

Butterfly Community Composition Across an Agricultural Gradient

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Insects, especially butterflies and moths, play an important role in ecosystems as pollinators and a food source for other organisms. With the continuous expansion of agricultural land to accommodate our growing population, it has become imperative to understand the impacts on insect populations. This study assesses butterfly community composition across sites representing different degrees of agricultural disturbance in the cloud forest of Costa Rica; including secondary forest, coffee farm, farm, and pasture. Butterfly data was collected through both baited butterfly traps and catching butterflies in nets. I calculated both the Shannon Diversity and Equitability Index for each site as a measure of the species diversity and evenness. I also compared community composition across sites. Contrary to my hypothesis,

both the pasture and coffee farm had the greatest species richness and abundance of butterflies and moths. A total of 222 butterflies and moths belonging to 11 species were caught in the mesh traps and 159 butterflies and moths belonging to 23 species were caught in nets or observed. From these totals, 118 and 63 specimens were from the pasture, respectively. However, species evenness was highest in the forest and coffee farm sites, which highlights the value of these forested areas in the preservation of biodiversity. The importance of different habitats for insect populations translates to an urgent need for conservation of these ecosystems.

Are Invasive Jorō Spiders a Threat to Migrating Monarch Butterflies: An Empirical Test

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Invasive Jorō spiders (*Trichonephila clavata*), initially introduced to Georgia in 2014 (Hoebecke et. al, 2015), are expected to rapidly spread across the US in the near future (Davis and Frick, 2022). In Georgia, there is a temporal overlap between the Jorō spider's peak maturity and the migration period of Monarch butterflies (*Danaus plexippus*). The Monarch's southern migration occurs in September and October, and the maturation period of the Jorō spider peaks during this time as well; therefore, it is imperative that we examine the potential relationship between these two species and analyze this potential threat to Monarchs. To test this, lab-reared Monarch butterflies were systematically introduced to the Jorō spider web, and the resulting interaction was recorded. To rule out the possibility of prey-selection, two other native butterfly species, Tiger Swallowtails (Papilio glaucus) and Gulf Fritillaries (*Agraulis vanillae*), were used to determine whether size or coloring was a factor in the spiders' reactions. Furthermore, a photographic survey was conducted in order to document the Jorō spider diet amongst its population in Athens, GA. As a result of this study, we found that Jorō spiders preyed upon Monarch butterflies significantly less than the other two native butterflies studied. These findings suggest that Jorō spiders are not a threat to Monarch butterfly migration, and the reason why Jorō spiders have an aversion to Monarch butterflies is unknown.

Assessment of Trillium spp. coverage by protected land in Georgia

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Plants are some of the most abundant species across Earth and yet their overall population decline has gone largely unmonitored compared to their animal counterparts. Trillium spp. is a genus of plants that is charismatic due to their three distinct petals making them a strong public interest. However, little is known about their overall status in protected areas. Here I show through spatial analysis in ArcGIS that Trilliums in Georgia are well represented across the United States national GAP Status Codes, and potential land conversion threats in 2050 to showcase a need for future conservation. 65% of the 1,902 Trillium occurrences of Georgia are represented across all 4 GAP Status Codes with only 41% being covered across GAP Status 1 and 2, which are managed by naturally preserving protected areas without any outside disturbance. Furthermore, I found that 52% of Trilliums in GAP statuses protected areas face potential land conversion and 21% of Trilliums hold an extremely high likelihood to face land conversion by 2050. More than half of the Trilliums in Georgia are being protected; however, a large portion of those occurring on potential converted land. The provided data and maps showcase a broad view of the status of Trilliums in Georgia, paving ways for further conservation and protection against potential threats.

Joro Spiders Don't Care About Road Disturbance: Utilizing Simulated Prey

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The famous Joro spider is known to make its home anywhere it can spin a web, regardless of how populated the area is. Although these spiders seem very stress-tolerant, does constant exposure to stress result in a behavioral change for them? To properly quantify levels of stress, we examined spiders on roadsides and recorded traffic densities for each road. Road traffic can be a stressor to both vertebrates and invertebrates because of the noise, vibrational disturbance, and pollution that is produced. This constant barrage of traffic could influence spiders' behavior since they rely on vibrational queues for food. Increasing traffic could lead to spiders having reduced attack rates at higher traffic densities because of desensitization to vibration. Alternatively, higher traffic densities could induce stress, which can be manifested as aggression in some species (Hesselberg T.; Galvez D.). By using a tuning fork with a specific frequency, spiders can be tricked into attacking a simulated prey item, which also gives us a standardized stimulus for each spider. Observing Joro spiders' responses to a stimulated prey stimulus provides further insight into understanding how road traffic affects the behavior of these roadside arthropods.

