Kellogg Biological Station Undergraduate Internship and Research Symposium

Wednesday, August 3, 2016

3:30-5:30 p.m.

A special thanks to all of the mentors, host labs, and funding partners that were responsible for making this an extraordinary summer experience for the undergraduates involved in the Summer 2016 Kellogg Biological Station programs:

National Science Foundation (NSF)

MSU College of Natural Science (CNS)

MSU College of Agriculture and Natural Resources (CANR)

KBS NSF Long Term Ecological Research (LTER)

Great Lakes Bioenergy Research Center (GLBRC)

BEACON Center for the Study of Evolution in Action

Michigan Louis Stokes Alliance for Minority Participation (MI-LSAMP)

MSU Extension (MSUE)

CNS Dept. of Integrative Biology

CANR Dept. of Fisheries and Wildlife

CANR Dept. of Forestry

and

Endowed Scholarships and Funds to CANR and KBS

W.K. Kellogg Foundation (WKKF) Manor House Endowment

Gustafson Scholarship (CANR)

Joe Johnson Endowment for Wildlife Conservation (KBS)

George H. Lauff Scholarship (KBS)

Harris Trusts to the Kellogg Farm and Bird Sanctuary

Brunt Family Scholarship (KBS)

*****Student abstracts/summaries are in alphabetical order by last name.**

Science Education Internship
Lindsey Alderink, Michigan State University, Intern – KBS Science Ed & Outreach
Mentor: Kara Haas

This internship was of interest to me because I was able to interact with and build a network of practicing teachers. This internship added nicely to my previous work experience in a zoo setting and expanded my knowledge and ability in developing teacher professional development. As I continue on to my student teaching year with MSU, this internship experience has strengthened my ability to build engaging lesson plans. My favorite week of the summer was being able to implement the elementary professional development program Teaching Science Outdoors.

The effects of altered rainfall patterns on nitrous oxide reductase
Parker Anderson, Michigan State University, URA – Robertson Lab/LTER
Mentors: Kate Glanville and Dr. G. Phillip Robertson

Agriculture is no easy task, and often involves the usage of aids such as fertilizers. Fertilizers often contain a form of the element nitrogen, which provides plants with necessary nutrients in order to grow properly. However, this comes at a price, as nitrogen can be a major source of atmospheric pollution, specifically the gas nitrous oxide (N_2O). Of the all the sources of anthropogenic N_2O emissions, the majority are from agricultural soils. Furthermore, there have been recent changes in the characteristics of rainfall patterns due to global climate change, such as lengthened intervals between rainfall and the intensity of rainfall events. This may cause different patterns of N_2O to be released into the environment.

The purpose of this experiment was to determine the link between altered rainfall patters and the release of N_2O into the environment. We hypothesized that an increase in time between rainfall events / more intense rainfall events will result in an increase in the amount of N_2O released into the environment. To test this, we created soils exposed to different rainfall patterns using rainout shelters in corn fields. We manually sampled gas using the stainless-steel chamber method. Soil was analyzed for nitrous oxide reductase via the Denitrification Enzyme Assay method. Through examination and comparison of the soil and gas samples, the data showed a positive correlation between the amount of time between rainfall events and the amount of N_2O released into the environment from the system.

Effect of phosphate in carbonate soils among different land use types

Julie Adriana Barrios, University of California, San Diego, REU – Hamilton Lab/LTER
Mentors: Bonnie McGill and Dr. Steve Hamilton

Phosphorous is an important nutrient in life, but when there is an excess amount in freshwater there are negative consequences. Large quantities of PO_4^{3-} can lead to eutrophication and massive algae blooms, which can be harmful to humans and ecosystems. Phosphate is known to co-precipitate with calcium carbonate in surface waters (Hamilton 2009). We looked at the surface and carbonate soils in three locations and compared how much PO_4^{3-} solution was absorbed by each soil type and location. The three soil types were the LTER agricultural field, abandon field, and deciduous forest. From this study we learned that the agricultural surface soils lose their capacity to absorb PO_4^{3-}, when compared to soils that have no recent agricultural management like the old field and forest. It is hypothesized that the absorbance decreases due to exposer to P fertilizer on the surface soils.

Comparing calf raising systems for pre-weaned calves

Shelby Berens, Michigan State University, Intern – KBS Pasture Dairy Center
Mentors: Howard Straub and Dr. Brook Wilke

For my poster I chose to talk about the differences in a few of the many ways to raise calves. In my poster I talk about how we raise calves here at KBS and show a few other common ways calves are raised in the US. My poster includes pros and cons for all situations and some of the management techniques that may be used for each system.

