25TH ANNUAL GSS

Program

January 25-26, 2019

Odum School of Ecology
UNIVERSITY OF GEORGIA

Welcome and Acknowledgements

Welcome to the 24th annual Graduate Student Symposium (GSS) at the Odum School of Ecology! The symposium is organized by graduate students and serves as a medium to showcase ongoing student research at all stages of development. The goals of the symposium are to offer opportunities to give professional presentations, enhance communication between students and faculty throughout the University of Georgia, and provide a forum for interacting with a successful and prominent keynote alumnus or alumna.

This year's symposium could not have happened without the input of numerous graduate student volunteers on the following six committees, and their roles in organizing this event are appreciated!

- Program Committee: D. Cross, J. Skaggs, J. Vaz, A. Willoughby
- Undergraduate Poster Committee: J. Blaze, I. Ragonese, R. Richards, A. Schatz
- Judging Committee: R. Atkins, J. Beauvais, Z. Butler, D. Hawkins, K. Peterson
- Food & Beverage Committee: D. Carpenter, D. Fraser, A. Sharma, L. Rack, M. Tomamichel
- Souvenir Committee: E. Bertucci, D. Dunn, K. Parson, A. LaVere, C. Working
- GSS Documentation and A/V: K. Solomon, D. Vasquez Jr., J. Ziemba

Many undergraduate and graduate students also volunteered to serve as poster and presentation authors, session moderators, audio-visual coordinators, and countless other roles. Furthermore, faculty, post-docs, and students all contributed as presentation judges. The constructive feedback obtained from these judges is one of the hallmark components of GSS, and one of the most beneficial elements of the event. Thank you all!

The staff of the Odum School of Ecology provides administrative and technical support throughout the event ranging from troubleshooting computer problems to publicizing the event to coordinating speaker arrangements. In particular, Beth Gavrilles, Tyler Ingram, Caitlin McDonald, Brian Perkins, Gabrielle Saupe, Emily Schattler, Mica Turner, Shialoh Wilson, and Allison Walters are to be acknowledged with highest praise! We also thank Jeb Byers for hosting our keynote speaker. Additionally, we would like to thank the generous support from the Eugene and Will Odum Ecology Fund.

Finally, we thank you for taking time out of your busy schedule to attend the event. We hope you will not only hear something new, but will also provide feedback to the student participants, enjoy yourself, and consider contributing next year!

Sincerely,

Michelle Evans and Claire Teitelbaum
2019 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	David Walters	United States Geological Survey
2019	Michelle Evans, Claire Teitelbaum	Virginia Schutte	Louisiana Universities Marine Consortium (LUMCON)

History of the Graduate Student Symposium

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

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

This year marks the 25th annual Graduate Student Symposium, and we hope the tradition continues well into the future.

Talk formats

Standard talks are scheduled to start every 15 minutes with the expectation the presenter will speak for a maximum of 12 minutes. The remaining 3 minutes are allocated for questions and transition to the next speaker.

Rapid Fire talks are allocated 5 minutes. Each 45-minute Rapid Fire session will have four speakers. During speaking 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 return to the stage.

Cover art

This year's GSS logo was created by Julie Ziemba.

Keynote Speaker

Dr. Virginia Schutte

Science Media Officer

Louisiana Universities Marine Consortium (LUMCON)

Chauvin, LA

Ph.D. Ecology, University of Georgia (2014)

B.S. Biology, University of North Carolina Chapel Hill (2007)

Virginia Schutte is an award-winning science communicator who has both a PhD from the Odum School of Ecology and 5 years of extremely broad science media experience. She has worked with Springer Nature to deliver training workshops and run their digital scientific networking website; she created her own blog for publishing audio, video, and written articles; and she has been pioneering new institution-based science communication techniques since founding the Louisiana Universities Marine Consortium's Science Media Program in May 2017.

"A witty pop culture reference: but actually I'm a respectable person"

4:45 PM, January 26th, 2018

Odum School of Ecology Auditorium

Science communication research is a field of study in its own right. The number of scicomm jobs is going up. And science communication is increasingly being discussed in popular media with imperatives: scientists *should* be on social media, they *should* be blogging, they *should* get out of the ivory tower... So: Why all the fuss? What do the data say? How could communications planning impact your career? This address will introduce you to the science of science communication and ask you to think about some current issues in the field, which are relevant to all scientists. Come with an open mind- this will not be a typical seminar.

Friday, January 25th

9:00 – 10:00	**Breakfast**	**Ecology lobby**
10:00 – 10:15	Dr. Jeb Byers	Welcome from the Associate Dean

Standard Session I

Moderator: Joy Vaz

10:15 – 10:30	Carol Yang	Freshwater crabs increase leaf decomposition rates in tropical headwater streams
10:30 – 10:45	Julie Ziemba	Sublethal stressors in a complex life cycle
10:45 – 11:00	Matthew Hale	Embryonic origins of altered ovarian transcriptional networks in an environmental model of endocrine disruption, the American alligator
11:00 – 11:15	Talia Levine	Aroclor 1268 and mercury in preferred prey of Atlantic bottlenose dolphins (*Tursiops truncatus*) and humans surrounding the LCP Superfund Site, Brunswick, GA
11:15 – 11:30	**Break**	**Ecology lobby**

Standard Session II

Moderator: Jeffrey Beauvais

11:30 – 11:45	Blanka Tesla	Impacts of temperature on Zika virus transmission
11:45 – 12:00	Rebecca Atkins	Comparing "tipping points" in consumer effects across a latitudinal gradient

12:00 – 12:15	Zachary Butler	Nest predation of the loggerhead sea turtle (*Caretta caretta*) on Georgia's barrier islands
12:15 – 2:00	**Lunch (provided)**	**Ecology lobby**

Standard Session III

Moderator: Claire Teitelbaum

2:00 – 2:15	Kaylee Arnold	The microbiota of a Chagas disease vector across central Panama
2:25 – 2:30	Edward Stowe	Rangewide declines in amber darter (*Percina antesella*) identified with multivariate analysis
2:30 – 2:45	Caitlin Conn	Stable or unstable? How primary producers affect basal metabolic regimes across biomes.
2:45 – 3:00	Kate Sabey	Gut microbiota contribute to energy trade-offs during infection
3:00 - 3:15	Kerri Miazgowicz	The impact of temperature variation on *Anopheles stephensi* trait performance and implications for malaria transmission
3:15 - 3:30	**Break**	**Ecology lobby**

Rapid Fire Session I

Moderator: Reni Kaul

3:30 – 4:15	Emily Bertucci	Effects of environmental stressors on aging trajectories in medaka
	Anna Willoughby	A systematic review of environmental persistence across 25 viral families
	Akanksha Sharma	A framework for exploring aquatic and riparian connectivity
	Cali Wilson	Feeding wildlife in urban parks: effects on behavior, species interactions, and infection
	Q & A	

Rapid Fire Session II

Moderator: Nikki Solano

4:15 – 5:00	Dessa Dunn	Forest dynamics models and decision-making tools for conservation, restoration, and management of small forests
	Isabella Ragonese	Temperature-dependent infection dynamics and implications for a migratory insect host
	Katie Parson	Overwintering health of snakes: modeling the body conditions of southeastern rattlesnakes
	Ashley LaVere	Effects of testosterone on immune function in American alligators (*Alligator mississippiensis*)
	Q & A	
5:00 – 7:00	**Poster Session**	**Ecology lobby**

Saturday, January 26th

12:00 – 2:00	**TBD**	

Standard Session IV

Moderator: Kelsey Solomon

2:00 – 2:15	Joy Vaz	How do we think about spillover? Perspectives from across disciplines
2:15 – 2:30	Robert Richards	Identifying drivers of *Dracunculus medinensis* infection in the dogs of Chad
2:30 – 2:45	Megan Tomamichel	Black gill in Georgia's food shrimp: A mysterious threat to the shrimping industry
2:45 – 3:00	Samantha Bock	Linking proximate mechanisms of developmental plasticity to environmental variation in nature
3:00 – 3:15	Dana Carpenter	How wildfire and mycorrhizal fungi influence soil chemistry and decomposition
3:15 – 3:30	**Break**	**Ecology lobby**

Standard Session V

Moderator: Robbie Richards

3:30 – 3:45	Carolyn Cummins	Exploring the effects of increased temperature on leaf litter breakdown in streams across seasonal and spatial temperature gradients
3:45 – 4:00	Jeffrey Beauvais	Race and nature: The importance of a critical understanding of race for ecologists

