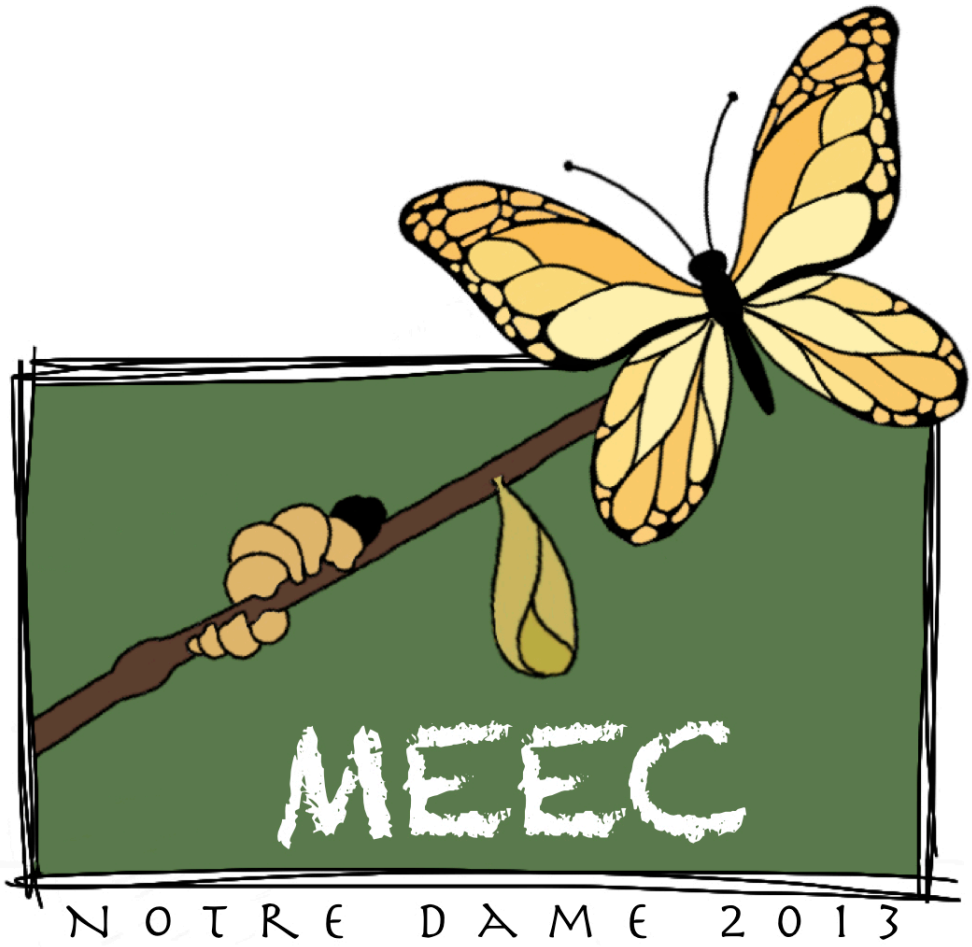

Midwest Ecology and Evolution Conference
2013

Conference Program

March 23rd – 24th

University of Notre Dame
Jordan Hall of Science

Welcome!

On behalf of the Department of Biological Sciences at the University of Notre Dame, welcome to the Midwest Ecology and Evolution Conference 2013. MEEC has been a great opportunity for students located in the Midwestern United States to present their research, to discuss research ideas, and to form collaborations in the past, and we are hoping to continue that excellent tradition this year.

We are honored to be able to host two respective scientists at the tops of their disciplines in ecology an evolution as part of the John A. Lynch lecture series. Dr. Michael Vanni at Miami University and Dr. Rowan Barrett from Harvard will be presenting their work during plenary presentations on Saturday and Sunday mornings. In addition to these great speakers, we have over 80 oral presentations and more than 90 posters from undergraduates, graduate students, and postdocs from around the Midwest, representing over 50 different institutions; ranging from large research institutions to smaller liberal arts colleges. Please take time to look through this program to appreciate the diversity of the research presented, and make the most of these packed two days.

The schedule for presentations is located at the front of this program, with abstracts for oral and poster presentations in the back. We have also included in the back of this program a few notes about places to eat, either for lunch or for dinner, that are both on and off campus. If you have any specific questions please find someone from Notre Dame, and they can hopefully help you out.

Thank you for your participation in MEEC 2013, and please let us know if there is anything we can assist you with during the conference, or during your stay in South Bend.

Sincerely,

MEEC 2013 organizing committee

Schedule of Events

Saturday March 23rd

Pick up registration material Jordan Hall of Science (JHS) atrium	7:45-8:15
Plenary Lecture by Dr. Michael Vanni Room 105 JHS	**8:15-9:15**
Break	9:15-9:30
*Oral presentations	9:30-12:00
Break	12:00-1:30
*Oral presentations	1:30-3:30
+Poster presentations	3:30-5:00
Banquet dinner *Location: JHS atrium*	7:00-9:00

Sunday March 24th

Plenary Lecture by Dr. Rowan Barrett Room 105 JHS	**8:45-9:45**
Break	9:45-10:00
*Oral presentations	10:00-12:15
Student award presentation Room 105 JHS	1:00-1:15

*Specific oral presentation schedule in the following pages of this program
+Poster locations (numbers) listed next to abstracts

<u>Plenary Speakers – sponsored by the John A. Lynch lecture series</u>

Dr. Mike Vanni

Miami University

Department of Zoology

Dr. Vanni is an ecosystems ecologist using a variety of techniques to examine questions pertaining to the ecology of food webs, nutrient cycling, and watershed-lake interactions. His current interests are in the effects of animals on nutrient cycling, incorporating ecological stoichiometry and metabolic ecology to study variation among species. Other interests include the relative importance of animal-mediated nutrient cycling among biomes and animal-influenced nutrient sink-source dynamics. This includes how the role of fish may vary over temporal scales and among watersheds with different land use demographics.

Lab Website: http://www.units.muohio.edu/vannilab/

Plenary Abstract: Animals can affect the fluxes of nutrients such as nitrogen (N) and phosphorus (P) in many ways and in many biomes. For example, all animals release N and P as waste products, and some animals can move transport great distances via their movements. In addition, animals can have strong indirect effects of nutrient cycling by regulating populations of plants and microbes, and by modifying physical habitats. While the importance of animals has been demonstrated in many situations, there has not been a synthesis of the role of animals in nutrient cycling. This talk will attempt to synthesize information on the roles of animals in mediating biogeochemical cycles, from individuals to biomes, and is structured in three parts. First, data from freshwater and marine taxa were compiled to assess the extent to which body size, temperature and animal body nutrient content can predict excretion rates of animals in the field. This synthesis of over 8000 observations shows that body size alone is an excellent predictor of both N and P excretion rates, but also that temperature and body nutrients are significantly related to excretion rates and the N:P ratio excreted. Metabolic scaling coefficients relating body size and excretion rates show negative allometry, but usually are different from 0.75 (the coefficient predicted by metabolic ecology theory). Temperature has a greater effect on N excretion than on P excretion, and excretion N:P is negatively related to body N:P, as

predicted by ecological stoichiometry theory. The second part of the talk presents case studies on the role of animals (mostly fish) in nutrient cycling in lakes. These studies show that nutrient excretion by fish can exceed nutrient supply from other sources known to be important (e.g., watersheds) and can support a significant fraction of ecosystem nutrient demand. However, the importance of fish varies considerably both spatially and temporally, even within a single ecosystem. The third part of the talk provides predictions regarding the roles of animals in nutrient cycling across aquatic and terrestrial biomes. Based on energy flow and other ecosystem properties, direct fluxes of nutrients through animals are predicted to be most important in pelagic ecosystems, least important in forests and of intermediate importance in grasslands. In contrast, the importance of indirect effects of animals in mediating nutrient cycling (via trophic cascades, selective feeding, ecosystem engineering) relative to direct effects (direct flux through excretion) is predicted to be greatest in forests and least in pelagic systems. General conclusions are that animals are under-appreciated in terms of their importance in nutrient cycling and have not been adequately integrated into conceptual models of biogeochemical cycling. A major challenge is predicting and testing for variation across ecosystems and over various scales.

Dr. Rowan Barrett

Harvard University

Dept. of Organismic and Evolutionary Biology Barrett uses molecular techniques and manipulative field experiments to study the genetic basis of species adaptation to shifting environments. By incorporating techniques from population genetics, molecular biology, and evolutionary ecology, Dr. Barrett seeks to answer questions about the reciprocal interactions that occur between evolutionary and ecological processes. This work has included a wide variety of organisms, ranging from microbes to deer mice, to even aquatic systems work with stickleback fish.

Lab Website:

http://www.people.fas.harvard.edu/~rbarrett/RDHB_Harvard/Welcome.html

Plenary Abstract: Climate change and other anthropogenic disturbances are forcing many natural populations to adapt to new environmental pressures, but the role of selection in shaping

genome evolution is not fully understood. What factors explain variability in how far and fast adaptation proceeds? Two fundamental challenges are identifying the molecular basis of adaptive phenotypic variation and elucidating the evolutionary processes acting on this variation. We would like to know which genes and, in particular, which alleles produce diversity, and how natural selection acts on this variation. In natural populations, putatively adaptive loci often have been identified using genome scans, which detect outlier loci with variation significantly different from neutral expectations. Yet, this approach has some limitations; for example, it cannot inform us about the mechanistic basis of selection, recombination can obscure signals of past selection, and it can be difficult to distinguish between patterns created by demographic versus selective forces. Experimental studies help clarify the genetics of adaptation by documenting the mechanisms and targets of selection that drive changes in allele frequency (the process) in ways that are not possible when investigating historical signatures of selection (the outcome). Here, I will describe some examples of my work with threespine stickleback fish and deer mice that use manipulative experiments to directly estimate how selection impacts the genome as populations adapt to new environments. The results shed light on the pace of adaptive evolution in nature and improve our understanding of the functional connections between genotype, phenotype, and fitness.

Oral presentation schedule

Saturday March 23rd

Session IA – Environmental Change – JHS 322

9:30-9:45 **Ecological consequences of human land-use for specialist herbivores and their parasitoids**
Amanda E. Nelson and Andrew A. Forbes

9:45-10:00 **Invasive Plants May be Detrimental to Grassland Bird Nesting**
Kerri C. Martin, Chelsea Merriman, Gary E. Belovsky

10:00-10:15 **Top predator recolonization leads to Great Lakes forest restoration**
David G. Flagel and Gary E. Belovsky

10:15-10:30 **Coming to terms with assisted migration**
Hällfors M.H., E. Vaara, M. Hyvärinen, M. Oksanen, H. Siipi, L. E. Schulman, S. Lehvävirta

10:30-10:45 **The Changing Forests of Ohio: Drivers of Composition Shifts Between the Settlement Era and Today**
Daniel Williams, Jillian M. Deines, Jason S. McLachlan

10:45-11:00 **Does engineering affect the ecology of freshwater-lake shorelines?**
Stacey M. Wensink and Scott D. Tiegs

11:00-11:15 **Life in Brown Waters: Aquatic Bacteria Respond to Increased Terrestrial Carbon Loading**
Mario E. Muscarella, Stuart E. Jones, Jay T. Lennon

11:15-11:30 **Drivers of methane production from lakes in forested and agriculturally dominated landscapes**
William. E. West, Kevin. P. Creamer, James. J. Coloso, Stuart. E. Jones

11:30-11:45 **Are changes in the genetic and morphological composition of butterfly hybrid zone over a 30 year period the result of climate change?**
Sean F. Ryan and Jessica J. Hellmann

11:45-12:00 **Genetic differences over time can affect predictions in plant response to increased CO_2 levels**
Marilia B. M. Figueiredo, Rachel M. Gentile, Jason S. McLachlan

Sesssion IB – Aquatic Ecology I – JHS 101

9:30-9:45 **Decomposition rate and macroinvertebrate colonization of artificial leaf packs in a forested headwater stream**
Nicholas R. Cusick, and Jennifer M. Clark

9:45-10:00 **Using benthic macroinvertebrate recolonization to gauge stream community response to potential disturbance caused by restoration**
Scot D. Peterson and Howard H. Whiteman

10:00-10:15 **Combinatorial salinity and pH stress responses of invasive Asian shore crab (*Hemigrapsus sanguineus*)**
Elsa C. Anderson, Mary E. Kasparian, Ciaran A. Shaughnessy, Jalene M. LaMontagne, Jason S. Bystriansky

10:15-10:30 **Assessing gastropod host competence in the Upper Mississippi River: Can an invasive snail serve as a host for a native parasite?**
Christopher M. Glodosky and Gregory J. Sandland

10:30-10:45 **Exploring the interactive effects of light, nutrients, and carnivore identity on aquatic food chain efficiency**
Amber Rock, Mia Hall, Michael Vanni, María González

10:45-11:00 **Hydrologic influences on the distribution of larval fishes in rivermouths of the Great Lakes**
Gainer, N.G., J.S. Schaeffer, J. Larson, W. Richardson, P. Seelbach

11:00-11:15 **The Effect of Dissolved Organic Carbon (DOC) on Planktivorous Feeding Habits**
Katherine Baglini, Jake Zwart, Stuart E. Jones, Brian C. Weidel

11:15-11:30 **Benthic invertebrate communities are more responsive to nutrient inputs than the presence of a sediment-feeding fish**
Ann M. Showalter, Allison L. Becknell, María J. González

11:30-11:45 **Land-Use Impacts to Stream Macroinvertebrate Communities in Southeast Michigan**
Jeremy A. Geist and Scott D. Tiegs

11:45-12:00 **The effects of the herbicide Atrazine and predation on the larval dragonfly *Ladona deplanata***
Ann F. Gilmore and Claire A. Fuller

Session IC – Adaptation and Evolution I – JHS 105

9:30-9:45 **What makes a successful virus?**
John Thompson and Catherin Putonti

9:45-10:00 **The codon bias of gene J in bacteriophage phiX174**
Alex Kula and Catherine Putonti

10:00-10:15 **Genomic exploration of bacterial habitat adaptation**
Dan Liu, Wei Zhang, Stuart Jones

10:15-10:30 **Temporal and ecological predictors of gut microbiome structure in wild baboons**
Laura E Grieneisen, Alex F Koeppel, Martin Wu, Elizabeth A Archie

10:30-10:45 **Temporal variation in diet and phenotypic plasticity in masticatory elements.**
Jeremiah E. Scott, Meghan M. Eastman, Joel Hlavaty, Andrew G. Mancini, Joseph P. Scollan, Jr., Kevin R. McAbee, Matthew J. Ravosa

10:45-11:00 **Suspensory behaviors and the neck: a comparative analysis of the cervical vertebrae of extant primates**
Thierra K. Nalley

11:00-11:15 **A Force to be Reckoned with: Seasonality, Plasticity and Development of Mammalian Skull Form**
Erin M. Franks, Meghan M. Eastman, Joel Hlavaty, Andrew G. Mancini, Joseph P. Scollan, Jeremiah E. Scott, Kevin R. McAbee, Matthew J. Ravosa

11:15-11:30 **Teaching with digital evolution software:**
Assessing student understanding of fundamental concepts
Amy Lark, Wendy Johnson, Louise Mead, Jim Smith, Gail Richmond, Robert T. Pennock

11:30-11:45 **Genetic architecture of tripartite interactions: Legumes, rhizobia, and mycorrhizal fungi**
Julia N. Ossler and Katy D. Heath

11:45-12:00 **Particle size distribution and optimal capture of fish environmental DNA.**
Turner, C.R., M. A. Barnes, C. C. Y. Xu,C. L. Jerde, Lodge, D.M.

Session IIA – Disease Ecology – JHS 322

1:30-1:45 **Detecting the Source of Infections Past**
Michael Shaffer and Catherine Putonti

1:45-2:00 **The influence of avian life-history and ecological traits on tick infestation.**
Christine Marie Roy, Sarah H. Cleeton, James R. Miller, Brian F. Allan.

2:00-2:15 **How Time of Exposure to the Amphibian Chytrid Fungus affects Cope's Gray Treefrogs (Hyla chrysoscelis) in the Presence of an Insecticide**
S.L. Rumschlag and M.D. Boone

2:15-2:30 **The Influence of Sex and Age on Patterns of Parasitism in Wild Baboons**
Emily Spulak

2:30-2:45 **When a Helminth isn't just a Helminth: Genera Specific Helminth Effects on Intracellular and Extracellular Microparasite Infections in Long-Tailed Macaques (*Macaca fascicularis*) in Bali**
Justin Wilcox, Kelly Lane, Agustin Fuentes, Hope Hollocher

2:45-3:00 **Exploring the role of migratory songbirds in the range expansion of the Lyme disease pathogen and its vector**
Cleeton, S. H., C. M. Roy, J. R. Miller, B. F. Allan.

3:00-3:15 **Ant disease carriers proliferate fungal pathogen control of an insect pest**
Erica J Kistner and Gary E. Belovksy

3:15-3:30 **Whirling Disease Dynamics: An Analysis of Intervention Strategies**
Kimbra Turner, Matthew Smith, Ben Ridenhour

Session IIB – Terrestrial Ecology – JHS 101

1:30-1:45 **Diversity and ecology of Wisconsin land snails in the Driftless region**
Chris Lynum, Rachelle Amundson, Kathryn E. Perez, Matt Kuchta, Amanda Little, Terrell Hyde

1:45-2:00 **Arthropod Diversity in Restored Prairies**
Sarah E. Atherton

2:00-2:15 **Forest bee diversity in relation to habitat and vertical stratification**
Jared D. Ruholl, Kenneth McCravy, James Zweep

2:15-2:30 **The effects of permethrin on Kingsnake (*Lampropeltis mexicana*) embryo development and eggshell thickness**
Benjamin Hagen, Benjamin Rausch, Richard Phillips

2:30-2:45 **Earlywood and latewood growth responses in northern red oak: the effect of climate at the Ft. Defian**
Aaron Cross

2:45-3:00 **Effects of Invasive Plant Species on Grassland Bird Nesting**
Chelsea Merriman, Kerri C. Martin, Gary Belovsky

3:00-3:15 **The hummingbird and the hawkmoth: Species diversity, competition and niche partitioning across the United States**
Abdel H. Halloway, Joel S. Brown, Christopher J. Whelan

3:15-3:30 **Interactions between *Echinacea angustifolia* and its specialist aphid: Phenology, herbivory, and plant performance**
Katherine Muller and Stuart Wagenius

Session IIC – Behavioral Ecology I – JHS 105

1:30-1:45 **Modulation of Anti-Predator Behavior by Coat Color in the Eastern Gray Squirrel (*Sciurus carolinesis*)**
Patricia Bohls and Thomas J. Koehnle

1:45-2:00 **Should I stay or should I go? Sibling cooperation and the age of nest-leaving in an altricial bird**
Keith Bowers, S. K. Sakaluk, C. F. Thompson

2:00-2:15 **Title: Trophic niche breadth in a widely-foraging snake (Colubridae: *Coluber*).**
Corissa P. Lennon and Stephen J. Mullin

2:15-2:30 ***Cancellation***

2:30-2:45 **Aggression and Food Competition Between Sympatric Hermit Crab Species**
Mark V. Tran, Mathew O'grady, Jeremiah Colborn, Kimberly Van Ness

2:45-3:00 **How do bats perceive owls: friend or foe?**
Gregg Janos

3:00-3:15 **Forage and Human Impact Analysis of a Reintroduced Black Rhino (*Biceros bicornis*) Population**
John Clark, Rachel Beyke, Dr. Michael Stokes, Dr. Craig Spencer, Stefan Bosman

Sunday March 24th

Session IIIA – Behavioral Ecology II – JHS 322

10:00-10:15 **Blind Dating: The role of different eye types in female mate recognition and prey detection by the wolf spider *Schizocosa ocreata* (Hentz)**
Rebecca Wilson, Tess Piening, George W. Uetz

10:15-10:30 **Estimating the spatial scale of arthropod attraction to herbivore-induced plant volatiles**
Joseph Braasch and Ian Kaplan

10:30-10:45 **Acoustic and vibratory signal production in the wolf spider *Gladicosa gulosa***
Alexander L. Sweger and George W. Uetz

10:45-11:00 **Effects of immune stress on multimodal sexual signaling of a wolf spider**
Rachel Gilbert, R. Karp, G. W. Uetz

11:00-11:15 **The effects of perceived male availability on female selectivity in a wolf spider, *Schizocosa ocreata***
Brent Stoffer and George W. Uetz

11:15-11:30 **Effects of landmarks on territorial behavior of *Hypsophrys nicaraguensis***
Piyumika S. Suriyampola, and Perri K. Eason

11:30-11:45 **The Effects of Varying Cache Depth and Mammalian Predator Scent on the Foraging Behavior of the Forest Deer Mouse**
Chelsea L. Gyure and Michael J. Cramer

11:45-12:00 **Impacts of the Fire-Grazing Interaction on the Nesting Ecology of Grassland Birds**
Courtney Duchardt, James R. Miller, Diane M. Debinski, David M. Engle

Session IIIB – Adaptation and Evolution II – JHS 101

10:00-10:15 **Using compositional properties to classify metagenomic reads**
Zachary Romer and Catherine Putonti

10:15-10:30 **Play the odds: Mate availability, not timing, impacts female reproductive investment**
Emily G. Weigel, Robin M. Tinghitella, Jenny Boughman

10:30-10:45 **The Role of Maternal Effects on Life History Variation in a Polyphenic Salamander**
Michael P. Moore

10:45-11:00 **Evolution of growth rates in invasive populations of rusty crayfish (*Orconectes rusticus*)**
Lindsey Sargent, Andy Deines, David Lodge

11:00-11:15 **Nutrient stoichiometry drives microbial eco-evolutionary feedbacks**
Megan L. Larsen, Steven W. Wilhelm, and Jay T. Lennon

11:15-11:30 **Sequential speciation amplifies biodiversity across trophic levels**
Glen R. Hood, Andrew A. Forbes, Thomas H. Q. Powell, Scott P. Egan, Jeffrey L. Feder

11:30-11:45 **Establishing a global DNA barcode for *Ozobranchus* spp. in the Atlantic and Pacific Oceans**
Triet M. Truong and Audrey E. McGowin

11:45-12:00 **The frontier of ecological speciation: Investigating western populations of *Rhagoletis pomonella***
Sheina Sim

12:00-12:15 **Can preexisting trait variation predict the outcomes of parasitoid competition in novel habitats?**
Gabriela Hamerlinck and Andrew A. Forbes

Session IIIC – Aquatic Ecology II – JHS 105

10:00-10:15 **A maximum likelihood approach to modeling zooplankton production**
Patrick Kelly, and Stuart Jones

10:15-10:30 **Environmental Drivers of Phytoplankton Light Use Efficiency in 25 Globally Distributed Lakes**
Jake A. Zwart, Christopher T. Solomon, Stuart E. Jones

10:30-10:45 **Climate and Watershed Land Use Determine Phytoplankton Nutrient Limitation Status**
Nicole M. Hayes, Michael J. Vanni, Martin J. Horgan, William H. Renwick

10:45-11:00 **Effects of food web structure and nutrient supply on methane release in lakes**
Rachel M. Pilla, Stuart E. Jones, Will E. West

11:00-11:15 **Pelagic nutrient uptake in 15 rivers with varying turbidity and nutrient concentrations**
Alexander J. Reisinger, Jennifer L. Tank, Emma J. Rosi-Marshall, Robert O. Hall, Michelle A. Baker

11:15-11:30 **Biofilm Accumulation and Diversity in the Intertidal and Subtidal Zones of the ACE Basin Estuary, South Carolina**
Ryan Wenkus, Garrett Einhorn, Laila Younes, Jalene M. LaMontagne, Jason S. Bystriansky

11:30-11:45 **Investigation of the cavernous diatom flora in Kauai, Hawaii, with the description of four diatom species new to science**
Laura Miscoe, Jeff Johansen, Rex Lowe, Patrick Kociolek

11:45-12:00 **Impact of freighter traffic on fish communities of St. Marys River wetlands (Michigan, USA)**
Jake Riley, Ashley Moerke, Scott Tiegs

12:00-12:15 **Inundation regimes affect invasive-plant-litter decomposition in a Great Lakes coastal wetland**
Anita M. Baxter, Donna R. Kashian, Scott D. Tiegs

Oral Presentation Abstracts
(alphabetical order)

Combinatorial salinity and pH stress responses of invasive Asian shore crab (*Hemigrapsus sanguineus*)

Elsa C. Anderson, Mary E. Kasparian, Ciaran A. Shaughnessy, Jalene M. LaMontagne, and Jason S. Bystriansky
DePaul University

Introduction of non-native species can have tremendous effects on local ecosystems. First introduced on American shores less than three decades ago, the Asian shore crab (*Hemigrapsus sanguineus*) has already successfully established populations from Northern Maine through the Carolinas. This study exposed Asian shore crabs to a range of environments and evaluated their survival and physiological responses. Asian shore crab were collected from an estuary at the southernmost reaches of the established range (ACE Basin, SC) and examined for pH and salinity tolerances. For 48 hours, crabs were exposed to our two-factor design, consisting of combinations of two salinity (5 or 30 ppt) and three pH (6.6, 7.6 or 8.6) treatments. Hemolymph ion levels, gill Na^+/K^+-ATPase activity, and whole-body ammonia excretion rates were measured to assess the ability of the crab to tolerate the interactive stress of these changes. Survival was near 100% in all treatments, and there was little change in crab physiological responses across experimental conditions. The Asian shore crab appears to be robust to all combinations of these stressors, which is consistent with the establishment of their population in the fluctuating estuarine environment of the ACE Basin.

Arthropod Diversity in Restored Prairies

Sarah E. Atherton
University of Louisville

Prairies are important ecological biomes that contain a high biodiversity of ecologically significant flora and fauna. Unfortunately, despite the vast historic distribution of prairies over most of mid-America, prairies are now generally reduced to small remnants, and even those remnant prairies are critically threatened due to urbanization and other anthropogenic activities. To improve this situation, many habitats have been restored to prairies. However, we have little knowledge of the stability of these prairies or how well they preserve typical prairie species. Species richness is used to assess the stability and condition of remnant and restored prairies, with higher species richness indicating greater stability. Because arthropod abundance comprises a significant portion of the animal species richness found in prairies, arthropods are ideal organisms for prairie assessment. In this study, arthropods were collected from April- July of 2012 at four restored prairies located in Jefferson (Iroquois Park and American Synthetic Rubber Company Landfill), Nelson (Jefferson Memorial Forest), and Bullitt (Bernheim Research Forest and Arboretum) Counties of Kentucky. Study sites were sampled biweekly using pitfall traps to collect ground-dwelling arthropods and sweep-netting to collect arthropods found on vegetation. Comparisons of species richness for arthropods and plants were made across study locations. Preliminary data indicates that Iroquois Park, the oldest of the prairies, has the highest arthropod family richness as well as the highest plant species richness. Data from the other study sites do not indicate significant differences in arthropod family or plant species.

The Effect of Dissolved Organic Carbon (DOC) on Planktivorous Feeding Habits

Katherine Baglini[1], Jake Zwart[1], Stuart E. Jones[1], and Brian C. Weidel[2]
[1]University of Notre Dame
[2]US Geological Survey

Dissolved organic carbon (DOC) has the potential to reduce the visibility of prey for predators in aquatic systems due to the increased brown color of DOC-rich lakes. Robertis et al. 2003 looked at the effect of turbidity in predator-prey interactions and found planktivorous fish experienced high difficulty capturing prey at high turbidity with the opposite effect in low turbidity. Increased concentrations of DOC may act similarly to turbidity in relation to visibility and thus could play a major role in predation.Roulet and Moore 2003 showed DOC concentrations have been increasing globally over the last twenty years. The effect of DOC on visibility in aquatic food webs is not well known and is an important area of research as this upward trend continues. In this experiment, planktivorous feeding trials were conducted for bluegill, juvenile largemouth bass, and fathead minnows. Trials were run across a DOC gradient which mimicked the natural variation found in 10 survey lakes from the surrounding propertyat the University of Notre Dame Environmental Research Center in Land O'Lakes Wisconsin. The gradient spanned four tanks at 3, 12, 20, and 28 mg of DOC per liter. For bluegill and largemouth bass, DOC concentration was negatively correlated with feeding rate, whereas the opposite trend was seen in fathead minnows. The findings suggest that DOC concentration does significantly reduce visibility for some species of planktivorous fish, though not all. Further research may help in explaining the different trend in minnows

Inundation regimes affect invasive-plant-litter decomposition in a Great Lakes coastal wetland

Anita M. Baxter[1], Donna R. Kashian[2], and Scott D. Tiegs[1]
[1]Oakland University
[2] Wayne State University

Anthropogenic changes to freshwater ecosystems, such as altering the inundation regimes of wetlands, may prompt changes in ecosystem-level processes. We evaluated the separate effects of inundation duration and frequency on a fundamental ecosystem-level process in wetlands, litter decomposition. Leaves from the non-native species *Phragmites australis* and *Typha angustifolia* were enclosed in coarse and fine-mesh litter bags (in order to isolate the effects of invertebrates and microbes to the decomposition process) and placed in a Lake St. Clair marsh (Michigan, USA). Using a randomized block design, rising and falling lake levels were simulated by moving the litter bags (n=400) into and out of the water for 180 days. Results show that inundation duration explained significantly more variation in our data set than did inundation frequency (ANOVA, $p<0.001$), with increasing duration translating to more rapid decomposition. *P. australis* decomposed more rapidly than *T. angustifolia* ($p<0.001$). Invertebrate feeding (evidenced as differences between mesh types), while statistically significant ($p<0.001$), was a modest source of mass loss compared to microbial decomposition. These results bear relevance for resource managers, who are increasingly managing hydrologic regimes to meet management goals, and also for understanding unmanaged wetlands that are impacted by fluctuating water levels due to climate change.

Modulation of Anti-Predator Behavior by Coat Color in the Eastern Gray Squirrel (*Sciurus carolinesis*)

Patricia Bohls and Thomas J. Koehnle
Hiram College

In mammals, expression of melanocortin receptor ligands is correlated with both dark pigmentation and increased stress resistance and higher levels of aggression. Though many studies of captive and laboratory animals have explored this pleiotropic interaction, few studies of animal personality have occurred in free-living wild animals. The Eastern gray squirrel (Sciurus carolinensis), with both gray and black morphs, may provide a good model system to explore personality in a wild population. This playback study focused on the anti-predator behavior differences between black and gray morphs in Hiram, Ohio.
Over several weeks I recorded vigilance, tail flagging, freezing, lateral escape, and vertical escape behaviors in response to digital playback of a American Robin call, a car alarm, or a Red Tailed Hawk call. All squirrels exhibited increased anti-predator behavior after hearing increasingly threatening stimuli, in the order of increasingly threatening: American Robin call, Car Alarm, Red Tail Hawk call.
Consistent with prior findings in this and other labs, gray morphs were more likely to run up a tree after hearing a threatening call. Black squirrels were more likely to heighten their vigilance than attempt to escape. Habitat use also differed between color morphs, indicating better risk assessment capabilities in the black morph, or perhaps differential competitive capability. In summary, a growing body of evidence indicates that it is possible to study aspects of animal personality in free-living gray squirrels, and to use this model to examine pleiotropic effects of genes on animal behavior.