Although I did a lot of other things this summer other than just feed calves, one of the biggest reasons I chose to do my poster about calf raising is because almost every group of people that visit us at the dairy want to know about our calves. Since people aren't allowed to go out and see our calves I thought this was the next best thing. I hope when people visit us at the dairy they will see my poster and gain a better understanding of how calves are raised at KBS and other farms across the country.

Biodiversity vs. area and distance from shore of the Brooks Lodge floating peat islands

Alex Blair and Paul Sullivan, Michigan State University, FW419 (GIS)
Mentors: Dr. Alexandra Locher, Josh Green, and Lisa Vormwald

The Sherman Farm Marsh at Brook Lodge is a unique environment for many reasons. The marsh was flooded in the 60's, which left behind isolated floating peat islands scattered throughout the marsh. The impoundment is on the west side of the marsh where it would naturally flow into Douglas Lake. A place like this holds amazing research opportunities. One example being the study of the Theory of Island

Biogeography. Another example is how these islands have changed over time, yet this place is very poorly mapped. We used GPS receivers in order to map and calculate the area of each island. A shapefile for the main land was digitized, so that the distance from the islands to the shore could be determined. Each island was also assessed for biodiversity. In 2010, Tyler Bassett identified 30 plant species on the floating islands. Observing how many of these species grow on each island will provide insight on how biodiversity varies between them. Based on the Theory of Island Biogeography the larger and closer islands should be more biodiverse. Having this map of the islands will have great importance to the future study of the floating fens. This map would set a baseline for study on how the islands will change over time in size and diversity.

The carbon and nitrogen cycle collide in the soil of switchgrass

Kathryn Bloodworth, Eastern University, REU – Evans Lab
Mentors: Dr. William West and Dr. Sarah Evans

Greenhouse gas emissions are one of the main contributors to global climate change. Consequently, biofuels are being assessed as potential alternative energy sources to fossil fuels, which when combusted, release high amounts of greenhouse gasses. Switchgrass is an ideal candidate as a sustainable biofuel because it is a perennial crop, which thrives in marginal land soil and acts as a potential carbon sink. Although much is known about how to maximize switchgrass yields and its viability as a biofuel, little is known about the influence of switchgrass on the soil microbial community. In particular, there is limited evidence linking carbon quantity and quality to denitrification and the ratios of N_2O:N_2 emissions from the microbial community. Nitrous oxide (N_2O), a product of denitrification, has the global warming potential of 310 times that of carbon dioxide (CO_2) over a 100-year period. Therefore, it is crucial to understand more about the influence of switchgrass on microbially mediated denitrification rates to comprehensively understand the potential of switchgrass as a biofuel crop. In this experiment four different carbon molecules found in switchgrass exudates were added to marginal land soil along with a high and low concentration of nitrate (NO_3^-). During the incubations, denitrification rates were measured and the ratio of N_2O:N_2 was estimated. We expect that increasing NO_3^- availability will interact with the bioaccessability of organic C substrates in order to generate non-linear increases in net N_2O production. Additionally, increasing bioavailability and quantity of organic C will likely increase the total N_2O production, but will also increase the proportion of N_2O converted to N_2.

The effects of seed predation on sown prairie restorations
Logan Brissette, Michigan State University, URA – Gross Lab
Mentors: Anna Groves and Dr. Lars Brudvig

Prairie loss threatens many native plant and animal species that depend on and inhabit this ecosystem. Their restoration is therefore important in order to maintain and increase diversity, especially as they are important carbon sinks. In this light, prairies could even help mitigate the impacts of climate change.

Prairie restoration can be achieved through a variety of actions such as prescribed burns and planting native species. However, there is no copy and paste method for restoration due to the motley group of variables that change from year to year that affect these projects. These variables include location, planting time, rain abundance, temperature, aggressiveness of invasives, among many more. This experiment empirically explores the effects of granivores (seed predators). We ask: (1) Does granivory reduce germination by limiting the total number of seeds available for germination and does this change from year to year? (2) Does seed size play a role in selective seed predation?

Granivores are important because they have the ability to change the diversity of the plants as well as their establishment time of newly restored prairies. They are able to attain this impact depending on how much of what species they choose to eat. Our results provide insight for future restoration managers on how they should approach the abundances of seeds for certain species, as granivores do have consistent preferences (size and species), and that predation has little affect on germination in our study.