4:00 – 4:15	Jessica Chappell	Long-term (37 years) impacts of low-head dams on habitat connectivity in northeastern Puerto Rico: Implications for island-wide metapopulation dynamics for migratory shrimp
4:15 – 4:30	Megan Hopson	A Summary of State Water Recycling Policy Strategies in the United States with Recommendations for Georgia
4:30 – 4:45	**Break**	**Ecology lobby**

Keynote Address

4:45 – 5:00	Dr. Jeb Byers	Introduction
5:00 – 6:00	Dr. Virginia Schutte	A witty pop culture reference: but actually I'm a respectable person
6:00 – 8:00	**Dinner (provided)**	**Ecology lobby**

Standard Talk Abstracts

alphabetical order by speaker last name

The microbiota of a Chagas disease vector across central Panama

Kaylee Arnold[1,2] Troy Kieran[3], Christina Varian[4], Azael Saldana[5], TravisGlenn[3], and Nicole Gottdenker[4]

(1) Odum School of Ecology, University of Georgia
(2) Center for the Ecology of Infectious Diseases, University of Georgia
(3) Environmental Health Science
(4) Department of Pathology, College of Vet Med
(5) Parasitology Department, Gorgas Memorial Institute for Health Studies

Land use change has been widely shown to impact infectious disease transmission in humans. Some commonly reported impacts of land use change have included alterations of the spatial distribution of vectors and host, and changes in vector and host community composition. However, the underlying mechanisms of these changes are not well understood. One potential driver may be the diversity of the vector gut microbiome. By focusing on how land use change impacts the microbiome, we can further study how the landscape can influence the transmission of vector-borne diseases, such as Chagas disease. Chagas disease is caused by the parasite *Trypanosoma cruzi* and spread via blood-feeding kissing bugs. Studies have shown that deforestation is associated with increases in kissing bug abundance and infection with *T. cruzi* in the tropics, yet potential impacts of different land use types on microbial communities in kissing bug survivorship and parasite transmission is unknown. I will present my findings on the range of the whole-body microbiota found in sylvatic *R. pallescens*, the primary vector of Chagas disease in Panama. Individuals were collected in two distinct regions in central Panama across a deforestation gradient and measured using 16s rRNA Illumina sequences. The two regions had significantly different infection rates and significant differences in alpha and beta microbial diversity. These results highlight patterns of microbial diversity which may be impacted by vector infection status and other environmental variables. Further analyses will explore these patterns across the deforestation gradient.

Comparing “tipping points” in consumer effects across a latitudinal gradient

Rebecca Atkins [1] & Craig Osenberg [1]

(1) Odum School of Ecology, University of Georgia

Southeastern US salt marshes are some of the most productive ecosystems in the world. Within these marshes, the marsh periwinkle, *Littoraria irrorata*, is a dominant grazer of saltmarsh cordgrass, *Spartina alterniflora*. At high densities, *Littoraria* can denude expansive swaths of cordgrass, destroying associated ecosystem services. My previous research in a Georgia saltmarsh has demonstrated that both small and large *Littoraria* can shift the *Littoraria-Spartina* interaction from beneficial (+) at low densities, to deleterious (-) at high densities, and that changes in consumer interaction strength with plant biomass can be predicted based upon the total metabolic demands of the consumer population (i.e., as determined by both size-structure and density). Initially, I’ve quantified spatial variation in *Littoraria* populations and *Littoraria-Spartina* interactions in salt marshes spanning Florida to Virginia. I have found that these interactions, while varying unimodally with respect to latitude, are also negatively related to consumer population metabolic demand. I would now like to explore the within-site relationship between *Littoraria* population metabolic demand and their consumer effects. This study will allow me to compare how the shift from facilitative to deleterious consumer effects varies across a latitudinal gradient within this system.

Race and nature: the importance of a critical understanding of race for ecologists

Jeffrey Beauvais[1]

(1) Odum School of Ecology, University of Georgia

Race is one of the most tenacious categories of difference used to separate people, despite race not having a neat biological basis. The entrenchment of race as a concept did not occur in a vacuum but is juxtaposed with and reinforced by understandings of nature. From the early dominance of environmental determinism in naturalizing racial difference and justifying colonialism, to modern disparities in environmental amenities and burdens along racial lines, race and nature have long been entwined. Given that almost all ecosystems on Earth are affected in some ways by humans, ecologists can no longer ignore critical consideration of social systems and their impacts on the environment. In this talk I will briefly outline why ecologists need to be conscious of how the nature we study molds, and is molded by, understandings of race. By engaging with critical race theory, ecologists can gain more nuanced understandings of factors that influence their study systems, find avenues to apply their work, and avoid empowering regressive and oppressive concepts of race.

Linking proximate mechanisms of developmental plasticity to environmental variation in nature

Samantha Bock[1,2] & Benjamin Parrott[1,2]

(1) Odum School of Ecology, University of Georgia
(2) Savannah River Ecology Laboratory, University of Georgia

Interactions between organisms and their environment during development can exert lasting influences on phenotypic expression later in life. One of the starkest examples of this phenomenon, termed developmental plasticity, is temperature-dependent sex determination (TSD). Occurring in a range of taxa, including all crocodilians, TSD provides a unique window through which to examine how external stimuli are integrated into physiological responses that shape phenotypic diversity in terms of both inter- and intra-sexual variation. However, our understanding of the mechanisms underlying TSD has historically been shaped by experimental studies employing constant incubation temperatures that do not reflect the variability of environments experienced in nature. In order to understand the scope of thermal variation experienced during development by the American alligator, this project uses field data to characterize the thermal dynamics of 70 alligator nests monitored over seven years at two geographically distinct sites. Examination of the ecological drivers of nest temperature variation revealed that both ambient environmental conditions and local habitat factors shape the thermal environment experienced by alligator embryos. Interestingly, in a majority of nests, alligator embryos experience both male- and female-promoting temperatures, sometimes within a daily cycle. To assess how these opposing environmental signals are translated into sexually dimorphic developmental signaling cascades across fine temporal scales, we employed empirically derived thermal fluctuations in laboratory investigations. This project demonstrates the utility of field data in informing empirical tests of the interactions between ecologically-relevant thermal dynamics and developmental processes to reveal the fundamental mechanisms underlying developmental plasticity as it occurs in nature.

Nest predation of the loggerhead sea turtle (*Caretta caretta*) on Georgia's barrier islands

Zachary Butler[1,2], Mark Dodd[3], and Seth Wenger[1,2]

(1) Odum School of Ecology, University of Georgia
(2) River Basin Center, University of Georgia
(3) Georgia Department of Natural Resources

Predation of loggerhead sea turtle (*Caretta caretta)* nests by native and non-native species is a significant threat to recovery efforts throughout the species' nesting grounds. In Georgia, USA, nests are threatened by predators including but not limited to: raccoons, feral hogs, armadillos, ghost crabs, snakes, and fire ants. Nesting beaches are patrolled daily at dawn, with surveys occurring below the previous night's tide to ensure that all sea turtle emergences are detected. Daily patrols were conducted for the duration of Georgia's sea turtle nesting season (15 May-1 October) in 2009-2018. The objective of this study was to examine a historical data set provided from beach

monitoring efforts since 2009 and compare loggerhead nest losses due to different predators on two of Georgia's barrier islands (Sapelo Ossabaw Islands). We hypothesized that northern raccoons (*Procyon lotor)* would be the most frequent predator of loggerhead nests, while invasive feral hogs (*Sus scrofa)* would be responsible for the greatest mean egg loss per predation event. We also hypothesized that nine-banded armadillos (*Dasypus novemcinctus*) and Atlantic ghost crabs (*Ocypode quadrata)* would have a low predation effect compared to that of other predators. Our preliminary results show that raccoons have depredated an estimated 9714 eggs, while hogs have predated approximately 8617 eggs across the two islands. Egg losses from other predators were substantially lower: 1457 from ghost crabs, 310 from armadillos, 55 from birds, 17 from kingsnakes, 12 from fire ants, and five from possums. Our results provide a data-driven basis for predator management on Georgia's barrier islands that could have significant implications for sea turtle conservation efforts taking place along the Georgia coast.