Effects of habitat alteration and co-occurrence with introduced red-eared sliders on southwestern pond turtle abundance in a southern california urban creek

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Species inhabiting urban waterways face numerous threats including water pollution, invasive species, and habitat alteration. While virtually all water bodies are at risk of significant human modification, urban waterways are subject to a unique set of human modification practices to reduce flood risk. As a result, management agencies often implement flood and erosion control measures such as creation of drop structures, riprapping, deadwood removal, and manual modification to streamline watercourses. These efforts can reduce the habitat quality for native species. The added effects of other urban habitat alterations, such as invasive species introduction, could further exacerbate any negative effects associated with an already physically altered habitat. Aquatic turtles can be especially prone to such disruptions due to their reliance on many microhabitats to survive and varying tolerance to external stressors. We conducted 250 hours of surveys over the course of approximately six months investigating the distribution of native Southwestern Pond Turtles (*Actinemys pallida*) and non-native Red-Eared Sliders (*Trachemys scripta elegans*) in an urban creek in Orange County, California. We used a series of Bayesian hierarchical models to investigate what environmental variables predict where Southwestern Pond Turtles and Red-Eared Sliders occur in highest abundance. Results are interpreted in context of urban stream management, and the effects both heavy human modification of a creek system and introduced species can have individually, and together, on Southwestern Pond Turtles. We also recommend management practices that may benefit declining Southwestern Pond Turtles based on the results obtained herein.

Using stable isotopes to determine *Aratus pisonii* food resource use on docks and in salt marshes

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As climate change progresses, more warm adapted species are expanding their habitat ranges poleward into previously harsh environments due to the lack of severe winters which often delay rapid habitat expansion. Climate-induced species range shift can alter species behaviors and patterns in novel ecosystems where they are exposed to new environments and species interactions. *Aratus pisonii*, known as the mangrove tree crab, is traditionally found in mangrove stands and is considered an important

foundational species to their habitat, contributing to leaf litter processing and nutrient cycling. Due to warming temperatures and more mild winters, both mangroves and *A. pisonii* are migrating up the Atlantic seaboard into salt marshes. *A. pisonii* recently broke off from the paired crab-mangrove migration to inhabit salt marshes and can be found at higher latitudes than the northernmost mangrove. *A. pisonii* can now be found on Sapelo Island, GA, where they must adapt to a completely different habitat structure which generates different species interactions and resources. One adaptation is their use of built infrastructure, such as docks, as habitat substitutes due to their thermal buffering capacity, protection from predators, food sources, and *A. pisonii* natural tendency to climb structures which help in facilitating their migration northward. I chose both dock and marsh sites on Sapelo Island, GA to study mangrove crab food resource use for tissue production by using carbon and nitrogen stable isotope analyses on collected mangrove crabs and food resources such as macroalgae, vegetation, detritus, benthic microalgae, and suspended particulate organic matter (SPOM).

Route Learning through Carrying in Temnothorax

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When the nest of an ant colony in the themnothorax genus is destroyed they utilize two different methods to relocate ants to the new nest, reverse tandem running and carrying. Tandem running involves an ant that does not know the route following an ant that does. The ants that are led through reverse tandem running generally return to the original nest. Previous research has found that the routes that the led ants take are close to the routes they were led on, demonstrating that the ants learn routes by being led. However, there has been no research into if carrying teaches the route. The carrying process involves an ant that already knows the route carrying an ant from the old nest to the new nest. The ant is generally carried upside down which would hamper the ability of the ant to learn the route and the carried ants seldom return to the original nest, which is why it is commonly thought they do not learn. Some ants do return to the original nest after carrying, however, so this experiment will find if the consensus is accurate. The research involved watching recordings of the relocation process and recording when carried ants were carried from the original nest and when they returned. Clips of both routes were then analyzed using the UMA Tracker software. The results of this analysis will be compared in order to see if the routes are similar, and thus there is evidence of learning.

6 Years After Tropical Storm Nate: The Recovery of Macroinvertebrate Community Composition in a Neotropical Stream in Costa Rica

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Climate change is causing increased temperatures, more intense storms, and changes in precipitation patterns in tropical watersheds. However, there are few long-term studies on the effects of these impacts on tropical freshwater streams. Our study site, Quebrada Alondra, in San Luis, Costa Rica was devastated by Tropical Storm Nate in 2017, and since then, has been monitored annually for macroinvertebrates and abiotic factors including canopy cover during the wet season. We collected macroinvertebrates to monitor the recovery and changes in community composition within the stream over time. We hypothesized that richness would continue to increase since Tropical Storm Nate as Alondra recovers and will shift in community composition becoming more similar to pre-Nate (2016). Canopy cover decreased by 36% to 43% after Nate, but subsequently, increased to 70% in 2023. The canopy cover in 2023 increased by 15% from 2021. Macroinvertebrate richness remained similar to 2021 (~18 families). However, the community composition is different than previous years both pre- and post- Nate. Density increased significantly from 2021. Overall, richness is higher than before Tropical Storm Nate and there have been smaller disturbance events with intense rainfall suggesting intermediate disturbances since Nate is increasing taxa richness and community composition.