The science of storytelling
Sabrina Brown, Meredith College, Intern – KBS Marketing and Communications
Mentor: Bethany Bohlen

My name is Sabrina Brown and I am a rising senior at Meredith College majoring in Communication with a concentration in Mass Media while pursuing minors in marketing and psychology. As the Communication and Media intern here at KBS the goal for the summer was to facilitate the growth of my visual and written communication skills in a scientific context. Throughout the summer I have worked and contributed on various projects where I had the opportunity to enhance and strengthen my skills in video, photography, and design. My main 2 projects for the summer were producing and directing the first graduate promotional video and a research abstract video on Jakob Nalley, a PhD researcher here at KBS. These two videos tested me on my abilities to be creative and strategic while keeping in mind the brand of MSU and the target audience of each video. This summer I was able to learn the process it takes to create a good and effective story in both media and written format.

Leaf trait variations between varieties of switchgrass

Peter Drogosh, Michigan State University, URA – Gross Lab/GLBRC
Mentors: Dr. Karen A. Stahlheber & Dr. Katherine L. Gross

Switchgrass is an important crop grown for its ability to produce large quantities of biomass that can be converted into liquid biofuel. With increasing carbon emissions around the world contributing to climate change, it is important to consider the use of more alternative and cleaner energies. Switchgrass has the potential play a significant role in the future of biofuel production, but more research must be conducted to improve its yields. A major indicator of biomass yield between varieties of switchgrass is specific leaf area (SLA). This ratio of leaf area to dry mass has been compared between 12 varieties of switchgrass grown in GLBRC fields at Kellogg Biological Station. Previous studies have found consistent differences between varieties, so we expect to see a range of SLA values among the samples being tested, especially between upland and lowland varieties. Upland varieties are better adapted to northern regions like Michigan, which may be associated with a larger SLA compared to the lowland varieties, indicating faster growth. With this information, scientists may gain a better understanding of the leaf traits of switchgrass, so that future endeavors to use switchgrass biomass for conversion to biofuel will be more economically feasible.

A study of relative contribution of ammonia oxidizing archaea (AOA) and ammonia oxidizing bacteria (AOB) to nitrification under different land use types

Aleah Dungee, Norfolk State University, REU – Robertson Lab/LTER
Mentors: Di Lang, Dr. G. Philip Robertson

Soil nitrification is a biological process that converts ammonia to nitrate. Excess nitrate is prone to leaching, which results in financial loss for farmers and water pollution. It is known that ammonia oxidizing archaea (AOA) and ammonia oxidizing bacteria (AOB) are able to nitrify, but it is unclear how much they contribute to this process individually. To answer this question, we conducted an experiment at the Kellogg Biological Station Long Term Ecological Research (LTER) to determine how AOA and AOB contribute to soil nitrification. Soil samples were taken from seven different land treatments including T1 (conventional wheat), T4 (biologically based wheat with cover crop), T5 (poplar), T7 (early successional community), T7 Fertilized subplots, DF (Deciduous Forest), and DF Fertilized subplots.

Trail mapping of Lux Arbor Reserve & trail safety system
Louren Rose Escamilla, Michigan State University, FW 419 (GIS)
Mentors: Josh Green, Lisa Vormwald, Dr. Alexandra Locher

Trails are one of the common ways that people across the world use for recreational entertainment. The views of these are stunning, the air fresh, and the opportunities on them plentiful. One important thing to always keep in mind when on the trails is safety. Trail managers need to keep in mind the safety of the patrons using their trails. Manager of the Lux Arbor Reserve, Mark Manuszak, was interested in the safety of occupants utilizing Lux Arbor. My spatial objectives are to map the roads and trails of Lux Arbor and overlay a grid system in order to efficiently communicate location within the reserve. These objectives are important to address because this property has been a part of MSU for nearly three decades and has not been thoroughly mapped out. I mapped the area using a GPS receiver to identify all the trails as well as trail conditions (two track, improved, & maintained) and lengths. Signs of the overlaid grid system could be placed strategically around the reserve itself to help people navigate the property.

Environmental Education Internship
Tim Faass, Michigan State University, Intern – Kellogg Bird Sanctuary
Mentors: Misty Klotz and Sarah Reimer

This summer I acted as the Environmental Education Intern at the Kellogg Bird Sanctuary through the Kellogg Biological Station. My job consisted of creating and presenting science education programming for youth of all ages. I played a major role in setting up the programming and scheduling for the summer camp as well as our biweekly program “Wild Wednesdays.” Science education is an integral part to any education curriculum. By offering these programs in the summer when children are void of schooling, the kids attending these programs are learning new scientific concepts and skills ahead of their peers. The preparation of the biweekly younger kids program and the summer camp took weeks of lesson planning, schedule creating, and general set up. I was responsible with creating and choosing lesson plans and activities for both camp and Wild Wednesdays. Creating the lesson plans/activities and scheduling them were completed as a long term project to get everything ready for camp and programs. The result of weeks of planning and set up exceeded my expectations. Camp went off without a hitch and my lesson plans/activities were effective in teaching kids new scientific concepts and having fun while doing so. All of the Wild Wednesday programs were also very successful. Kids were engaged and getting excited for science before ever learning any science in school. Science education is a key to an informed population and our programs were able to fill the educational void of summer with new and quality science learning opportunities.