Interactions between fungi and fire create a novel forest ecosystem

Dana Carpenter[1] & Nina Wurzburger[1]

(1) Odum School of Ecology, University of Georgia

The southern Appalachians are a highly productive and biodiverse ecosystem, however, a legacy of biotic and abiotic disturbances has increased the amount of fire intolerant trees in these forests, which has resulted in an accumulation of the organic horizon and a possible change in soil chemistry. These changes make this once fire-tolerant ecosystem less tolerant and my lead to the counter-intuitive result of greater increase of fire-intolerant trees within the forest. The fall wildfire season of 2016 presents an opportunity to understand how long-term fire exclusion and smoldering wildfires might further change in the forests of the southern Appalachians. We broadly hypothesize that the strongest changes in decomposition rate and soil chemistry will be seen in stands with lesser dominance of fire tolerant trees. This hypothesis will be tested using the 20 plots located across the site of the 2016 Rock Mountain wildfire that occurred on Chattahoochee-Oconee and Nantahala National Forests.

Long-term (37-year) impacts of low-head dams on habitat connectivity in northeastern Puerto Rico: Implications for island-wide metapopulation dynamics for migratory shrimp

Jessica Chappell[1], S. Kyle McKay[2], Mary Freeman[3], and Cathy Pringle[1]

(1) Odum School of Ecology, University of Georgia
(2) Environmental Laboratory, U.S. Army Engineer Research and Development Center, New York City, NY
(3) United States Geological Survey, Patuxent Wildlife Research Center, Athens, GA

Freshwater migratory shrimp populations in Puerto Rico depend on habitat connectivity to persist. Furthermore, shrimp populations are inter-connected, as shrimp species across watersheds are genetically similar and form an island-wide metapopulation. El Yunque National Forest (EYNF), located in northeastern Puerto Rico, is likely a key source of larval shrimps to the metapopulation, given high shrimp densities and a lack of large dams. However, in the EYNF low-head dams paired with water intakes and drought can reduce instream flow and impact the export of shrimp larvae through reduced connectivity. Here we examine the cumulative effects of water withdrawals on habitat connectivity for migratory shrimp over a 37-year period across seven watersheds draining El Yunque National Forest. We calculated total habitat connectivity and refugia habitat connectivity (where refugia habitat is defined as predator-free upstream reaches above waterfalls > 5 m) at a monthly time step using a habitat-weighted longitudinal riverine connectivity index. Findings indicate that total habitat connectivity declined slowly yet consistently over 37 years due to an increasing proportion of water withdrawn relative to stream discharge, which results in a reduced contribution of shrimp larvae to island metapopulation. Similarly, refugia habitat connectivity declined but at a slower rate. Our findings indicate the importance of minimizing water withdrawals from watersheds characterized by an abundance of refugia habitat. We also highlight the necessity of using a long-term (37 year) dataset and short time-step to fully understand the cumulative effects of multiple water intakes (associated with low-head dams) on habitat connectivity across several watersheds.

Stable or unstable? How primary producers affect basal metabolic regimes across biomes

Caitlin Conn[1,2], Seth Wenger[1,2], Amy Rosemond[1], and Mary Freeman[1]

(1) Odum School of Ecology, University of Georgia
(2) River Basin Center, University of Georgia

Primary production provides a basal resource for food webs and is a key step in how carbon and nutrients cycle within or through an aquatic system. Prior studies indicate that differences in producer growth form determine the susceptibility of producers to hydrologic variability and thus shape the temporal and spatial structure of basal resources. Research also indicates that these growth forms exhibit differences in physiology that translate into distinct functional responses such as carbon fixation rates or uptake rates. In light of ever-increasing anthropogenic stressors, including but not limited to climate change, the resistance of particular growth forms to disturbance

events could translate into more or less stable aquatic ecosystem function. My current research in the Middle Oconee River in Athens, GA indicates that the predominant macrophyte, *Podostemum ceratophyllum*, provides resource stability during times of high flow. This particular species is structurally similar to a bryophyte and able to withstand high velocity waters. I am proposing research in northern Europe to determine whether primary producers in other biomes also provide basal metabolic stability. Specifically, I want to examine whether an analogous macrophyte species, *Ranunculus fluitans*, has the potential to provide resource stability, and thus functional stability, under varying hydrologic conditions.

Exploring the effects of increased temperature on leaf litter breakdown in streams across seasonal and spatial temperature gradients

Carolyn Cummins[1], Amy Rosemond[1], Phillip Bumpers[1], Nate Tomczyk[1], Jonathan Benstead[2], and Vladislav Gulis[3]

(1) Odum School of Ecology, University of Georgia
(2) University of Alabama
(3) Coastal Carolina University

Breakdown of terrestrial organic matter in streams and rivers is an essential part of the global carbon cycle. As temperature increases, the Metabolic Theory of Ecology (MTE) predicts that leaf litter breakdown rate should increase with an activation energy of 0.6-0.7 eV. However, the relative responses of microorganisms and leaf-shredding aquatic insects (shredders) to warming temperatures may deviate from MTE predictions and affect the relative proportions of terrestrially-derived carbon that are lost as CO2, integrated into the food web, and transported downstream. We conducted two-month leaf litter incubations in streams across a temperature gradient at the Coweeta Hydrologic Laboratory (NC, USA) between September 2017 and October 2018. We compared litter breakdown rates between coarse and fine mesh litterbags containing either *Rhododendron maximum* or *Acer rubrum* leaves and quantified the relative contributions of shredders and microorganisms to leaf litter breakdown for both litter types across temperatures. Across a seasonal temperature gradient, microbial contributions to breakdown increased with increasing temperature, although the slope of this relationship differed from MTE predictions. Shredder contributions were highest during the coldest months of the year. This pattern is opposite of what is predicted by MTE and is most likely driven by seasonal shredder community dynamics. Shredder physiology, community structure, and life history are all important factors that may dictate the response of litter breakdown to increased temperature across seasonal and spatial gradients.

Embryonic origins of altered ovarian transcriptional networks in an environmental model of endocrine disruption, the American alligator

Matthew Hale[1,2], Jessica A. McCoy[3], Brenna M. Doheny[4], Thomas M. Galligan[5], Louis J. Guillette, Jr.[6], and Benjamin B. Parrott[1,2]

(1) Odum School of Ecology, University of Georgia
(2) Savannah River Ecology Laboratory, University of Georgia
(3) College of Charleston
(4) School of Public Health, University of Minnesota
(5) Department of Fish and Wildlife Conservation, Virginia Tech
(6) Department of Obstetrics and Gynecology, Medical University of South Carolina

Environmental contaminants that interfere with native functioning of the endocrine system have been linked to reproductive abnormalities and population declines in wildlife and humans globally. Investigations into a population of alligators inhabiting a contaminated system in Florida, Lake Apopka, have uncovered the roots for some of these abnormalities in altered estrogen signaling during development, including shifts in ovarian function and transcription that persist into later life stages. Using a model in which juvenile alligators, collected as eggs from Lake Apopka and a reference site, were raised under identical laboratory conditions and challenged with either a vehicle control or a gonadotropin hormone (FSH) that stimulates ovarian function, we employed a non-biased RNA seq-based method to probe the depth and etiology of population-level differences in ovarian function associated with contaminant exposure. After identifying core transcriptional networks shared between populations, including FSH-responsive genes involved in steroid hormone production, cell proliferation, and oocyte development, we uncovered a cohort of responsive genes unique to each site that are putatively linked to contaminant exposure. Furthermore, in the non-challenged ovary, we identified an unexpectedly large proportion (40%) of transcripts that differ across populations, suggesting that FSH challenge might ameliorate some degree of functional differences between populations. Collectively, these findings indicate a substantial role for developmental contaminant exposure in shaping future ovarian function. Given prior evidence in the alligator linking similar functional shifts to precocious estrogen signaling in the developing gonad, this research suggests a critical role for estrogens in shaping future patterns of plasticity in the ovary.

A summary of state water recycling policy strategies in the United States with recommendations for Georgia

Megan Hopson[1,2] & Laurie Fowler[1,2,3]

(1) Odum School of Ecology, University of Georgia
(2) River Basin Center, University of Georgia
(3) School of Law, University of Georgia

Water is necessary for all living beings on this planet to survive and as the human population continues to grow, so grows the dilemma of water scarcity. As a result, communities across the globe are turning to water recycling, the treatment of previously-used water followed by another use in the same geographic area. One of the main barriers to water recycling is public perception of risk. It is believed that with the implementation of state policies to direct the quality, liability, and oversight

requirements for recycled water, it will increase the public's confidence and willingness to use it. Through the investigation and summary of 14 state policy strategies, we identified the common components and made recommendations for future Georgia state policies. Recommendations included establishing clear legislative goals, assigning primary responsibility to the Georgia Environmental Protection Agency with input from the Georgia Department of Health, and requiring evaluation of the potential for recycling. Increasing the understanding of successful water recycling policies will grow the number of successful recycling projects, protecting both human and ecological communities.