Should I stay or should I go? Sibling cooperation and the age of nest-leaving in an altricial bird

Keith Bowers, S. K. Sakaluk, and C. F. Thompson
Illinois State University

In altricial birds, siblings raised within a nest usually leave the nest over a short span of time, despite often differing considerably in age. The youngest siblings are often underdeveloped relative to their older siblings and, thus, less likely to survive outside the nest, yet they risk abandonment if they do not fledge with their older siblings. Nest-leaving is usually initiated by the older offspring, which could delay this process to provide more time for their younger siblings to mature prior to leaving the nest, increasing the younger siblings' post-fledging survival and the older siblings' inclusive fitness. We tested this hypothesis in a population of house wrens (*Troglodytes aedon*), and found that broods with broad age spans among siblings had longer nestling periods than broods with narrow age spans, and that delayed fledging improves the survival and reproductive prospects of younger siblings. We also manipulated age spans through cross-fostering, and found that older foster nestlings postponed fledging when raised with younger brood-mates, as predicted if the age of younger nestlings helps determine the time of fledging. Our results support the kin-selection hypothesis and demonstrate that the exact time of fledging is attributable, at least in part, to sib-sib interactions.

Estimating the spatial scale of arthropod attraction to herbivore-induced plant volatiles

Joseph Braasch and Ian Kaplan
Purdue University

Herbivore-induced plant volatiles (HIPVs) are integral components of effective foraging by predacious and parasitic arthropods. These odorous cues are reliable indicators of herbivore presence and have been shown to be highly attractive to certain natural enemy taxa. Field studies which deploy synthetic HIPVs have demonstrated their capacity to significantly augment populations of beneficial insects. Yet, studies which have attempted to define the exact distances over which these compounds are active find effects terminating at 1m or less from the lure. In light of these incongruent findings, we conducted an experiment using a vacuum sampling method, as opposed to the sticky trapping method used in past experiments, to identify the range over which the common HIPV phenylethyl alcohol is active. In addition, we examined how insects redistribute themselves within the field after encountering an HIPV lure. We found insect responses (both attractive and repellent) to consistently extend 8m beyond the lure, and for one wasp family, a distribution pattern indicative of redistribution within the field, rather than augmentation of total numbers. This implies that HIPVs are in fact detectable over relatively large distances, consistent with the idea that they are useful foraging cues. Additionally, by examining the influence of HIPVs on predator distribution within an area we can better understand how the presence of HIPVs spills over into the surrounding landscape and alter arthropod populations.

Forage and Human Impact Analysis of a Reintroduced Black Rhino (*Biceros bicornis*) Population

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In late 2011, 19 black rhinos (*Diceros bicornis*) were translocated to a private reserve adjacent to Kruger National Park where they would face a lower threat of poaching and serve as breeding stock. Once released, the animals dispersed, with seven establishing residency within the reserve where they were released. These individuals have been closely monitored and locations were determined as often as possible through both visuals and the use of VHF transmitters and triangulation. From mid-June through December 2012, 235 location estimates were used to estimate home ranges. We conducted random plot vegetation sampling within the reserve to determine the type of browse available to the animals, and these data were then compared to forage data gathered through back-tracking and direct observation to develop electivity indexes for each species encountered during the study. We are using both attractive (browse) and deterrent (human activity) features of the reserve landscape to build a suitability model to estimate carrying capacity and determine future

Exploring the role of migratory songbirds in the range expansion of the Lyme disease pathogen and its vector

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Research on black-legged tick (*Ixodes scapularis*) hosts has mainly been limited to mammals, despite the fact that these disease vectors commonly parasitize a wide variety of North American passerines. The majority of these avian species can infect *I. scapularis* with *Borrelia burgdorferi*, the causative agent of Lyme disease. To examine the role of migratory songbirds in the range expansion of both *I. scapularis* and *B. burgdorferi*, we captured migrants using mist nets during the fall of 2012 in central Illinois where Lyme disease is non-endemic. Ticks were removed from captured birds and blood samples were taken from select species. Ticks were subsequently identified to species and life stage. Whereas most related studies only test larval ticks for the presence of *B. burgdorferi*, we uniquely screened both tick and avian blood samples for the pathogen using a combination of PCR and gene sequencing. We found a total of 124 ticks on 197 individual birds (representing 45 species). *Ixodes* spp. were detected on 10 birds, and to date, the presence of 10 *I. scapularis* larvae has been confirmed. We took blood samples from 29 birds, 9 (or 31%) of which were infected with *B. burgdorferi*, despite the fact that only one of these birds had attached *I. scapularis* larvae. This infection prevalence is much higher than any reported in the literature, and it would have gone unnoticed had only larval ticks been screened. Migrants may be playing a more important role in the spread of *B. burgdorferi* than has been previously thought.

Impacts of the Fire-Grazing Interaction on the Nesting Ecology of Grassland Birds

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Grassland bird populations are experiencing steep declines, a trend attributable in part to fragmentation and loss of grassland habitat. To appropriately manage what little habitat remains for breeding grassland birds, an understanding of the behavior and ecology of these species is crucial. The Grand River Grasslands of southern Iowa and northern Missouri are managed with differing applications of fire, cattle grazing, and the interaction of these two disturbance regimes, but the effects of these management treatments on the behavior of nesting birds is not well understood. I monitored the nests of grasshopper sparrows (*Ammodramus savannarum*), eastern meadowlarks (*Sturnella magna*), and dickcissels (*Spiza americana*) in the summer of 2012, and quantified vegetation at nests and at nearby points to investigate factors affecting both nest-site selection and nest success in these species. ArcGIS was used to quantify distances between nests and multiple edge types to detect patterns of edge avoidance or selection. We located and monitored 261 nests in 2012. Average nest success was almost identical between treatments, and ranged from 20%-33% for all three species. Preliminary analyses indicated an avoidance of pasture edges, and selection for certain habitat traits that are influenced by fire and grazing. For example, dickcissels appeared to select areas with higher vegetation density where at least some woody vegetation was present. By improving our understanding of the factors affecting nest-site selection and nest success, we can more efficiently cater management to the needs of these imperiled grassland species.

Earlywood and latewood growth responses in northern red oak: the effect of climate at the Ft. Defiance site in Iowa

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The objective of this study was to determine what climate variables most strongly influence earlywood and latewood formation in northern red oak (*Quercus rubra L.*) at the Fort Defiance site in Iowa. Tree ring measurements were taken for 28 cores representing 14 individual trees sampled from the site. Measurements were then correlated (using Pearson's Correlation) with monthly values for several climate variables, which included precipitation, temperature, max temperature, Pearson's Drought Severity Index (PDSI), actual evapotranspiration, and actual evapotransporation/ potential evapotransporation ratio. Latewood growth mirrored correlations present in total ring width analysis and was most strongly correlated with current year growing season during the months of May, June, and July. Significant correlations were observed for latewood, primarily in precipitation, PDSI, and max temperature. No significant earlywood correlations were observed in response to climate variables for which we tested in this study. These results will be interpreted in the context of seasonal growth patterns and carbon allocation.

Decomposition rate and macroinvertebrate colonization of artificial leaf packs in a forested headwater stream

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Leaf packs are natural sources of nutritional input as well as habitat for invertebrates in stream ecosystems, and can vary widely in composition and colonization by organisms. In this study, we examined leaf decomposition rate and macroinvertebrate colonization using three different types of artificial leaf packs [American Beech (*Fagus grandifolia*), Sugar Maple (*Acer saccharum*), and a combination treatment of equal mixtures of each] in riffles ($n = 3$) and pools ($n = 3$) in an Ohio headwater stream (Silver Creek, Portage County). Subsets of the leaf packs were removed two, four, and six weeks after initial deployment during winter 2012. Dissolved oxygen, pH, water depth, current velocity, and temperature were measured during each sampling period. The dry weight of leaf species significantly decreased over the three sampling periods ($P < 0.0001$) with Sugar Maple having significantly more mass loss than the combination treatment and the combination treatment having significantly more mass loss than American beech ($P < 0.0001$). However, the effect of habitat type on leaf decomposition was not significantly different between riffles and pools ($P = 0.9010$). Further, macroinvertebrate abundance significantly increased throughout the three sampling periods ($P < 0.05$) but there was no significant difference between leaf types ($P = 0.4165$). Significant variance in decomposition rates between leaf types and relatively insignificant difference in colonization of invertebrates between leaf types, and finally the lack of impact of habitat type on decomposition suggests that macroinvertebrate species instead of abiotic parameters play a strong role in leaf decomposition in system.

Genetic differences over time can affect predictions in plant response to increased CO2 levels.

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Plant growth response to elevated CO2 is difficult to predict due to acclimation and plasticity. Evolution can also affect plant response to elevated CO2 and could have large implications for ecosystem processes like carbon sequestration, but is often over looked. In order to determine whether genetic differences over a 100-year time scale could result in changes in growth response under future CO2 levels, we went "back in time" by germinating Schoenoplectus americanus seeds that have remained viable in sediments for up to 100 years. This population has not yet been exposed to current CO2 levels. Therefore, in a growth chamber experiment we examined how these "ancestral" plants responded to their historical CO2 concentrations (290ppm) versus current CO2 concentrations (400ppm). We quantified the growth response between the two CO_2 treatments with and without an inclusion of genetic shifts through time. Results demonstrate significantly higher stimulation in growth of the ancestral population over the modern population ($p<0.05$) when placed at current CO2 levels, suggesting that evolution could play a major role in estimates of carbon capture and storage over 100 years. We also identified shifts in phenotypic plasticity, which could suggest a mechanism by which selection is acting on Schoenoplectus americanus. Our results indicate that the current assumptions underlying the predictions of plant growth in elevated CO2 should begin to account for evolution

Top predator recolonization leads to Great Lakes forest restoration

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Through intensified sapling browsing, overabundant ungulates have altered several forest communities by inhibiting tree regeneration. If predators reduce herbivore numbers and/or change their foraging behavior, then their reintroduction may reduce herbivory pressure and benefit plant growth. This predator-herbivore-plant interaction is known as a "trophic cascade". My research focuses on whether the recolonization of the long-extirpated gray wolf (*Canis lupus*) may be generating trophic cascades in Great Lakes forests by altering white-tailed deer (*Odocoileus virginianus*) herbivory. I constructed ten deer exclosures, which were distributed evenly among high and low wolf use areas in a northern mesic forest (Land O' Lakes, Wisconsin), in order to compare deer herbivory impacts. I also placed camera traps in high and low wolf use areas to record differences in deer behavior. My results suggest wolves promote maple (*Acer* spp.) regeneration by altering white-tailed deer herbivory behavior. Deer used high wolf use areas less (t-test, $p=0.04$) and sacrificed feeding time for vigilance in these areas (t-test, $p=0.03$). As a result, deer browse damage was substantially lower (t-test, $p<0.01$) and average sapling height doubled (ANOVA, $p=0.01$) in high wolf use areas. The significant negative impacts of deer seen in low wolf use areas (ANOVA, $p=0.04$) actually disappeared in high wolf use areas (ANOVA, $p=0.62$). Deer had no impact on maple abundance as browsing is often nonlethal. These results suggest wolves may be generating strong trophic cascades restoring Great Lakes forests by directly and/or indirectly reducing deer herbivory on saplings, allowing individuals to grow to form the forest canopy.

A Force to be Reckoned with: Seasonality, Plasticity and Development of Mammalian Skull Form

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The influence of dietary properties on craniofacial form has long been the focus of functional and paleontological studies of mammals. However, the role of temporal dietary variability has received less attention, specifically the morphological correlates of fallback foods, which are lower quality, difficult-to-process items consumed due to seasonal limits in dietary resources. Accordingly, there is a significant gap in our understanding of the important role of dietary seasonality on patterns of variation and covariation in the skull.
To investigate the effects of fallback foods on mammalian evolution and development, we investigated craniofacial plasticity in growing rabbits subjected to seasonal shifts in dietary properties. Forty weanling male *Oryctolagus cuniculus* were divided equally among four dietary cohorts and raised until one year old. One cohort was fed rabbit pellets only (control). Two cohorts were fed pellets supplemented with hay cubes for part of the experimental period simulating early and late seasonal changes in diet. The final cohort was fed pellets supplemented with hay cubes for the duration, modeling an annually tough diet. MicroCT was conducted biweekly to detail changes in craniomandibular development vis-à-vis dietary seasonality. Among-cohort comparisons of craniofacial dimensions were performed controlling for age (ANOVA, $p<0.05$) and ontogenetically (regression, $p<0.05$). While altered masticatory stress affects phenotypic plasticity in the skull, the strength of the response and patterns of integration vary among craniomandibular units. This integrative, longitudinal approach underscores the important benefits of mimicking seasonal dietary variation and offers unique insights into adaptive determinants of morphological evolution in living and fossil mammals.

Hydrologic influences on the distribution of larval fishes in rivermouths of the Great Lakes

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Rivermouth ecosystems in the Laurentian Great Lakes are mixing zones where lake and tributary waters combine to form biologically productive areas analogous to marine estuaries. Complex hydrogeomorphology of rivermouths creates diverse habitats that support diverse ecosystem processes (e.g., nutrient cycling, larval fish nurseries). An improved scientific framework for characterizing processes throughout the rivermouth habitat is needed for successful management and restoration. Existing data were used to create conceptual models that highlight four zones within the rivermouth (lower river valley, delta, receiving basin, and lake plume) and evaluate variability in large-scale environmental drivers. These models guided 2011 and 2012 field investigations that characterize the biophysical structure of four intensely studied Lake Michigan and Huron rivermouths: Ford (minimal impacts), Pere Marquette (moderate impacts), Manitowoc (highly altered), and Thunder Bay (moderate impacts) Rivers. Larval fishes are important indicators and outcomes of rivermouth dynamics and their assemblages are important to understand for fisheries management. They were collected from each of the four zones with 500µm paired bongo net tows. Species abundance and diversity were analyzed to help explain the differences of characteristics within each watershed and microhabitat zone. The Ford River

had the greatest number and diversity of larval fishes compared to Manitowoc, Pere Marquette, and Thunder Bay Rivers. The larval fish data were supplemented with water quality and nutrient dynamic processes data to provide a better understanding of how ecosystem structure and function are connected in rivermouth systems. With this information, better management practices can be possible in the biologically vital rivermouth areas.

Land-Use Impacts to Stream Macroinvertebrate Communities in Southeast Michigan

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Land cover is increasingly being converted from forests to agricultural and urbanized areas across the globe, with sometimes poorly understood consequences for aquatic ecosystems. Regional-scale investigations can lend insight into the often-unique interactions that can occur between land-use and stream ecosystem functioning and structure. To evaluate the effects of projected land-use change in Southeast Michigan, aquatic invertebrate communities were sampled from twenty streams in the Clinton River watershed. Streams were randomly selected from a sample population of all headwater streams found in the watershed and the extent of forest, agriculture and urbanization was quantified. Intuitively, preliminary results indicate a positive relationship between forest cover and invertebrate taxa richness ($R2 = 0.57$, $P<0 .000$), and a negative relationship between urbanization and invertebrate taxa richness ($R2 = 0.74$, $P<.000$). Surprisingly, a positive relationship was observed between invertebrate taxa richness and agriculture ($R2 = 0.53$, $P = 0.000$). Forthcoming results will include an evaluation of community diversity and functional feeding guilds across the three land-uses. Results from land-use studies such as this will progress our understanding of how human activities impact freshwater ecosystems and help direct management efforts at regional scales.

Effects of immune stress on multimodal sexual signaling of a wolf spider

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Theory suggests that male signals and secondary sexual traits may serve as honest indicators of immune function in female mate assessment. Male *Schizocosa ocreata* wolf spiders exhibit multiple condition-indicating traits (foreleg tufts, courtship vigor) used as criteria in female mate choice, but the direct and/or indirect effects of immune stress on these sexual signaling traits is unknown. To evaluate the effects of immune stress on sexual signaling, immature males were infected with a bacterial pathogen (*Pseudomonas aeruginosa*) and were assessed at maturity for several fitness-related measures. Fluctuating asymmetry (FA) in male foreleg tufts (secondary sexual characters) was significantly greater in spiders subjected to bacterial infection. Adult mass and body condition indices were significantly lower among infected individuals than uninfected (control) individuals. In addition, we examined whether females can detect infection status via chemical cues in male silk. Females were significantly more receptive and showed more receptivity displays towards a courting male video stimulus when uninfected male silk was placed in front of the screen than infected male silk. Females also spent significantly more time on uninfected male silk than infected male silk. These results indicate that immune stress from bacterial infection significantly reduces overall body condition and negatively impacts key indicator traits (leg tufts), potentially reducing mating success. These results also show that it

may be possible for females to detect infection via male silk cues. Ongoing research will investigate further the role of immune stress on sexual selection in this species.

The effects of the herbicide Atrazine and predation on the larval dragonfly *Ladona deplanata*

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Predicting the fate of agricultural chemicals in aquatic communities is an important goal for ecologists. Atrazine is a common herbicide found in freshwater habitats worldwide with numerous negative effects on aquatic wildlife. Typical concentrations are relatively low (~100 ppb), yet may impair wildlife behavior, physiology, and fitness traits. Recent research indicates that effects are often magnified in the context of community interactions. Because macroinvertebrates are a keystone species in aquatic habitats we sought to determine how sublethal concentrations of atrazine (80 ppb) and predator cues (*Anax junius*) affect larval dragonflies (*Ladona deplanata*) throughout development. We used a split-plot experimental design with aquatic mesocosms to test the interaction of these stressors over a six-week period. We tested both stressors on immune parameters, growth, and fat storage, phenotypically plastic traits that have fitness implications for adult dragonflies. Preliminary analyses using two-way ANOVAs indicate a significant interaction evident after two weeks of exposure with predator cues significantly affecting growth and immune parameters over the entire period. At six weeks, the effects of atrazine was dependent on the specific immune response measured. The results of our study indicate that sublethal atrazine exposure affects immune function in larval dragonflies with implications for parasite resistance and the potential for tradeoffs between growth and immune investment. In the context of a natural community, sublethal herbicide exposure may be intensifying the effects of predators with implications for survival to metamorphosis and adult fitness.

Assessing gastropod host competence in the Upper Mississippi River: Can an invasive snail serve as a host for a native parasite?

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Invasive species extensively alter native ecosystems through their interactions with parasites. Unfortunately, little is known about the potential for invasive species to alter transmission of native parasites. *Bithynia tentaculata* is an invasive aquatic snail that was first detected in the Upper Mississippi River (UMR) in 2002. Its arrival has sparked major concern in the UMR due to the fact that it carries 4 trematode species that are responsible for annual waterfowl deaths in the area. Although recent work has looked at associations between this invader and its parasitic hitchhikers, nothing is known about how this snail interacts with native parasites. The goal of this study was to determine the competency of *B. tentaculata* and a native snail (*Physa gyrina*) after controlled exposures to a native parasite species (*Echinostoma revolutum*). Results of our laboratory experiment indicated no significant difference in prevalence or intensity of infection in native versus invasive snails. The ability of *E. revolutum* to infect both native and invasive snail species may have consequences for parasite transmission within this system. First, the occurrence of a competent invasive host may increase the transmission of *E. revolutum* to

definitive host species. Second, the presence of an additional competent host in the snail community may actually reduce infection risk for native snail species through parasite dilution. Together, these results may allow us to better predict: 1) transmission outcomes in the UMR and 2) the potential alterations that may occur in ecosystems

Temporal and ecological predictors of gut microbiome structure in wild baboons

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Intestinal bacterial communities, commonly referred to as the gut microbiome, are an understudied and important component of an animal's health, behavior, and development. Variation in gut microbiome structure has been linked to immune function, metabolism, energy storage, and numerous diseases—especially in humans and lab animals. However, to date, little research has been conducted on how an individual's microbiome changes over its lifetime or within seasonally changing environments. This is important because the gut microbiome structure appears to be intertwined with diverse aspects of an animal's physiology, and studying it in a natural context will provide a full perspective that cannot be obtained from lab experiments that place animals in an artificial environment. We hypothesized that ecology, life history traits (including age, sex, and social rank), and time all have significant effects on the structure of bacterial communities. The Amboseli Baboon Research Project, in the Amboseli ecosystem, Kenya provides an unusually powerful system for addressing these questions, with 40+ years of life history data on individual baboons and 17 years of preserved fecal samples. We used 454 sequencing to analyze the gut microbiome community of 32 individual wild baboons at multiple time points during the wet and dry seasons over 16 years. Preliminary analyses suggest there are seasonal abundance patterns for different bacterial taxa, but that sample sterility did not have a major effect. Our results will help contribute to understanding temporal and ecological predictors of microbiome structure in a wild population and what areas we should focus on for future research.

The Effects of Varying Cache Depth and Mammalian Predator Scent on the Foraging Behavior of the Forest Deer Mouse

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Cache depth and perceived risks of predation can affect the foraging behavior of many granivorous rodents. Olfaction plays a crucial role in both foraging behavior and assessment of predation risks in many of these species. One factor affecting the strength of olfactory signals is cache depth, which can alter the search time of these rodents. Moreover, the threat of predation can also affect search time and induce a time-cost trade-off between foraging and vigilance for predators. This laboratory study examined the effects of varying cache depth and mammalian predator scent (*i.e.,* mink urine) on the foraging behavior of the wild-caught forest deer mouse (*Peromyscus maniculatus gracilis*). Mice did not alter the time spent foraging when assigned shallow (1 mm) or control (10 mm) maple seed caches in the absence or presence of mink urine. However, mice did reduce their foraging time when assigned deep caches (20 mm) in the presence of urine. These responses to deep caches and the presence of urine reflected a trade-off

between foraging and vigilance for predators. *P. maniculatus* preferentially chose to utilize their time for vigilance rather than foraging and thus optimized their time by spending less time foraging (*i.e.,* searching) and more time remaining vigilant for predators. These responses provide insight into the complexity of factors affecting foraging behavior of granivorous rodents.

THE EFFECTS OF PERMETHRIN ON KINGSNAKE (*Lampropeltis mexicana*) EMBRYO DEVELOPMENT AND EGGSHELL THICKNESS

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The use of polychlorinated biphenyl (PCB) pesticides, such as permethrin, has caused global concern because they exhibit toxic, bioaccumulative, semi-volatile, and persistent properties. Many studies have examined various effects, such as eggshell thinning, of these pesticides on other animal species, but few have looked at these same effects in reptiles. Permethrin, unlike other PCBs, is not banned for pesticide use and is still widely used. Past studies suggest that permethrin is non-toxic to most animals, but is extremely toxic to others, such as cats and fish. 30 kingsnake eggs were incubated in nests contaminated with 0, 10, or 30 ppm permethrin for 0, 10, 20, 30, and 40 days. At ten day intervals, six eggs, two from each treatment level, were removed and frozen for later analysis. Pictures of each embryo and egg shell thickness were taken using microscopy. Permethrin did not cause any significant egg shell thinning ($F_{2,29}=0.22$, $p=0.807$, x10ppm=0.170472, x30ppm=0.171065, xcont=0.179753), but eggshell thinning was noticed over time ($F_{4,29}=5.70$, $p=0.005$). The embryos exposed to permethrin exhibited delayed development compared to those in the control group. A possible difference in eggshell thickness between treatment groups at 30 and 40 days was present, which could impact egg survival in the later stages of development. These results suggest that clutch and genetics impact eggshell thickness. Further analysis will determine whether or not permethrin penetrated across the eggshell.

Coming to terms with assisted migration

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In the face of the present biodiversity crisis, assisted migration (also called managed relocation or assisted colonization) has emerged as a new concept to reduce the risk of species extinction caused by climate change. The measure involves moving species or other biological units to their predicted future climatic range, i.e., to areas where the species should be moving on their own, but which they cannot reach due to time limitation and fragmented habitats. During the last decade, this controversial conservation strategy has been mentioned more and more frequently in the literature, and the benefits and constraints of AM are currently being thoroughly debated. However, the idea has been defined, named, and presented inconsistently, which may hamper the discussion, operationalization, and development of the measure.
We conducted a literature review and found 30 different terms and almost 50 definitions for describing the measure, reflecting rather different conceptualizations of the idea. Based on our findings and subsequent analyses of terms and definitions, we present a comprehensive definition of the measure and suggest a suitable term for it. In my talk, I will present the main

results of this analysis and introduce a definition-based framework for assessing the species-specific need of assisted migration and for operationalizing the concept. I will also elucidate some transdisciplinary research needs to enable the theoretical and practical development of this novel conservation strategy.

The hummingbird and the hawkmoth: Species diversity, competition and niche partitioning across the United States

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Competition between hummingbirds and hawkmoths is likely, yet that potential remains understudied. While differing in taxonomy and ontogeny, hawkmoth and hummingbird adults fill functionally similar niches as nectarivores. In this study, we analyzed the distribution of hawkmoths, Sphingidae, and hummingbirds, Trochilidae, in the continental United States, correlating their patterns of diversity with environmental variables. We tested for latitudinal and longitudinal biases in their species richness (S) and the potential role of 10 environmental variables. Finally, to establish the generality or uniqueness of these taxa's patterns, we also sought out the latitudinal and longitudinal biases of 7 different families of insect and 5 different families of birds. Hawkmoth diversity increases sharply with longitude (eastward-bias) while hummingbird diversity shows the reverse trend (westward-bias). Analyses of the environmental variables showed that hawkmoth diversity increases with July minimum temperature and declines with elevation; hummingbird diversity increases with elevation, greater winter precipitation compared to summer, and higher maximum July temperatures. We initially hypothesized that hummingbirds and hawkmoths may show a new type of niche partitioning according to elevation. Three various hypotheses were developed to explain the results including inter-taxon competition. Results from the other bird families showed that all were significantly westward-biased, making the case for competition weaker and coincidence stronger. It remains an open question whether hawkmoths and hummingbirds influence each other's continent-wide diversity patterns. We suggest other potential avenues to studying competition between these two taxa.

Can preexisting trait variation predict the outcomes of parasitoid competition in novel habitats?

Gabriela Hamerlinck and Andrew A. Forbes
University of Iowa

Parasitoid wasps often specialize on one or a few hosts and host shifts may explain the tremendous amount of parasitoid diversity if parasitoids using novel hosts become reproductively isolated from their source population. In this study we ask if different parasitoids compete for a novel resource and whether some species possess preexisting traits that enable them to better colonize particular novel hosts. Further, we ask if we can predict successful host shifts based on analyses of characteristics of the ancestral system. We have designed a mathematical model to describe the population dynamics of competing parasitoid populations on successful colonization of a novel host. As a case study to parameterize this general model, we use races of the wasp *Diachasma alloeum* that attack *Rhagoletis* larvae in hawthorn and

blueberry fruit to determine their ability to attack *Rhagoletis* larvae in a new plant host, apple. Specifically, this model evaluates preexisting morphological characters that may allow one *D. alloeum* race to successfully utilize its host in a novel fruit over the other. Preliminary analyses focus on the effect of ovipositor length on the ability of a parasitoid population to outcompete another to colonize a novel host. Preliminary results show threshold values of ovipositor lengths that result in competitive exclusion and no instances of coexistence. While the empirical evidence used to parameterize the model come from a specific system, the model is broad in scope and is able to be expanded to use in other models of insect host shifts.

Climate and Watershed Land Use Determine Phytoplankton Nutrient Limitation Status

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A dominant paradigm assumes that phosphorus (P) is the limiting nutrient of lake phytoplankton. However, recent research suggests that nitrogen (N)-limitation exists on seasonal to decadal time frames. In human-impacted water bodies, watershed land-use explains some of the patterns in nutrient availability but climate, specifically precipitation, connects the terrestrial landscape to aquatic ecosystems. The goal of this research was to determine the interactive effects of climate and watershed land use on phytoplankton nutrient limitation status. To address this question we quantified the identity (N vs P) and severity of nutrient limitation on 400 lake-dates from reservoirs. We used the Palmer Drought Severity Index (PDSI), which couples temperature and precipitation, as an index of runoff that enters the reservoirs and calculated a principal component axis combining watershed land use (agriculture versus forest) and watershed area:lake area as our land use metric. We used regression trees to compare all lake-dates. We also examined seasonal trends in three reservoirs, across a gradient of land use (from 80% agricultural to 80% forested) that were each sampled multiple times per season for at least 6 years. We assessed the interactive effects of climate and land use by comparing spring (wet) and summer (dry) nutrient limitation in addition to wet and dry years (estimated from growing season PDSI).

Sequential speciation amplifies biodiversity across trophic levels

Glen R. Hood, Andrew A. Forbes, Thomas H. Q. Powell, Scott P. Egan, and Jeffrey L. Feder
University of Notre Dame

Diversity can beget diversity when speciation by one organism drives diversification of associated organisms in adjacent trophic levels, a term coined sequential. If organisms diverge and create new niches for others to exploit, catalyzing a "chain reaction" of speciation events, what are the (1) frequency of such events and (2) barriers to gene flow in diverging populations that reinforce diversification? The apple maggot fly, *Rhagoletis pomonella* (Diptera: Tephritidae), is a classic example of sympatric speciation in action. Races of hawthorn and apple flies differ in eclosion timing, host odor preference and allele frequencies. Recently the *R. pomonella*–attacking parasitoid wasp, *Diachasma alloeum* (Hymenoptera: Braconidae), has undergone sequential speciation. Paralleling their fly hosts, wasps exhibit differences in allele frequencies, eclosion timing, and odor preference. We tested the sequential speciation hypothesis in the remaining members of the *Rhagoletis*-attacking parasitoid community, *Diachasmimorpha mellea* and *Utetes canaliculatus.* Both *D. mellea* and *U. canaliculatus* exhibited differences in

eclosion timing, host odor preference and microsatellite allele frequencies across sympatric populations attacking flies in the *R. pomonella* species group. This ecological and genetic evidence supports the hypothesis that allochronic isolation via eclosion timing and behavioral isolation via host odor discrimination contributes to host-associated genetic structure in sympatry and is an important mechanism structuring parasitoid communities in this system.

How do bats perceive owls: friend or foe?

Gregg Janos
Bowling Green State University

The goal of this research was to assess how bats perceive owls, which are potential predators of bats. Owls do not often take bats as a prey item but little is known about this interaction. At the Oak Openings Preserve in Swanton, OH, we examined if the presence of a calling owl would deter bats from foraging in the area. We created an audio CD of owl calls from three different species: Great Horned Owl, Barred Owl, and Eastern Screech-owl. Each species of owl was played individually at a site once a minute for 10 minutes. In addition we also utilized a noise treatment of American toad calls, Common Nighthawk calls, and a train horn, all of which are typical ambient noises heard at the park. The purpose of the noise treatment was to assess if bats responded to the owl calls or noise in general. The amount of bat activity was recorded using an Anabat, an acoustic monitor that records the echolocation calls of bats. Our results indicated that bat activity was not altered during any of the owl treatments or the noise treatment. Even when owls flew into the area, bat activity did not appear to be influenced by the owl's presence. It is likely that owls do not regularly prey upon bats when bats are foraging. In addition, bats are extremely agile and may be able to readily escape potential predators. Furthermore, the benefits of foraging outweigh the predation risks associated with owls. Bats in the United States are decreasing primarily due to habitat loss, wind energy, and White-nose Syndrome; however, this study, along with others, suggests that owl predation is not likely to be a major factor influencing trends in bat populations.