Quantifying changes in land cover of Lux Arbor Reserve over 55 years
Alex Fischer and Matt Galovan, Michigan State University, FW419 (GIS)
Mentors: Dr. Alexandra Locher, Josh Green, Lisa Vormwald

Land cover history of Lux Arbor Reserve, property of the Kellogg Biological Station, is not well documented. Quantifying previous and current land cover could provide insight into how Lux Arbor has changed over time0.., and how it may change in the future. Our objectives for this project were to not only classify the past and current land cover, but to quantify how that land cover has changed from 1961 to 2014. To accomplish this, we obtained aerial photographs of Lux Arbor Reserve from 1961, which was not georeferenced, as well as imagery from 2005. We also obtained a more current aerial photograph of Lux Arbor from 2014. Next, we georeferenced the images and classified the land cover through digitizing and supervised land cover classification techniques in ArcMap. Finally, we used the Calculate Geometry and Statistics tools to quantify the various land cover types, and compared them to the previous land cover quantities. We found that crop land and prairie areas increased in acreage, while forested areas showed a decrease. This data could be beneficial to natural resource professionals, specifically those managing Lux Arbor, by providing useful data on how the land cover has changed, and how it is likely to change in the future. Depending on how the land cover is predicted to change, strategic management plans can be put in place to obtain desired results.

Compared behavior of unfamiliar kin and familiar kin in the American toad
Olivia Guswiler, Michigan State University, URA – Getty Lab
Mentors: Sara Garnett and Dr. Tom Getty

American toads are one of many taxa that exhibit kin-biased behavior (where individuals behave differently around kin compared to non-kin). Lab experiments have shown that tadpoles of this species exhibit a preference for associating with kin over non-kin, but can no longer distinguish between them when their nostrils are blocked. This suggests that they recognize each other using olfactory or chemical cues. We wanted to know if these cues are recognized inherently, or if they are learned through association with their kin. To find an answer we looked at clutches of tadpoles that had been separated into two groups early on in development. We then reintroduced the families in tanks with low density and high density groups, keeping some separated in low densities to remain as controls. Low density tanks consisted of 30 tadpoles (15 from each group of the same family), while high density tanks consisted of 50 tadpoles (25 from each group of the same family). Before being placed in the tanks we measured the mass, developmental stage, and snout to vent length of each tadpole. Once set up, we monitored the tanks, removing and measuring tadpoles when they reached metamorphosis (at least one front leg visible). By comparing the differences in size and developmental rate between unfamiliar kin and familiar kin we were able to determine whether the recognition of kin is innate or learned.

Comparing short-term physiological acclimation to different temperatures in phytoplankton populations experimentally adapted to two different temperatures

Clare S. Harper, Beloit College, REU – Litchman Lab
Mentors: Danny O'Donnell and Dr. Elena Litchman

The Litchman lab has maintained replicate populations of the marine diatom *Thalassiosira pseudonana* at low (16°C) and high (31°C) temperatures for ~450 generations. These experimental conditions have resulted in evolutionary divergence between treatment groups in their thermal optimum (T_{opt}) and in nutrient-dependent growth kinetics. However, divergence between treatment groups in many other temperature-dependent traits remains unexplored, as does potential evolutionary change in their short-term plasticity (non-genetic change) in response to a novel environment (acclimation). We measured changes in per-capita population growth rate, cell size, chlorophyll yield, and the cellular elemental stoichiometry (carbon, nitrogen, phosphate, silicate) in *T. pseudonana* during acclimation to novel temperature environments. The assay was prefaced with an initial "common garden" phase, in which two populations from each selection environment (16°C and 31°C) were acclimated to a common, intermediate temperature (26°C). We then conducted a reciprocal transplant (at 16°C and 31°C) as well as an acclimation assay at more extreme high and low temperatures (10°C and 33°C). We predicted that phytoplankton evolved to 31°C will acclimate more rapidly to environments of higher temperatures (31°C and 33°C) and populations evolved to 16°C will acclimate more rapidly to environments of lower temperatures (10°C and 16°C). While changes in growth rate, cell size, and chlorophyll yield indicated no directional trends during the common garden phase, we see the emergence of trends during the assay phase. Data on cellular stoichiometry are pending, and may shed additional insight into the physiological underpinnings of temperature acclimation in *T. pseudonana*.