Aroclor 1268 and mercury in preferred prey of Atlantic bottlenose dolphins (*Tursiops truncatus*) and humans surrounding the LCP Superfund Site, Brunswick, GA

Talia Levine[1], Laurie A. Fowler[1,2], Dr. Robert Bringolf[3], and John Schacke[1]

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

The LCP Superfund site, located in Brunswick, GA, was added to the U.S. Environmental Protection Agency's (EPA) Superfund National Priorities List in 1996 due to contaminated soil, groundwater, and sediment. Approximately 670 acres of the site are tidal marshland, and a signature formulation of polychlorinated biphenyls —Aroclor 1268— and mercury are among contaminants of concern at the site. Fishing advisories are in place in this community, but it is unclear whether residents are following this guidance in preparation and consumption of fish. Wildlife that inhabit the waters surrounding the site—the Turtle Brunswick River Estuary (TBRE)— have been studied extensively, and Atlantic bottlenose dolphins (*Tursiops truncatus*) in Brunswick, GA, contain the highest documented levels of PCBs of any marine mammal. Fish are a likely vector transporting PCBs beyond the boundaries of the LCP site. This study will seek to determine concentrations of Aroclor 1268 and mercury in preferred prey of bottlenose dolphins and humans and how these are distributed throughout different zones of the LCP advisory area as compared with a reference site north of Brunswick.

The impact of temperature variation on *Anopheles stephensi* trait performance and implications for malaria transmission

Kerri Miazgowicz[1,2] & Courtney Murdock[1,2,3]

(1) Department of Infectious Diseases, University of Georgia
(2) Center for the Ecology of Infectious Diseases, University of Georgia
(3) Odum School of Ecology, University of Georgia

Vectors, hosts and the diseases they carry exist in a variable world. However, most laboratory studies are conducted at constant temperatures. Rate summation is a computational technique that can be used to infer the performance of traits in a fluctuating environment from performance at constant temperatures. Yet, rate summation has been shown to breakdown at the extreme ends of

the thermal ranges for other ectothermic organisms. Thus, the accuracy of laboratory studies performed under constant temperatures in recapitulating transmission dynamics for mosquitoes under real-world temperature fluctuation is unknown. Individually-housed *Anopheles stephensi* were placed across five mean temperatures under both a constant and fluctuating temperature regime. We directly measured bite rate, mortality rate, and fecundity daily for each individually-housed mosquito across our temperature treatments. Trait performance under fluctuating conditions were estimated using rate summation and directly compared to empirically derived performance. Furthermore, the implications these deviations have on transmission dynamics were evaluated with a biologically informed temperature-dependent R0 model.

Identifying drivers of *Dracunculus medinensis* infection in the dogs of Chad

Robert Richards[1,2], Chris Cleveland[3], Richard Hall[1,2,4], Andrew Park[1,2,4], Michael Yabsley[3], and Vanessa Ezenwa[1,2,4]

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Few human infectious diseases have been driven as near the brink of eradication as *Dracunculus medinensis*, or guinea worm. By 2010 the number of cases had dwindled from 3.5 million in 1986 to 1,797. In the same year a new outbreak occurred in Chad which differed from those prior. Human cases were no longer clearly associated with each other and genetically related cases began to become far more common in domestic dogs, suggesting a canine origin to many cases. This new host threatens the viability of eradication efforts, making an understanding of the factors driving infection in dogs essential to this mission. To this end we ask what demographic, geographic, or climatic factors are most predictive of *D. medinensis* infection in a village's dog population. To address this question, we used boosted regression tree models to identify covariates of importance for prediction of 4 distinct representations of *D. medinensis* infection in a village's domestic dog population. We find that local measures of infection such as presence of infection in a village are mostly predicted by demographic (e.g. prevalence of fishing) and geographic factors (e.g. standard deviation in elevation). Regional measures of infection such as presence of a village in a spatial hotspot are mostly predicted by climatic factors (e.g. precipitation of the warmest quarter). This work provides important insights into the landscape-scale ecology of this debilitating parasite, and is likely to be helpful in the effective targeting of eradication and control efforts.

Gut microbiota contribute to energy trade-offs during infection

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Animals obtain a proportion of their energy from their gut microbiota, but infection may impact how this energy is allocated among various aspects of host physiology. While healthy hosts can invest microbially-derived energy toward growth, infection may force trade-offs in energy investment between self-maintenance and immune defense. We therefore examined the role of the gut microbiome in shaping such energy trade-offs in wild African buffalo exposed to bovine tuberculosis (*Mycobacterium bovis*, BTB). Female buffalo were sampled in Kruger National Park, South Africa from 2009-2012 to assess BTB infection status, body condition, and circulating monocyte counts (a measure of BTB immune defense). Fecal samples were then processed for 16S rRNA gene sequencing to determine whether relationships between gut microbiota and host physiology were consistent between BTB-infected and uninfected hosts. Only weak differences in microbial diversity were present between BTB-infected and uninfected individuals. However, associations between microbial composition and both body condition and monocyte counts were significantly altered by BTB infection. For example, key bacterial taxa that negatively co-varied with body condition in uninfected hosts were maintained at more constant levels in BTB-infected hosts, while the same taxa were positively associated with monocytes in infected hosts. These patterns suggest that the gut microbiome may help support investment in BTB immunity by mediating energy trade-offs during infection. Overall, this study reveals gut microbiota are a notable component of wildlife responses to infectious diseases.

Modeling Joint Effects of Infection and Toxicant Exposure in a Wildlife System

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Exposure to toxicants (e.g. pesticides, heavy metals, persistent organic pollutants) can have wide-ranging effects for wildlife, including altering demographic processes, impairing movement, and decreasing body condition. They can also affect infection processes, such as by increasing susceptibility, impeding recovery due to immune suppression, or increasing parasite mortality. What are the consequences for a wildlife population facing both pathogen infection and exposure to toxicants? I first provide some case studies, then present some preliminary modeling results exploring how infection prevalence and population size of a wildlife system depend on the extent of toxicant-contaminated habitat across the landscape.

Rangewide declines in amber darter *Percina antesella* identified with multivariate analysis

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Federally protected species in the U.S. require periodic assessments of extinction risk, which is typically evaluated based on the demographics and distinctiveness of each separate population, as well as the overall number and location of populations. Such assessments do not typically examine the extent to which stochastic fluctuations are independent between populations: this may be important, because overall extinction risk is expected to increase when populations fluctuate synchronously. Multivariate autoregressive state-space (MARSS) modeling can be used to estimate non-independence in population fluctuations across multiple populations, while also estimating parameters associated with population viability, such as long-term growth rate. Using sampling data from 16 shoal sites in north Georgia from 1996-2017, we used MARSS models and AIC-based model selection to assess the status of the Federally Endangered Amber Darter (*Percina antesella)* within its known populations in the Conasauga and Etowah rivers. The abundance of Amber Darters has declined substantially over the last two decades in the study area, although at differential rates: approximately 12% annually in the Conasauga and 9% in the Etowah. However, annual population fluctuations between the rivers were correlated, suggesting that the two populations experience similar annual environmental variation. Ultimately this analysis indicates the extent to which both of the known Amber Darter populations are imperiled, and that the risk of extinction may be compounded by non-independent population fluctuations. This analysis also demonstrates the utility of MARSS modeling for assessing extinction risk.

Impacts of temperature on Zika virus transmission

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Diseases like Zika, dengue, and chikungunya, which were once considered tropical and sub-tropical diseases, are now threatening temperate regions of the world due to climate change and increasing urbanization. Temperature is a strong driver of vector-borne disease transmission, and characterizing the thermal range and optimum for transmission is crucial for accurately predicting arbovirus emergence and spread. To address the lack of data on the relationship between temperature and key pathogen traits for emerging arboviruses, we conducted a series of experiments to estimate the thermal performance of Zika virus (ZIKV) in field-derived *Aedes aegypti* across eight constant temperatures. We observed strong, unimodal effects of temperature on vector competence, extrinsic incubation period, and mosquito survival. We used thermal responses of these traits to update an existing temperature-dependent R0 (the basic reproductive number) model, to infer how temperature impacts ZIKV transmission. We demonstrated that ZIKV transmission is optimized at a mean temperature of approximately 29°C, and has a thermal range of 22.7°C to 34.7°C. The predicted thermal minimum for Zika transmission is 5°C warmer than for dengue virus which

suggests that current estimates on the global environmental suitability for Zika transmission are over-predicting its possible range. Accurately characterizing the unimodal effect of temperature on emerging arboviruses, like ZIKV, is critical for estimating the potential geographic and seasonal range for transmission, and accurately predicting where future climate change will increase, decrease, or have minimal impact on transmission.