A maximum likelihood modeling approach for the estimation of zooplankton production

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Common methods for the estimation of secondary biomass production by zooplankton rely on established regressions from the literature that use mean biomass, but seldom account for environmental characteristics. These techniques ignore changes in predator density, food quantity or quality, and temperature. Regressions are also often based on log-log regression, with poor model fits. These non-dynamic models likely poorly estimate zooplankton production, and can therefore lead to uninformed evaluations of environmental impacts on zooplankton, and the aquatic food web as a whole. We developed a production model that accounts for changes in environmental conditions using a stage structured population model and maximum likelihood approaches. Model parameters were fit using maximum likelihood estimation, and simulated using weekly zooplankton stage structured abundance, temperature, and chlorophyll concentration data collected during the summer of 2011. The strengths of this modeling approach lie in the dynamic ability of the model through time, and the possibility to include changes in environmental variables. We feel as though this approach more adequately estimates

zooplankton production, and thereby can allow for a better assessment of environmental impacts on the aquatic food web

Ant disease carriers proliferate fungal pathogen control of an insect pest

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Mounting scientific evidence indicates that pathogens have important implications for host populations. However, little field work has experimentally examined how host populations are limited by disease. Entomopathogens and grasshoppers present an excellent insect host-pathogen model system for studying disease dynamics under field conditions. Entomopathogens are fungal pathogens which often have limited dispersal abilities and may require assistance from disease carriers to increase disease transmission rates. I conducted a manipulative field experiment using mesocosms (cages) in western Montana to examine the effects of common grasshopper scavengers (ants: *Formica fusca*) on fungal pathogen (*Entomophora macleodii*) limitation of a pest grasshopper (*Camnula pellucida*). I implemented a 2 x 3 design which consisted of ant abundance (organic ant repellent, no repellent) and *E. grylli* presence (resting spores, conidia, absent). I found that ants significantly increased grasshopper disease mortality ($F_{1,20} = 4.890$, $P = 0.039$). While there was no significant difference between conidia versus resting spore exposure ($F_{1,20} = 2.121$, $P = 0.161$), resting spore induced mortality benefited more from ants than conidia induced mortality. Ants also increased the impact of disease on grasshopper numbers. Grasshopper survival was reduced by ants in resting spore exposed treatments (Breslow-Gehan = 6.380, $df = 1$, $P = 0.012$). Ants also reduced grasshopper numbers in conidia exposed treatments, but this trend was not significant (Breslow-Gehan = 0.668, $df = 1$, $P = 0.414$). My results indicate that ant scavengers increase disease limitation of grasshopper hosts by acting as disease carriers.

The codon bias of gene J in bacteriophage phiX174

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Small, viral pathogens often rely on their host species for translational machinery. Given that their host has a particular bias or preference in the usage of codons, the viral species often exhibits this same preference in an effort to expedite its replication. To explore the degree to which a virus selects for host-preferred codons we altered a segment of the J protein coding region within the bacteriophage ΦX174, replacing those codons preferred by its host *Escherichia coli* C with those used less frequently. The J protein is a small protein found to assist in the formation of the pre-initiation complex, more specifically the J protein is found to be involved in DNA binding. The J mutant strain exhibited a reduced fitness as expected. The J mutant was evolved in triplicate along with three lines of unaltered wild-type strain (serving as a control) for several hundred generations. The altered region in the J mutant line was sequenced over the course of the experiment revealing a number of synonymous as well as non-synonymous mutations both within the engineered region as well as positions elsewhere within the genome (putative compensatory mutations). Furthermore, the majority of the mutations which occurred within the engineered region integrated a more host-preferred codon. The incorporation of more

host-preferred codons within the engineered region was found to be tightly correlated with the improved fitness of the phage over the course of the experiment.

Nutrient stoichiometry drives microbial eco-evolutionary feedbacks

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The development of species interactions can be directly influenced by resource availability. Microorganisms, such as the picocyanobacterium *Synechococcus* and the viruses (phage) that infect them, reside in resource limited environments and play essential roles in nutrient cycling and net primary productivity. Using *Synechococcus* and a phage in long term-continuous cultures, we explored the ecological and evolutionary feedbacks under stoichiometric constraints by manipulating nitrogen (N): phosphorus (P) supply ratios. We found that *Synechococcus* densities were more stable, exhibiting lower amplitude fluctuations and slower recovery rates, under P-limitation relative to N-limitation. These differences may have been influenced by selection for phage resistant phenotypes in N- or P-limiting environments. Phage-cyanobacteria infection networks, generated by quantifying infectious interactions between hosts and phages, suggest that cyanobacterial resistance and phage host range expansion and contraction strongly contributed to the overall population dynamics under resource limitation. Additionally, while both treatments produced highly nested structures, P-limited networks were more structured than N-limited networks. This suggests that, overall, P-limitation produced more stable eco-evolutionary feedbacks despite the degree of limitation. Together, our results demonstrate that nutrient stoichiometry drives the development of eco-evolutionary feedbacks between cyanobacterial hosts and phages. This information is critical for making accurate predictions and advancing our knowledge about how populations respond to both biotic and abiotic changes in their environment.

Genomic exploration of bacterial habitat adaptation

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Studies of bacteria in different habitats enable us to understand the taxonomic composition of microbial communities in each environment, the genetic diversity of these communities, and the processes they mediate. In this research we adopted a comparative genomic approach to identify discriminatory taxonomic and genetic markers of microbial communities in human gut, marine and soil. The activities and functions of these three environments are both mediated by bacterial processes and extremely important to people. Although humans depend on all of these ecosystems, these environments are very different from a microorganism's perspective. As a result, we found that 1) soil bacteria tend to have more genes while gut bacteria have fewer genes; 2) soil bacteria have higher 16s rRNA number, suggesting that bacteria in soil grow faster than marine or gut bacteria; 3) genes and pathways characteristic of bacteria in each habitat are different. We believe understanding how bacteria have specifically adapted to their environment will inform how they may respond to ongoing environmental change.

Diversity and ecology of Wisconsin land snails in the Driftless region

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The terrestrial snails of North America are a diverse and threatened group, but conservation status of the majority of species is uncertain. There are ~100 species of land snails in Wisconsin and several habitats are known to have globally significant levels of land snail species richness, however, most are minute (<5 mm) and their distributions and ecologies are poorly known. The survey of land snails in the Driftless region, an area free of ice during the last glaciations period, was done not only to identify the locations of the 21 land snail species of conservation need but also todiscover the variables driving land snail diversity and compare these variables in other regions to test the similarities with communities outside of the Driftless area. Georeferenced museum records were used to create a GIS model which incorporated sites with high gastropod richness with environmental information. Areas identified by the GIS model as highest priority were targeted for surveys along with a few low priority areas to ground-test themodel. At each site there was a minimum 30 minute visual search for macrosnails and at least $2m^2$ of leaf litter were gathered to sieve for microsnails. Environmental data such as slope, ground cover, and canopy cover were taken at each habitat in the site. The leaf litter was washed to remove sediment, air dried, and put through a series of sieves to separate coarse organic matterfrom the microsnails. After sieving, the litter is searched twice under a low-power dissecting microscope and the snails are collected, sorted, and identified to species. These surveys have resulted in the discovery of several new populations and a large range extension for a state threatened species *Hendersonia occulta,* the cherrystone drop snail.

Teaching with digital evolution software:
Assessing student understanding of fundamental concepts

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Avida-ED is award-winning software that provides students with the opportunity to investigate evolution in action. Unlike other programs that only simulate evolution, Avida-ED serves simultaneously as a model and instance of the evolutionary process. Instructors use Avida-ED to engage students in *authentic* science practices and discussions about evolution and the nature of science. Students use Avida-ED to pursue their own questions, test hypotheses that they have generated and developed, design experiments, collect and analyze data, and communicate their findings. We present preliminary data on student understanding of fundamental evolutionary concepts before and after engagement in activities involving Avida-ED. These preliminary data are part of a larger, multiple-case study investigating the use of Avida-ED digital evolution software by undergraduate biology instructors. The study seeks to reveal patterns in implementation and how these are linked to student assessment outcomes.

Title: Trophic niche breadth in a widely-foraging snake (Colubridae: *Coluber*).

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The trophic niche width of a species varies depending on the foraging strategy employed by the individuals within a population. Among reptiles, the niche breadth of many species of snakes is relatively understudied. Within this clade, the genus *Coluber* includes wide-ranging, actively foraging snakes that have been historically labeled as dietary generalists. We report on the diet composition of *Coluber constrictor foxii*, the Blue Racer. The dietary information available for this subspecies is limited and little is known about ontogenetic or seasonal differences in the prey species consumed. In addition to obtaining gut and fecal contents, we employed stable isotope analyses using $\delta^{13}C$ and $\delta^{15}N$ to describe the dietary preferences of *C. constrictor foxii*. We collected blood and tissue samples of *C. constrictor foxii*, along with whole specimens representing a range of potential prey taxa. We freeze-dried all samples, homogenized them using an amalgamator, and analyzed the samples using mass spectroscopy. We performed ANOVA to investigate differences in the isotope signatures of individual snakes. We used a Bayesian mixing model to determine the source of $\delta^{13}C$ and $\delta^{15}N$ in the snake tissues, and assessed differences in diet between individuals representing different genders, seasons, and ontogenetic stages. At the population level, *C. constrictor foxii* appears to support the pattern typical of a dietary generalist; differences exist, however, when comparing prey taxa consumed by different life-history stages and sexes.

Invasive Plants May be Detrimental to Grassland Bird Nesting

Kerri C. Martin, Chelsea Merriman, and Gary E. Belovsky
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Grassland bird populations are declining potentially through habitat degradation and nest predation. Nest predation is the leading cause of reproductive failure in grassland birds, and predation is the result of a complex interaction between birds, their predators and the environment. Birds choose nest sites based on foliage density and predators may take advantage of this specificity. The potential prey site hypothesis explains that predators may recognize potential nest sites and increase their search efficiency by only focusing on these sites when searching for prey. Grassland bird habitat is being decreased by exotic plant invasions when plants have vegetation characteristics outside those favored for nest sites. Through the potential prey sties hypothesis, the invasive species would not only decrease habitat, but increase predation risk. In a study conducted in Lake County, Montana, we investigated this idea by first establishing that invasive plants have different vegetation characteristics (percent vegetation cover, foliage density, height, and litter depth) than nest sites and then comparing predation rates to invasive plant cover. We found that higher invasive plant cover does increase apparent nest predation ($p=0.05$), as was predicted by the potential prey site hypothesis. These results show that exotic plant invasions have multiple negative effects on grassland bird populations and avian conservation efforts should include reduction of harmful invasive plants.

Effects of Invasive Plant Species on Grassland Bird Nesting

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The spread of invasive species is a problem in most areas of the United States. Currently, little is known about invasive species' effects on animals, particularly grassland birds. As indicators of ecosystem health, grassland birds could be used to help quantify effects of invasive species on an ecosystem. In the grasslands of northern Lake County, Montana, nesting preferences of vesper sparrows, meadowlarks, and grasshopper sparrows were studied. Vegetation at nest sites and random plots were classified as invasive or native, measured, analyzed, and compared to characteristics of known native and invasive vegetation. Grassland birds were shown to avoid nesting in invasive species. Birds favored nest sites with lower plant heights, litter depths, visual obstruction, and overall coverage than offered by invasive species. These results show that grassland species can be affected by invasive species, assisting scientists and conservationists to better monitor ecosystems and more effectively combat invasive species.

Investigation of the cavernous diatom flora in Kauai, Hawaii, with the description of four diatom species new to science

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The Hawaiian Island archipelago is one of the most isolated island chains in the world, and the Hawaiian biota displays remarkable diversity and endemism. The algal diversity of Hawaii has been vastly understudied, and there has been minimal work describing algae from cave habitats. We surveyed a variety of microhabitats in five caves on Kauai, Hawaii to analyze diatom diversity, distribution, and to look for potential endemic species. A total of 80 taxa across 45 genera were identified, and unique diatom floras were found in each of the five caves. Based on morphological investigations using light microscopy and scanning electron microscopy, we found four endemic taxa new to science. These new discoveries highlight the undiscovered biodiversity of Hawaiian algae and the need for further research.

The Role of Maternal Effects on Life History Variation in a Polyphenic Salamander

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Maternal effects form a flexible linkage between maternal and offspring environments. In amphibians, maternal effects such as embryo size are known to have strong context dependent larval fitness consequences, however relatively little is known about their influence on adult life history variation. Facultatively paedomorphic salamanders provide a model system in which to examine these questions. We investigated how experimentally manipulated embryo size differences regulated larval growth and phenotype production in mole salamanders. We predicted that larger embryos would direct larvae towards rapid growth and paedomorphosis, while smaller embryos would direct larvae towards slower growth and metamorphosis. Individuals were reared at one of three conspecific densities in experimental ponds by embryonic

treatment (control versus ~20% embryonic yolk reduction). Individuals from each tank were captured five times throughout the 2012 season to assess growth rates, and tanks were emptied in mid-November at which point adult phenotypes were recorded. Reduced treatment animals were significantly smaller at hatching, but demonstrated no overall size differences after 30 days. After 105 days, larval growth exhibited negative density dependence with context dependent effects of embryonic treatment, where reduced larvae were smaller at low densities but larger at high densities than control larvae. The reduced treatment produced more metamorphs at high densities than the control treatment, but did not influence % paedomorphosis. These data represent a strong example of the context dependent fitness consequences of maternal effects, and suggest that embryonic yolk stores act as a signal of previous environmental conditions that can maximize offspring fitness.

Interactions between *Echinacea angustifolia* and its specialist aphid: Phenology, herbivory, and plant performance

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Habitat fragmentation disrupts pollination and herbivory networks in terrestrial plant communities. The prairie perennial *Echinacea angustifolia* is a model system for studying ecological effects of habitat fragmentation. Its most common herbivore is a specialist aphid (*Aphis echinaceae*) that is commonly tended by ants. Together, aphids and ants play a role in shaping the assemblage of herbivores on host plants and their combined effects may be negative or positive. My goals were to 1) characterize the seasonal phenology of aphid infestation and 2) determine the net effects of aphids and ants on host growth, foliar herbivore damage, and senescence. I addressed these questions by manipulating aphid infestation on 100 plants and observing naturally-occurring aphid infestation in an experimental plot and six remnant populations. Aphid infestation rose and fell sharply during the summer, peaking earlier in 2012 than 2011. The peak occurrence of winged morphs occurred earlier than the peak of aphid infestation and coincided with the peak flowering date of *Echinacea,* suggesting that the phenology of aphid infestation is linked to that of the host plant. Aphids did not alter growth from 2011 to 2012. The relationship between aphid infestation and foliar herbivore damage was negative in the experiment and positive in observational data. While the first result supports top-down regulation of herbivores by aphids, the second suggests bottom-up control by plants. Aphid addition accelerated autumn senescence in 2012, but not 2011. Considering 2012 was a hotter, drier year, this suggests that abiotic conditions may exacerbate the stress induced by aphids.

Life in Brown Waters: Aquatic Bacteria Respond to Increased Terrestrial Carbon Loading

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Bacteria are essential for the functioning of natural and managed ecosystems; however, it is unclear how they will respond to environmental changes. For example, due to climate change dissolved organic carbon (DOC) export from terrestrial to aquatic ecosystems has been increasing. Terrestrial DOC is generally regarded as refractory, yet ecosystem level measures, such as CO_2 flux and bacterial respiration, indicate that at least a subset of the bacterial

community use the resource. In order to understand how terrestrial DOC affects the diversity and composition of aquatic bacterial communities, we manipulated the carbon loading rates in ten experimental ponds. We added a terrestrial carbon analog (SuperHume), comprised of humic and fulvic acids, to each pond along a gradient of carbon loading rates (0 $g/m^2 yr^{-1}$ – 212 $g/m^2 yr^{-1}$). For each, we collected bacterial biomass for community DNA and RNA coextractions, and amplified the V3-V5 region of the 16S rRNA gene to analyze the bacterial community diversity and composition. By analyzing both the DNA and RNA pools we are able to distinguish the total community (DNA) and the active members of the community (RNA). DOC loading rates significantly reduced the taxa richness and evenness of active bacteria, but had no significant effect on the total community. Likewise, we found major compositional changes in the active community as a response to carbon loading, but not in the total community. Together, these results suggest that altered DOC loading influences the active members of the microbial community by selecting for a small subset of the total community which may be able to use the resource.

Suspensory behaviors and the neck: a comparative analysis of the cervical vertebrae of extant primates

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As the interface between the head and trunk, the cervical spine performs a range of functions, including directing head movement and withstanding the forces of gravity and soft-tissue loading associated with the pectoral girdle. Morphological variation in the pectoral girdle's bony components (scapula and clavicle) and the nuchal musculature has been linked to differences in locomotor behavior among extant primates, particularly between suspensory and nonsuspensory taxa. However, the degree to which these morphological differences are reflected in cervical vertebral morphology has yet to be examined. The goal of this study was to test biomechanical models of the cervical spine by comparing extant suspensory and nonsuspensory primates. Vertebral features were quantified using linear and three-dimensional coordinate data in 525 specimens representing 50 primate species. Relationships between vertebral morphology and positional behavior were analyzed using pairwise comparisons and phylogenetic comparative methods. Results support a functional link between cervical morphology and positional behavior in some features. Specifically, transverse processes in suspensory primates are more dorsally positioned when compared to nonsuspensory taxa. In contrast, a number of features appear to be correlated with skull length, supporting a functional link to head balancing instead of positional behavior. Those taxa with increased skull lengths, specifically portions ventral to the spinal column, demonstrate vertebral features that indicate greater resistance to bending, such as greater cross-sectional areas of the laminae and pedicles. Finally, the scaling relationships of cervical features across primate groups are discussed.

Ecological consequences of human land-use for specialist herbivores and their parasitoids

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Heterogeneous energetic, chemical, and biological human inputs concomitant with urbanization and intensive agriculture impact the function and composition of terrestrial ecosystems

worldwide. Population and community level responses to anthropogenically-driven landscape change are taxon and context specific so that predicting biotic responses in coupled human-natural systems presents a substantial challenge. Our aim is to characterize effects of human landscape changes on spatial distributions, abundances, and ultimately patterns of gene flow and dispersal in specialist insects across trophic levels. Specialists constitute the majority of described insects and are expected to be more sensitive to habitat modification than generalists. We are focusing on two systems in which fruiting tree species (*Prunus serotina* and *Juglans nigra*) are host to specialist fruit flies (*Rhagoletis cingulata* and *R. suavis*), which are in turn host to specialized parasitoid wasp taxa. We assessed 250 random 150 x 150 meter sampling plots in a 360 km^2 urban/ agricultural landscape for host tree presence, followed by two seasons of insect collections. We have compared mean densities of the three trophic levels across broad- and fine-scale landcover categories. We have also utilized geographical tools to assess patterns of spatial autocorrelation and the explanatory power of land cover with differing spatial scale. These lines of inquiry suggest that landscape characteristics in cities may serve to constrain insect dispersal. Our preliminary results provide promising evidence that anthropogenic development affects distributions and dispersal of specialist insects across trophic levels.

Genetic architecture of tripartite interactions: Legumes, rhizobia, and mycorrhizal fungi

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The cost and benefits of pairwise mutualisms can be impacted by the presence of third party species interacting with one or both partners. Multi-player interactions may change the strength of natural selection on these pairwise interactions. One underappreciated dimension of many tripartite interactions is overlapping genetic control in the host. Shared regulatory pathways underlie the interactions of legumes with both rhizobia and arbuscular mycorrhizal fungi (AMF). Understanding the genetic architecture of plant responses to these symbionts is important in understanding the evolutionary outcomes of both mutualisms. If plant genetic variation exists in overlapping genetic regulatory pathways, then we expected to find positive phenotypic and genotypic correlations for the abundance of both symbionts in plants. We present the results of two studies. To see how AMF and rhizobium abundances are correlated in the field, we first collected 179 *Chamaecrista fasciculata* (partridge pea) from a remnant prairie in Illinois and measured plant biomass and abundance of each symbiont in the roots (nodule number and size for rhizobia and total number of intraradical structures for AMF). Second we grew 31 plant genotypes (USDA accessions) in the greenhouse in field soil, measuring abundance and plant growth, and computed genetic correlations.

Results/Conclusions

We found positive phenotypic correlations in both the field ($r = ; p < 0.0001$) and greenhouse ($r = ; p < 0.0315$) between the total number of nodules present on plants and allocation to AMF arbuscules. Neither correlation was explained by plant biomass, suggesting that positive feedbacks between plant condition and symbiont abundance alone did not drive these correlations. In the greenhouse experiment, we partitioned the variance among plant genotypes and found evidence for a positive genetic correlation between nodules and arbuscules (consistent with the phenotypic correlation; $r = , p = $). These results are consistent with the presence of plant

genetic variation for symbiosis in overlapping regulatory pathways. Positive phenotypic and genotypic correlations suggest that these plant symbioses are more closely linked evolutionarily than previously thought. Historical co-opting of AMF pathways by rhizobium symbiosis is well-known. The existence of shared genetic variation in contemporary natural populations, however, is novel and suggests that evolution of one symbiosis might have dramatic effects on the evolutionary trajectory of the other. For example, increased allocation to rhizobia in high-nitrogen environments would be predicted to lead to decreased investment in AMF. More generally, quantitative genetic approaches provide a framework for understanding the evolution of tripartite interactions in nature.

Using benthic macroinvertebrate recolonization to gauge stream community response to potential disturbance caused by restoration

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Restoration projects in anthropogenically dominated landscapes have greatly increased over the past decade. In the case of streams, improvement of in-stream habitat potentially disturbs an already impacted system by physically altering the stream bed, yet our understanding of the ability of the biotic community to recover after these perturbations is lacking. We assessed modes of benthic macroinvertebrate recolonization at two sites of varying degradation in an agriculturally impacted 3rd order stream in western Colorado, USA, in order to gauge community recovery from restoration-related disturbance. Using recolonization traps, each open to particular modes of colonization (upstream, downstream, aerial, hyporheic, and control), we compared overall abundance, biomass, diversity, and functional group composition to determine differences between recolonization routes among sites. Upstream traps at the low impact site had nearly twice the total abundance as controls, but biomass, trap richness and Shannon diversity varied little between traps and sites. Differences in community composition were detected using Non-metric Multidimensional Scaling (NMDS) analysis. Functional feeding group composition in control traps was similar between sites. However, grazers dominated abundance and biomass in all traps at the high impact site, while more functionally diverse communities colonized traps at the low impact site. Our results indicate that macroinvertebrate communities have the ability recolonize quickly with dispersal from upstream sources having the greatest influence on community composition. Additionally, the changes in functional feeding groups suggest that recolonization may be driven by available resources. Thus, restorations should maintain undisturbed upstream sites as a potential source of both biota and resources.

Effects of food web structure and nutrient supply on methane release in lakes

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Lakes are a globally important source of atmospheric methane, which is affecting climate change as a greenhouse gas. In addition, methane plays a major role in the food web of lakes, as it can serve as a source of energy for some microorganisms and other components of the food web. We conducted an *in-situ* mesocosm experiment in Morris Lake, Michigan, over seven weeks to assess the effects of additions of top predators (minnows) and of nutrients (nitrogen and phosphorus) on methanogenesis, methane oxidation, and methane emissions. Cascading trophic

interaction studies predict that additions of a top predator would affect the zooplankton communities, which have been shown to regulate methane-oxidizing bacteria in the water column. Additional nutrient supply predicts an increase in algal biomass, a food source for zooplankton and for detritivorous methanogens. However, the interactions between these two factors on methane release in lakes have not been well studied.
Chlorophyll-*a* analysis showed that the additional nutrients did increase the algal biomass. Sediment organic matter was shown to be a predictor of methane sediment production. Zooplankton abundance was significantly higher in those mesocosms with nutrient additions and was significantly lower in those with minnow additions; however, there was no conclusive interaction between the two.

Pelagic nutrient uptake in 15 rivers with varying turbidity and nutrient concentrations

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The ability of large streams and rivers to retain nutrients is understudied relative to headwater streams. Nutrient uptake in rivers has often been inferred/modeled from empirical studies of smaller systems where benthic processes drive nutrient uptake. In contrast to headwaters, rivers can support a free-living pelagic community that potentially contributes to nutrient uptake. To characterize the importance of water column nutrient demand relative to the benthos, we measured pelagic uptake of ammonium, nitrate, and phosphate using *in situ* chambers in 15 rivers that varied across a turbidity and nutrient gradient. We then compared these rates to whole-river nutrient uptake measured using the pulse addition technique (PAT). Nutrient uptake in the pelagic zone was variable, accounting for 0.1-37% of whole-river nutrient removal; pelagic uptake rates were higher in low-turbidity rivers. In fact, turbidity significantly lowered pelagic uptake velocity of all solutes, and phosphate (but not ammonium or nitrate) removal was controlled by background nutrient concentrations. Pelagic nutrient uptake occurs across a variety of rivers, but the importance of the pelagic zone relative to the benthos decreased in more turbid rivers.

Impact of freighter traffic on fish communities of St. Marys River wetlands (Michigan, USA)

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Coastal wetlands of the Laurentian Great Lakes provide vital nursery and spawning habitats for numerous fish communities. Freighter traffic is common in these wetlands, with an average of 15 freighters a day passing them in the summer of 2012. This barge traffic can create greater turbidity and total suspended solids and cause water level fluctuations in these wetlands with unknown consequences for fish communities. To address this research gap, we used fyke nets to sample fish communities in seven coastal wetlands of the St. Marys River watershed with differing exposure to barge traffic (four barrier and three exposed) and compared life-history and community level attributes. Consistent with our hypotheses, preliminary data showed that on

average, protected wetlands have a greater species richness, and different community makeup of young-of-year (YOY) fish compared to exposed sites. For example, all barrier wetlands contained YOY sunfish and bullhead species but no YOY white suckers, a contrast to freighter-exposed sites. Additionally, we found that freighter-exposed sites generally contained a greater number of early-maturing, short-lived, and highly resilient species, a contrast to protected sites. This research should be useful in understanding how fish communities respond to disturbance in coastal wetlands and informing management of this valuable resource.

Exploring the interactive effects of light, nutrients, and carnivore identity on aquatic food chain efficiency

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Food chain efficiency (FCE), the proportion of primary production converted to production of the top trophic level, is an ecological process describing energy flow through a food chain. FCE is determined by the efficiency of each trophic coupling; herbivore efficiency (HE) describes the producer – herbivore energy transfer, and carnivore efficiency describes the herbivore – carnivore transfer. In aquatic systems, FCE can be influenced by top-down (predation) and bottom-up (light and nutrient supply) controls. We conducted a mesocosm experiment manipulating light, nutrients, and carnivore identity to test the interactive effects of these factors on aquatic FCE. We predicted that bluegill, a vertebrate with high body phosphorus, would be more P-limited and therefore decrease FCE and CE relative to *Chaoborus,* an invertebrate. We also predicted that bluegill would exert stronger top-down control on zooplankton herbivores, decreasing HE in those treatments. Within a predator treatment, we predicted that low light and high nutrient supply would lead to the highest FCE, HE, and CE because this treatment would produce more nutrient-rich phytoplankton, alleviating potential nutrient limitation. We found a significant effect of predator and the light*predator interaction on FCE, suggesting that top-down effects of the two predators may be more influential than bottom-up effects. Within the bluegill treatments, we found a significant effect of light on FCE, but we found no significant light/nutrient effects within the *Chaoborus* treatments. Within the bluegill treatments, we found a significant effect of nutrients on HE, but we did not find any other significant effects on HE or CE.

Population Size and Waterhole Visitation Patterns of Striped Hyena

Dasynda Rosenbarger
Indiana University Southeast

The striped Hyena (*Hyaena hyaena*) is considered threatened on the IUCN red list. The striped hyena population has declined in its most northerly range such as India and most middle eastern countries. Several camera traps have been set up in Jordan's Dana Nature Reserve facing artificial waterholes. These cameras have been able to capture striped hyenas visiting the waterholes on a regular basis. They have been able to allow us to estimate striped hyena waterhole use in Dana. We have been able to calculate the minimum population size of seven individuals across three waterholes. The camera traps have also shown that the month of August has the highest rate of visitation of striped hyena. The striped hyena depends on rare resources such as waterholes in Dana's arid environment. Striped hyena depend on scavenging kills as

much as waterhole acceptability. The population of larger predators, key prey species and access to water is important in the future management of these animals.

Using compositional properties to classify metagenomic reads

Zachary Romer and Catherine Putonti
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Mapping reads from large metagenomic samples of thousands of potentially unknown species presents a challenge when considering sequences beyond marker genes. As such several tools have been developed, which given the sheer number of metagenomic reads generated by next generation technologies, must rely on heuristics to employ their search. Both similarity-based, often utilizing BLAST-like searches, and composition-based means of ascertaining the putative species and/or gene from which the read came have been developed. While the former has greater accuracy and specificity, composition-based approaches are less costly with respect to both time and memory. Herein we present an efficient classifier of metagenomic data involving the integration of composition and homology based comparisons, providing increased accuracy and expediency. This method for DIScovery through COmpositional profiles, known as DISCO, utilizes multidimensional k-mer frequency information combined with a probabilistic framework to predict the taxonomic group in which sequencing reads belong. Integrating multiple values of k facilitates the recognition of various sequence signals, e.g. codon usage, tetranucleotide usage, etc. Both sequencing reads and available genomic sequences are mapped to this multidimensional compositional space, generating the probability in which each read belongs to particular species and genera.

The influence of avian life-history and ecological traits on tick infestation.

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Life-history theory states that a given organism should face trade-offs to ensure current and future fecundity and survival. To successfully complete migration, a bird must meet a number of energetic demands. In doing so, the bird makes physiological trade-offs amongst ecological and life-history traits to ensure that energy is expended in the most efficient manner possible. In the short term, this should improve the likelihood of successful migration, and in the long term should improve the prospect of returning to breed the following year. Recent studies report that increased investment in reproduction negatively influences immune response in birds, a prime example of a trade-off between life-history traits that has been well studied. The impact of trade-offs made by migrating birds, however, have received disproportionate attention in light of the influence they may have on ecological systems. During fall 2012, we conducted a pilot study to explore the role of birds in the Lyme disease system, with a specific focus on their participation in the spread of black-legged ticks (*Ixodes scapularis*) and the Lyme bacteria, *Borrelia burgdorferi*. Preliminary results suggest that migratory birds are important dispersers of *I. scapularis* in Illinois. From this study, I developed the hypothesis that avian traits (foraging strata, age class, and molt status) will influence tick infestation. Foraging strata and age class of birds appear to be influential traits in terms of the proportion of birds infested, lending further urgency to the exploration of mechanisms that influence interactions between avian hosts and the black-legged tick.

Forest bee diversity in relation to habitat and vertical stratification

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Relatively few studies have examined bee diversity in temperate deciduous forests, particularly in relation to vertical stratification. We investigated differences in bee species composition between early successional and oak/hickory Midwestern forest habitats. Both habitats were sampled using vane traps and pan traps suspended 10 m in the canopy and at 1 m above the ground. A total of 4,611 bees constituting 76 different species were captured, with *Augochlora pura* comprising 66% of the total collection. Species composition was significantly different between the two habitat types and between canopy vs. understory, with *A. pura* both included and excluded from the analyses. Based on indicator species analyses, several species of bees were associated with either the canopy or understory of the two habitat types. *Agapostemon virescens*, *Lasioglossum macoupinense*, and *L. smilacinae* were associated with oak/hickory understory, while *Certina calcarata* and *L. versatum* are associated with oak/ hickory canopy. *Lasioglossum coeruleum* was the only species to be associated with the early successional canopy. Our results suggest that substantial spatial variation in bee diversity can occur within Midwestern deciduous forests.