Impact of Brush Pile Characteristics on Soil Arthropods in a pre-montane wet forest

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Brush piles are an important man-made addition to landscapes which can house and support local wildlife while repurposing landscaping waste. This study investigates the influence of brush pile characteristics and the piles' surrounding environment on the presence of arthropods within eight brush piles located on the CIEE Monteverde Campus, Costa Rica. We recorded brush pile characteristics such as area, maximum height, location, and examined macroinvertebrate communities using pitfall traps. A total of 1,396 individuals were collected and examined spanning eleven unique arthropod orders. In contrast to previous studies, we found a negative correlation between macroinvertebrate abundance and brush pile size. Species evenness was higher in brush piles than the surrounding area. However, issues such as sampling limitations, small sample sizes, and unknown variables like pile age warrant caution in drawing broad conclusions. This study underscores the need for further standardized investigation to comprehend the nuanced ecological dynamics of brush pile and macroinvertebrate interaction to maximize the usability of brush piles to local wildlife.

How Environmental Factors Affect Calling Patterns of the Rufous-Eyed Brook Frog

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The rufous-eyed brook frog, *Duellmanohyla rufioculis*, is a moderately small, stream-breeding tree frog endemic to the humid montane forests of Costa Rica. Its population crashed in the late 1990's due to *Batrachochytrium dendrobatidis*, or chytrid fungus. However, it has since had a remarkable and steady recovery with some range expansion. The life history of *D. rufioculis* is still poorly known. We aimed to quantify calling rates for *D. rufioculis* males over several nights and across multiple sites and compare these rates with environmental data such as weather and lunar phases. Here we show that *D. rufioculis* males call with a nonuniform pattern of multiple consecutive calls and then a break. We also analyzed the rate of calling and its correlation with environmental variables. Our results add to the knowledge of the life history of *D. rufioculis* and contribute to our understanding of how the species is persisting post-chytrid. Life history information will further our understanding of the species and allow us to effectively aid in its recovery and management.

The sublethal effects of disease-causing parasites on oyster filtration

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Oysters are ecosystem engineers, substantially modifying their physical environment in a variety of ways. In addition to providing shelter and food to estuarine species, oysters improve water quality by removing microalgae and seston from the water column via filter-feeding. Along the east coast of the United States, the eastern oyster, Crassostrea virginica is susceptible to multiple parasites. Two protozoan parasites, *Perkinsus marinus* and *Haplosporidium nelsoni*, which cause the diseases Dermo and MSX, are becoming more prevalent with warming conditions and are known to directly affect oyster conditions and in many cases cause direct mortality. This study investigates the sublethal effects of the presence and intensity of *P. marinus* and *H. nelsoni* on oysters' role as an ecosystem engineer via their filtering function. To examine the effects of *P. marinus* and *H. nelsoni* infection on filtration rates of individual oysters, we conducted an

experiment measuring chlorophyll-a removal by oysters. Following each experiment, oysters were dissected and assessed for parasite presence and intensity using quantitative PCR. Understanding the sublethal effects of these two disease causing parasites, may provide insight into how water quality may vary within coastal systems as a function of infection.

Mud crabs prefer less boring prey

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Predator-prey dynamics play a critical role in stabilizing community structure. However, these interactions may become disrupted when prey species become infected with parasites making them more susceptible to predation. Parasitic boring sponge (*Cliona celata*) reduces the shell integrity of the ecosystem engineer, the Eastern oyster (*Crassostrea virginica*), making them more brittle. However, the effects of boring sponge on predation of oysters, specifically by shell-crushing predators like crabs, has not been well documented. In this study, we examined how the presence of boring sponge infections influences mud crab (*Panopeus herbstii*) foraging behavior. Specifically, we conducted a prey-choice experiment allowing mud crab predators to select uninfected and infected prey and quantified the number of interactions and handling time by mud crabs for each prey type. We found that mud crabs exhibit a 20% greater likelihood of interacting with uninfected oysters and spend 30% more time handling uninfected oysters compared to infected ones. These results suggest that mud crabs will preferentially interact with uninfected oysters and avoid parasitized prey. The avoidance of parasitized prey by predators may further deplete oyster reefs as infected oysters perish from infection while uninfected oysters are consumed by higher trophic levels. The continued loss and degradation of this ecosystem engineer from parasitism and predation may have cascading effects resulting in decreased coastal water quality, carbon sequestration, and shoreline protection.