Black gill in Georgia's food shrimp: a mysterious threat to the shrimping industry

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Black gill disease in food shrimp (*Litopenaseus setiferus* and *Farfantepenaeus aztecus*) has been implicated in the significant decline of the Georgia shrimping industry. The disease is caused by the shrimp's innate immune response to infestation by an unknown species of ciliate. The immune response encysts the ciliate on the shrimp's gills resulting in melanized nodules that reduce the shrimp's ability to process oxygen. As a consequence, the shrimp suffer increased mortality due to oxygen stress and increased predation because of their reduced capacity to escape. Causes of the recent rise in black gill prevalence are unknown, however there appears to be strong seasonal and temperature components to infection rates. Infection first appears in August, and prevalence increases through the early fall until dissipating in January with the cooling water temperatures. Additionally, food shrimp appear to contract the infection while migrating into the estuary to mature, rather than transporting the infection with them from the open ocean. My research will focus on answering some of the many questions surrounding this important parasite, including refining our understanding of the temperature dependence of transmission, uncovering if there is a "reservoir host" for the parasite, developing models for evaluating mitigation methods to protect Georgia's shrimping industry, and understanding what ecological impacts the sudden loss of food shrimp has on the estuary.

How do we think about spillover? Perspectives from across disciplines

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Zoonoses are widespread both in the U.S. and around the world, As many as 60% of all communicable diseases and 75% of emerging infectious diseases of humans in the last decade originated with animals. Zoonotic pathogen transmission fundamentally involves animals, humans, and the environment in which they interact, making it crucial to adopt a "One Health" or interdisciplinary perspective to understand the factors underlying this process. An integrative approach is necessary to draw together information from different disciplines that focus on disparate components of the spillover process. The overarching aim of this project is to synthesize perspectives

from multiple disciplines about how pathogens pathogens spillover from animals to humans. Using a systematic review of the literature, we identify i) hypothesized mechanisms by which spillover occurs, ii) the contribution of scientific disciplines to various hypotheses, and iii) conceptual gaps in spillover research.

Freshwater crabs increase leaf decomposition rates in tropical headwater streams

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Freshwater crabs are commonly encountered in many tropical headwater streams, but few studies have examined their roles in ecosystem processes such as leaf litter breakdown. As omnivorous macroconsumers, freshwater crabs affect various trophic levels and may directly increase leaf breakdown by direct consumption and fragmentation, or decrease breakdown by consuming shredding insects. I used an enclosure experiment in a natural stream setting to quantify the effects of crabs on the rate of leaf breakdown and insect colonization of leaves. After 42 days of incubation, enclosures with crabs had faster rates of leaf breakdown (with crabs: k = -0.020; without crabs: k = -0.016; p ¡ 0.05). In order to scale up the impact of crabs on leaf breakdown across headwater streams, I quantified crab densities across 20 headwater stream sites. Stream sites in undisturbed forested watersheds had higher crab densities than sites near human development. Anthropogenic pollution may decrease crab population densities and affect rates of leaf litter breakdown in tropical headwater streams.

Sublethal stressors in a complex life cycle

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Amphibians with complex life cycles undergo periods of energy-demanding tissue reorganization and ecological niche shifts that expose them to combinations of anthropogenic stressors in aquatic and terrestrial habitats. For vertebrates, chronic exposure to stressors generally causes elevated glucocorticoid production, which can alter growth, development, and immune function. However, much of what we know about stressors and immune function in amphibians comes from experiments that either artificially elevate glucocorticoids by applying exogenous corticosterone to subjects, or do not directly measure corticosterone production despite exposing amphibians to ecologically-relevant stressors. Further, these studies do not consider how ontogeny may mediate stress, and are typically limited to observing effects of a stressor at only one or two life stages of a single generation. We are proposing a long-term laboratory study using invasive Cuban tree frogs (*Osteopilus septentrionalis*) and ranavirus as a model system to: 1) investigate the sublethal effects of two common stressors (heavy metals and organic contaminants) in amphibian habitats, 2) evaluate chronic corticosterone elevation as a potential mechanism for immunosuppression and

variation in disease exposure outcomes, 3) elucidate acute effects of stressors experienced at different life stages, and 4) the long-term cumulative effects of stressors throughout development and 5) across generations. We predict that chronic corticosterone elevation due to pre- and post-metamorphic contaminant exposure will reduce immune defense (lower plasma microbicidal activity) and increase ranavirus susceptibility (higher viral load) and viral shedding rates of individuals. Additionally, we expect maternal stress history to affect the ranavirus susceptibility and shedding rate of their offspring.

Rapid Fire Talk Abstracts

alphabetical order by speaker last name

Effects of environmental stressors on aging trajectories in medaka

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Age specific patterning of DNA methylation (epigenetic aging) is the single best marker of biological age as it is strongly correlated with chronological age, the onset of age-related disease, and all-cause mortality. Discrepancies between chronological and biological age can be used to explore the molecular underpinnings that determine different aging trajectories. Previous research in humans demonstrates that adverse environmental conditions are associated with accelerated epigenetic aging, but it is not clear if some life stages are more sensitive to shifts in epigenetic aging trajectories than others. Additionally, the relationship between epigenetic age acceleration due to environmental stressors and the response of the stress axis (i.e. elevation of cortisol) has not been described. We aim to describe the relative contributions of early and late life stress on epigenetic age acceleration and to further examine the relationship between environmental stressors, epigenetic aging, and cortisol. To do this we will expose medaka (*Oryzias latipes*) to a ubiquitous environmental stressor, methylmercury, or exogenous cortisol during early development (0 to 20 days post fertilization (dpf)) or as adults (120 to 140 dpf). After exposures, fish will be reared to six months at which time they will be assessed for age acceleration through several measures of biological age: epigenetic age, telomere length, and regenerative capacity. We hypothesize that early life exposures to environmental stress will cause disproportionate age acceleration relative to adult exposures which may have implications for the timing of ecologically important life history traits such as the onset of reproduction and senescence.

Forest dynamics models and decision-making tools for conservation, restoration, and management of small forests

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People are increasingly recognizing the value of small forests, especially when they contain rare ecosystems, unique biological qualities, desired aesthetics, or recreational opportunities. However, balancing ecological integrity alongside community values presents multiple and often conflicting objectives, which is one of the many challenges of managing and conserving small forests. A

common ecological concern is the fate of the tree community itself, but the tools typically used to study tree dynamics are often developed for larger ecosystems, and they may not provide relevant information for small forest management. This study evaluates different forest dynamics models to assess their applicability to small forests, including models of individual species population dynamics, communities and succession through gap models, and ecosystem service production. For each model, I review spatial and temporal scales, levels of organization, and data requirements, from which I assess whether and how the use of each model would inform small forest management. Based on the type of information produced by each model, I also assess its usefulness in broader decision-making (DM) frameworks, such as structured decision-making, which are used to compare and optimize multiple management objectives. This is particularly important when considering both the ecological integrity and social values of small forests. This literature review will hopefully provide small forest managers a convenient survey of available and appropriate models and DM frameworks, and the findings of this review will be used to select a model and DM framework to evaluate conservation and management options for maritime live oak forests on Jekyll Island.

Effects of testosterone on immune function in American alligators (*Alligator mississippiensis*)

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Parasite-mediated sexual selection posits that pathogen resistance in some males allows those individuals to delegate more reserves towards secondary sexual traits. Thus, variation in resistance may mediate variation in the quality of secondary sexual displays. One mechanistic explanation of this relationship arises from the Immunocompetence Handicap Hypothesis (ICHH), which postulates that testosterone positively affects development of secondary sexual characteristics while simultaneously suppressing immunity, creating a trade-off between sexual signaling and vulnerability to infection. Though this has been supported across taxa, there are gaps in understanding what components of immunity are compromised, and the implications for organisms in pathogen-rich environments. This presentation will provide an overview of my proposed research which seeks to test the ICHH in a population of free-ranging American alligators (*Alligator mississippiensis*) from Merritt Island in Florida. Males in this population have been shown to undergo seasonal fluctuations in testosterone levels that differ across a threshold of male body length; a trait correlated with dominance in the alligator mating system. Additionally, there were simultaneous fluctuations in levels of a testosterone precursor, dehydroepiandrosterone (DHEA), which has some support for being an immunostimulant. I hypothesize that DHEA may help mitigate the costs of testosterone. Using archival blood (plasma) samples, I will assess alligator immune responses to 6 different microbes to test relationships between testosterone, DHEA and immune function and evaluate the relative responses of males with different hormone profiles to pathogen exposure. This research will advance our understanding of how physiological trade-offs shape variation in pathogen vulnerability in natural populations.