How Time of Exposure to the Amphibian Chytrid Fungus affects Cope's Gray Treefrogs (Hyla chrysoscelis) in the Presence of an Insecticide

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Host susceptibility to pathogens can be influenced by changes in the immune system that occur during development and by environmental factors that negatively affect immune system function. Amphibians worldwide are suffering population declines from chytridiomycosis, a fungal disease caused by Batrachochytrium dendrobatidis (Bd). Outbreaks may be influenced by timing of exposure to Bd and by abiotic stressors, like pesticides, that influence susceptibility. To examine the effects of larval pesticide exposure and timing of Bd exposure, we exposed Cope's gray treefrogs (Hyla chrysoscelis) to the insecticide malathion chronically throughout larval development and to Bd at 1 or 3 weeks post-hatching, or following metamorphosis. We reared tadpoles through metamorphosis and then for 28 days in the terrestrial environment to examine effects on survival, time to and mass at metamorphosis, and growth following metamorphosis. We predicted that survival, time to and mass at metamorphosis, and terrestrial growth would be negatively affected by malathion and Bd exposure. We predicted that effects of Bd would be greatest when exposure occurred at metamorphosis. We found that malathion exposure resulted in a 8% decrease in mass at metamorphosis and a 6% decrease in terrestrial growth. Bd exposure at metamorphosis decreased terrestrial growth by 30%. However, we saw no interaction between Bd and malathion exposures. Our study indicates that metamorphs are more affected by Bd exposure than larvae, but metamorph susceptibility is not increased by larval exposure to malathion. Post-metamorphic life stages are a vulnerable time of disease exposure, and sublethal effects occur that could reduce population levels.

Are changes in the genetic and morphological composition of butterfly hybrid zone over a 30 year period the result of climate change?

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Clinal variation in species traits that correspond with climatic gradients are predicted to shift as climate change alters this underlying gradient. However, surprisingly few studies have documented such changes. Using historically (1980s) and recently (2010s) collected specimens from a butterfly hybrid zone (*Papilio glaucus*, *Papilio canadensis*) we explored whether a number of morphological and genetic traits that are known to differ between these two species have shifted in response to recent warming. Specifically to test whether the hybrid zone has shifted over the last 30 years we compared the historic and contemporary distribution of mitochondrial (Cytochrome Oxidase 1; COI) and 16 neutral (microsatellite) loci. A number of species diagnostic wing morphology traits, including a melanic band putatively involved in thermoregulation were also measured. Both the morphological and genetic trait clines of the *P. glaucus – P. canadensis* hybrid zone have shifted over the last 30 years and these changes correspond with documented warming in the region. Analysis of genetic data suggests gene flow is extensive between species and that the *P. glaucus* allele for COI has significantly increased in frequency at higher latitudes over the last 30 years. Similarly, we found many wing traits have also changed during this period, with butterflies becoming smaller and producing less melanism, particularly in the southern portion of the hybrid zone where warming has been the greatest. Taken together, these results suggest that the *P. glaucus – P. canadensis* butterfly hybrid zone is undergoing phenotypic and genetic changes that may be a response to rapid warming.

Evolution of growth rates in invasive populations of rusty crayfish (*Orconectes rusticus*)

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Some nonindigenous species cause extensive ecological and economic harm, and those species that have strong impacts often share a suite of r-selected life history traits that allow them to reach high densities. We examined the genetic basis for differences in growth, survival, and behavioral response to predators between native and invasive range populations of rusty crayfish (*Orconectes rusticus*). We hypothesized that repeated introductions into lakes would select for increased investment in growth and reproduction to overcome Allee effects. We collected *O. rusticus* as eggs from three native range and three invasive range populations and reared young of year crayfish in two common garden experiments. In summer 2011, we reared crayfish from both ranges in three lakes within the invasive range. In summer 2012, we reared crayfish in the laboratory where we controlled the presence of predatory fish, food quality, and temperature, which are likely important for *O. rusticus* growth. *O. rusticus* in the invasive range had faster growth and higher survival in lakes and in the laboratory than *O. rusticus* from the native range. Predatory fish presence reduced growth in crayfish from both ranges, and increased mortality in crayfish from the invasive range. Our data indicate that these r-selected life history traits have evolved since *O. rusticus* were introduced to the invasive range, and are consistent with our predictions of how selection in the invasive range would shape life history characteristics of nonindigenous populations. These traits likely contribute to the strong community level impacts of this invasive species.

Temporal variation in diet and phenotypic plasticity in masticatory elements.

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Recent discussions of feeding adaptations in extinct primates have focused on the extent to which the masticatory systems of these species were influenced by seasonal variation in dietary properties. This issue is typically framed in terms of reliance on nonpreferred, mechanically difficult-to-process fallback foods at certain times of the year. Here, we report preliminary results from an animal-model-based diet-manipulation experiment designed to examine this issue. We obtained 40 weanling rabbits (five weeks old) that were assigned to three dietary cohorts: pellets only (control); pellets supplemented with hay cubes ("annual"); and pellets supplemented with hay cubes for only part of the 48-week experimental period ("seasonal"). Each subject was imaged longitudinally every two weeks using microCT. From these scans we obtained bone cross-sectional areas in the coronal plane at four sites involved in force resistance during biting and chewing: the mandibular symphysis, condyle, and corpus, and the hard palate. Measurements were size-adjusted using maximum cranial length for intergroup comparisons. At ten weeks into the experiment, annual rabbits had significantly ($P<0.05$) greater relative cross-sectional areas than control rabbits at the corpus, palate, and condyle. Seasonal rabbits, which received hay for only the first six weeks, resembled annual rabbits early on but were more similar to the control rabbits four weeks after switching to an all-pellet diet. These results confirm previous findings regarding organism-level responses (i.e., phenotypic plasticity) to variation in dietary properties and suggest that such responses are site specific and sensitive to experimental conditions that mimic seasonal variation in diet.

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Detecting the Source of Infections Past

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The CRISPR system is defense mechanism various bacteria and archaea have developed to protect against bacteriophages. These prokaryotes are able to recognize nucleic acid sequences from invading viruses and then incorporate them into their own genomic DNA between tandem repeats as spacers. These sequences are later expressed and incorporated into proteins which utilize them to recognize similar sequences in invaders and subsequently defend against them. We have developed a new software tool to examine large volumes of virus and CRISPR sequence data, search for similarity between CRSIPR spacers and all possible virus subsequences, and then check the functionality of subsequences in viruses associated with CRISPR sequences. Using this software, we have analyzed numerous bacterial CRISPR sequences identifying possible viral sources suggesting previous infection(s). We then checked gene ontologies to find possible correlations in spacer sequence function.

Benthic invertebrate communities are more responsive to nutrient inputs than the presence of a sediment-feeding fish

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Watershed land use practices alter nutrient inputs to freshwater ecosystems. Increased nutrient inputs from agricultural watersheds enhance algal productivity, favoring pelagic communities over benthic communities. Reservoirs in Ohio are often characterized by high nutrient inputs from agricultural watersheds and high abundances of sediment-feeding gizzard shad (*Dorosoma cepedianum*). When feeding, gizzard shad disturb benthic invertebrates living in the sediments. Therefore, increased nutrient inputs and sediment disturbances can negatively affect benthic invertebrate communities in these reservoirs. In our study, we investigated the role of nutrients and gizzard shad on benthic invertebrate communities. To test this, we monitored benthic invertebrate communities over ten months in large experimental ponds. Nutrient levels (high or low) and gizzard shad presence (present or not) in ponds were manipulated. In general, we observed stronger nutrient effects than gizzard shad effects on benthic invertebrates. Preliminary results suggest that benthic invertebrates were more abundant in low nutrient treatments than high. All treatments were dominated by chironomids; however, *Chaoborus* were more abundant in high nutrient treatments, while mayfly abundance was higher in low nutrient treatments. Although gizzard shad presence/absence did not affect benthic invertebrates, we did observe trends for higher benthic invertebrate abundance with decreasing gizzard shad density in high nutrient treatments and increasing gizzard shad density in low nutrient treatments. Our results suggest that benthic invertebrate communities in shallow lakes are more affected by nutrient inputs than the presence of gizzard shad, although gizzard shad density may benefit or hinder benthic invertebrate communities depending on nutrient conditions.

The frontier of ecological speciation: Investigating western populations of Rhagoletis pomonella

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A major goal of biological research is to understand how populations diverge to become separate species. The apple maggot fly, *Rhagoletis pomonella* (Diptera: Tephritidae), has made several important contributions to our current understanding of ecological speciation and host race formation due to its rapid host shift in the eastern United States from historically infesting native hawthorns (*Crataegus mollis*) to introduced apples (*Malus pumila*) in the last 150 years resulting in apple and hawthorn host races. Previous studies have shown that host races differ in phenology (adult eclosion time) and host odor discrimination of adult flies and exhibit large areas of genetic divergence within the genome. Recent introduction of apple flies to the western United States has initiated the development of an interesting twist to the natural history of *R. pomonella* when it made a reversal in host shift back from infesting apples to infesting two separate western hawthorn species (*C. douglasii* and *C. monogyna*) where there were previously no known apple maggot infestations. We sampled and genotyped several populations of western *R. pomonella* flies and have found evidence of population structure between flies infesting the three different hosts existing in sympatry. These results provide evidence for recent genetic divergence between recently formed host associated populations, which can be a prelude to the formation of host races and is a process that has been argued to have produced the entire *R. pomonella* sibling species complex of five or more taxa.

The Influence of Sex and Age on Patterns of Parasitism in Wild Baboons

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The health-survival paradox describes a robust pattern whereby women experience greater longevity but higher rates of illness throughout their lives than men. To date, we do not understand the evolutionary origins of the health-survival paradox, or whether there is evidence for this paradox in non-human primates, such as baboons. Specifically, while we know that female baboons typically live longer than males, we do not yet know whether males or females exhibit greater rates of disease or parasitism as they age. To test whether the health-survival paradox occurs in baboons, I am currently testing the prediction that female baboons bear higher parasite loads than males throughout old age. This is done through standard float and sedimentation procedures performed on fecal samples collected from known-age wild baboons studied by the Amboseli Baboon Research Project (ABRP), near Amboseli National Park, Kenya. Age and sex-specific rates for two measures of parasitism, species count and *Trichuris trichuria* egg count, have been calculated. Preliminary data analyses suggest that the health – survival paradox is occurring, as females harbor more parasite species than males as they age. If the health-survival paradox is found to occur in wild primates, such as baboons, it could lead to two important insights. First, this could provide important insight into the understanding of the evolutionary origins of this paradox. Second, because the health-survival paradox plays an important role in determining differences in health and longevity in humans, baboons could serve as a useful model for human disease, parasite infection and aging.

The effects of perceived male availability on female selectivity in a wolf spider, *Schizocosa ocreata*

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Theory predicts that female mate preferences will vary depending on operational sex ratios (OSRs) in the population and/or the potential availability (perceived density) of males. In the brush-legged wolf spider, *Schizocosa ocreata,* males typically mature in the field two weeks prior to females, which may give females time to assess potential mate availability before maturation to adulthood. Previous studies have shown that juvenile exposure influences adult mate-choice in *Schizocosa spp.*, but the role of OSR and potential mate availability is unknown. We used video playback in the lab to simulate different levels of male density and perceived sex ratio that females experience as penultimate juveniles. Females were exposed to videos of one or three courting males (equal vs. male-biased sex OSR) at a frequency of once every two days or twice per day (low vs. high male density). At adulthood, females were presented videos of courting males with small or large tufts (a conspicuous secondary sexual character) to test for adult mate-choice preferences. Female receptivity towards males with large tufts increased significantly with the cumulative number of males that females were exposed to as juveniles, supporting the hypothesis that females are more selective as they encounter more males. Further, analysis through mixed models revealed that this relationship was consistent through time, providing evidence that this is a repeatable preference. This study adds to the growing body of literature that suggests that invertebrates demonstrate plasticity in their mate-choice decisions depending on their social environment.

Effects of landmarks on territorial behavior of *Hypsophrys nicaraguensis*

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Using landmarks as boundaries has important implications at the population level since it can influence the size, shape, and defensibility of territories, and ultimately population dynamics. In this field study of *Hypsophrys nicaraguensis*, a territorial cichlid fish, we investigated the responses of neighbors to the presence of a landmark at the boundary. The study was conducted in sandy habitat of a caldera lake in Nicaragua where there were no distinct landmarks. First, we identified boundaries of two adjacent territories by observing the behavior of breeding pairs for five minutes. In this species, opponents face off against one another at varied distances with the midpoint between them marking the boundary. We used a plastic aquatic plant, similar to naturally occurring aquatic plants, as a landmark. We recorded aggressive behavior and the distance at which fish interacted with one another for 10 minutes with and without the landmark at the boundary. When there was no landmark between territories, fish performed face offs from a significantly greater distance compared to the landmarked treatment, suggesting that fish leave a larger, unused area when there is no landmark. Furthermore, boundaries were less precisely defined when landmarks were present. Without landmarks, on average, the midpoint of face offs were five times further from the boundary than when landmarks were present. Findings of this study have important implications for wildlife managers and captive breeders as it suggests that the presence of a landmark could be useful in maximizing space use by territorial species.

Acoustic and vibratory signal production in the wolf spider *Gladicosa gulosa*

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Many wolf spiders produce complex multimodal signals, while others rely entirely on vibration, making them excellent models for testing hypotheses about the evolution of signaling behavior and information content in different modalities. The "purring" wolf spider *Gladicosa gulosa* has been widely overlooked in previous and current research, though a few early studies suggest that males of this species produce an airborne signal during courtship. However, the method of production of this airborne signal, the possible mechanisms of direct signal reception, and its potential adaptive value are unknown. We examined acoustic/vibratory communication in *G. gulosa*, using Laser Doppler Vibrometry and sensitive microphone recordings, and characterized the components of male courtship on both vibrating and non-vibrating substrata. Results suggest that courtship displays by males of this species involve both airborne and vibratory signals, and that the components of these complex signals are produced by both stridulation and percussion mechanisms. However, both airborne and vibratory components of the signal are fully ablated on a non-vibrating surface. Our data suggest that the airborne component of courtship in this species may be the indirect result of vibration of the substratum during courtship. We suggest that substrate resonance may play a role in production of the airborne signal, which could potentially have adaptive consequences in this species.

Aggression and Food Competition Between Sympatric Hermit Crab Species

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Asymmetrical outcomes of food competition can have strong influences on community dynamics and species distributions. Aggression can play an important role in determining the outcomes of interspecific resource competitions, with highly aggressive species often outcompeting less aggressive species. In the intertidal zone, competitive displacement is a strong contributor to the vertical (depth) zonation patterns observed among species, with superior competitors inhabiting areas of highest food availability. Hermit crab species in the intertidal region of the Gulf of California show vertical zonation, with multiple ecologically-similar species occupying different depths of water. In this study, I analyzed the aggressive interactions and the outcomes of food competitions between two Gulf of California hermit crab species, *Clibanarius digueti* and *Paguristes perrieri*, which occupy adjacent zones in the intertidal region. *C. digueti* occurs slightly higher (lower water depth) than *P. perrieri*. Because carrion is usually stranded at the land-water interface, areas higher in the intertidal are predicted to have higher food availability than lower areas. Based on the positioning of the two species in the intertidal zone, I predicted that *C. digueti* would be more aggressive than *P. perrieri*, and that *C. digueti* would gain increased access to food resources during direct interspecific competition. During interspecific foraging bouts, *C. digueti* showed higher rates of aggression and fed longer than *P. perrieri*. When foraging individually, there was no significant difference in feeding times between species. The results suggest that aggression-mediated food competition may be an important determinant of the distribution patterns of competing hermit crab species.

Establishing a global DNA barcode for *Ozobranchus* spp. in the Atlantic and Pacific Oceans

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Marine turtle leeches (*Ozobranchus* spp.) are suspected vector organisms behind fibropapillomatosis (FP), a neoplastic disease plaguing sea turtles. Morphological identification of these leeches can be difficult or impossible due to their small size (ranging from less than 2 mm to 23 mm in length) and various life stages. Character-based DNA barcoding using mitochondrial (mtDNA) cytochrome *c* oxidase I (COI) gene as a molecular marker was employed to identify both species of *O*. spp. (*Ozobranchus branchiatus* and *Ozobranchus margoi*) at all stages of development from turtles in Barbados (five *O*. spp. samples from hawksbill turtles), Florida (43 from green turtles and 13 from loggerheads), Hawaii (34 from green turtles), Hong Kong (two from a green turtle), Brazil (ten from green turtles), and Mexico (two from olive ridley turtles). This is the largest molecular data set assembled for *O.* spp. with the most documented number of turtle host species.

Particle size distribution and optimal capture of fish environmental DNA.

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Aqueous macrobial environmental DNA (eDNA), the DNA-containing material shed by large organisms into water, has recently gained attention as a source of genetic information about the location, abundance, and diversity of aquatic and terrestrial macrobes. Understanding the relationship between eDNA and the organism it came from is critical for assessing how well eDNA can serve as a proxy for directly observing the organism. To better describe this relationship we measured the particle size distribution (PSD) of aqueous eDNA for a model fish (common carp, *Cyprinus carpio*) and compared this with PSDs of total eDNA and total suspended solids in the same water bodies. Carp eDNA represented a tiny fraction of total eDNA and most carp eDNA was found at particles sizes larger than 1.0 µm. The PSD suggests that extracellular DNA is only a minor constituent of fish eDNA suspended in water. These results also provide guidance for optimizing the capture of fish eDNA when searching for rare species that are difficult to detect another way. As eDNA-based monitoring of aquatic ecosystems integrates across the microbial/macrobial divide, these findings will help improve data collection and interpretation.

Whirling Disease Dynamics: An Analysis of Intervention Strategies

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Whirling Disease (WD), a severe and widespread disease of salmonids, is caused by the myxosporean parasite *Myxobolus cerebralis*. It is characterized by a unique two-host life cycle, utilizing the oligochaete *Tubifex tubifex* as an intermediate host. *M. cerebralis* is an invasive species that has been affecting North American populations including epidemics that killed in excess of 90% of populations in Colorado and Montana streams within the past 20 years. Currently, there is no known cure for WD. Afflicting both natural and agricultural populations of salmonids, control strategies are numerous and include chemical and physical approaches aimed at targeting multiple points of the disease system; the accepted methods of control are to remove infected fish from the population or to sterilize the environment entirely. To address the gap in our understanding of the growth and spread of WD, we produced an epidemiological model of the system using a compartmental model and calibrated it with recent advances in understanding of the life cycle and ecology of *M. cerebralis*. Through utilization of our model, population dynamics can be accounted for in determination of effective treatment and control methods for WD. Approaches targeting the oligochaete *T. tubifex* appear the most influential in limiting disease outbreaks. However, our model shows that oligochaete mortality rates would have to be in excess of 92% to yield R_0 below 1. As such, the combination of multiple intervention strategies would most effectively reduce WD incidence.

Biofilm Accumulation and Diversity in the Intertidal and Subtidal Zones of the ACE Basin Estuary, South Carolina

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Bacteria that exist in marine and estuarine environments adhere to most subtidal and intertidal solid surfaces by forming sessile multicellular communities known as biofilms. Little is known about the bacterial species that make up estuarine biofilms, yet they are often the first to colonize a surface in the intertidal zone, and therefore are frequently used as indicators of environmental health. We were interested in whether emergence and air exposure due to tides affects biofilm accumulation and diversity. We expected distinct bacterial species to form biofilms at the different tide levels, with most attachment at the subtidal level. Biofilm was allowed to accumulate on microscope slides, suspended in tubes affixed to a PVC structure in the intertidal and subtidal zones of Mosquito Creek, and collected after two or three days of exposure. Biofilm was removed from slides and spread onto prepared marine agar plates or cultured in marine liquid nutrient broth and incubated at 24°C. Morphologically distinct colonies were isolated onto new marine agar plates that wereincubated at 37°C for 120 hours then stored at 4°C. Isolates were Gram stained and colonies from isolate plates were cultured in marine liquid nutrient brothat 37°C. Our results indicate approximately 20 distinct bacterial species that appear to be present at both subtidal and intertidal zones. To identify species, we are isolating and culturing bacteria from biofilms and will identify them by phylogenetic analysis using 16s rDNA sequences. DNA from these cultures will be extracted and 16s rDNA sequences amplified by PCR.

Play the odds: Mate availability, not timing, impacts female reproductive investment

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Reproduction often involves female choice and investment, two potential targets of sexual selection.[1] As sexual and natural selection work in concert to drive evolution, selection targets such as choice and investment can have important population-level consequences, particularly when the interacting factors are out-of-sync or acting in opposition. Threespine stickleback (*Gasterosteus* spp.) have recently been shown to vary temporally and spatially in operational sex ratio (OSR) in the field , and recent laboratory experiments have demonstrated variable mate choice in response to OSR and seasonality. However, the evolutionary consequences of this variable mate selection depend on the *investment* (here, clutches) females make. Previous work has failed to address whether and to what extent investment patterns exacerbate or 'correct for' maladaptive choices made in response to OSR and/or seasonality. In a laboratory experiment, wild-caught stickleback females were placed into either male- or female-biased tanks and their investment tracked across the summer reproductive season. The results of this study show that mate availability strongly impacts female development and investment in individual clutches as well as growth ($P<.001$), however investment across season appears to be constant.

Does engineering affect the ecology of freshwater-lake shorelines?

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Freshwater shorelines are ecotones that link aquatic and terrestrial ecosystems, and support biodiversity and productivity in both. Riprap, retaining walls, and other engineering structures are commonly constructed to improve access for recreational activities and to prevent erosion as shorelines are developed for human use. Engineering structures are quite different physically from natural substrates, and likely disrupt aquatic-terrestrial linkages as well. We compared pairs of natural and riprap-engineered shorelines of Lake St. Clair (Michigan, USA) to investigate how ecological functions of freshwater-lake shorelines may be impaired. Standing stock of wrack (washed-up organic matter), decomposition of cellulose, shoreline slope, temperature, and primary production (periphyton growth) were quantified. Natural shorelines had standing stocks of wrack 3.4 times greater than engineered shorelines (ANOVA, $p<0.001$), even though cellulose placed above the waterline decomposed 3.8 times faster on natural shorelines (ANOVA, $p<0.001$). These findings suggest that engineering impairs the deposition or retention of wrack. Decomposition of cellulose submerged in shallow, intermediate, and deep locations did not differ between shoreline types (ANOVA, $p=0.106$, $p=0.078$, $p=0.099$, respectively). We found engineered shorelines to be nearly 1.5 times steeper (ANOVA, $p<0.001$). Natural and engineered shorelines did not differ in mean daily water temperature (ANOVA, $p=0.842$) or primary production (ANOVA, $p=0.854$). Engineering appears to alter some, but not all aspects of freshwater shoreline ecology. Additional studies are planned to investigate how engineering may alter decomposition of natural wrack components, temperature during other seasons, and fish and invertebrate communities.

Drivers of methane production from lakes in forested and agriculturally dominated landscapes

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Freshwater inland lakes are a significant source of methane (CH_4) to the atmosphere. However, current global estimates of lake contributions to atmospheric CH_4 are static in nature. More specifically, current global estimates are based on the product of average empirical rates and global lake surface area. Furthermore, regional and global estimates of CH_4 production and emissions do not predict dynamic changes observed in the watershed of lakes. To begin to address this issue, we conducted a survey of methane production for twenty-nine lakes in forested and agriculturally-dominated watersheds across the upper and lower Midwest USA. Our survey revealed contrasts between drivers of CH_4 production from lakes in forested versus heavily agricultural watersheds. We also used our survey results to generate landscape predictors in order to facilitate the extrapolation of CH_4 production and emissions rates to broader spatial scales.

When a Helminth isn't just a Helminth: Genera Specific Helminth Effects on Intracellular and Extracellular Microparasite Infections in Long-Tailed Macaques (*Macaca fascicularis*) in Bali

Justin Wilcox, Kelly Lane, Agustin Fuentes, and Hope Hollocher
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Several helminth taxa are known to modulate host immunity and this may lead to changes in host immune response to concomitant microparasitic infections. Evidence for this has been found at both the physiological, ecological, and epidemiological levels in several microparasite/helminth systems. However, existing literature on this topic has overwhelmingly focused on interactions between a small subset of helminthes and intracellular microparasites. Where these interactions have been found they are often attributed to polarization of host immunity toward a humoral immune response, at the expense of intracellular immunity. However, some helminth taxa are known to generally suppress host immunity, which could lead to synergistic effects on extracellular microparasites as well. Here, we analyzed a previously compiled data set of enteric parasites infecting long-tailed macaques on the island of Bali, Indonesia, to determine if concomitant helminth infection increased shedding of two genera of intracellular (*Cryptosporidium* and *Isospora*) and two genera of extracellular micoparasites (*Entamoeba* and *Giardia*). We also made comparisons between the effects of difference helminth taxa on microparasite shedding. We found interactions between helminthes and all four genera of microparasite included in our analysis. Platyhelminthes were found to be more important to driving interactions with included microparasites than nematodes, with *Taenia*, *Paragonimus*, and *Alaria* all showing positive associations with more than one microparasite. Our findings demonstrate that interactions between helminthes and microparasites occur across a broader range of taxa than anticipated by helminth mediated polarization of host immunity alone, but that they are also highly dependent of the particular taxa involved.

The Changing Forests of Ohio: Drivers of Composition Shifts Between the Settlement Era and Today

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Present-day forests in Ohio are the product of complex environmental and anthropogenic interactions, including past climate, geology, and species prevalence. Natural forest succession and disturbance can be altered by human land-use decisions like field drainage, timber harvesting, and fire exclusion. To test the extent to which land use has modified vegetation patterns, we reconstruct Ohio forest composition at the time of European settlement (1797-1819) using hand-drawn maps of Public Land Survey records from 27 counties. We then compared historic forest composition at the county level to estimates of modern composition from the U.S. Forest Service Forest Inventory and Analysis. Pre-settlement forests were dominated by beech in northwest Ohio (mean: 26.9%; range: 2.2-46.1%), which was covered extensively by swampland, and southeast Ohio was predominantly oak forest. Modern forests, however, are more heterogeneous in northwest Ohio with a decline in beech (mean: 1.2%; range: 0-7.1%) and southeastern counties are characterized by an increase maple and poplar. We then ran a series of partial Mantel tests to determine the relative contributions of land use and environmental variables to variation in species composition between settlement-era and modern forests.

Extensive agricultural development has altered original hydrology patterns making northwest Ohio more suitable for species that thrive in well-drained soil, and frequent anthropogenic forest disruption has largely excluded slow-developing species. This work furthers our understanding of the original climate and ecological characteristics of Ohio and informs decisions about management in remaining forests in the region.

Blind Dating: The role of different eye types in female mate recognition and prey detection by the wolf spider *Schizocosa ocreata* (Hentz)

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Female *Schizocosa ocreata* wolf spiders utilize visual cues for both prey recognition and capture as well as when assessing males during mate choice. As wolf spiders have eight eyes in two sets, with different sizes and orientations, we tested the hypothesis that the anterior (small) and posterior (large) eyes play different roles in detection and decision-making processes involved in mate choice and prey detection. We occluded the different sets of eyes of individual females using an opaque, non-toxic paint, and presented them with either video playback of a courting male stimulus or a live cricket. With courting male video stimuli, latency (seconds) to orient and respond with receptivity were shortest with unmanipulated controls, but when the posterior eyes were occluded, there was a significantly longer latency to orient, as well as to respond to males with receptivity when compared to (unmanipulated) controls. There was no statistically significant difference in mean latency to orient between controls and females with anterior eyes occluded. In addition, a composite receptivity score (sum of female displays) was significantly reduced when posterior eyes were occluded. This suggests the posterior eyes are involved in mate detection and recognition. With live prey, the latency to orient and approach crickets was shortest for unmanipulated controls, intermediate for anterior eyes occluded, and significantly longer when posterior eyes were occluded. Taken together, these data suggest that the two sets of eyes may have different roles in detection and identification of prey and courting males (with posterior eyes playing a more important role).

Environmental Drivers of Phytoplankton Light Use Efficiency in 25 Globally Distributed Lakes

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Lake metabolism, including gross primary production (GPP), respiration (R), and net ecosystem production (NEP = GPP – R), is important to understanding lake trophic status, food web structure, and carbon cycling at regional and global scales. GPP is controlled by phytoplankton abundance and physiology, or the efficiency at which phytoplankton use resources, such as photosynthetically active radiation (PAR). Using data from 25 lakes distributed globally, we examined environmental drivers of the efficiency at which phytoplankton use PAR. We estimated the daily rate of GPP per unit of PAR (termed Iota) via maximum likelihood fits of a free-water metabolism model to continuous high-frequency measurements of dissolved oxygen. Uncertainties in estimates were calculated using a bootstrap analysis, allowing us to identify significant day-to-day differences of Iota. Across lakes, Iota was positively correlated to both

total phosphorus and the light attenuation coefficient, and combining both parameters explained 76% of the variation of Iota. Within lakes, Iota varied at seasonal and daily time scales with drivers of variation including phytoplankton community composition, Schmidt Stability, and buoyancy frequency. This study reinforces previously known drivers of lake metabolism and highlights the importance of physical parameters as drivers of seasonal and daily variation.

Poster Presentation Abstracts
(organized by location – poster number)

1. Venus flytrap (*Dionaea muscipula*; Droseraceae) digestive glands exhibit properties of both apocrine and merocrine modes of secretion

Caroline M. Matchett, Kevin M. Gribbins, and Matthew H. Collier
Wittenberg University

The insectivorous Venus flytrap, *Dionaea muscipula*, has long been studied because of its unique method of nutrient procurement. The trapping mechanism is triggered when prey contact one of the three trigger hairs located on the surface of each brightly colored, bilobed leaf. Upon closure, microscopic glands on the leaf surface secrete proteolytic enzymes that digest prey over a 5-12 day period. Although the mechanism of flytrap leaf closure is well documented, the secretory nature of the digestive glands remains poorly understood. This study investigates the ultrastructure of flytrap digestive glands to determine if they exhibit secretory properties commonly associated with animal apocrine/eccrine glands. To examine gland ultrastructure, leaves (N=30), were removed from flytraps immediately after feeding and at days 3, 6, and 9 post-feeding. All samples were cut into 3 equal CS pieces, fixed, and embedded. Tissue blocks were sectioned (90 nm) using an ultramicrotome and prepared for TEM. Gland secretory cells appear to accumulate osmophilic dense materials apically, suggesting apocrine secretion. Though the cell wall is thin around gland cells it is improbable all materials are released in this fashion. Evidence was also seen for merocrine release of gland products via exocytotic vesicles. Thus, we hypothesize that flytrap glands show properties of both apocrine and merocrine secretion, providing a mechanism for the exocytosis of both large vesicular materials and inclusions. Previous studies concentrated only on direct enzyme release via the endomembrane system; thus, the present data for large material release adds new insight to digestion in carnivorous plants.

2. Temperature and water relations of eggs aimed at heat treatment of lumber for control of the emerald ash borer

Terrance J. Smith, Andrew J. Jajack, Andrew E. Rosselot, and Jay A. Yoder
Wittenberg University

Transport of lumber infested with eggs and newly hatched larvae is the primary route for spread of the emerald ash borer, *Agrilus planipennis*, a wood-boring beetle that kills ash trees by larvae tunneling through wood. Using gravimetric methods using a microbalance, net transpiration (water loss) rates of eggs were measured as a function of temperature and relative humidity to determine the temperature threshold of a particularly rapid, lethal water loss that may target the egg stage in lumber heating pre-treatments. Results showed that the eggs featured a low water

content, low water loss rate, and inability to absorb water vapor, implying that these eggs are closed systems that are modified for water conservation. Eggs laid individually were as resistant to water stress as eggs laid in groups of five and ten, as evidenced by having similar water loss rates. Upon Arrhenius analysis, water loss followed a typical Boltzmann temperature function yielding a single, low activation energy (single component curve) without an abrupt increase in water loss; that is, these eggs lack a critical transition temperature permitting survival at high temperature. Eggs require a dry habitat for hatching and this matches behaviorally the female adults laying eggs on the sun-exposed sites on trees mostly during mid-summer droughts, and there is a strong shellac-like coating of water-proofing lipids covering the eggshell chorion that resists breakdown at high temperature. Extreme resistance to desiccation of eggs implies that standard 60°C for one hour lumber treatment used for killing larvae may not affect the eggs.

3. Has an allele putatively involved in adaptation to climate in a butterfly hybrid zone shifted in response to recent warming?

Tyler Wagner, Sean F. Ryan, and Jessica J. Hellmann
University of Notre Dame

Adaptation may be critical to some species survival to climate change. Yet little is known about the role that adaptation will play in species' response to climate change. Traits putatively involved in adaptation to temperature are excellent candidates to explore evolutionary responses to climate change, as they are already believed to be sensitive to climate. Here we used the hybrid zone between *Papilio canadensis* and *Papilio glaucus* to test whether recent warming has led to the northward shift on an allele that is segregating between the two species and is believed to be involved in adaptation to temperature: Lactate dehydrogenase (LDH). Previous work with *P. canadensis* and *P. glaucus* has found a non-synonymous single nucleotide polymorphism (SNP) that differs between the species and is believed to lead to differences in the thermal sensitivity of LDH. Using historically and recently collected specimens from along a latitudinal transect that spans the center of Wisconsin we compared the frequencies of this allele between a 30 year period of warming (1980s and 2010s). We predicted that due to increased temperatures over the past three decades the putatively warm-adapted *P. glaucus* allele will have shifted further northwards, displacing the putatively cold-adapted *P. canadensis* allele. This work takes advantage of a rare opportunity to evaluate the potential shift of a molecular marker putatively involved in adaptation to temperature and thus provides insight as to how species may adapt to climate change.

4. Effects of habitat type and leaf species on macroinvertebrate diversity in a forested headwater stream

Zachary C. Nemec, Kailey N. Cooper, Nicholas R. Cusick, and Jennifer M. Clark
Hiram College

Food webs in forested headwater streams tend to be driven by autochthonous inputs (i.e., leaves). Leaf species, however, can be highly variable in nutritional quality and better quality food resources tend to be decomposed more rapidly by shredder invertebrates. In this study, artificial leaf packs of three different types [American Beech (*Fagus grandifolia*), Sugar Maple (*Acer saccharum*), and a combination treatment of equal mixtures of each] were used to assess colonization of macroinvertebrates in riffle (n = 3) and pool habitats (n = 3) in a headwater

stream in northeastern Ohio (Silver Creek, Portage County). Leaf packs used for comparison were pulled at approximate two week intervals on 11 November and 1 December 2012. Kick samples were collected in five random locations within each habitat (total of 30 samples) to allow for comparison of macroinvertebrate diversity between leaf packs and the stream system proper. Macroinvertebrate diversity significantly increased from the two week to the four week sampling period ($P < 0.05$) and leaf packs from riffle habitats had higher diversity overall ($P < 0.05$). Regardless of habitat or leaf type, collector-gatherers and shredders tended to dominate the leaf packs with Plecopteran shredders being most abundant. Our results suggest that macroinvertebrate colonization and diversity increase as leaves become more conditioned; however, macroinvertebrates appear to not show preference for a particular leaf type.

5. Effects of low doses of caffeine on feeding rate and growth of crayfish (*Procamarbus clarkii)*

Preston R. Caldwell, Maci T. Nelson, and Jennifer M. Clark
Hiram College

The escalating amount of caffeine products consumed today has resulted in detectable amounts of caffeine in our surface waters. Since caffeine cannot be filtered through wastewater treatment systems, concentrations are likely to continually increase. Little is known about the consequences this has on aquatic organisms. In this study, we assess the effect that low doses of caffeine has on crayfish (*Procambarus clarkii*) feeding rates and growth in a laboratory setting. To assess feeding rates, crayfish were placed in hanging baskets (allowing FPOM to fall) in 10-gallon aquaria stocked with known weights of conditioned sugar maple leaves in either control (distilled water) or treatment (0.0033g/L anhydrous caffeine powder dissolved in distilled water) tanks. Feeding trials lasted for 2 days and final leaf weight was measured. To evaluate differences in growth trials, crayfish were exposed to either distilled water only or a 0.0033 g/L concentration of caffeine (n = 18 each treatment) in 14 L tanks for six weeks. Our preliminary results show that low doses of caffeine did not have a significant effect on crayfish feeding rate (control average = 0.7119g, treatment average = 0.5355g, t-test: $P = 0.3329$) or growth measured by number of molts (t-test: $P = 0.3024$). These results indicate that low doses of caffeine currently found in streams systems may not alter crayfish feeding rates or growth and have no substantial impacts on the food web at low levels. Further experiments are needed to detect long-term trends in growth and if higher doses of caffeine have impacts.

6. Naticid prey preference: Does bivalve size matter?

Heather A. Rider, Ramsey G. Millison, Dimitar B. Zlatev, Allison E. Grecco, Michael C. Lordon, Andrew C. Steffen, Erica A. Binelli, Jason S. Bystriansky, and Jalene M. LaMontagne
DePaul University

Although numerous laboratory experiments have analyzed prey preference in naticid snails, few have studied bivalve mortality through large-scale shell collection. The factors associated with predation, such as prey preference, can affect intertidal community characteristics such as size, density, and distribution of species. Marine carnivores select prey based on preferable characteristics, which could help maximize a predator's net energy intake. We collected 997 bivalve shells on the shoreline of Edisto Beach, South Carolina and compared the characteristics of shells with no predation marks to shells containing the borehole through which snails feed to

determine whether naticids have a prey size preference. The results indicate that the shells of predated bivalves are significantly smaller than of those that were not predated. In comparing the width of predated and non-predated bivalve shells, we found that predated shells were significantly smaller than non-predated shells. We also noticed a size threshold in which no predated shells greater than 37 mm wide and 6.0 g in mass were found. Smaller shells may be preferred because predators expend less energy locating and boring a hole through the shell. These findings support the hypothesis that naticids select prey based on size to maximize net energy gain. Much is already known about the feeding behavior of naticids; however, this study concludes through inductive evidence that snail boreholes are more common in smaller bivalves.

7. A new citizen science initiative at Hiram College: FrogWatch USA frog and toad monitoring program

Gurneet Raina, Jennifer Clark, Jim Metzinger, Anthony Solis,
Carol Shreiner, and Cara Constance
Hiram College

In order to determine which amphibian species inhabit the James H. Barrow Field Station at Hiram College (Portage County, OH) a frog and toad survey was conducted using the ODNR protocol during the breeding season of 2012. Surveys completed between March – August, 2012 indicated that Northern Spring Peepers are the prevalent species during March while Northern Green frogs and American Bullfrogs are prevalent during the months of June and July. To promote consistent data collection over the entirety of the breeding season from February to August, a FrogWatch USA chapter, managed by the Association of Zoos and Aquariums, was established at Hiram College in January, 2013. This program provides an opportunity for citizen scientists to contribute to long-term monitoring of frogs and toads in order to assemble a data set that identifies the diversity, range, and phenology of both native and non-native frogs and toads. It also provides a wide range of opportunities for institutions to interact with their community. Our chapter held training sessions in January and February of 2013 for approximately 25 volunteers, including college students (enrolled in a FrogWatch seminar course) and adults and children in the community. These volunteers learned about the importance of amphibians, how to identify frogs and toads by call, and the protocol for monitoring for FrogWatch USA. Our volunteers will begin collecting data in February, 2013.

8. Buoyancy and hatchability of historic cyst samples harvested from Great Salt Lake, UT

S. A. Sura, S. E. Bueter, and G. E. Belovsky
University of Notre Dame

Brine shrimp (*Artemia franciscana*) cysts from Great Salt Lake (GSL) are commercially harvested and used as feed in the aquaculture industry. Cysts can sink, float or remain neutral in the water column; however, they are selectively harvested by skimming off the floating cysts, which may also be more viable (higher hatching success). Selective harvesting may reduce the fitness of certain phenotypes and can lead to directional selection. Due to this potential selective pressure against floating cysts, I examined whether the relationship between salinity (45, 90, 120 ppt) and cyst buoyancy or hatchability differs among years (1991, 1995, 1999, 2003, 2007, 2011) for historic samples of harvested cysts. I hypothesize the proportion of floating cysts and their

hatchability should have decreased over time with harvesting. For each experimental trial (n=5), I counted the number of cysts floating, sinking or neutrally buoyant on day 0 and hatched nauplii on days 1-4. Using time series analysis (Mann-Kendall Test), I examined whether the slope between the response variable (hatchability, proportion of floating cysts, proportion of sinking cysts) and salinity has changed directionally over time. Hatchability has not decreased (Kendall-Tau=0.200, p=0.679), proportion of floating cysts has not decreased (Kendall-Tau=-0.333, p=0.207) and proportion of sinking cysts has not increased (Kendall-Tau=0.067, p=0.453) over time. Cyst hatchability and buoyancy (floating or sinking) do not appear to be experiencing directional selection due to harvesting techniques. Continuing to monitor cyst hatchability and buoyancy will help ensure the selective harvesting of the cysts is not negatively impacting *A. franciscana* populations in GSL.

9. Alterations of cross-system subsidies, associated with the removal of a riparian forest invader (*Lonicera maackii*), drives shifts in aquatic biota and ecosystem processes

Rachel E. McNeish, M. Eric Benbow, and Ryan W. McEwan
University of Dayton

Riparian forests throughout the world are vulnerable to invasion by exotic species, which can change community composition and ecosystem function. We assessed the impacts of an invasive riparian shrub, *Lonicera maackii,* on organic matter subsidies and bottom-up effects in a headwater stream in southwestern Ohio, USA. *Lonicera maackii* was removed along a 150m stream reach, 10m downstream of the non-removal reach in August of 2010. Autumnal, in-stream leaf litter was assessed over 75 d and benthic primary production and macroinvertebrate density were measured monthly for two years. We found *L. maackii* removal decreased overarching canopy cover but significantly increased in-stream coarse organic matter (COM: leaf litter) overall, specifically from native leaf litter during the first 14 d ($P < 0.05$). In contrast, COM from invasive leaf litter was significantly reduced in the removal reach during this timeframe ($P < 0.05$). Invasive species removal also differentially influenced the timing and abundance of leaf litter genera within the stream. For example, *Platanus* spp. contributed the most COM within the removal reach (35-40%) but was mainly absent in the control reach (<10%). Benthic primary production peaked twice after removal and two months earlier than macroinvertebrate density peaks (Spearman $r = 0.9762$, $P = 0.0004$). Macroinvertebrate density was generally higher in the removal reach, especially from spring to early summer months. These findings suggest removal of a dominant invasive shrub affects terrestrial organic matter subsidies into headwater streams, influencing the timing and abundance of leaf litter habitat and food resources for macroinvertebrates.

10. A comparison of phytoplankton quantifying techniques to assess nutrient limitation of communities

John Whalen, Mike Vanni, Beth Mette, and Nicole Hayes
Miami University

Phytoplankton growth is limited by the availability of solar radiation and limiting nutrients. Nutrient limitation assays are commonly used to determine whether phytoplankton are individually or co-limited by nitrogen and/or phosphorus. The degree of nutrient limitation of phytoplankton is traditionally assessed using a fluorometer, which measures chlorophyll-a as an

indicator of phytoplankton biomass. There is little research that utilizes a spectrofluoroprobe for nutrient limitation assays. The spectrofluoroprobe is unique in that it not only estimates phytoplankton biomass, but also the concentration of major phytoplankton taxonomic groups. Nutrient limitation assays were conducted on phytoplankton samples from two sites in Lake Acton using both the fluorometer and spectrofluoroprobe techniques. This allowed us to 1. compare the two techniques for quantifying phytoplankton biomass and the degree of nutrient limitation of the whole community and 2. assess the variations in the degree of nutrient limitation of four major phytoplankton taxonomic groups (chlorophytes, cyanobacteria, diatoms, cryptophyta).

The data show that the two methods are strongly and positively correlated when looking at the two sites, both together and independently ($p < 0.0001$). The two methods are strongly and positively correlated with each type of limitation, while independently evaluating both sites ($p < 0.005$). This study suggests that the phytoplankton community composition impacts the response of the whole community to nutrient limitation, as the taxonomic groups had differential responses to nutrient limitation.

This suggests that the spectrofluoroprobe technique is a promising method for assessing nutrient limitation of the whole phytoplankton community and within individual taxonomic groups.

11. Estimating trophic position of *Ambystoma tigrinum nebulosum* larvae in a western Colorado stream

Kaylin R. Boeckman
Murray State University

In fishless lentic systems, larval Arizona tiger salamanders (*Ambystoma tigrinum nebulosum*) have been shown to induce trophic cascades and act as keystone predators. The role they play in lotic food webs, however, is not well understood. In western Colorado, *A. t. nebulosum* are able to inhabit streams in the absence of native Colorado cutthroat trout (*Oncorhynchus clarkii pleuriticus*) or non-native, introduce trout. As a first step in understanding the potential role of this top predator in lotic ecosystems, the trophic position of salamander larvae in this system was evaluated by assessing prey diversity and abundance within stomach samples. Trophic level of prey was used to estimate the mean trophic position of *A. t. nebulosum*. Larval salamanders were found to feed on a varied diet, including primary consumers (e.g. Ephemeroptera) as well as secondary and tertiary consumers (e.g. Hemiptera and Coleoptera). Mean trophic level data will be compared to that from lentic studies, and eventually augmented with stable isotope analyses. Data from this initial investigation will also facilitate the design of mesocosm experiments aimed at testing the strength of salamander induced trophic cascades in lotic systems.

12. The effects of atrazine and grazing pressure on periphyton biomass in aquatic mesocosms

Erin M. Lloyd, Brian E. Ringholz, and Amber A. Burgett
Wittenberg University

Atrazine is a widely used agricultural herbicide that has been shown to cause a range of negative impacts on both wildlife (e.g.: hermaphroditic male amphibians, increased mortality rates of aquatic organisms) and humans (e.g.: birth defects). Consequently, atrazine has been banned in many European countries; however it is still commonly used in the United States. As a result of

agricultural runoff, atrazine has the potential to be particularly disruptive in aquatic ecosystems. As an herbicide, atrazine may cause a direct decrease in primary production in aquatic ecosystems by decreasing algae, periphyton, and aquatic plant biomass. Additionally, atrazine may have an indirect positive impact on production if it causes an increase in herbivore mortality. We examined how the presence or absence of atrazine and a common stream consumer (*Lirceus fontinalis*) impacted the biomass of periphyton in a mesocosom study. In the timeframe of this study, we did not see a significant impact of grazing activity on periphyton biomass regardless of atrazine presence or absence. Atrazine exposure had no significant impact on periphyton biomass, but atrazine presence did statistically increase the mortality rate of *L. fontinalis*. Although we saw a reduction in the overall survivorship of grazers in this experiment, periphyton biomass did not change during the study period. As consumer survivorship and thus density decreases with atrazine exposure, impacts on primary production such as periphyton biomass may not be straightforward. Future studies are needed to disentangle the potential long-term direct and indirect effects of atrazine exposure on primary production in aquatic ecosystems.

13. Predicting the effectiveness of chemical defenses based on the physical defenses of three gastropods in the presence of two crayfish predators

Nick Anderson and Shayna Sura
University of Notre Dame

Predation poses a serious threat to prey species' fitness. Prey species invest energy into morphological and behavioral defenses to avoid predation. While these defenses offer the benefit of reduced predation, they also incur costs for the defended organism. Predators counteract defenses with their own adaptations and by selectively foraging on prey items that offer enough nutritional benefit to outweigh the costs of consumption. We explored this interaction by observing the preferential browsing of two crayfish species— *Orconectes propinquus* and *Orconectes virilis*—on three gastropod species—*Bellayma chinensis*, *Lymnaea stagnalis*, and *Helisoma trivolvis*. Possible chemical defenses were isolated by removing the snail species' physical defenses. We predicted snails that invest more in physical defenses would possess fewer chemical defenses and they would be preferentially browsed upon. We found this was not always the case and that *H. trivolvis*, the species with the fewest physical defenses, was more often preferred by the crayfish species over the other snail species. Further study is needed to adequately assess chemical defenses and the nutritional value of these gastropods as well as the relative effectiveness of their defenses against predation.

14. Nutrient limitation of riverine biofilms: The role of turbidity and cation-induced inhibition

Martha M. Dee, Alexander J. Reisinger, and Jennifer L. Tank
University of Notre Dame

Biofilm growth in headwater streams may be limited by nitrogen (N) or phosphorus (P) or co-limited by both N and P; although understudied, it is likely that similar nutrient limitation influences biofilms in rivers. Light may also limit biofilm growth, particularly in turbid rivers with strong light attenuation in the water column. Using nutrient diffusing substrata (NDS), we examined biofilm nutrient limitation status in five Western rivers that span a nutrient and

turbidity gradient, using gross primary production (GPP) and community respiration (CR) as response metrics post-incubation. On inorganic substrata, GPP was P limited in three rivers, but was not nutrient limited in the other two rivers. On organic substrata, CR was inhibited by P in three rivers, and not influenced by nutrient amendment in two rivers. Surprisingly, all significant effects of nutrient amendment on CR were inhibitory rather than stimulatory, apparently driven by the presence of P. Given these results, combined with similar reports in the literature, we are examining causes for potential P inhibition using NDS incubations with phosphate salts containing different cations, including NaH_2PO_4, $MgHPO_4$, and KH_2PO_4.

15. The Effects of Temperature, Predator Density, DO, and % Emergent Plants on *Lithobates sylvaticus* Body Mass

Nick Kalejs
University of Notre Dame

Across their geographic distribution, tadpoles of the wood frog (*Lithobates sylvaticus*) can be found in a variety of small ponds and lakes. Among these ponds, predators, aquatic plants, and abiotic factors can be highly variable. As these factors are known to affect the growth and development of tadpoles, the variation in these factors among ponds should correlate with the variation in tadpole body mass, a key indicator of tadpole growth. In this study, I tested the effects of pond temperature, predator density, dissolved oxygen content, and percent emergent plants on the body mass of *L. sylvaticus* tadpoles. Tadpoles were collected from nine ponds on the University of Notre Dame Environmental Research Center (UNDERC)-East property, located in the Upper Peninsula of Michigan. Body mass was analyzed as average body mass per pond and as variability in body mass per pond. Variability in body mass was found to be positively correlated with predator density (Slope ± 1 SE; 0.071 ± 0.023, $P = 0.019$) and with dissolved oxygen content (Slope ± 1 SE; 0.028 ± 0.012, $P = 0.049$). All other factors showed no correlation with average body mass or with variance in body mass. These results indicate that body mass can be affected by certain environmental pressures. They also point to the importance of the environment in shaping life histories.

16. Distribution of *Chaoborus* larvae in water columns across a dissolved organic carbon gradient

Stephen Elser and Jake Zwart
University of Notre Dame

Dissolved organic carbon (DOC) drastically alters the aquatic light environment through light attenuation. DOC has been steadily increasing in freshwater systems over the past several decades, and is likely to continue increasing. *Chaoborus* spp. larvae are integral parts of aquatic food webs and can have large impacts on community structures. They are also a food source for fish and because of this, often exhibit diel vertical migration (DVM). In this study, we sampled chaoborids in 3 lakes at the University of Notre Dame Environmental Research Center to examine vertical distribution and DVM in different DOC environments (24.38 mg/L, 8.27 mg/L, and 2.6 mg/L). Chaoborids were closer to the lake surface in lakes with higher concentrations of DOC. The relative depth of the average *Chaoborus* was significantly shallower in the high DOC lake than both the medium DOC lake ($p=0.02$) and the low DOC lake ($p<0.0001$). These results

suggest that DOC plays a large role in structuring zooplankton communities and distribution within lakes.

17. Looking beyond macronutrients: Pacific salmon (*Oncorhynchus* spp.) as potential vectors of micronutrients to stream ecosystems

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[3]Oakland University; [4]USDA Forest Service

Large amounts of material are transported annually from the ocean to spawning streams by migrating Pacific salmon. Previous studies have focused on the macronutrients nitrogen and phosphorus but have ignored other nutrients, collectively referred to as micronutrients. However, these elements are essential for the growth and metabolism of biofilms that form the base of stream food webs. To determine the potential of micronutrients as subsidies, we measured their concentrations in salmon tissue, water, and biofilm from seven Alaska streams. Biofilm and water were sampled before and during the salmon run in all streams, and at multiple times in 12-Mile Creek. Dried samples were subjected to closed-tube digestion. Concentrations of 13 elements were measured using ICP–OES. We hypothesized that concentrations of salmon-borne micronutrients would be elevated in water and biofilm in streams where salmon spawn, and higher in water and biofilm during the salmon run than before the run. Furthermore, we predicted that in 12-Mile Creek, environmental concentrations of those micronutrients would be highest during peak spawner densities. Ten of the thirteen elements (B, Ca, Cu Fe, K, Mg, Mn, Na, Si, Zn) were detectable in all compartments. During the salmon run, concentrations of copper and zinc in biofilm were significantly higher than before the salmon run (by 31% and 106%, respectively), but the extent of change depended upon the stream. Our study better informs the ecological role of salmon and their potential for contributing micronutrient subsidies to stream ecosystems.

18. Land use change and nutrient concentrations as drivers of cyanobacterial dominance in 475 U.S. lakes

Jonathan Doubek and Bradley Cardinale
University of Michigan

Cyanobacteria are a huge water quality problem in the U.S. Large abundances of lake cyanobacteria are associated with annual fish, wildlife and livestock kills because of consequences like elevated concentrations of neurotoxins and hepatotoxins in the water column. Cyanobacteria are also responsible for decreased human use and consumption of lakes. As cyanobacteria are expected to increase in U.S. lakes in the future it is important to understand specific biological and chemical triggers that promote their onset and dominance in lakes. We analyze data from a recent EPA National Lakes Assessment survey to better understand cyanobacterial recruitment in U.S. lakes. We find that as lakeside proportional agriculture and human development land use increases, there is a strong shift in the phytoplankton community from green algae and diatoms to cyanobacteria. In applying an Indicator Species Analysis, we find that increased lakeside human influence indicates a strong recruitment of certain cyanobacterial genera that have the capability to produce toxins, like *Anabaena* and

Aphanizomenon. Although humans indirectly influence cyanobacterial recruitment, we find little evidence that phosphorus and nitrogen alone promote an increase in lake cyanobacteria. Additionally, we discover that the TN:TP ratio of 29:1, previously cited as a threshold that results in a large decrease in proportional lake cyanobacterial abundance, is severely underestimated. Simply decreasing phosphorus loading into lakes may not be a solely effective management strategy. It is important to consider that certain genera of cyanobacteria have different adaptations, and different environmental conditions can cause an increase in different cyanobacterial species.

19. Diatoms as water quality indicators in Tinker's Creek, Ohio

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Pollution has been known to cause severe problems in freshwater ecosystems. In Ohio they resulted, among other effects, in several fires of the Cuyahoga River. Since Tinker's Creek watershed is the largest contribution to the Cuyahoga River, it strongly influences its water quality before its inflow to Lake Erie. Despite the importance of this stream, little is known about its water quality. In this study we examined the current conditions of Tinker's Creek using diatom assemblages from five sites along the stream. Diatom communities were collected from guts of Catostomus commersoni and Pimephales notatus as well as periphyton. We analyzed diatom assemblages using the Lange-Bertalot (LBI), Great Lakes Environmental Indicators (GLEI), and Shannon Diversity (SD) indices to measure water quality. The LBI, a measure of saprobity, and SD index showed that downstream sites near the mouth of Tinker's Creek were more polluted with lower species diversity than those upstream. However, we found no significant difference between sites using the GLEI index, a measure of total phosphorus enrichment. Results from this study were compared to unpublished historical data. Although improvement of overall water quality since 1922 was observed, current values suggest that stream conditions may be declining again. The presence of the diatom species Pleurosira laevis, an indicator of increased conductivity, and abundance of phosphorus-tolerant taxa according to the GLEI index suggest phosphorus and salt may be the main contributors of pollution in Tinker's Creek.

20. Larval damselflies increase foraging effort in response to low nutrient levels

E. C. VanTine, A. M. Showalter, and M. J. González
Miami University

Foraging effort of consumers can be affected by the food quality in the environment. In aquatic systems, light and nutrient levels affect food quality by the altering carbon:nutrient ratios in primary producers. Because consumers are often nutrient-limited, high carbon:nutrient food is of low quality and can limit consumer success. In response, consumers may increase their foraging effort in order to acquire the necessary nutrients. We tested the effect of food quality on the foraging behavior of damselfly (*Enallagma aspersum*) larvae. To manipulate food quality larvae were reared, under conditions of high/low light and high/low nutrients. Our hypothesis was that the damselfly larvae would forage less in low light, high nutrient conditions (highest food quality), and they would forage more in high light, low nutrient conditions (lowest food quality). Our hypothesis was partially supported, as the larvae in low nutrient treatments were

significantly more active in their foraging for food. The larvae reared in low nutrient treatments made significantly more strikes at prey and ate more prey than the larvae reared in high nutrient treatments. Future analysis on the nutrient composition of both predator and prey, could help to further support the hypothesis that consumers may be foraging more because of lack of nutrients.

21. Food quality for larval damselflies affects adult fat content

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Miami University

Light availability and nutrient levels in an aquatic ecosystem affect food quality for primary consumers. Under low light conditions, phytoplankton exhibit lower carbon:nutrient ratios due to higher nutrient storage under higher light conditions. Some studies have shown that food quality effects can travel up the food chain and affect predator success. We tested how light and nutrient levels for larval damselflies (*Enallagma aspersum*) affect adult fitness (fat storage). We reared the larval damselflies to adulthood in outdoor tanks under conditions of low/high nutrients and low/high light. We measured fat content of 20 random adult female damselflies from each of the treatments. We expected that treatments with damselflies eating food grown in low light and high nutrients (highest food quality) would have higher fat contents than damselflies eating food grown in high light low nutrient (low food quality) conditions. Our preliminary results agree with our predictions that higher food quality (low light, high nutrients) leads to higher fat content. These results suggest that damselflies exposed to higher quality food as larvae should have higher fitness compared to damselflies reared on lower quality food.

22. Light affects nutrient excretion of an invertebrate aquatic predator

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Miami University

The relative amount of light and nutrients controls the carbon:nutrient ratio of primary producers. Carbon:nutrient ratios determine the quality of the food available to consumers. In homeostatic consumers, variation in food quality may affect consumer nutrient excretion. If ingested carbon:nutrient ratio is dissimilar to consumer body carbon:nutrient ratio, consumers may excrete excesses to compensate for the disparity. To determine the effects of light and nutrient conditions on consumer nutrient excretion, we examined the excretion rates of larval dragonflies (*Epitheca cynosura*) raised in tanks with low/high light and low/high nutrient conditions for five weeks. We expected the highest nutrient excretion rate under low light and high nutrient conditions and the lowest nutrient excretion rate under high light and low nutrient conditions. Preliminary data revealed that light had a significant effect on the per capita excretion rate of phosphorus, as well as the mass-specific excretion rates of both phosphorus and nitrogen. Individuals reared in low light conditions had a higher rate of nutrient excretion than those reared in high light conditions. Variation in nutrient levels had no effect on excretion rates. The interaction between light and nutrients had a marginally significant effect on the excretion rate of nitrogen. Thus, our predictions were only partially supported. These data suggest that light plays a significant role in the carbon:nutrient ratio available to consumers, and thus on nutrient recycling in aquatic ecosystems.

23. The effects of terrestrial carbon inputs on food quality for zooplankton: A survey using fatty acids and stoichiometry

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In the effort to evaluate the true basis for measuring the quality of algal seston as food for zooplankton, it is necessary to understand the interrelationship between the several factors now commonly considered be the primary determinants of this metric. Traditionally, nutrient limitation of algae, specifically as measured by total phosphorus (TP) and carbon to nitrogen ratio in the algae (C:N), has been attributed to the relative food quality of algae (Elser et al., 1988). More recently, however, highly unsaturated fatty acid (HUFA) content of algal seston, particularly as it relates to essential fatty acid (EFA) content, has been shown to correlate positively with zooplankton growth rate (Brett et al., 1997). It is only in more recent years that these differing metrics for food quality have been examined in relationship to one another (Park et al., 2002; Mueller-Navarra et al., 2003). In some instances, the relative content of algal EFA has been shown to correlate negatively with lake trophic status (Mueller-Navarra et al., 2003). In other instances, however, a positive correlation of EFA to nutrient content has been established, which might suggest that EFA content serves as a reflection of underlying algal nutrient limitation and thus only indirectly represents algal food quality (Sundbom and Vrede, 1997). It is our objective in this experiment to determine more definitively the manner in which our current proxies for algal food quality relate to one another. Total phosphorus content, C:N ratios, and lipid profiles for algae across a number of lakes at the University of Notre Dame Environmental Research Center (UNDERC) were analyzed, and relationships between variables determined by multiple regression analysis. It is our expectation that EFA content may reflect underlying nutrient limitation and thus be positively correlated with one or more of these nutrient measurements. It is our hope that demonstrating the interrelatedness of several variables that are taken in themselves to be determinants of algal quality will help to spur further research into the mechanics that underlie the complex, holistic 'food quality profile' of algae.

24. The effects of light and nutrient supply on bluegill (*Lepomis macrochirus*) fitness and stoichiometry

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Miami University

An important ecosystem service is food chain efficiency, defined as the amount of energy fixed by primary producers that makes it to the top trophic level. Specifically, stoichiometric quality of algae, i.e., the ratios of carbon (C), nitrogen (N) and phosphorus (P) influences phytoplankton production and ultimately fish production. To better understand the relationship between producer stoichiometry and consumer stoichiometry, we manipulated light, nutrient supply, and nutrient ratios in a field experiment. We used juvenile bluegill (*Lepomis macrochirus*) as our top consumer in a three level pelagic food web, and quantified bluegill nutrient excretion, body nutrient composition, growth rate, and condition factor. We hypothesized that maximum food chain efficiency and thus maximum fish performance would be at low light, high nutrients, and intermediate N: P ratio, i.e., where algal quality is highest.
Growth rate and condition factor of the bluegill increased with increasing light and nutrients. There was a significant light, nutrient level, and N: P ratio effect on bluegill growth rate; growth

was greater at high light than at lowlight. Phosphorus excretion rates increased with body mass under high light, high nutrient levels, and high N:P. Both mass and N:P supply ratio affected bluegill N excretion. We also found a significant mass and treatment effect on body nutrient content; body P was highest under low light treatments and lowest under high light treatments. Our results show that light and nutrient effects mediate consumer nutrient stoichiometry and excretion in complex ways.