Overwintering health of snakes: modeling the body conditions of southeastern rattlesnakes

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Recent studies in the southeastern United States have reported increasing winter activity among snake populations. However, there are multiple risks associated with surfacing in the winter including: 1) burning of fat stores; 2) difficulty escaping predators due to reduced performance ability; and 3) difficulty digesting prey items. It has been noted that surfacing during winter is related to temperature fluctuations and precipitation, yet, with the associated risks, observations of snakes surfacing during winter seem potentially maladaptive. Research has shown that snakes with challenged immune systems may prioritize reaching a higher body temperature at the expense of metabolic efficiency or risk exposure. Therefore, snake winter surfacing behavior may be related to infection and an effort to increase its metabolism to help fight infection. Here, I will present a model depicting expected body condition changes from wintertime surfacing among healthy and diseased snakes and compare model predictions to actual data from winter weight loss of eastern diamondback rattlesnakes (*Crotalus adamanteus*) on Jekyll Island, Georgia. We hope this model can be used to identify metabolically costly periods for winter surface activity by snakes to better understand the drivers of wintertime behavior and emerging infectious diseases.

Temperature-dependent infection dynamics and implications for a migratory insect host

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For ectothermic organisms like insects, environmental temperatures can influence their physiology, survival, daily and seasonal activity patterns, and largescale distribution. Given that insects are important vectors of disease, a growing body of research has focused on the effects of temperature on insect-pathogen interactions. While much of the work so far has emphasized how temperature alters individual host or parasite traits (e.g. immune response or growth), contemporary climate change intensifies the need to quantify how these within-host processes scale up to influence local transmission and regional infection patterns. Monarch butterflies (*Danaus plexippus*) and their protozoan parasite *Ophryocystis elektroscirrha* (OE) are an apt system for studying temperature dependent infection dynamics at multiple scales. Their iconic migration allows them to recolonize the North American continent in successive generations. This migration is thought to reduce infection prevalence via culling of infected individuals and escape from OE-contaminated breeding sites. Temperature shifts that influence the distribution of monarchs and timing of migration could affect the efficacy of these parasite reduction mechanisms. My specific goals are to (1) quantify thermal responses of host competence, (2) examine the temperature dependence of local parasite transmission, and (3) use this information to predict regional infection patterns. We will develop a stage-specific compartment model that uses empirically-informed functional relationships between

temperature, transmission parameters and demographic rates to simulate seasonal infection dynamics in the eastern US, enabling us to predict where OE infection risk will increase or decrease under different warming scenarios.

A framework for exploring aquatic and riparian connectivity

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Aquatic and riparian ecosystems are of critical importance in arid environments, supporting a diverse suite of resident and migratory species over different life stages. Ecological connectivity is an important property in the functioning of these ecosystems, and a significant subject of interest for researchers, scientists, resource managers, practitioners and other stakeholders. Furthermore, a variety of perceptions exists on aquatic and riparian connectivity among these stakeholders, and connectivity of these ecosystems in arid landscapes is a relatively unexplored subject. We focused on these issues in the US portion of the Madrean Archipelago by combining qualitative methods to capture the diversity of perspectives among experts and quantitative spatial analysis to capture the variety of factors that influence aquatic and riparian connectivity. We synthesized available literature and the resultant expert perspectives into a Connectivity Component-Dimension Framework that deconstructs aquatic and riparian connectivity into connectivity components and their dimensions. Using GIS and regression analysis, we applied this framework to a case study of the threatened Chiricahua leopard frog (*Rana chiricahuensis*) in the Cienega Creek basin in Arizona and created connectivity indices for this focal species. Some factors that emerged significant in this case study included elevation, fire hazard potential, and density of leopard frog sightings. This connectivity framework and the related indices provide customizable options for stakeholders to assess aquatic and riparian connectivity multidimensionally using readily available data. These tools can be used by stakeholders for exploratory analysis, assessment and visualization of aquatic and riparian connectivity, in arid landscapes, and beyond.

A systematic review of environmental persistence across 25 viral families

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Outside of their hosts, viruses typically decay and loose infectiousness rapidly. Understanding taxonomic patterns of viral persistence and the importance of specific environmental factors are crucial to understanding transmission via fomites and infected substrates. Additionally, the effect of abiotic factors like temperature, pH, and desiccation on viruses can be translated into intervention methods. We conducted a systematic literature review of virus survival using PRISMA methods, identifying papers that experimentally tested viral decay. From each study, we extracted viral species, laboratory methods, abiotic variables, publication theme, and persistence metrics. We

identified 297 studies on 85 species from 25 viral families that fit our criteria. Studies are dominated by enteric viruses in the Picornaviridae family (36%). Most studies test temperature (60%) or pH (46%) effects rather than decay changes due to humidity (4%). For the most part, metrics for both viral quantification and viral persistence are widely variable and make comparative analyses difficult. We conducted meta-analyses of viral half-life on a subset of 88 studies of human viruses. Half-life ranged from less than an hour to three weeks, with an average of 65 hours across viral families. Relevant variables included viral composition and transmission pathway, along with environmental conditions. Most research centered on water quality, hospital hygiene, veterinary health, and food safety. Our review highlights key gaps in the knowledge of virus environmental persistence, such as zoonotic hantaviruses. We also identify areas to improve standardized experimental procedures and reporting of data from laboratory studies.

Feeding wildlife in urban parks: effects on behavior, species interactions, and infection

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Feeding wildlife is a popular way for people to engage with, and learn about, wild animals. Food subsidies can have profound impacts on animal health, behavior, and species interactions, although these impacts are not always beneficial, especially when they alter disease transmission. I will investigate how host-parasite dynamics are mediated by variation in individual behavior (e.g., aggressiveness) and community composition (e.g., rate of interspecific contact), along a gradient of human-provided food. I will explore these dynamics in urban populations of American white ibis (*Eudocimus albus*) in South Florida that are habituated to taking human-provided food and host a variety of pathogens. Within species, I will test whether greater supplemental feeding at parks will increase ibis flock sizes and contact rates, and alter the behavior of ibis. At the community level, I will test whether sites with greater supplemental feeding have a higher proportion of non-native and domesticated species and more interspecific contact. Lastly, I will build two mathematical models incorporating data collected in the field studies to explore how i) individual variation in behavior and ii) community composition affect disease dynamics. These models can be used to understand transmission dynamics occurring in other systems with heterogeneity in host behavior and competency to better predict disease spread and outbreaks.

Undergraduate Poster Abstracts

alphabetical order by speaker last name

Population dynamics of *Aphis nerii*

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Aphis nerii is a species of aphid found in Costa Rica that feeds on the milkweed species *Asclepias curissavica*. Parasitic wasps are a common predator of *A. nerii*. They predate the aphids by laying larvae inside of the aphids, causing the aphid to become mummified. I observed the growth pattern of *A. nerii* and the relationship between aphid population size and the number of mummified aphids present in the population. I determined the growth pattern of *A. nerii*, by attaching segments of colonized milkweed stems onto ten uncolonized milkweed plants and measured the growth of the colonies over a nine-day period. To measure the relationship between colony size and mummified aphid abundance, I walked transects throughout a pasture and measured the length of aphid colonies and the number of mummified aphids present. Although I found that 7 of the 10 subpopulations had reached extinction, the metapopulation showed exponential growth because of the growth of one subpopulation (despite some predation). I found that there was no correlation between population size and the presence of mummified aphids, but I observed a potential relationship between density of milkweed plants and presence of parasitoids. The mechanism by which parasitoids mummify aphid colonies may be related to the ability of the parasitoid to disperse from one colony to the other.