25. Using stable isotopes to inform management strategies for threatened migratory birds in Alaska

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Stable isotope analysis (SIA) has been used to trace material flux through ecosystems and enhance understanding of food webs. This technique provides more integrated information about assimilation than traditional "snapshot" methods such as gut or fecal contents, especially with respect to migratory bird diets. Threatened populations of the dusky Canada goose (*Branta canadensis occidentalis*) and rusty blackbird (*Euphagus carolinus*) seasonally utilize ponds in the Copper River Delta, Alaska. These coastal wetlands are threatened by global climate change whereby increased temperatures may alter the abundance and emergence of aquatic invertebrates, a potentially important food resource for adult birds and fledglings. We measured carbon and nitrogen stable isotope ratios of egg membranes of both bird species, benthic organic matter, aquatic macrophytes, and invertebrates. The mixing model program *IsoSource* was used to assess the dietary contribution of potential sources. Our results show that dusky Canada geese are generalist feeders, whereas rusty blackbirds may be foraging beyond nesting sites or feeding on sources other than those sampled. SIA also suggests that both species may be nutritionally impaired, with potential implications for species recovery.

26. Fighting decisions in African cichlids: How opponent size influences aggressive decision making in the African cichlid Melanochromis auratus

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Bowling Green State University

Observed in nearly every taxa, aggression remains one of the most complex and multifaceted phenomenon seen in nature. The rising level of societal misconduct has promoted a great deal of research on aggressive behavior, but this often focuses primarily on the genetic composition or endocrine functions underlying outward behavioral manifestations. Environmental and social context, however, are equally important in shaping behavioral phenotypes and evolution has molded aggressive behaviors into highly adaptable and environmentally sensitive characteristics. Success in competition and resource acquisition depend largely on the utility of various behaviors and the rate at which they can be altered in response to ecological variation. Game theory models provide a useful conceptual framework for evaluating the differential success of various competitive strategies. Since correct assessment of the relative fighting ability of potential rivals is a critical component to successful strategizing, signaling emerges as an extremely critical component of resource competition. Utilization of informative signals avoids costly escalation into high-level aggressive encounters during which

there is a higher probability of sustaining substantial loss or injury. In altered mirror image stimulation experiments, we investigate the effect of opponent size on fighting strategies and decision-making in the highly aggressive Malawi cichlid *Melanochromis auratus.* Unexpected tendencies to interact with larger opponents ($P < 0.001$) were observed as well as significant differences in preferred behaviors dependent on the sex and maturity of test subjects. These results are discussed in the context of sexual selection and speciation.

27. Responses of female wolf spiders (Lycosidae) to vibratory and visual signals of males in laboratory leaf litter mesocosms

Ali Kluckman and George W. Uetz
University of Cincinnati

The distance was measured at which female *Schizocosa ocreata* wolf spiders respond to the seismic and visual signals of live males in laboratory mesocosms with a substrate of natural leaf litter. Females were enclosed in either (a) an opaque cylinder (to block visual cues) on the surface of a leaf, or (b) a clear acetate cylinder upon a block of granite (to block seismic cues), placed within a container filled with leaves collected from the field. Males were introduced at the opposite end of the container (approx. 40-50 cm away from the female), and allowed to move freely. We induced males to court by adding several leaves upon which females had been placed overnight (to lay down silk and chemical cues). Females were observed during the trial, and as soon as a female exhibited an orientation and/or receptive response to the courting male, the distance between male and female was measured. Results suggest that the ranges of detection for visual and vibratory signals overlap, but that female detection of male signals over distance in leaf litter has high variability.

28. Fitness-related costs of increasing egg production in female house wrens (*Troglodytes aedon*)

Christine J. Hodges, Charles F. Thompson, and Scott K. Sakaluk
Illinois State University

Understanding the relationship between reproductive effort and parental fitness has been a goal of life-history theory. Trade-offs of resource allocation between parents and their offspring can directly influence current and future reproductive effort. David Lack first hypothesized that the clutch size of altricial birds is shaped evolutionary by the demands of chick rearing, and that birds are selected to produce the maximum number of young for which they can provide food. However, many brood-manipulation studies have disproved Lack's hypothesis, shifting the attention to the hypothesis that clutch size may be limited during the egg-production or incubation stages of the breeding cycle.

In a preliminary study, I induced female house wrens to lay and incubate additional eggs and to raise the additional young during their first brood. Females producing enlarged clutches laid similar clutch sizes in the second brood as unmanipulated females, but produced fewer surviving offspring; suggesting that an inability to provide food to their nestlings may limit the number of offspring a female can raise. Therefore, I tested the hypothesis that the number of offspring a female can raise is limited by the cumulative effect that extra egg-production and incubation effort has on her ability to provide food to her nestlings. I predicted that experimental females that were induced to produce 3-4 extra eggs and given a food supplement during the nestling

provisioning period would (i) produce more offspring, (ii) be more likely to produce a second brood, and (iii) be in better body condition than unsupplemented, experimental females.

29. Requirement of pollen for establishment of the red mite in a new geographic application in the biological control of plant pests

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Wittenberg University

Red mites, *Balaustium murorum*, appearing in the thousands during the spring, are beneficial predators of small insects, namely aphids and scale insects. Largest populations of these mites are in sites where pollen falls. This study aimed to determine whether the mites may eat pollen along with determining whether a pheromone may be emitted during feeding that recruits mites to sites where pollen is abundant. These hypotheses were examined using pollen grains stained with Evans blue to track pollen intake as evidence of feeding and using fed mites as targets in Petri plate six-sector attraction bioassays to see if other mites would cluster around them. Results showed that pollen from tulip (*Tulipa*), daffodil (*Narcissus*), pear (*Pyrus*), maple (*Acer*), viburnum (*Viburnum*), and crabapple (*Malus*) cultivars was consumed by mites of all stages as indicated by blue coloration in the gut. Feeding preference shifted from daffodil and viburnum pollen in larvae to maple and crabapple pollen in deutonymphs and adults, based on speed of attraction and clearance of pollen by feeding. Feeding activity by larvae was especially rapid, while in pheromone tests, fed mites prompted no attraction, or repellent, responses when free ranging mites encountered them. We found that preferred habitats by red mites are encountered randomly through scurrying, not recruitment by a previously existing population through pheromones. Our finding that pollen is an alternate food source is important for continuing mite survival when prey are less abundant, which facilitates laboratory rearing of these mites for mass release in classical biological control programs.

30. Baseline corticosterone and fitness-related traits in the nestling house wren (*Troglodytes aedon*)

Meghan Strange, Charles Thompson, and Scott Sakaluk
Illinois State University

Corticosterone (CORT) is a glucocorticoid hormone present in all birds and is involved in modulating behavioral and physiological responses to environmental challenges. Baseline CORT levels can vary considerably among individuals, with high levels thought to occur in individuals in poor condition and with poor survival and reproductive prospects. This is known as the CORT-fitness hypothesis. Empirical support for this hypothesis is mixed, with only 50% of studies supporting the hypothesis. It has been suggested that these inconsistencies may result from the context in which CORT is measured, such as specific developmental stages.
This study examined developmental changes in CORT levels and documented the relationship between variation in baseline CORT levels and fitness-related traits in house wren (Troglodytes aedon) nestlings. Based on the CORT-fitness hypothesis, I predicted a negative correlation between baseline CORT levels and fitness-related traits. Baseline CORT levels were assessed by obtaining nestling blood samples six and 11 days after the first egg of the clutch hatched. I measured the fitness-related traits of mass, hematocrit, tarsus length, and immune response on the 11th day after hatching. CORT levels ranged from 0.04 to 18.49 ng/ml (mean=2.12 ng/ml) on

the sixth day and 0.57 to 27.84 ng/ml (mean= 6.94 ng/ml) on the 11th. This relationship between CORT levels and fitness-related traits in nestlings will be discussed.

31. Male stickleback (*Gasterosteus* spp.) courtship activity fluctuates across the season

Anna Reh-Gingerich, Emily G. Weigel, and Jenny Boughman
Michigan State University

Threespine stickleback, *Gasterosteus aculeatus,* are a freshwater fish species that exhibit both male parental care and female mate choice. Because males raise the offspring, a female's only investment involves carrying eggs. Males invest heavily in building nests, courting females, and caring for young. Recently it has been discovered that female investment is consistent across the season, but females become less choosy as the season progresses. The central question of our study is to ask how *males* might adjust their investment in courtship across the season. Might lesser-quality males exploit decreased choosiness but consistent female investment, thereby slowing the evolutionary progression of the species? To test this, we enticed males daily to build nests (N=143) from April to August 2012. Males who completed nests (N=34) were placed in a three-day rotation of no choice trials with females that were ready to deposit eggs. We measured nest quality, nuptial coloration intensity, and courtship patterns. Our results strongly indicate that males were more likely to perform nesting behaviors rather than court the female as trial number (not seasonal timing) increased ($p<0.001$), but females were more likely to respond to courtship behaviors during mid-late season, with increasing importance placed on the quickness of the first courtship behavior ($p=0.0430$). Thus, practice matters for males, yet timing matters for females, in determining mating success. Future studies will investigate how quality in male appearance and courtship might compare to nest quality and nesting behavior in female choice, and how male investment in each changes over time.

32. The effect of baboon hybridity on parasite resistance mechanisms

Jeffrey Hansen, Susan Alberts, and Elizabeth Archie
University of Notre Dame

The effect of hybridity upon the fitness of individuals varies across species. For instance, the concept of hybrid vigor proposes that hybrid organisms benefit from outbreeding. Alternatively, hybridization may be costly if it disrupts locally-adapted gene complexes. To this end, hybridization may be especially detrimental to fitness when species or populations have locally adapted to parasite communities. The baboon population in the Amboseli basin is a natural hybrid zone between two sub-species: yellow baboons (*Papio cyncocephalus*) and Anubis baboons (*Papio cyncocephalus Anubis*). Using data accumulated from this community, I hope to explain the effect of hybridity on patterns of parasitism and from that draw conclusions to how hybridity affects parasite resistance. If parasite diversity is unique to each sub-species and environment, yellow baboons may have better resistance to parasites in the Amboseli ecosystem and consequently have a lower parasite load compared to immigrant Anubis baboons and hybrids. If though parasite species are not localized and similar species are spread across regions in Africa, each sub-species may have developed a unique method of combatting parasitism. Consequently, the mechanisms of parasite resistance will complement each other in hybrid baboons and result in the observance of higher parasite loads. This study will be among the first

to explore the effects of hybridity on parasitism in a wild primate setting and results will have implications for understanding the selective forces that may maintain species boundaries.

33. A hierarchy of health: Dominance rank and parasite burden in wild male baboons

Suzanne Spitzer and Elizabeth Archie
University of Notre Dame

Previous research suggests that differences in social status can influence individual health. For instance, several studies have found correlations between social status and measures of health such as parasite load, body condition, and immune response. Male savannah baboons are no exception; in male baboons, Papio cynocephalus, an individual's position in the social hierarchy has an effect on his reproductive success, stress level, and access to resources, and any or all of these factors may affect parasitism and immune function. I am currently testing several hypotheses using data on social status and parasite loads in wild, male baboons living in Amboseli National Park, Kenya. Analyses are in progress but certain extraneous factors, namely variance in season, appear to have a stronger effect on parasite burden than dominance rank. The results of this study could provide further insight into possible health-related costs and benefits of social dominance for individuals living in complex hierarchical societal structures and could potentially present more comprehensive information about individual disease risk.

34. How many points does it take to determine a home range? A meta-analysis of home range calculation methods from GPS collar data.

Amy Klegarth, Agustin Fuentes, and Hope Hollocher
University of Notre Dame

Recent reviews home range measurement methodology has highlighted a need for a standard currency of measurement and reporting. Across methods including, but not limited to minimum convex polygon, kernel density estimation, linear home range, and harmonic mean, researchers struggle with reproducibility in home range determination.

In an effort to aid standardization of home range estimation methodology we have sub-sampled data and calculated home ranges over a variety of methods from 3 GPS satellite collars. Collars recorded the locations of long-tailed macaques (*Macaca fascicularis*) over 1-4 week long periods in mixed, rainforest canopy and manicured park space in Singapore. The collars fixed a position in >98% of positioning attempts for collars deployed at Bukit Timah but only ~63% of the time for a collar deployed at Upper Seletar (1: 1786/1810; 2: 1704/1705; 3: 386/609 programmed positions). The dense amount of data taken across intervals varying from every 5 minutes to hourly across 1-4 week long time periods enable us to sub-sample data to determine the most efficient collar program settings. Furthermore, we will include data from other studies utilizing both VHF and GPS tracked individuals to compare the relative methodological efficiency to help researchers evaluate whether the man-hour costs or monetary investment associated with VHF telemetry and GPS collars respectively are most worth investing in. The meta-analysis will also examine the importance of sampling interval. Finally, we will report on the functionality of a remote-trigger drop-off mechanism and report on the impact of study site location and collar programming add/drop times.

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Conservation, the National Science Foundation East Asia Pacific Summer Institute program, National Science Foundation #BCS-0639787, and funds from the University of Notre Dame Office of Research.

35. Potential for shifting seed predation pressure in a Great Lakes forest

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Climate change may already be shifting the ranges of rodent granivores, potentially altering relative seed predation pressure and thus apparent competition among reproducing trees. However, this impact on forests has received little attention. We used cafeteria-style feeding trials to compare the seed preferences of the four dominant northern rodent granivores (*Peromyscus maniculatus, Napaeozapus insignis, Zapus hudsonius*, and *Myodes gapperi*) in a northern mesic forest (Land O' Lakes, WI) with a southern species (*Peromyscus leucopus*) which is expanding its range northward into this forest. Wild-caught rodents were presented with equal masses of the dominant seed-producing tree species sugar maple (*Acer saccharum*), red maple (*Acer rubrum*), black cherry (*Prunus serotina*), and balsam fir (*Abies balsamea*). Mass consumed per species was then used to estimate preference. Northern species displayed strong preferences for red maple, no preference/slight avoidance for sugar maple, and strong avoidance of balsam fir and black cherry (Kruskal-Wallis, $p < 0.001$). Red maple was significantly selected over all other seeds (Conover-Inman, $p \leq 0.01$). The southern rodent species differed substantially, exhibiting a much more generalist selection pattern. *P. leucopus* had no/slight preferences for red maple, sugar maple, and black cherry (Kruskal-Wallis, $p < 0.001$). In sharp contrast to the northern species, *P. leucopus* showed no significant difference in preference among these three seed species (Conover-Inman, $p = 0.23$-0.98). If ongoing climate change leads to further northerly expansion and growth of *P. leucopus* populations, these results suggest such shifts could potentially alter apparent competition among northern mesic forest tree species.

36. Effect of ambient UV radiation in competition between seedlings of Populus deltoids
Effect of ambient UV radiation in competition between seedlings of Populus deltoides

Nilsen L. Lasso-Rivas
Iowa State University

The effect of ambient solar Ultra Violet radiation UV (280-400 nm) on the competitive interaction between seedlings of Populus deltoides was investigated in a greenhouse study. Two UV conditions, ambient UV and UV exclusion and two competition arrangements were combined in a factorial experiment. Assessments of the effects of the treatments on growth parameters were done after three months. The results of the experiment show that the UV exclusion treatment result in a slight increase in height, and in the change in the morphology of the leaves due to changes in leaf thickness which resulted in thinner leaves. There were no differences between relative growth rate or total dry weight between ambient and exclusion UV treatments. However, there was an interactive effect between UV exclusion and competition on height (H), relative growth rate (RGR) and total dry weight (TDW) ($P<0.05$) with a greater increase caused by UV exclusion when seedlings were grown alone, followed by seedling grown alone under UV, and finally seedlings grown in competition showed similar values of H, RGR and TDW regardless of the UV treatment. The results indicate that ambient levels of UV

radiation have no effect on the morphology of seedling of P. deltoides when grown in completion.

37. Evaluating the occurrence of the CRISPR/Cas systems in the environment

David A. Baltrusaitis, Michael Shaffer, John J. Kelly, and Catherine Putonti
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The CRISPR/Cas (clustered regularly interspaced short palindromic repeats and CRISPR-associated genes) system has been identified in the genomes of many bacterial and archaeal species. Previous studies have found that the CRISPR/Cas system serves as a rudimentary bacterial immune system against foreign genetic material such as bacteriophages and plasmids. While the CRISPR/Cas system has been identified in a number of sequenced genomes, the prevalence of the system in the environment and the impact it has on shaping microbial communities is largely unknown. Addressing this knowledge gap presents two challenges. Firstly, different genera and species include different members of the Cas gene family. Secondly, significant sequence divergence has been observed amongst orthologous *cas* genes. In this study, algorithms were developed to identify the variance in the *cas* genes present within 300+ bacterial and archaeal genomes, a far greater number of species than had been considered in previous studies. Phylogenies for each of the *cas* genes were derived revealing high mutation rates at the genus level. PCR primers for each taxonomical group were designed. Informed by 16S sequence analysis, taxon-specific amplification can be performed to ascertain the presence/absence of the *cas* genes as an indicator of the CRISPR/Cas system. These assays are intended for utilization in any complex environment, e.g. soil, water, etc., providing insight into the *cas* gene diversity present in these environments.

38. The effects of antibiotic treatment on the honey bee-associated bacterial community

Horton, M., F. J. Lee, H.R. Mattila, and I. L. G. Newton
Indiana University

Microbial communities play an important role in health and disease of their associated hosts. The disruption of this community, through antibiotic treatment, can often result in a decrease in microbial diversity and selection for antibiotic resistance. Importantly, the gut microbiome of important agricultural animals has been shown to harbor antibiotic resistance post treatment, suggesting that long term exposure to antibiotics can alter the resistance profile of resident microbes. We present a study on how antibiotics affect the microbiome in the honey bee. Apis mellifera is an important agricultural organism both for the production of honey and for their role in pollination. The honey bee is an appealing model system because the colony can be massively sampled across known age groups. In addition, hives are treated with the antibiotic oxytetracycline twice a year or more making them an interesting proxy for human studies. We have sampled three age groups of honey bees in both oxytetracycline treated and untreated control hives every five days for 25 days and on day 45. We used a polyphasic approach, combining culture, clone library sequencing, qPCR, and in situ hybridization to determine the similarities and differences in the bacterial community across the different age groups and treatments. We present preliminary data that antibiotic resistance is found in untreated hives and that it persists many days after antibiotic treatment. Antibiotics alter the natural microbiome within the honey bee, increasing the number of resistant strains and decreasing diversity.

39. Metatranscriptomic analysis of the honey bee gut

Fredrick J. Lee and Irene L. G. Newton
Indiana University

The recent drastic decline in the general health of one of the world's most important pollinator: *Apis mellifera* (Honey Bee) has peaked the interest of scientist around the world. Recently, researchers have begun to characterize the microbiotas associated with the honey bee. In previous work, researchers have utilized 16sRNA-based pyrosequencing or metagenomics to identify microbial diversity within the honey bee gut. To gain more insight on the active gut microbiota of the honey bee and its potential role(s), we collected worker honey bees, dissected out the guts, and extracted total RNA. A portion of the total RNA was then enriched for microbial RNA, treated with DNAse, and synthesized into a cDNA library. We utilized next-generation sequencing of the cDNA to deeply sequence the microbial contribution to the honey bee gut. Quality reads were aligned into contigs and assembled into a metatranscriptome. Based on preliminary analysis of the metatranscriptome, we have identified diverse active members associated with the honey bee microbiota, and expression of genes corresponding to intriguing metabolic processes. Understanding the presences and potential function(s) of the honey bee gut microbiome not only provides insight into the potential role of commensals in the digestive tract, but aids in elucidating potential prokaryotic and eukaryotes interactions in microbiomes.

40. Effects of a generalist herbivore (white-tailed deer) and an invasive species (*Lonicera maackii*) and on forest herb layer composition

Jessica R. Peebles-Spencer and David L. Gorchov
Miami University

Once an invasive species is introduced to an area, it can become disruptive to biological communities. One such invasive plant species is *Lonicera maackii* (Rupr.) Herder, which negatively affects both tree and herb species. White-tailed deer (*Odocoileus virginanus*), an abundant generalist herbivore, is also a factor in driving change in forest composition.
In order to assess the combined effect *L. maackii* and deer on forest floor composition, pairs of 20m-by-20m deer exclosures and controls were established at each of five sites in the Miami University Natural Areas near Oxford, Ohio. In half of each exclosure or control, *L. maackii* was removed and stumps were treated with herbicide, resulting in 20 20m-by-10m plots. We determined identity and cover of all plants less than 1 meter high in 18 subplots per plot. Plots were sampled twice in 2011 and 2012; data from 2011 are used as baseline data.

Species richness and mean garlic mustard (*Alliaria petiolata*) cover were assessed by subplot using analysis methods for split-plot design. In spring of 2012, there was a significant effect of *L. maackii* removal on species richness ($P < 0.05$); plots where *L. maackii* was removed had higher richness. There were no significant effects of deer exclosure or *L. maackii* removal on species richness in other seasons, or on garlic mustard cover.

This experiment is continuing to determine responses of herb layer species richness and composition to deer exclosure and *L. maackii* removal. Results from this study can inform management for *L. maackii* and deer.

41. Does phylogeny help to explain patterns of invasiveness in the Ohio flora?

Colin G. Cope and Jean H. Burns
Case Western Reserve University

Predicting when introduced plants are likely to become invasive requires that we examine both traits of introduced species and the native community. The phylogenetic novelty of introduced plants relative to the native flora is one metric that takes both traits of invaders and the native community into account. "Darwin's naturalization hypothesis" suggests that more phylogenetically novel introduced species would be more likely to invade if they are more likely to escape from competition with close native relatives. Alternatively, Darwin also suggested that less novel species would be more likely to succeed on introduction, if they are similar to the native flora. In this study, we examined phylogenetic patterns in the native and introduced flora of Ohio using the USDA Plants database. We ranked invasiveness according to the Ohio Department of Natural Resources. Species were classified as taxonomically novel if they were found within a genus not native to Ohio. We found a total of 449 introduced species that were novel and 498 that were less novel. We found more less novel (30) species that are highly invasive and very few species that are novel and highly invasive (19), more consistent with the alternative to Darwin's naturalization hypothesis. Close relatives of the native flora may be more successful upon introduction as a result of habitat filtering, if they have similar adaptations to the native flora. We will conduct further tests of potential mechanisms that may drive phylogenetic patterns in the introduced flora of Ohio.

42. Measuring niche overlap in a community of invertebrate eating snakes

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Competition for resources exerts significant influence in the structure of biological communities, particularly when species having similar habitat requirements are involved. Despite their widespread abundance and role as successful predators, there is a paucity of information about niche partitioning among snake species. The dietary ecology of invertebrate specialists, in particular, is difficult to study because of the relatively rapid digestion of prey. Using stable isotope analysis, we quantified the dietary niche overlap between five different species of invertebrate eating snakes (genera: *Coluber*, *Diadophis*, *Opheodrys*, and *Storeria*). We collected blood, scale, and tail tissue from wild-caught snakes, as well as a range of whole prey specimens to assess niche partitioning between species across a broad temporal scale. All samples were freeze-dried, homogenized, and analyzed using mass spectroscopy. We compared the isotope signatures of potential prey taxa to those from the different tissue types obtained from all five snake species to determine the prey items that each species includes in its diet. We used a Bayesian mixing model to determine the sources of carbon and nitrogen in the snake tissues, and assessed differences in diet among the species. We discuss our findings as they pertain to the co-existence of these snakes in a single habitat. Similar analyses can reveal fine-scale shifts in diet that have the potential to alter the dynamics of the trophic web within a given community.

43. A phylogenetic analysis of HIV-1 to identify putative treatments

Steven Reisman, George Thiruvathukal, and Catherine Putonti
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RNA-interference has potential therapeutic use against HIV-1 by targeting highly-functional mRNA sequences that contribute to the virulence of the virus. Empirical work has shown that within cell lines, all of the HIV-1 genes are affected by RNAi-induced gene silencing. While promising, inherent in this treatment is the fact that RNAi sequences must be highly specific. HIV, however, mutates rapidly, leading to the evolution of viral escape mutants. In fact, such strains are under strong selection to include mutations within the targeted region, evading the RNAi therapy and thus increasing the virus' fitness in the host. Taking a phylogenetic approach, we have examined 3000+ HIV-1 strains obtained from NCBI'S database for each of the HIV genes. Integrating the wealth of information available from each genome's record, we are able to observe how conserved regions vary with respect to their distribution throughout the world. This was made possible through the development of a new software tool, developed such that similar analyses can be conducted for any species or gene of interest, not just HIV-1. In addition to the phylogenetic signal which we can recognize from the HIV-1 genomes examined, we can also identify how selection varies across the genome. Taking this evolutionary approach, we can detect regions for future development as RNAi treatment.

44. Fungicide use in North Carolina decreases mold in blue honey, putting honey bee colonies at risk of diseases

Mary Clare Yerke, Andrew J. Jajack, Andrew E. Rosselot, and Jay A. Yoder
Wittenberg University

Blue honey appears periodically from the Sandhills region where honey bee, *Apis mellifera*, colonies are kept close to peach tree orchards that are sprayed routinely with fungicides for increased yield. Mycoflora profile of blue honey and non-blue honey controls was examined using classic culturing techniques using three agar growth media (Sabouraud, potato dextrose, corn meal) to determine whether sooty molds may be responsible for the blue color. Results showed that the primary isolates were *Aspergillus*, *Penicillium*, *Cladosporium*, and *Rhizopus*, and *Alternaria*, *Aurebasidium*, *Mycelia sterilia* (consequence of stable colony conditions and darkness), *Paecilomyces*, *Scopulariopsis*, and *Trichoderma* were present as minor components in both blue and non-blue honeys, regardless of habitat. Variation in the honey mycoflora between different bee colonies, even in the same yard, was in the minor fungal components. The major difference between blue and non-blue honeys was that the total amount of fungal isolates present in blue honeys was reduced in overall quantity. Pollen analysis of blue honey by microscopy suggests that spring/summer titi is the cause of the dark color. Chalkbrood, a lethal fungal disease of bee larvae, was present in colonies having blue honey based on a bee disease diagnosis. Our conclusions were that blue honey is not a type of honeydew honey, showing no unique sooty molds and no heightened spore concentrations; reduction in bee colony fungi is associated with honey bee diseases; and linkage between fungicide spraying and chalkbrood in the honey bee is more widespread than previously thought.

45. Tick excreta (guanine) as a clustering agent for natural control of household/kennel infestations of the brown dog tick

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Infestations by brown dog ticks, *Rhipicephalus sanguineus*, can occur quickly because of their ability to colonize in homes and kennels, concentrating in cracks and baseboards of walls. Not only is this tick species a pest, but it can transmit spotted fever rickettsia to people and febrile, lameness and anemia-associated diseases to dogs and livestock. Blood feeding causes these ticks to excrete copiously, leaving white, guanine deposits that accumulate over time where the ticks hide. It may be that excreta contains a pheromone. Accordingly, ticks were tested against guanine and five species of tick excreta under dry (33% RH, approximates relative humidity of human homes) and moist (93% RH) conditions using six-sector Petri dish attraction bioassays. Results were that over 70% of ticks arrested when they made contact with excreta, which resulted in the formation of clusters, and this was mimicked by guanine, except with a slightly lower number of ticks showing arrestment. Speed of cluster formation occurred faster, within minutes compared to hours, at 33% RH rather than at 93% RH. Excreta from other tick species similarly caused arrestment by *R. sanguineus*, but not as strong as the response to excreta from conspecifics. Positive response to guanine did not occur in a dose-response, indicating that clustering results with only a small amount of guanine. We conclude that tick excreta contains an assembly pheromone that signals preferred microhabitat sites, cleaning out excreta could prevent in-house infestations, and guanine could be used as a bait to design tick traps.

46. Increased incidence of chalkbrood disease that mummifies bee larvae as a pathogenic consequence of fungicide spraying near honey bee colonies

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Pollen stored by honey bees, *Apis mellifera*, is converted into bee bread, a source of food for development and growth of larvae, by fermentation carried out by beneficial fungi: *Aspergillus*, *Penicillium*, *Cladosporium*, and *Rhizopus*. Fungicide spraying for improving crop yield minimizes the amount of naturally occurring spores in the environment. When bee bread is improperly processed, colonies are weakened from malnutrition that may promote infection. To explore the relationship between fungicide spraying and disease, bee bread from seven habitats was analyzed for fungicide residues by GC/MS and fungus composition by culturing, combined with a bee disease diagnosis. Results indicate that bees are susceptible to fungicide spraying of adjacent orchards within their 3.5 km flight range. *Aspergillus*, *Penicillium*, *Cladosporium,* and *Rhizopus* were primary fungal isolates regardless of habitat differences. Fungicide contamination reduced fungal levels, particularly *Aspergillus*. Bee bread contaminated with fungicide was found in colonies with chalkbrood. Our conclusion is that a reduction in beneficial fungi makes colonies more susceptible to infection. Inactive bee colonies that died from unknown causes had lower levels of fungicides along with less drastic depletion of fungal components in bee bread. Thus, fungicide spraying may contribute more to chalkbrood than colony collapse disorder. Important information for beekeepers is that approved concentrations of fungicide applied in the field still permit active colonies with viable bee bread, except such colonies are at increased risk of developing chalkbrood because beneficial fungus levels, notably *Aspergillus*, are low.

47. Modeling reassortment in non-human viral pathogens

Jordyn Lucas and Catherine Putonti
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The reassortment of segments in RNA viruses has proved to be a common pathway in the change of viruses. Various reassortment-modelling techniques have shown to be innovative in predicting certain RNA reassortment patterns. With the help of these models, viruses can be further understood and more easily predictable. By comparing one strain's lineage with another, a lot can be inferred about the environment's effect on the virus. While most models have been developed for reassortment events in viruses infecting humans, reassortment does occur within viruses infecting other animals, plants and bacteria. Due to different lifestyles of the host, different parameters must be considered. The goal of this research project is to design a model for reassortment within viruses infecting bacteria, also called bacteriophages, which are model laboratory systems for studying infection, transmission, and evolution of viral pathogens. We have developed a mathematical model implemented as a software solution to simulate reassortment within viral species. Coupled with empirical results, we can improve our understanding of how these species reassort and the impact of reassortment on viral fitness.

48. Use of artificial models to study maintenance of polymorphism in red-backed salamanders

Meghan Kelley and Joshua Traub
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Polymorphism is a mostly unexplained phenomenon that theoretically should be eliminated in natural populations due to selection against rare phenotypes. However, three color morphs of *Plethodon cinereus*, the red-backed salamander, exist in northeastern Ohio populations, including the red-striped morph, the lead- or ochre-striped morph, and the erythristic, or all-red morph. In this study, clay models were used to compare predation on the red-striped and erythristic morphs in relation to mimicry. Both red-striped and erythristic morphs display a red-orange color similar to the aposematic coloring of the toxic red eft of *Notophtalmus viridescens*, the eastern newt. If the coloration of these salamander morphs is meant to mimic the eastern newt, we hypothesized that the erythristic morph would be predated upon less because the erythristic morph more closely resembles the full-bodied red color of the toxic, unpalatable newt. Because the erythristic morph is less common, aposematism could be one possible explanation for this observed maintenance of polymorphism. A third model, an all-brown salamander that does not exist in the local area, was used as a control because it lacked the red coloration of the other two naturally occurring morphs. We hypothesized that this brown model should experience the greatest predation of the three model types because it lacked any possible warning coloration. However, no significant differences of predation were observed among the three model colors, indicating that it might be beneficial for future work to consider additional potential drivers of this polymorphism, such as sexual selection or genetics.

49. Exploring the effects of host plant phenology and climate on the voltinism of two hybridizing species, *Papilio glaucus* and *Papilio canadensis*, using an individual-based simulation model

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University of Notre Dame

Voltinism, the number of generations an insect has in a given year, is predicted to increase under climate change for many insect species. However, little is known about what impacts an increase in voltinism will have on insect population dynamics, genetics and phenology. For many terrestrial insects, voltinism is determined by diapause, which is turn determined by environmental factors such as temperature, photoperiod, and even host plant phenology. Here we used a simulation model to explore how host plant phenology, climate (growing degree days) and their interaction affects the voltinism of the two hybridizing species of butterfly, *Papilio glaucus* and *Papilio canadensis*. First, to determine the relationship between climate and plant phenology, we collected data from Project Budburst and the Harvard Forest Dataset on the dates in which budburst and senescence occurred for the shared host plants of the two butterfly species: *Fraxinus americana*, *Populus tremuloides*, *Prunus serotina*, and *Betula papyrifera*. Data on the growth rates of *Papilio glaucus* and *Papilio canadensis* were then used to calculate the degree day requirements of each species. These data were used to parameterize an individual-based simulation model that predicts voltinism across space and time, based on climate, butterfly species and host plant phenology. Results from this work will provide insight as to how varying climate and host plant phenology affect the voltinism patterns of a butterfly hybrid zone and can lead to changes in the population dynamics and phenology of these species.

50. Does pollen availability limit reproduction in a native wind-pollinated prairie grass?

Maria Wang
Northwestern University

Pollen limitation (PL) occurs when insufficient quantity or quality of pollen hampers plant reproductive success. PL is widely studied in animal-pollinated plants, but less so in wind-pollinated plants. According to some theory, PL is not expected in wind-pollinated, but evidence suggests that PL might be more prevalent than previously thought, especially in fragmented populations. I quantified PL using a pollen addition and exclusion experiment in a small and isolated remnant prairie population of *Dichanthelium leibergii*, a wind-pollinated native prairie grass. I hypothesized that the seed set (proportion of viable seeds per inflorescence) differed among inflorescences receiving different treatments on the same plant: 1) supplemented with outcross pollen from distant plants (pollen-added); 2) excluded from external pollen (self-pollen only); or 3) open-pollinated (unmanipulated). Seed set did not differ among treatments ($p=0.101$), but differed among plants (GLM with quasibinomial response, $n= 77$ inflorescences on 32 plants, $p=0.008$). Plant traits such as height, diameter, and density of neighboring conspecifics were not associated with seed set within the open-pollinated group. The results indicate that reproduction in this *D. leibergii* population is not pollen-limited, and that *D. leibergii* is self-compatible. Nevertheless, pollen-added and self-pollinated inflorescences showed consistently higher seed set than open-pollinated inflorescences on the same plants. Although not conclusive, this trend suggests evidence of pollen limitation, and warrants an experiment with larger sample sizes. My study provides insight into habitat fragmentation in a

remnant D. leibergii population, which will inform prairie conservation and improve understanding of PL in wind-pollinated species.

51. Optimizing sampling strategy to estimate genetic diversity in a recently introduced species

Katherine Lenkiewicz, Derrick Parker, and Jessica Hellmann
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Estimates of genetic diversity parameters (e.g. expected heterozygosity, allele frequency and diversity) can be subject to bias due to sampling strategy, particularly for rapidly expanding populations or populations prone to perturbations (e.g. gene flow, selection, genetic drift), such as those characteristic of biological invasions or climate-driven range shifts. Recent studies suggest relatively high allelic diversity may be the norm and not the exception of successful invaders even when singly introduced. We sought to evaluate the effects of the number of introduced populations sampled and intensity of sampling per population on estimates of genetic diversity. We explore this relationship between sampling scheme and genetic diversity in a recently introduced mosquito vector, *Aedes japonicus japonicus*, and in a putative area of introduction (Long Island, NY) where allelic diversity should be greatest within the introduced range. *Ae. japonicus* were collected from seven sampling locations and over a four month period to maximize the likelihood of capturing complete allelic diversity within a population. Using a previously published dataset of microsatellite loci, we simulated random sampling of varied sample sizes (n=2 to 49) from our dataset to estimate genetic diversity. Our study takes advantage of previously reported genetic analyses of *Ae. japonicus* in the U.S.

52. In vitro Embryo Culture of Schoenoplectus americanus Achenes

Benjamin Foster, Rachel Gentile, and Jason McLachlan
University of Notre Dame

Living plant specimens germinated from ancestral seeds are useful for investigating plant responses to environmental changes of the past. Century-old seeds from the salt marsh sedge *Schoenoplectus americanu*s remain viable, and we use plants grown from these seeds to determine how populations respond to a changing climate. Germination studies on this plant and its relatives have shown consistently low germination rates despite high percentages of seed viability. Plant hormone treatments and diurnally fluctuating temperature regimes have resulted in limited successes. In a further attempt to grow plants from seed, we employed plant tissue culture methods, bypassing traditional germination protocols. Embryos were excised from the pericarp and cultured for a five-week period. Other seeds were treated with traditional germination regimes: a constant 30° C temperature and a diurnally fluctuating temperature of 27° and 15° C. We successfully grew 4% of the sample in media and 10% of the sample using other methods. Results show that in this first trial, tissue culture did not improve germination success over previous methods, however, overall our success rate has improved. We did find that plant tissue culture is a viable option as there was limited success, and we identified areas of improvement in our procedure. The use of old seeds to recreate past populations provides a powerful method to understand evolution and climate change. The development of a

reliable method of growing old plants is vital to our study and might provide an opportunity for other scientists to make similar investigations in various seed banks.

53. *Clarkia tembloriensis* as a novel system for the study of sexual conflict in flowering plants

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Sexual conflict arises when sex-specific reproductive systems provide a fitness benefit to one sex over the other. This phenomenon has been well documented in the animal kingdom but has only recently been explored in plants. In the plant kingdom, it may influence reproductive fitness between pollen and ovules. Greater fitness may result in ovules that produce larger quantities and/or higher quality seeds, as well as pollen with higher rates of successful fertilization. One factor that may influence relative fitness is the plants mating system. Plant forms of sexual reproduction include outcross-pollination, self-pollination, or a mixed mating system. *Clarkia tembloriensis* populations vary in flower size and breeding system, providing a unique system to examine sexual conflict in flowering plants. We used plants within specific *Clarkia* populations that vary as follows: 1) large, strongly protandrous outcrossing flowers, 2) small protandrous outcrossing flowers, and 3) small homogamous selfing flowers. The present investigation was undertaken to provide a baseline of the characteristics of each flower type. Specifically, pollen and ovule numbers were counted and ratios were determined for each flower type using buds collected from wild populations in 2011. We found that the number of ovules was significantly greater in both large and small protandrous outcrossing flowers than in small homogamous selfing flowers. In addition, large protandrous outcrossing flowers had the highest pollen numbers, small protandrous flowers an intermediate number, and small homogamous selfing flowers had the lowest pollen numbers per bud. Pollen ovule ratios varied from 100, 71, to 36 among tested populations. These results provide a good foundation for the study of sexual conflict between pollen and ovules in these populations.

54. The effect of emerald ash borer-caused canopy gaps on understory invasive shrubs and forest regeneration

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Emerald ash borer, (EAB) *Agrilus planipennis,* is an invasive forest pest of particular concern to deciduous forests of eastern North America. Mature ash, *Fraxinus spp.,* will succumb to larval feeding in 1-4 years, resulting in forest canopy gaps which could greatly benefit invasive plant species due to dramatic increases in light. Additionally, tree sapling and seedling responses within EAB-generated canopy gaps have major implications for long-term forest composition. To investigate the impacts of EAB on invasive plants and tree recruitment, we tagged and measured shrubs and tree seedlings and saplings in plots established for long-term EAB monitoring by the United States Forest Service (USFS), and will re-measure these annually. Metrics of interest included recruitment, growth, cover, and fecundity of native and invasive shrubs, with a special focus on the invasive Amur honeysuckle, *Lonicera maackii*, and recruitment and growth of tree seedlings and saplings. Sapling, seedling, and shrub measurements will be combined with canopy tree diameters, ash health assessment, and percent

canopy openness which the USFS has recorded since 2005. Measurements in 2012 were collected at 24 sites located throughout western and central Ohio, with a sub-set of 12 revisited to measure shrub fecundity.
Immediate effects of ash mortality will be assessed from data collected beginning in 2012. All data collected is pooled with data previously and currently collected by the USFS on canopy tree growth, Forest Inventory and Analysis cover data, and site indices for incorporation into Forest Vegetation Simulator software to model long-term effects of ash mortality.

55. Climate change effects on grassland trophic dynamics

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University of Akron

Climate change is expected to strongly alter North American Grassland communities. Little is known about how grassland communities of plants and animals will respond to climate change, especially in species abundance and diversity of graminoids, forbs, and insects and the interactions between them. I tested for effects of experimental warming chambers on an Ohio grassland community. I measured how responsive trophic diversity is to minor shifts in climate change by way of tracking temperature in open-top chambers, which strongly altered peak temperatures over the controls in the experiment. I estimated plant community graminoid to forbs ratios in each of the plots. Insects moving within the plots were trapped and collected on a weekly basis throughout the experiment. Insects and arachnids were counted as a measurement of abundance and then grouped by taxonomic order to obtain a measure of diversity. I found that warming strongly alters community structure of plants and insects within the chambers. This experiment serves to inform the broader scope of climate change predictions that community structure and trophic diversity of North American grasslands will be impacted by warming.

56. Assessing the occurrence of bats in the Oak Openings region of Northwest Ohio

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Bats, despite their ecological importance, are understudied and face many threats including White Nose Syndrome and habitat destruction. Therefore, it is vital to understand bats and their needs.

Using previous data on bat activity, species-specific habitat models for bat species found in the Oak Openings Region of northwest Ohio have been developed in order to predict their presence across the region in protected areas. The accuracy of these models had only been tested over one season. As bat activity can vary significantly among seasons, we retested these models to examine how well they would perform from year to year, and both within and outside of protected areas.

We conducted surveys in protected and unprotected areas using a broadband acoustic device, which records the echolocation calls of bats, between June and August of 2012. We analyzed each call recorded, identified the species, and examined whether the species in question was predicted to have been present at that location based on the previously developed models. We found that 96% of calls (protected areas) and 91% of calls (unprotected areas) occurred in locations where they were predicted to occur. This suggests that these models can be applied outside of parkland, and strengthens our confidence in their usefulness within parkland. Our

research contributes to tracking changes in habitat and the potential impacts on the bat inhabitants, which is important for their long-term viability in the Oak Openings Region and elsewhere.

57. Exploring the "citizen science landscape" across the United States: assessing the field-to-date and identifying potential gaps

Tracy VandeWater, Sean F. Ryan, and Jessica J. Hellmann

Climate change, invasive species, and habitat loss are predicted to negatively impact ecosystems globally. To fully understand the impacts of these factors and make accurate predictions about how ecological systems will respond to further perturbations will require extensive knowledge about the affected ecological systems. However, a lack of data often limits our ability to understand and make predictions about these systems. One approach to addressing this data inadequacy is through the use of citizen science. Citizen science is the involvement of volunteers in scientific research. As a growing field, citizen science provides an inexpensive means to collect vast amounts of data over broad spatial and temporal scales that would be unachievable by professional scientists alone. We set out to document the spatial and temporal distribution of ecological citizen science projects in the United States and to determine the scope and level of participation of these projects. We documented over 650 projects through a comprehensive search using two online databases for citizen science projects: Scistarter and Citsci. Using a questionnaire sent to each project, we collected data about the scope, focus, and distribution of each project (i.e., theme, participation, and spatial and temporal scope). This data was then used to reveal geographic areas or themes that are currently underrepresented in the United States. Results from this work will help to identify existing data and infrastructure that can be used to fill data needs for the most salient ecological issues and identify gaps that map exist in the current citizen science landscape.

58. Environmental DNA analysis to accurately determine the presence of *Ambystoma laterale*

Natalie Colletti and Katherine Greenwald
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Environmental DNA (eDNA) analysis is a method of analysis in which DNA can be extracted from an environmental sample without requiring direct handling of any target organisms. In order to determine the presence of a single target species in an environment using eDNA analysis, an environmental sample is filtered or centrifuged to isolate any DNA present from the sample. A species-specific primer is then added to amplify the target species' DNA to a detectable quantity through Polymerase Chain Reaction (PCR). This method of analysis may prove valuable in determining the presence of Blue Spotted Salamanders (*Ambystoma laterale)* in an environment. Identification through traditional trapping and spotting methods is especially challenging for this species. Because they only venture above ground to breed in vernal pools for a few weeks during early spring, trapping Blue Spotted Salamanders means potentially interrupting the breeding activities of a state endangered species. In addition, Blue Spotted Salamanders are physically nearly identical to their Unisexual salamander counterparts. We will be comparing eDNA analysis results from 30 ponds in northwest Ohio and southeast Michigan to data previously obtained from the same 30 ponds through traditional field trapping and

spotting methods. Our results will add evidence regarding the accuracy of this relativley new technology, which can be an especially useful tool for identifying habitats of endangered species, and for early detection of the presence of invasive species.

59. Long-term fire-elephant interactions drive *Acacia drepanolobium* community dynamics in a Kenyan savanna

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Savanna ecosystems are characterized by highly dynamic grass-tree mosaics at the landscape level. Fire, rainfall, and herbivory are understood to be important factors influencing plant community changes. We present evidence that the interaction between elephant (*Loxodonta africana*) browsing and fire in a Kenyan savanna affects mortality and influences composition of height classes in *Acacia drepanolobium* communities. In the summer of 2011, we re-surveyed 11 experimental plots located in Laikipia, Kenya that had been burned in 2004 and 2005 as a part of the Scale and Fire Ecology (S.A.F.E.) project. We measured stem diameter, height, species of myrmecophyte ants residing in the swollen thorn domatia, and quantified elephant browsing in both burned and unburned areas. We found significant declines in *A. drepanolobium* densities in burned areas, with tree loss the most pronounced at the tallest height classes. While elephant foraging was noted in both burned and unburned areas, elephants knocked over a higher percentage of trees in burned areas. While underlying mechanisms of elephant preferential browsing in burned areas are not well understood, fire-driven ant community changes might play a role, as the myrmecophytic ants confer varying degrees of defense against browsing. Our study suggests that both elephant browsing and fire have both separate and compounding effects on *A. drepanolobium* communities, emphasizing the importance of examining interactions between fire and herbivory.

60. Catalytic mechanism and dynamics of ADP-Glucose Pyrophosphorylase

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Adenosine-‘5-Diphosphate Glucose Pyrophosphorylase (AGPase) is an essential allosteric enzyme that catalyzes the regulatory step of the biosynthesis of glycogen in bacteria and starch in plants. These polymers are the main sources of energy in numerous organisms. AGPase is the catalyst in the rate limiting reaction between ATP, an energy source, and Glucose-1-Phosphate (G1P) to produce ADP-glucose and pyrophosphate which is used to elongate α-1,4-glycosidic chains. We utilize computational methods for modeling, virtual mutations and molecular dynamics. (Molecular dynamics is a simulation that shows the movement of molecules over a period of time.) Site directed mutagenesis is performed in a region of highly conserved residues located in the active site. Previous kinetics experiments have shown that Arginine 32 plays a vital role in the catalytic function of the *E.coli* AGPase. When residue 32, located in the active site, was mutated from Arginine, a charged amino acid, to a Lysine, similar in size and charge to Arginine, the rate of reaction drastically decreased making the protein nearly inactive. This led us to conclude that the interaction between the Arginine and the ATP substrate is specific and imperative for the furtherance of the reaction. This project can potentially reveal a more efficient

starch and glycogen synthesis and could possibly contribute to bio-fuel and genetically modified food incentive.

61. Characterizing the structure and function of L1s in a heterochromatic region

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We use the short, or p, arm of chromosome 21 (HC21p) as a model to study the structure of heterochromatic regions of the human genome. L1 retrotransposons have not previously been studied in such regions. The ability of these elements to relocate into the coding regions of important genes can clearly cause disease, and some studies have indicated that L1s are vastly more active in cancer cells. We have previously shown that full-length L1s are over-represented on HC21p versus euchromatic genomic regions, while L1s in general are underrepresented on HC21p. We are sequencing phage clones from HC21p that contain L1s in order to more fully characterize the elements. PCR is used to amplify regions of interest, which are then cloned into bacterial plasmids that are purified and sequenced. This approach is being supplemented by direct sequencing of the phage clones. Repeating this procedure, we have been able to determine the sequences of several HC21p L1s. We are now determining the genomic integration sites for the HC21p L1s in the phage clones as well as those in recently-identified BAC clones from HC21p. This will allow us to determine whether the preferred integration sites differ between the heterochromatin of HC21p and euchromatic regions elsewhere in the genome. We will also determine whether the integration sites differ between different L1 families, which would have important implications for human genome evolution.

62. Evolution of molecular compatibility and virulence in novel hosts

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Because viruses with smaller genomes lack tRNAs, they rely on their host for protein synthesis and often utilize codons preferred by their host species to increase translational efficiency. If viruses incorporate less abundant host tRNAs, translation speed will be affected and result in an attenuated virus. If and when a virus switches hosts, it is likely ill-adapted for the hosts abundance of tRNAs. Previous work shows that attenuated viruses are under strong selection to incorporate more host-preferred codons, and correspondences in virus and host codon usage have been observed in a number of pathogen-host pairs. However, the exact process by which such adaptations are initiated is not well understood. An attenuated bacteriophage ΦX174 has been engineered, replacing several host-preferred codons in the genome with synonymous codons having a lower preference and/or tRNA abundance within the bacterial host. Employing molecular and bioinformatic techniques, phenotypic and genotypic changes in evolved strains have been investigated. The project provides a better understanding of viral evolution and assesses the effects synonymous mutations can confer within a genome. This specific interaction between ΦX174 and its host, *Escherichia coli* C, serves as a model and is applicable to a wider range of systems that undergo co-evolution.

63. May the force be with you: Dietary seasonality and adaptive plasticity in mammals

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Despite its direct importance to understanding morphological evolution the wild, little is known about long-term musculoskeletal plasticity in the mammalian skull and feeding apparatus. The anatomical, behavioral and functional similarities between rabbits and primates allow for the New Zealand rabbit to be a useful subject for which to simulate dietary seasonality while simultaneously recording plasticity responses due to the varied chewing stresses on masticatory regions of the mammalian skull. Data on bony proportions gathered from microCT scans were used to document the rabbits' physiological ability to adapt and respond to altered environments throughout development. It is hypothesized that animals experiencing increased chewing stress will exhibit elevated bone formation vs. groups that eat less mechanically challenging diets. Weanling rabbits were divided into four cohorts of ten rabbits each, including three cohorts raised on diets simulating seasonal or annual overuse of the mastication complex and one control group. The skulls of the growing rabbits were imaged biweekly via microCT and analyzed statistically to document osteogenic changes from weaning through adulthood. Preliminary data indicate that rabbits subject to seasonal and annual overuse of the jaw show increased growth of components of the chewing apparatus in comparison to rabbits raised on the control diet. Our ultimate goal is to produce a fundamental model that explores the biological effects of long-term loading on the plasticity of masticatory and non-masticatory regions of the skull as well as expand our understanding of hierarchical changes in musculoskeletal plasticity that allow organisms to adapt postnatally to specific environmental niches.

64. Comparative neuroanatomy of social and solitary Hymenoptera

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Social lifestyles are perceived to be more complex than solitary ones because social demands are considered to impose added pressures leading to an increase in cognitive capability. These pressures lead to an increase in size in brain regions responsible for social behavior. In insects, the mushroom bodies are associated with multisensory integration and learning. Social Hymenoptera are known for their large and elaborate mushroom bodies, suggesting sociality facilitates an increase in mushroom body volume. However, it has been shown that these complex structures arose before sociality in Hymenoptera within ancestral parasitoids. Recent research has also shown that increasing brain size isn't the only strategy for handling the demands of sociality. In eusocial insects, division of labor may narrow the behavior repertoire of individuals, lessening the need for a larger, more complex brain. I investigate if sociality, parasitoidism, or generalist behavior is associated with larger, more elaborate regions of the brain by relating allometric measurements to species' social structure and behavior repertoires.

65. Sex, love, and rock & roll: An analysis of reproductive references in songs of different genres, different gender artists, and across an artist's career

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Rose-Hulman Institute of Technology

Frogs, birds, and lions use sound in mate attraction; humans are no different. Previous work demonstrated that reproductive references are more prevalent in popular songs than unpopular songs. Our analysis extended this concept by applying it to gender, genre, and career profile. We randomly selected songs from Billboard charts, and then categorized references into seventeen evolutionary significant categories. Additionally, we chose five artists with careers spanning multiple decades of Top Ten hits to examine patterns in reproductive references as an artist ages through a career. Male and female artists did not differ in the number, type, or distribution of reproductive references. R&B songs had significantly more reproductive references than the other genres (especially short term messages), with Rock songs having the least references overall. The long-career artists had more long-term messages than short-term messages, with both types of references remaining constant over their careers. The number of reproductive references didn't differ between #1 songs and non-#1 songs for the long-career artists, but #1 songs from 2011 had more long term references than non-#1 songs. Beyond this comparison, popularity measured as highest rank on the appropriate Top Ten list or on the Hot 100 was not related to the number of reproductive references. These data demonstrate that songs may present reproductive references, but the scheme of that representation is more complicated than simple evolutionary expectations suggest. Popularity and longevity as a musical artist are not simply a function of the amount or type of references in music.

66. Fine structure of spermiogenesis within the seminiferous epithelium of the lizard, *Sceloporus variabilis*

Caroline L. Matchett, Sarah A. Wilson, and Kevin M. Gribbins
Wittenberg University

Spermiogenesis and sperm morphology are valuable tools for phylogenetic investigations. Ultrastructural data on spermatid characters during spermiogenesis are starting to increase in reptiles, but are still relatively limited within squamates. This study focuses on the ontogenic events of spermiogenesis within an oviparous and seasonally spermatogenic lizard, Sceloporus variabilis to provide ultrastructural characters that may prove useful to current phylogenetic analysis within Squamata. Five lizards were collected in April 2011 from riverbeds around Veracruz, Mexico. The testicular tissues were processed normally for TEM and analyzed to access the ultrastructural differences between spermatids during spermiogenesis. The present data was compared to the spermiogenic information available on the viviparous *Sceloporus bicanthalis*. Interestingly, some differences exist between *S. bicanthalis* and *variabilis* spermatids, which are in the same genus, however most of the spermatid characters are conserved between these species. Degrading and coiled myelin figures were visible within the developing acrosome, which are likely remnants of transport vesicles of the Golgi complex. During spermiogenesis, an electron lucent line between the subacrosomal space and the acrosomal medulla was observed in *S. variabilis* spermatids, which has been mentioned in other squamates but not accurately described. Thus, we elect to term this region the acrosomal lucent ridge. This study furthers the existing knowledge of spermatid development in squamates, which

could be useful in future work on the reproductive systems of lizards. Furthermore, our study suggests that spermiogenesis may be more conserved in the genus *Sceloporus* than in other lizard taxa studied to date.

67. A complete ultrastructural analysis of spermatids in the testis of *Pelamis platurus*

Brenna Burkhart, Kevin Gribbins, and David Sever
Wittenberg University

Little is known about spermatid development during spermiogenesis in snakes, as there is only one complete study in ophidians, which details the spermatid ultrastructure within Cottonmouths. Therefore, the objective of the following research is to expand our knowledge of the ontogenic steps of spermiogenesis in snakes by studying spermatid maturation in *Pelamis platurus* that were collected in Costa Rica in 2010. The testes were removed, fixed in Trumps, and the tissues were processed for standard electron microscopy. The spermatids of *P. platurus* share many similar ultrastructural characteristics to what has been described for squamates and ophidians during spermiogenesis. Two notable differences between the speramtids of *P. platurus* and those of other snakes is a more prominent central lacuna within the nucleus and radiating arrays of the outer longitudinal manchete microtubules. The epinuclear lucent zone is shorter in comparison to other squamates and may be a synapomorphy for snakes. Also, the midpiece is much longer in *P. platurus* and is similar to that reported for all snakes studied to date. Other features of chromatin condensation and morphology of the acrosome complex are similar to what has been observed in the Cottonmouth. Though the spermatids in *P. platurus* appear to be highly conserved, some differences in subcellular details are observed. These ultrastructural characteristics could be used to help determine the evolution of aquatic snakes from terrestrial snakes. Analysis of developing spermatids reveals morphologically conserved traits between different species along with subtle changes that could help determine phylogenetic relationships.

68. Uncorking the diversity of *Wolbachia* at Southern Indiana wineries

Randy D. Hicks, Kathy Sheehan, and Irene Newton
Indiana University

Wolbachia is an obligately intracellular bacterium known for manipulating the biology of their hosts in favor of continued widespread infection. Belonging to the Rickettsiaceae family, *Wolbachia* infection is a global epidemic amongst insects, with roughly 40% of insect species predicted to be infected. To survey diversity and extent of *Wolbachia* infection within the Brown County, Indiana area, we collected Drosophila species at local wineries using traps and net sweeping over the course of the summer. In addition to visual identification, the fruit fly hosts were also sorted via sequence analysis of the mitochondrial cytochrome oxidase I gene. Primers designed to amplify the *Wolbachia* surface protein wsp were used to test for infection and acquire strain information for these symbionts. These data revealed that the Southern Indiana wineries hosted a variety of Drosophila host species. Of the samples collected, we found a large amount of diversity in *Wolbachia* strain within and across host species across both time and space. Understanding the extent of *Wolbachia* diversity found within and between different species is important in building a larger knowledge base concerning *Wolbachia*. Possessing a greater ecological perspective can lead to more efficient and thorough approaches to researching *Wolbachia* vertical and horizontal transmission dynamics. This could also result in an improved

format for studying the effects *Wolbachia* may have on host species evolution as a result of its prolonged intracellular presence.

69. Elucidating the status of Michigan's red-eared slider (*Trachemys scripta elegans*)

Patrick Terry and Dr. Katherine Greenwald
Eastern Michigan University

The red-eared slider, *Trachemys scripta elegans,* is an aquatic turtle native to the Southeastern United States. Due to influences from the pet trade, fossil evidence and Michigan's close proximity to the turtle's native range, the native or introduced status of this species has been in question since it was first described in Michigan in 1941. Elucidating the status of this species will have several conservation implications and, to do so, we propose to use methods consistent with phylogeographic studies. These methods are particularly well suited at determining the geographic origins of populations because they take advantage of the similarity between genealogical lineage and geographic distribution caused by the relatively rapid mutation of selectively neutral genes. If some populations are native we expect that will possess a unique genetic structure and be easily discernible from introduced populations or they will possess genetic structures similar to those within populations throughout the Great Lakes Region as is the case with other turtle species known to have re-occupied post-glacial Michigan. If introduced we expect populations to bear similar genetic structures to those within populations that were involved in pet trade from the turtle's Southern native range.

70. Genetic population structure in long-tailed macaques (*Macaca fascicularis*) across Singapore

Julia Kohn and Amy Klegarth
University of Notre Dame

Anthropogenic landscape changes alter the population structure of many species by promoting or impeding gene flow. The long-tailed macaque (*Macaca fascicularis*), a non-human primate native to Singapore, is one such species. Singapore is highly urbanized, with fragmented forest patches and parks surrounding a large central forest reserve. Changes in the size and connectivity of the central reserve over the past 200 years may have significantly changed gene flow dynamics between the various macaque troops on the island. Singapore was completely forested with no anthropogenic barriers to gene flow until 1819, after which primary forest remained only at Bukit Timah. However, rapid urbanization and reforestation followed in the past 100 years. Phylogenetic analyses of mtDNA sequence data from the hypervariable D-LOOP region indicate minimal population structure among Singapore's macaques. Most notably, Bukit Timah and Bukit Batok, two adjacent parks southwest of the Central Catchment, appear to be more genetically isolated than any other site, including peripheral parks. Our analyses show 30 unique haplotypes across 16 sites on Singapore. This high but evenly distributed diversity suggests the macaques are able to successfully disperse across the urban environment. As an edge-loving species, the reduction in forested spaces over time may actually have increased suitable macaque habitat and made the distances between troops easier to traverse. It remains unclear why individuals at peripheral parks are not genetically isolated, given the seemingly large dispersal barriers between those sites and the catchment; further landscape genetic analyses will lead to a better understanding of this phenomenon.

71. Comparison of genetic diversity in the freshwater mussel *Pyganodon grandis* between Lake Erie and Lake Ontario

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Cleveland State University

Pyganodon grandis is a freshwater mussel (Family Unionidae) common in the Great Lakes. Its mode of dispersal, like other Unionid mussels, is through larval glochidia which are parasitic on fish gills or scales. *P. grandis* glochidia have the ability to parasitize the scales of a wide array of host fish and as a result are more widely distributed throughout the Great Lakes. In light of this, it still may not be expected that female mitochondrial DNA would pass from Lake Erie to Lake Ontario, over Niagara Falls, through glochidia attached to fish. Sequences of the mitochondrial cytochrome oxidase C subunit 1 (CO1) gene from 260 samples of *P. grandis* show one dominant haplotype across Lake Erie, from the western basin to the Niagara River. Our results from collections of *P. grandis* from inlets along the eastern end of Lake Ontario suggest that the same CO1 haplotype is the most common there as well. Lake Erie began to flow through the Niagara River into the Ontario Basin ~12,400 years ago with fluctuating flow rates occurring since that period. This flow is responsible for the formation of Niagara Falls. Our results imply that there may have been more recent gene flow between these two large lake populations to maintain the common haplotype in the two lakes.

72. Survivorship of ploidy-variable unisexual *Ambystoma* salamanders across stages of development

Christina Casto and Katherine Greenwald
Eastern Michigan University

Unisexual *Ambystoma* salamanders reproduce in a unique mode known as kleptogenesis, where entirely female populations persist by "stealing" genetic material from males of compatible sexual *Ambystoma* species (e.g., the Jefferson salamander *A. jeffersonianum*, and the blue-spotted salamander *A. laterale*). Kleptogenesis can result in ploidy variable embryos within the same egg mass because the female may or may not incorporate the genome acquired from a male ambystomid. Therefore, diploid, triploid, tetraploid and pentaploid individuals can be found in unisexual populations. Little is known about the survivability of ploidy-variable individuals across stages of development. This research will assess the frequency of ploidy levels in three sample populations during four life-stages: breeding adults, early and late larval stages, and metamorphs. These data will serve to: identify trends in survivorship of the unisexual individuals, provide insight into the significance of genome addition, and suggest the ploidy level at which developmental complications may hinder survival.