African ungulates respond to a temporally dynamic landscape of fear

Annabelle Barr[1] & Ricardo Holdo[1]

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Predation can have profound impacts on a prey population beyond direct consumption and mortality. The non-lethal effects of predation include changes in animal behavior based on the threat of predation. Risk of predation varies as a function of habitat due to predator behavior, creating what is commonly referred to as a “landscape of fear.” In the landscape of fear, predation risk becomes a feature of the prey’s habitat. Prey may respond to this effect by avoiding high-risk areas or by

showing increased vigilance. While it is clear that non-lethal effects exist, the generality and strength of these effects are yet to be fully understood. Furthermore, landscapes of fear have mostly been assumed to be static over time, but predation risk varies throughout the daily cycle due to changing visibility and predator activity. In this project, we used camera trap data to investigate how African ungulates alter their habitat use through time in response to the risk of predation. Sixteen motion-activated camera traps were deployed in paired woodland and grassland habitats at eight sites in Serengeti National Park, Tanzania. Woodlands provide cover for predators and are considered high-risk environments, whereas open grasslands are considered low-risk. These cameras took photos of large mammals during 2017 and 2018, and we have classified the images by recording the presence/absence of N species. We will analyze the effect of diel on habitat preference by fitting generalized linear mixed-effects models to counts of species occurrences.

Disease vectors and biodigesters: the detection, characterization, and control of *Aedes aegypti* in effluent ponds

Tommy Bui[1], Ron Carroll[1], and Amanda Rugenski[1]

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The use of biodigesters is currently promoted to small farms in Costa Rica to create biogas and fertilizer from human and animal waste. Although this practice is beneficial in terms of sustainability, the open-air effluent ponds involved with the breakdown of waste pose a risk of creating environments for disease carrying mosquitoes to breed and oviposition, such as *Aedes aegypti*, which is a competent vector for arboviral diseases, such as Dengue and Zika. In the animal waste biodigester ponds at the UGA Costa Rica campus, we detected the presence of *Aedes aegypti* through sampling and rearing larvae from the effluent. Furthermore, we used a multi-probe to characterize abiotic factors of the effluent as it flowed through the lagoons and compared them to the density of the mosquito populations at each transect. Finally, we explored the use of a plastic screen and introduction of natural predators to control the mosquito population. Our results indicated a higher density of mosquito larvae at transects with median values for dissolved oxygen, ammonium, and total dissolved solids. The use of a plastic screen showed no significant effect in preventing mosquito oviposition, however the introduction of dragonfly larvae to effluent ponds resulted in a significant decrease in mosquito larvae shortly thereafter. It is unclear if dragonflies provide a sustainable approach to mosquito control in biodigesters, however this project identifies and presents potential solutions to a previously unknown problem that requires further investigation.

Fungus amongst us: macrofungal diversity in different stages of secondary growth in a tropical premontane wet forest

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Tropical forests sequester large amounts of carbon and nearly 40% of these forests are secondary growth. Fungi fill essential niches in forest ecosystems, forming links between trophic levels and play an important role in nutrient cycling, improving plant growth and stress resistance. They are also an important assessment of forest health. I examined the macrofungal assemblages in three stages of secondary growth tropical premontane wet forest. I grouped the forest into age classes of <30 years, 40-60 years, and >70 years, and then sampled three 25m line transects in the middle and youngest age classes and four in the oldest age class. I counted or estimated numbers of each species found, and took photos for later identification. I hypothesized that the diversity of macrofungal communities would be higher in older sections of secondary growth and that abundance levels would also be higher due to larger amounts of downed wood. I found increasing richness from youngest to oldest forest age class, with around 26 for the oldest age class, 20 for the middle age class, and 13 in the youngest age class. A percent rank abundance graph of all the transects shows an increasingly even community distribution with age class. Shannon's Diversity Index was 2.3 for the oldest age class, 1.8 for the middle age class, and 1.3 for the youngest age class. My study supports the hypothesis that macrofungal diversity does increase with forest age, indicating a resilient system with the ability to return to full functioning after disturbance.

Feeding rate as a function of body size, temperature and site in a species of littorinid snail

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Individual performance is known to scale with body size and temperature. Aquatic ectotherms in particular exhibit a strong correlation between performance and temperature. Quantifying these scaling relationships (e.g. individual performance as a function of both body size and temperature) can provide valuable insight into how individual within and across populations may vary in their response to the environment. Through this study, we hope to examine how feeding rates of a salt marsh gastropod species, *Littoraria irrorata*, scale with temperature and body size. Additionally, we aim to investigate whether or not these scaling relationships vary across three marsh sites spanning a latitudinal gradient of 8 degrees. Quantifying these scaling relationships for feeding, we aim to demonstrate the importance of population size structure and thermal environment for predicting population-level consumer effects.

Are darters picky predators? Potential consumer effects on prey communities during drought

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Droughts are increasing in frequency and intensity in the southeastern United States. These dry periods can have significant effects on consumers as drought reduces food availability. Conversely, predators may maintain populations by adjusting their consumption patterns, consequently altering prey communities. Darters, small perch-like fishes, are important predators in many temperate stream ecosystems. In the Middle Oconee River, located in Athens, GA, one of the most frequently observed fish is the turquoise darter (*Etheostoma inscriptum),* which feeds primarily on aquatic insect larvae. Turquoise darter populations concentrate in shoal habitats (shallow rocky areas with swift flow) during drought, increasing in both density and number. Darter prey, aquatic macroinvertebrate larvae, concurrently decline. However, it is still unclear how darter consumption during drought impacts the macroinvertebrate community, or if darters change their consumption patterns. To address this, I compared gut contents of turquoise darters collected in wet and drought years in the Middle Oconee River shoals to identify the types and size of macroinvertebrates consumed. Preliminary results show that turquoise darters primarily consume *Chironomidae* and *Hydropsychidae* larvae, whereas previous studies have shown high abundance of other potential prey, such as *Baetidae*. This suggests that turquoise darters may alter macroinvertebrate community composition during dry periods.

The influence of abiotic factors on the arthropod communities of tank bromeliads in the Montverde Cloud Forest, Costa Rica

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Plants of the family Bromeliaciae, most of which are epiphytic on tropical trees, contain their own mini aquatic ecosystem making them perfect for studying community diversity and aquatic food webs. Arthropods are often found in bromeliads because of the water availability within the plant. Studies have shown a relationship between the bromeliad size and arthropod communities that inhabit them; however, little is known about the effects of light input on these communities. The purpose of this study is to analyze the relationship between abiotic factors and arthropod community structure in bromeliads across open and closed habitat types. We hypothesized that (1) a positive correlation between bromeliad size and water volume and positive correlation between species richness and water volume; and that (2) arthropod species richness will be higher in open habitats rather than in closed habitats and total suspended solids (TSS) will be higher in the closed habitat. We found that arthropod community structure is closely linked to habitat size and water volume within the plant. The open habitat had a higher species abundance and richness and habitat had no effect on the amount of total dissolved solids. Future studies should focus on measuring the chlorophyll content within the bromeliad to examine if there is more primary productivity in the open habitat versus the closed.

E. coli and water quality in the San Luis river and tributaries in Monteverde, Costa Rica

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Costa Rica's insufficient waste water treatment puts its citizens and ecosystems at risk of *E. coli* contamination and eutrophication that results from physical and chemical runoff. Increased nutrients from domestic runoff, septic tank overflow, and agricultural runoff can lead to eutrophication and result in stream water with coliforms levels higher than 125 cfu/L, which is the maximum amount of *E. coli* permitted in water for domestic and recreational use. In this study, BOD5 tests, ammonium amounts, total suspended solids, and *E. coli* amounts were analyzed to determine the quality of the stream water along the San Luis river in the northern Bellbird Biological Corridor in Costa Rica along with tributary streams. All sites tested had *E. coli* amounts of less than 125 cfu/L except one, a tributary stream site labeled Lindora. San Luis sites showed a general increasing trend in *E. coli* as samples moved from upstream to downstream. In addition, a regression test ($p=0.029$) showed a positive correlation between E. coli and TSS once outlier Lindora was removed. While most sites tested had water safe for domestic and recreational use, this data implies the importance of forested regions for water filtration. With the lack of waste water treatment in Costa Rica and this evidence of increasing E. coli amounts as water moves from upstream to downstream, it is important to further survey E. coli abundances in this region for the sake of human and ecosystem health.

Aquatic invertebrate community composition in tropical streams following a aajor disturbance

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Global climate change is causing changes in weather patterns, and in the tropics, this is leading to increases in extreme hydrologic events. Tropical storm Nate impacted the Monteverde region of Costa Rica in 2017, changing the landscape and watershed. Perennial stream Alondra and intermittent stream Bruja are located in the area impacted by the storm and were both affected. However, Alondra experienced a major debris flow which eliminated the riparian vegetation leading to increased solar radiation, while Bruja experienced a less severe debris flow leaving most of the riparian cover intact. We quantified the effect of this disturbance event on invertebrate community composition by comparing samples collected 1-year before tropical storm Nate. We hypothesized that the invertebrate community composition will be dominated by grazers in Alondra with lower taxa richness, however, Bruja would have a similar community composition and richness pre- and post-Nate. We sampled 3 transects in each stream using a 250μm Surber net and id invertebrates to genus or lowest possible taxonomic level. The loss of canopy cover and in stream disturbance of Alondra changed the invertebrate community composition. Baetidae grazers were the dominate taxa and richness and density decreased by 50% compared to pre-Nate. Burja community

composition and richness was similar to pre-Nate however variation was high. Our project will help to acquire a better understanding of how invertebrate communities respond to storm damage in tropical perennial and intermittent streams.