73. Reliability of morphological features in the identification of Acris species in area of sympatric

Jonathan Clinger, Nicole André, Keaton Hannon, Jane Neyer, and Richard Phillips
Wittenberg University

The ability to distinguish species based on morphological characteristics is important in studying their ecology. The northern cricket frog (*Acris crepitans*) and the southern cricket frog (*Acris*

gryllus) are morphologically similar species that are sympatric in portions of their range. Field guides and dichotomous keys suggest they may be distinguished through four morphological characteristics: extent of webbing on feet, distinctness of a rear thigh strip, snout shape, and/or the ratio of leg length to body length. In spring of 2012, we collected 75 cricket frogs in Lafayette County, Mississippi where distributions of both species overlap. Frogs were classified by each morphological characteristic separately and were scored either as a 1-southern, 2-hybrid, or 3-northern. Each separate morphological classification was totaled and a score of 3-4 resulted in the classification of a southern, 5-6 a hybrid, and 7-8 a northern, so that species classification was based on the proportion of characteristics exhibited. Based on these indicators, 39 were classified as southern (13 unanimously classified by all characters), 30 hybrid (3 unanimously classified) and 6 northern (0 unanimously classified). We examined each character in light of designation, to determine differences in the reliability among any of the identifying morphological characteristics. There were no significant difference ($x^2 = 0.46$; p= 0.5246) found between any of the morphological characteristics, thus all were deemed reliable methods for species identification. Future study will address genetic classification of species to examine the accuracy of any morphological features to make species level designations in Acris in areas of overlap.

74. The effects of larval predator exposure on susceptibility of northern leopard frogs (*Lithobates pipiens)* to a fungal pathogen in the terrestrial phase.

J. S. Caseltine, S. L. Rumschlag, and M. D. Boone
Miami University

Exposure to predators can influence population dynamics through direct effects on survival, but the stress associated with predator presence may also have latent sublethal effects such as decreased immunity. For amphibians, the risk of exposure to predators in the aquatic environment as larvae may have effects on susceptibility in the terrestrial stage. In this study, we tested to see if northern leopard frog (*Lithobates pipiens)* metamorphic susceptibility to a fungal pathogen, *Bactrachochytrium dendrobatidis* (Bd), would increase with exposure to predators in the larval stage. We first exposed tadpoles to crayfish predators until metamorphosis and then exposed individuals to Bd as metamorphs for 12 hours. We then measured mass and survival over the next seven weeks. Although exposure to Bd decreased growth, we saw no effects of larval exposure to predators. Our study shows that the extra stress caused in one stage of development does not necessarily impact susceptibility in next life stage.

75. Pectinase gene variability across saprotrophic fungal communities in temperate forests

Matthew D Gacura, Bess Heidenreich, Daniel D. Sprockett, and Christopher B. Blackwood
Kent State University

Much of the carbon and many nutrients important to proper terrestrial ecosystem function are locked within plant material. Most of this material is found is part of the plant cell wall, which is complex matrix made up of a variety of recalcitrant polymers and labile compounds that are decomposed by many specialized organisms. In this study primers were designed targeting the genes coding for pectinases of the Glycoside hydrolase family 28 (GH28) found in fungi. GH28 sequences in fungal genomes were aligned and potential primer sites were identified. After

preliminary testing the most successful pair of primers was 1786F and 2089R. To further test the primers DNA was extracted from multiple environmental samples which consisted of leaf litter gathered in late April 2010 from multiple sites in Manistee National Forest; MI. Leaves that were gathered came from species including: *Quercus velutina*, *Quercus alba*, *Acer saccharum* and *Tilia americana*. Clone libraries were then created for each of the leaves that were sampled. Environmental samples from all leaf types produced amplicons of approximately 300 bp. These were characterized as members of the fungal GH28 genes similar to several taxa. These taxa included possible mycorrhizal fungi of the order *Sebacinacea* and several known plant pathogens, including *Botryotinia fuckeliana* and *Colletotrichum lindemuthianum*. The data gathered in this study indicates that the GH28 primers developed are able to amplify genes found in a wide variety of fungal taxa. Based upon this evidence they will be useful in characterizing and quantifying functional traits using qPCR.

76. Variation in cone production of white spruce at two sites near its southern range limit

Allison E. Grecco and Jalene M. LaMontagne
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Although synchrony in cone production can be seen over large geographical areas, asynchrony has been observed at spatial scales just a few kilometers apart. Regional patterns of weather and climate have been linked to temporal variation in cone production, with temperature and precipitation affecting seed development. Since temperature and moisture patterns are factors expected to be altered by climate change, cone production is likely to be impacted, and species are most sensitive to climate change near their range limits. We studied spatial variation in cone production of white spruce (*Picea glauca)*, a dominant Boreal forest species, near its southern range limit. To determine whether there was spatial variation in cone production during 2012, we established twelve total sites at two regions: the Upper Peninsula of Michigan (Huron) and northern Wisconsin (Kemp). We marked 727 trees, determined individual and site characteristics, and quantified cone production. There was significant variation in median cone production between the two regions and between sites within each region. A cone mast occurred at the Huron region but not at Kemp. The closer proximity of Kemp to the southern range limit of white spruce, along with differences in precipitation between the two regions, may explain the observed variation in cone production. The availability of resources such as light also affects cone production, and competition among individuals for light could explain some of the variation observed, since sites with lower forest densities yielded higher median cones per individual

77. Why did the brownsnake cross the road? Examining factors that influence patterns of road mortality in an Illinois state park.

Iwo Gross, Andrew Durso, Corissa Lennon, and Stephen Mullin, Stephen
Eastern Illinois University

Roads are among several anthropogenic structures that can have negative impacts within a habitat. Even though the presence of roads might expand ecotone habitats, negative impacts might include increased fragmentation and risk of predation. Where roads occur between habitats used for hibernation and those occupied during the activity season, animals moving between habitats incur greater mortality from cars travelling along the road surface. Midland Brownsnakes (*Storeria dekayi wrightorum*) in an Illinois state park biannually cross a 2.4-km

stretch of road that separates over-wintering sites from activity season habitat. The road surface and shoulders provide the snakes with opportunities to thermoregulate, but crossing or basking on the road increases the chances of mortality.
Since October 2010, we have collected both live and dead-on-road (DOR) individuals using a combination of visual encounter surveys and an array of nine 100m-drift fences. We recorded morphometric, behavioral, life-history, and GPS location data for all individuals, and uniquely marked each snake prior to release. We discovered that male snakes incur higher mortality than females within and between years. By incorporating weather and traffic data, our results revealed that periods of highest traffic volume coincide with the most intense snake migratory pulses during the autumn. Further analyses using GIS also suggested that snake movements across the road formed along specific corridors associated with dried streambeds and other areas of low slope topography. Limiting vehicular access to park road during the second half of October, or adding culvert structures, would further improve survivorship for this brownsnake population.

78. The effects of malathion and pathogen exposure on American toads (*Anaxyrus americanus*)

R. S. Wise, S. L. Rumschlag, M. D. Boone
Miami University

Multiple factors contribute to amphibian population declines around the world. Interaction among stressors, such as disease and pesticides, may also contribute to declines, and understanding the potential for interactions is critical. Pesticides can act as immune suppressors, increasing disease susceptibility of the host; however, pesticides may also negatively affect pathogens by decreasing their virulence. This study examined the interactions between a disease and pesticide. In a laboratory experiment, American toad (*Anayxrus americanus*) metamorphs were exposed to the insecticide malathion (1mg/L or absent) and a pathogenic chytrid fungus, *Batrachochytrium dendrobatidis* (present or absent). We found that exposure to the chytrid fungus at metamorphosis significantly reduced survival, while exposure to malathion decreases weight gain. We did not find any significant effects of the interaction of malathion and chytrid fungus exposure, although we observed a trend that suggested that malathion exposure increased the negative effect of chytrid fungus exposure on weight gain. Our study suggests that American toad metamorphs are susceptible to this pathogen despite the absence of declines from the chytrid fungus in our area and could be impacting populations where this pathogen occurs.

79. Multi-scale habitat utilization by eastern box turtles (*Terrapene carolina carolina*) in Northwest Ohio.

Matthew D. Cross and Karen V. Root
Bowling Green State University

Eastern box turtles (*Terrapene c. carolina*) are a species on the decline throughout their remaining range. In northwest Ohio, box turtles are endemic to the Oak Openings region, a biodiversity hotspot, where identification of box turtle habitats is a conservation priority. We radio-tracked 13 box turtles throughout their 2012 active season to test habitat selection on three different scales (microhabitat, macrohabitat and landscape-scale). Home range sizes averaged 14.12 ha, and daily movements averaged 12.12 m/d. Turtles in our study exhibited hierarchical habitat selection preferring swamp, floodplain and upland forests at the macrohabitat and landscape scales. Models predicted that box turtles would exhibit complex microhabitat selection

based on structural and environmental variables including elevation, litter depth, humidity, distance to overstory trees and presence of logs. Home range sizes and daily movement rates were higher than reported in previous studies and is most likely a consequence of the large number of gravid females in our study. Disruption of these movement patterns and changes in available habitat through natural succession or management could be detrimental to this species. The results of this study can be used to guide management activities and help ensure the long-term survival of box turtles in the Oak Openings Region.

80. Distances Traveled between Captures by *Peromyscus* in Ohio

Cady Gannon, Josh Courlas, Richard Phillips
Wittenberg University

The white-footed deermouse, *Peromyscus maniculatus* is a well dispersed terrestrial resident that serves as an important component of the terrestrial foodweb and can be shown as an indicator of environmental health in region. Utilizing Sherman live traps and a mark recapture method; we estimated the movement patterns of male and female deermice. We then calculated the average distance travelled between the original trapsite and subsequent trap during August of 2010. With over 5 animal trap nights and 36 recaptures the distance travelled was not shown to differ between male and female. The variance in both sexes ranged from 0m to over 70m travelled between 2 traps. The maximum distance travelled in a single night was 35.88 m while the furthest movement from original capture site was 70.70 m. The relationship between distance travelled from original capture site and sex was insignificant, $t(9)=0.41$, $p=0.694$. Likewise, the distance travelled between subsequent trap sites related with sex of the animal was also insignificant, $t(9)=0.56$, $p=0.591$. Movement rate could be affected by a multitude of factors; short term being those such as weather or predation while long term factors could include habitat formation, health of the individual animal or mating. These data show much room for improvement by increasing sample size to further study this organism's travel pattern. Without further study, we cannot attribute an association of movement in these animals with any hypothesized factors. Also, one may begin incorporating other interests into this study such as a more long term capture period, habitat type in which traps were found, seasonality, time elapsed from a prescribed burn, etc. Furthermore, this study will be elaborated and further analyzed by many trapping teams to better understand the behavior of these organisms.

81. Impact of temperature on the growth of the variable kingsnake *Lampropeltis mexicana*

Benjamin Rausch and Richard Phillips
Wittenberg University

Ectotherms found in high elevation habitats often have to overcome issues associated with rapid temperature changes. Although microhabitat selection may minimize this fluctuation, temperature may influence growth rate and establish a strong selective force in such environments. Using a montane species of kingsnake, *Lampropeltis mexicana thayeri*, we investigated the impact of incubation and post-hatch temperature on the post-hatch growth rate. Captive-bred variable kingsnakes were assigned to 4 treatments (incubation-post-hatch temperatures), attempting to minimize clutch effects: 29°C-29°C (n=10), 29°C-23°C (n=9), 23°C-29°C (n=5) and 23°C-23°C (n=7). Snakes were fed known-weight pinkie mice, twice weekly, with each snake weighed weekly (n=11 times). Average treatment growth rates, mass

assimilation ratios (mass gained/mass consumed) and food rejections were analyzed using linear regression, ANOVA, and Chi-square, respectively. No differences were found in growth rates between treatments ($F_{3,27}$=2.410,p=0.089) or in the mass assimilation ratio ($F_{3,27}$=0.969,p=0.422). However, the total number of food rejections per treatment (X^2_3=78.41,p≤0.0001) were greater in the 29°C-23°C group than in the 23°C-29°C treatment. While no statistical significance was detected between treatments, the biological impact of such differences in growth rates among treatments could influence fitness over a longer period of time.

82. Temporal isolation in the flowering time of fragmented populations of *Echinacea angustifolia*

Kelly Kapsar
Carleton College

In Western Minnesota, the tall-grass prairie landscape has been extensively fragmented by agriculture. Limited gene flow among remnant populations and the resulting genetic drift may exacerbate disparities in the flowering time of prairie plants, leading to temporal isolation. This study analyzes the flowering phenology (timing and duration of flowering) of *Echinacea angustifolia*, the narrow-leaved pale purple coneflower, at five prairie remnants in Douglas County, Minnesota. I observed the first and last day of flowering for 260 *E. angustifolia* heads on 183 plants. I hypothesized that the flowering time, as characterized by the first, last, and peak flowering dates, would differ among the remnant populations. Similarly, I hypothesized that the degree of synchrony of all plants within a remnant (as measured by the average number of other flowering heads per plant during the duration of flowering) would vary among remnants. Thus far, I have found that peak flowering date differed significantly between the 2011 and 2012 growing seasons as well as between burned and unburned remnants within the same growing season. The observed variation in phenology may result from differences in the genetic makeup in these populations, perhaps resulting from genetic drift, and/or unique environmental factors such as unusual weather patterns or fire. My findings have the potential to help conservationists better understand the effects of isolation on prairie plants by determining the influence of environmental and genetic variability on flowering time.

83. The effect of treefall gaps on the spatial distribution and dispersal of four invasive plants

Angela Klinczar, Charlotte Freeman, Nicole Angeli, and David Gorchov
Miami University

Plant invasion is contingent on several factors, with the most prominent being invasibility and propagule rain. Propagule rain is the extent to which established individual of a species add offspring to the exotic environment. Invasibility, the intrinsic susceptibility of an area to invasion, is typically high in disturbed areas. The objective of this study is to determine the spatial distribution of invasive plants in a mature forest, to explore the role of disturbance (specifically treefall gaps) and propagule rain in plant invasion, and to investigate the role of diffusion and long-distance dispersal in the invasion process. Nine hectares, divided into 2x2 m subplots, of secondary upland forest were surveyed at the Smithsonian Environmental Research

Center in Maryland, USA. For each subplot, invasive plants were identified, and, for the four most abundant invaders, *Rubus phoenicolasius, Berberis thunbergii, Rosa multiflora*, and *Lonicera japonica*, numbers were counted per life history stage. The height of the canopy was assessed, with heights less than 10 meters indicative of canopy gaps. Overlaying gap locations on distributions indicates that *R. phoenicolasius* is more associated with gaps than the other species. Geographic Information Systems and spatial statistics will be used to assess predictors of the spatial pattern of these invasive plants, particularly the importance of treefall gaps and a nearby propagule source, a recently logged stand. The implications of this study are to understand the mechanisms and importance of site conditions for plant invasion, which must be known in order to implement control and management.

84. What role do white-tailed deer play in seed dispersal of Amur honeysuckle?

Peter W. Guiden and David L. Gorchov
Miami University

Long-distance dispersal is an important aspect of invasive species ecology because it results in new invasion frontiers. We investigated seed dispersal of Amur honeysuckle (*Lonicera maackii*), a prolific invasive shrub in the eastern and midwestern US. Seeds of *L. maackii* are dispersed by birds, and also survive digestion by white-tailed deer. We aim to quantify viable *L. maackii* seeds in deer pellets. During fall/winter 2013, we will collect deer pellet groups from uninvaded woodlots in Darke County, Ohio and quantify the *L. maackii* seeds within. This winter, we collected deer pellet groups from Butler County, Ohio in order to determine the optimal method for testing seed viability: sieving pellet material to isolate *L. maackii* seeds, versus potting pellet groups directly and identifying seedlings. We also asked whether deer prefer to browse on fruiting *L. maackii* branches. We also conducted a paired browse preference survey between *L. maackii* branches with fruits removed and branches with fruits retained in southwestern Ohio. In 55% of pairs, branches with fruits intact had more new browse than branches with fruits removed, but this difference was not significant (sign test, $p=0.13$). We also plan to project the seed shadow of *L. maackii* endozoochory through deer, using data from published literature. This will provide a theoretical expectation of *L. maackii* long-distance dispersal events. Ultimately, this study will enhance our understanding of how *L. maackii* invades new areas, and give new insight into the adverse ecological effects of deer.

85. The effects of grazing and invasive plant species on butterfly communities in northwestern Montana

Mason Murphy
University of Notre Dame

In this study I examined how butterfly species richness, abundance and diversity differed under two different grazing methods: bison summer grazed and bison winter grazed plots. I also compared these data to plant diversity, invasive species cover, and habitat heterogeneity. In addition, I examined the differences in plant diversity and invasive species cover between the two different grazing patterns. I conducted 2 plant surveys to assess vegetation diversity, and also recorded flowering forb percentages. I found that butterfly diversity is significantly affected by both elevation and habitat heterogeneity, and that plant diversity has no effect on butterfly

diversity. This knowledge will be helpful in designing conservation programs for threatened butterfly species.

86. Maintenance of the plant-soil symbiont mutualism by means of differential carbon allocation

Natalie Christian and Jim Bever
Indiana University

Belowground microbial communities are highly dynamic and have been shown to drive the maintenance of aboveground diversity. One of these remarkable abovegroundbelowground interactions is mutualism between plants and soil microbes. While evolutionary theory predicts that these mutualisms should be destabilized by cheating, they remain common, persistent, and critical, and have been shown to drive communitylevel processes, such as succession. The mechanism of such belowground dynamics, however, is widely unknown and must be further explored to understand how terrestrial communities are affected. Using a mathematical model, we asked, how do mutualistic interactions persist in the face of cheating? We modified an existing framework that demonstrates how plants preferentially allocate carbon to overcome costs of mutualism with their root symbionts. We predicted that by factoring in exploitation competition among microbes we could identify a condition for their coexistence. The novel component of this model is treating carbon as two separate resources – carbon utilized for construction of the plant-symbiont relationship, and carbon preferentially allocated by the plant once the relationship is established. This approach demonstrates a condition for coexistence of two microbial species of varying benefit on the same host plant. Furthermore, it allows us to trace the symbiont dynamics under varying abiotic and biotic conditions, and identify three possible outcomes depending on the degree of carbon allocation: competitive exclusion of the mutualist, coexistence, or competitive exclusion of the pathogen. The ability to quantitatively describe the nature of plant-soil symbiont dynamics can have profound implications on understanding plant community structure and productivity.

87. Out of synch: simulated changes in seasonal temperatures disrupt adaptive life cycle synchronization in Rhagoletis fruit flies

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Synchronization of life cycles with favorable environmental conditions is a crucial adaptation in seasonal environments. For example, most temperate organisms synchronize active growth with summer conditions and curtail growth and reproduction during winter. Changes in seasonality associated with climate change (e.g., shorter winters, larger temperature fluctuations) may disrupt proper synchronization by changing the timing of temperature cues. Thus, we would like to be able to predict how changing seasonal temperature fluctuations will affect life cycle timing. We performed experiments simulating the effects of warmer falls and warmer springs on the life cycle timing of Rhagoletis pomonella, a fly that has one generation per year and enters a dormant (diapause), overwintering stage as a pupa. We find evidence that warmer temperatures can expose formerly covert, maladaptive variation that leads to poor life cycle synchronization. Warmer temperatures when flies are initiating diapause can cause R. pomonella to forgo the

diapause phase. Thus temperature cues during the fall are of primary importance. Populations within the Rhagoletis species complex vary in the frequency of this maladaptive, non-diapause developmental mode, suggesting that evolutionary responses may play a major role in response to contemporary climate change.

88. Infection with a trematode parasite (*Microphallus* spp.) increases aggression in native and invasive orconectid crayfish

Iris Petersen, Lindsey Sargent, and David Lodge
University of Notre Dame

Invasive species are a major threat to global biodiversity. Invasive rusty crayfish (*Orconectes rusticus*) have recently been introduced to lakes in northern Wisconsin and Michigan where they decrease native biodiversity by displacing resident crayfish species (*O. virilis* and *O. propinquus*), and consuming macroinvertebrates and aquatic plants. A trematode parasite (*Microphallus* spp.) infects the hepatopancreas of all three species of crayfish. Preliminary research indicates that this parasite alters crayfish shelter competition and may affect each species differently, possibly because it alters aggression. We quantified aggressive behaviors of uninfected and infected crayfish in conspecific and heterospecific encounters. We found that infected *O. rusticus* and *O. propinquus* were more aggressive during conspecific encounters than uninfected individuals; however, there was no difference in aggression between infected and uninfected *O. rusticus* and *O. propinquus* in heterospecific encounters. We also found that infected crayfish were more likely to win shelter competitions in conspecific trials, but not in heterospecific trials. Both infected and uninfected *O. rusticus* were aggressive in competitions against heterospecifics, which is likely why we did not observe an effect of infection on the outcome of these trials. We did find that the overall aggression score for each trial (average score for both crayfish) increased in both conspecific and heterospecific trials when at least one crayfish was infected. The increased intensity of trials due to infection may lead to an increase in crayfish mortality in the field due to injury from agonistic encounters. Our results do not suggest that infection alters the outcome of competition between orconectid crayfish species.

89. The functional response of *Temnochila virescens* and the effect of competition with *Thanasimus dubius* on adult *Ips grandcollis* survival

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Southern Illinois University Carbondale

Outbreaks of bark beetles are widespread and can cause high financial loses. The predators *Temnochila virescens* and *Thanasimus dubius* are two common predators of bark beetles. It was of interest to study the functional response in order to determine the impact of *T. virescens* on its *Ips grandicollis* prey. To evaluate the functional response, *T. virescens* and *I. grandicollis* adults were combined in varying densities and the effect of this predator was determined. We also studied the interaction between *T. virescens* and *T. dubius* in a multiple predator, single species experiment. The study was conducted to determine the effect of competition between adults on the success of prey colonization. The predators were placed together and alone at various combinations. In both experiments, the bark was removed to determine the number of prey successfully in the log and the number eaten determined. The functional response was shown to be ratio-dependent, with the per capita attack rate of *T. virescens* strongly dependent on predator

density. The multiple predator experiment showed a significant interaction between densities of *T. dubius* and *T. virescens* indicating possible emergent predator effects, and in particular that the two predators are not substitutable. In fact, the predator *T. dubius* alone was the most effective in reducing *Ips* survival. The functional response provided further details on the overall impact of *T. virescens* on *I. grandicollis* success. The multiple predator experiment indicates the importance of low-density releases for use in biological control due to higher densities providing only marginal improvements in *Ips* mortality.

90. Comparisons of geometric morphometric variation within and between lineages of *Peromyscus leucopus*.

Joseph Baumgartner and Susan M. G. Hoffman
Miami University

The white-footed mouse (*Peromyscus leucopus*) of northern Michigan has recently expanded its range northwards. Over the past decade, populations of *P. leucopus* in the Upper and Lower Peninsulas (UP & LP respectively) have been sampled for population genetic and morphometric analyses. During this time, high levels of morphometric variation in the LP lineage of *P. leucopus* have been reported, but no formal, geometric quantification of this variation has been done. In the course of this study, the morphometric variation of this lineage (LP) was quantified and compared with that of the northern lineage (UP).

91. Risk behavior of Peromyscus spp. in clear-cut, saw timber, and mature forest stands

Diana Saintignon
Ohio State University

According to the optimum foraging theory, organisms attempt to maximize their net energy intake per unit time by using the least amount of energy to consume the highest quality of food. The point at which the costs (predation) of foraging at a location outweigh the gains to be had will often result in the organism abandoning the site. In this study foraging cost of predation on Peromyscus spp. across three sets of three successional stages; clear cuts, saw timber and old growth forests are compared in attempts to understand how human harvesting techniques impact prey behavior. It was hypothesized that clear cuts with the highest percent of ground cover will have lower GUDs. Peromyscus spp. are an important food source for the state endangered bobcat and the Eastern rattlesnake so results may prove useful for their management. Five food trays were placed at random intervals along 200 ft transects at each successional stage with three replications. Each feeding station consisted of a track pad and an aluminum pan filled with 1 liter of sand and 5 grams of millet seed. A weight proportion of grams of millet left from the initial amount resulted in the giving up density (GUD) at that tray. While GUD varied between stands, saw-aged stands appeared to have had risk behaviors practiced in lower levels than in clear-cuts and mature-aged stands, despite cover measurements that suggest the saw-aged stands had the lowest cover. Variation in GUD could have been caused by a variety of factors that are difficult to control for such as locally more preferable food or removal of food from trays to eat in a more desirable location"

92. Spreading the Disease: Using Tiger Salamanders as Sentinels of Chytrid Fungus for Boreal Toad Restoration

Morgan Geile and Howard H. Whiteman
Murray State University

The chytrid fungus Batrachochytrium dendrobatidis (Bd) has been linked to mass mortalities of a variety of amphibian species world-wide. Unfortunately this fungal disease appears to be one of the few pathogens that continuously emerges in "pristine" ecosystems, and is therefore a critical current issue in conservation biology. High elevation boreal toads (Anaxyrus boreas) are one species that has been suffering population declines due to chytrid in Colorado. However, not every infected host suffers mortality. Tiger salamanders (Ambystoma tigrinum) are resistant to the disease and can become a pathogen reservoir species, therefore serving as a sentinel of Bd. The goal of this study was to test for the presence of Bd in aquatic habitats located in the Grand Mesa-Uncompahgre-Gunnison (GMUG) National Forests, in order to support the restoration of the boreal toad. Many of the boreal toad populations have been reduced or gone extinct within this area, and possible reintroduction locations were tested for presence of Bd by swabbing adult tiger salamanders for tissue/zoospore samples which were found in aquatic habitats that are otherwise suitable for toad reintroduction. Samples were collected during the summer 2012 where 9 ponds and 157 salamanders were sampled. Results showed one positive site for chytrid. Analysis was done in collaboration with the Colorado Division of Parks and Wildlife and results contributed to the chytrid distribution data of the region. This research directly aids boreal toad restoration and also served as a contribution to the overall understanding of the range and proliferation of this enigmatic fungus.

93. Temporal and Spatial Variation in Enteric Protozoan Parasites of Singapore's Long-Tailed Macaques (*Macaca fascicularis)*

David Link, Justin J.S. Wilcox, and Hope Hollocher
University of Notre Dame

This high rate of human-macaque interactions in Singapore makes macaques a possible important vector for parasite transmission. By evaluating temporal differences in macaque protozoan composition, we can begin to evaluate how and why these differences are occurring. Macaque fecal samples were collected during the summers of 2011 and 2012, trichrome stained, and examined for gastrointestinal protozoans. Data from these collections were examined using MANOVA calculations in comparison to each collection site within years, and overall parasite variation in common sites between years. In the 2011 data, only the Blastocystis populations in Bukit Timah, and Bukit Batok were found to be statistically different, but temporal data indicated statistical prevalence changes in Iodamoeba, Retortamonas, Balantidium, Isospora, and Coccidians, and abundance changes in Iodamoeba, Retortamonas, Isospora, and Coccidians. Because temporal variation in parasite composition has not been widely studied, especially in primates, further examination of these changes could help us understand not only why parasite composition is changing in macaques, but also the effect it may have on humans.

94. Investigating the relationship between immune defense and secondary sexual characteristics in *Schizocosa ocreata* wolf spiders

Charity Combs, Rachel Gilbert, George W. Uetz
University of Cincinnati

Ground-active wolf spiders must combat constant exposure to soil-dwelling parasites and pathogens, as well as the potential for exposure from food and water sources. As a consequence, these spiders have developed an effective innate immune system, which consists of both a cellular and humoral response. One type of response, encapsulation, is an immediate immune response to a foreign invader. This involves the phagocytosis of the foreign object by hemocytes, resulting in the formation of a melanized capsule which immobilizes the object. The encapsulation response has been shown to be a good measure of immune function in spiders and other invertebrates, since the melanization response can be quantified. While the importance of the immune function is obvious, the energetic cost that this imposes on the spider is also important. The amount of energy required for successful defense against pathogen or parasite could potentially detract from the energy available for costly courtship behaviors, and vice-versa. In this study, we evaluate the viability of this method in examining the impact of bacterial infection on a terrestrial wolf spider species, *Schizocosa ocreata*. This species has energetically-costly multimodal courtship, which has been shown previously to be negatively impacted by bacterial infection as a juvenile. By measuring immune function, we hope to further understand the relationship between immune stress and the condition-dependent sexual signaling characters

Recommended Restaurants on or near the Notre Dame Campus

Don't forget to check your 2013 South Bend / Mishawaka Visitor's Guide for other unique dining opportunities downtown and throughout the metropolitan area!

ON CAMPUS

Au Bon Pain - $
Hesburgh Library Lobby
10 AM – 10 PM Saturday , 10 AM – 1 AM Sunday
Coffee shop with various sandwiches, wraps, paninis, and soups.
Also bakery goods.

Burger King - $
Lafortune Student Center – 1st Floor
11 AM – 10 PM Saturday and Sunday
Burgers, fries, soda, etc.

Huddle Mart - $
Laforune Student Center – 1st Floor
9:30 AM – 4:00 AM Saturday and Sunday
Convenience store. Soups and pre-made sandwiches available.

Legends of Notre Dame - $$
South of Notre Dame Stadium, located in parking lot.
11 AM – 2 AM Saturday, 11 AM – 9 PM Sunday
Full service restaurant and alehouse pub.

Reckers - $
South Dining Hall – South end of building.
Open 24/7.
Wood-fired pizzas, piadina sandwiches, and Freshens smoothies.

Subway - $
Lafortune Student Center – 1st Floor
10 AM – 1 AM Saturday and Sunday
The standard submarine sandwich place.

Starbucks - $
Lafortune Student Center – 1st Floor
9:30 AM – 1:30 AM Saturday and Sunday
Coffee shop with a few sandwiches and baked goods.

Taco Bell / Pizza Hut Express - $
Lafortune Student Center – Basement
11 AM – 4 AM Saturday, 11:00 AM – 1:30 AM Sunday
Standard Taco Bell fare and personal pan pizzas.

EDDY STREET COMMONS

(walking distance from Jordan Hall, just south of campus)

Biggby Coffee - $
1130 East Angela Blvd., Suite 101
6 AM – 9 PM Saturday , 7 AM – 9 PM Sunday
Coffee, coffee, coffee, coffee…

Brothers Bar and Grill $-$$
1234 N. Eddy Street, Suite 125
Burgers, wings, sandwiches, wraps, appetizers, etc.

Chipotle Mexican Grill $-$$
1250 N. Eddy Street, Suite 101
11 AM – 10 PM Saturday and Sunday
Giant burritos, tacos, and other related fare.

Five Guys Burgers and Fries - $-$$
1233 North Eddy Street, Suite 110
11 AM – 4 AM Saturday, 11 AM – 10 PM Sunday
Just like the name implies, burgers and fries.

Hot Box Pizza $-$$
1234 Eddy Street, Suite 109
11 AM – 12 AM Saturday, 11 AM – 10 PM Sunday
Pizza and breadsticks of a different variety. Delivery available.

Jamba Juice - $
1234 N. Eddy Street, Suite 107
Fruit smoothies and frozen yogurt.

Kilwin's Chocolates and Ice Cream - $-$$
1044 E. Angela Blvd. Suite 101
11 AM – 11 PM Saturday, 11 – 10 PM Sunday
Gourmet chocolate/dessert shop.

McAlister's Deli - $
1130 Angela Blvd., Suite 102
Soups, sandwiches, salads, and desserts.

O'Rourke's Public House $ - $$
1044 Angela Blvd., Suite 103
11 AM – 3 AM Saturday, 11 AM – Midnight Sunday
Pub and grill serving burgers, appetizers, and Irish fare.

Romy's Café - $
1234 Eddy St., Suite 101
Coffee shop nestled inside the Hammes bookstore.

The Mark Dine and Tap - $$-$$$
1234 Eddy St., Suite 111
9 AM – 10 PM Saturday, 9 AM – 8 PM Sunday
An urban gastro pub serving various gourmet meals and deserts

Meal Price Guide

$ = <$10 **$$ = $10-$20** **$$$ = >$20**

Notes

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