Stable isotopes under varied insolation in Siderastrean corals

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The scleractinian corals found near the mouth of the Amazon River receive limited light due to their depth and seasonal coverage by the turbid Amazon River plume. Solar-irradiance determines whether habitat is hospitable for hermatypic corals that provide spatial complexity necessary for tropical reef ecosystems. As scleractinian colonies grow, they deposit calciferous skeletons, and the ^{13}C and ^{18}O ratios in these skeletons can be used to assess the coral's dependence on photosynthetic zooxanthellae. In order to provide a baseline for assessing photosynthetic dependence in Siderastrea corals from the Amazon, I analyzed the stable isotope ratios in Caribbean Siderastrea siderea from a variety of depths, expecting ^{13}C to decrease with depth and ^{18}O to remain stable. ^{13}C did show a negative correlation with depth, while the ^{18}O remained relatively constant. In addition to testing museum specimen, I am currently conducting an insolation experiment on live Siderastrea radians collected from the Florida Keys. An experimental group will receive decreased irradiance for five weeks, while a control group will receive normal levels of light. After five weeks, I will dry out the specimen and collect dust for isotope analysis using the methodology applied to the museum specimen. I expect the corals given less light to rely more heavily on heterotrophy and to contain greater proportions of ^{13}C than the controls. This data is meant to act as a reference against which the isotope ratios of corals from the Amazon Reef System, which experience months of complete darkness annually, can be compared.

Effects of chronic stress on the acute stress reaction of horned passalus beetles, (*Odontotaenius disjunctus*)

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All animals are faced with situations that are stressful, often for long periods of time. The stress reaction of animals is primarily designed to enhance animal performance temporarily, so as to allow it to deal with the danger at hand. This 'acute' stress response is therefore beneficial. However, problems can occur if animals are faced with repeated or chronic stressors. Most of the work dealing with stress physiology comes from research conducted on vertebrate animals (mice, birds, humans). However, there is very little research focusing on invertebrates, and especially on the effects of long-term, chronic stress. The intent of this project is to explore the effects of chronic stress in an insect, the horned passalus beetle. Beetles were hand-collected and brought to the lab on campus. An experiment involved exposing them to daily bouts of mechanically induced stress

over 3 weeks. This will stimulate their acute stress reaction on a daily basis. Following this exposure, beetles will be examined for their heart rate reactions to subsequent stressors. This research represents a significant biological interest as it has never been studied before and could indicate an evolutionary disposition towards reduced or enhanced stress responses over extended periods of time.

Biological nitrogen fixation is dynamic after disturbance in southern Appalachian forests

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In the southern Appalachians, extensive logging and the chestnut blight in the early 20th century were major disturbances that triggered forest recovery over many decades. In this region, black locust, *Robinia pseudoacacia*, a dominant early-successional tree species, supports biological nitrogen fixation (BNF) through an association with symbiotic bacteria, but it was unclear how black locust supports BNF over time. The goal of this study was to quantify BNF by black locust across a stand age gradient, as part of a larger project estimating historical BNF inputs following the logging in 1921. We hypothesized that BNF would peak within the first decade following disturbance then decrease with time. We predicted this pattern to manifest because of differences in nodule mass, frequency of nodulation, and allocation of energy towards BNF over stand age, rather than differences in fixation activity per mass of nodule. To test this hypothesis, we quantified BNF across 125 trees and 11 stands ranging from 3 – 75 years. We found that BNF by black locust peaks at 10 years of stand age, and then declines in a curvilinear fashion. Our results also revealed that mass of nodule per stem decreased exponentially, the proportion of nodulating trees declined linearly, and the energy allocation towards BNF declined exponentially with stand age. These findings suggest that BNF inputs to the ecosystem are concentrated within the first decade following disturbance, making it important to study community dynamics and ecosystem processes during early successional periods in order to understand long-term legacy effects of disturbance.

More than a cup: analysis of a fungal pathogen in shade grown coffee

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Coffea arabica is among the most valuable legally traded commodities from the developing world. As temperature and precipitation patterns change, tropical economic plants, such as coffee, may be at risk for decreasing yields. One cause of decreasing yields is fungal diseases, such as *Mycena citricolor*. Given that fungal incidence may be influenced by changing climate patterns, it is important to quantify how this fungus is related to moisture and shade. We studied fungal incidence, soil moisture, and canopy cover on twenty juvenile coffee plants grown in a plot on the UGA Costa Rica campus. We also studied these factors in ten juvenile coffee plants in the premontane wet forest ecosystem on campus. In a one-month wet season span, the percent of

leaves with fungus grew greatly in plants already infected, while leaves on plants with no fungus remained unaffected. We found percent soil moisture had a significant negative relationship to percent of leaves with fungus ($p = 0.035$, $r2 = 0.37$). We also found a significant negative relationship between canopy cover and percent of leaves with fungus ($p < 0.001$). This study found shade grown coffee practices may serve as protective factors against *Mycena citricolor*. This finding has important implications for agriculture practices in the tropics in light of changing climate patterns and may serve to reveal another benefit of shade grown coffee practices.

Phenotypic plasticity in response to predation in two species of tadpole

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We quantified the effects of predator presence on growth and development in two species of tadpole, *Bufo marinus* and *Lithobates taylori*, in San Luis, Costa Rica. A total of sixty tadpoles, thirty of each species, were captured from the same pond and placed into twelve aquarium tanks for 21 days. Half of these tanks contained dragonfly larvae, natural predators of these tadpoles, behind a mesh divider which allowed for a visual cue of the predators as well as a chemical cue. We calculated instantaneous growth rate and recorded each tadpole's developmental stage. In both species, tadpoles that were in predator treatment tanks experienced a slower growth rate and faster developmental rate than those placed in tanks with no predation. *B. marinus* tadpoles experienced higher mortality than *L. taylori* when in predator treatment. Our experiment supports the hypothesis that the presence of a predator creates a cue that may induce an effect on growth rate and development in both the *Bufo marinus* and *Lithobates taylori* tadpole species.

Modeling optimal laboratory testing strategies for bacterial meningitis in Africa

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The introduction of a meningococcal serogroup A conjugate vaccine (MenAfriVac) in the African meningitis belt drastically reduced the incidence of invasive Neisseria meningitidis serogroup A (NmA) disease, which previously accounted for ~85% of all meningococcal meningitis cases in the region. The meningitis belt still experiences annual seasonal epidemics of non-serogroup A meningitis. Efficient meningitis surveillance in the region remains critical to monitor current circulating meningococcal strains. The proportion of suspected cases that require laboratory testing in order to inform a public health response is a critical operational parameter. In this study, we analyze case-based meningitis surveillance data during the 2014-2017 seasons from Burkina Faso, Niger, Togo, Mali, and Chad. By comparing sample estimates of the relative case burden of meningitis-associated bacterial pathogens with the true distribution for each country-season, we show how the expected precision of a meningitis surveillance program varies with the proportion of

cases selected for laboratory testing. Our findings can be used by public health authorities to set goals for meningitis surveillance programs, and were used to inform an increase in the WHO laboratory testing target for enhanced meningitis surveillance in Africa from 10% to 50% in October 2018.

Characterizing root architecture and anatomy in African savanna trees and grasses

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We still have a limited understanding of how root morphology and anatomy influences the water uptake and transport ability of savanna tree and grass species. Such knowledge is important because plant water uptake potential can inform how tree-grass savanna systems respond to future drought and other changes in climate. We investigated water uptake capability of tree and grass species found in African savannas by characterizing their individual root architecture and anatomy. We determined 1) root architecture by analyzing photographs of intact root systems to quantify total root length and diameter; 2) xylem vessel number and diameter in root cross-sections using microscopy; and 3) whole plant conductance by comparing maximum transpiration rates of species grown under common conditions. When compared to grasses, we found that trees had lower total root length per unit leaf area, contained more xylem vessels, and had generally smaller vessels per root. Additionally, our results show that trees transpire about half as much water as grasses per unit biomass. We discuss the broader implications of these trait differences between these two functional groups.