Effect of long term nitrogen fertilization on the ecology of plant communities

Carly Hendershot, Michigan State University, Independent Study – Lau Lab
Mentor – Dr. Jen Lau

Agricultural ecosystems, in particular row cropping (corn and soy) are managed intensively with tillage, chemical fertilizers, herbicides and pesticides. The evolutionary consequences of these agronomic practices have only recently begun to be studied. Of particular importance, the mutualistic relationship between soil rhizobia and legumes when exposed to extended periods of nitrogen fertilization. Traditionally the products of legume photosynthesis are exchanged for fixed nitrogen from rhizobia bacteria. Legumes are unable to fix nitrogen and must rely on this relationship to survive. Legumes such as clover and soy, are planted in rotation with other crops to maintain soil nitrogen levels. However, added nitrogen inputs has been found to alter the legume-rhizobium relationship, due to the evolution of less-productive bacterium (Lau et all. 2014). Using bacteria isolated from a long-term nitrogen addition experiment the

ecological effects of these less-mutualistic rhizobia is examined, including legume growth characteristics, herbivory preference and decomposition rate. It is hypothesized that the less-productive bacteria will produce smaller plants, increase herbivory and decrease decomposition rate in *Trifolium repens,* White Clover. The results of this study could affect row cropping management and restoration techniques of native ecosystems.

Exploring land management at Lux Arbor Reserve

Taylor Hess and Eleanor Domer, Michigan State University, FW419 (GIS) and Kellogg Forest Interns
Mentors: Patrick Duffy, Josh Green, Lisa Vormwald, Dr. Alexandra Locher

Lux Arbor Reserve (LAR) is one of the largest of 30 outlying properties owned by Michigan State University (MSU). The maps and management information for LAR are outdated, and in some cases, inaccurate. Specifically, management plans often are not spatially explicit. To that end, we wrote an updated management plan for the LAR conifer stands, totaling 393 of 1,557 total acres on the property. To do this, we ground-truthed existing stands and re-digitized and classified them using ArcMAP. Our project included taking forest inventory plots, stand ages, and growth indices. We then added species, acreages, age, growth information, and management descriptions for each stand. Then, information was summarized via a detailed management plan document. These improved tools are the first step in facilitating responsible management of this valuable resource.

Effect of N-fertilization and candycane morph on galls in *Solidago Canadensis*

Samantha Honroth, Denison University, Independent Study – Lau Lab/LTER
Mentors: Dr. Jen Lau and Dr. Andy McCall (Denison University)

Solidago canadensis, more commonly known as Canada goldenrod, is frequently parasitized by a variety of insects that induce gall formation. This interaction has been studied by numerous researchers in an attempt to understand how it is affected by both biotic and abiotic factors in local environments. For instance, fertilization with nitrogen (N) may increase host quality, altering parasitoid-plant interactions. In addition, candy-cane morph, a unique mutation in which the apex tip of the goldenrod stem points downward, has been found by previous studies to confer immunity against gall-forming insects. In this short experiment, I analyzed the effect that N-fertilization and candy-cane morph have on gall presence and size in succession plots at the Long-term Ecological Research (LTER) Site. A variety of variables were measured on goldenrod plants in a $1m^2$ quadrat in N-fertilized and control succession plot replicates (1-6). My results are consistent with previous research indicating that galls are less common in goldenrod exhibiting candy-cane morph and that there is no significant difference in gall presence between control and N-fertilization treatments. Succession plot replicates had significant variation in gall presence, suggesting that gall formation is affected and controlled by a complex suite of environmental interactions.

The effect of nitrogen fertilizer and irrigation on lime carbon sequestration
Carlneshia Johnson, Alcorn State University, REU – Hamilton Lab/LTER
Mentors: Bonnie McGill and Dr. Steve Hamilton

Agriculture is necessary for food security, but it can also be potentially harmful to our planet by contributing greenhouse gases that cause climate change. Nitrogen fertilizer is essential for crop productivity, but it also acidifies the soil through nitrification, a microbial process. Because the soil becomes acidic, farmers apply lime (calcite, $CaCO_3$, or dolomite, $CaMg(CO_3)_2$. The carbon in the lime can potentially convert to carbon dioxide, CO_2, an important greenhouse gas. We studied how farm management affects how much of the lime ends up as CO_2.

To an agricultural surface soil, we added nitric acid (HNO_3) to represent the nitrified fertilizer, lime, deionized water to represent rain, and alkaline irrigation water from a groundwater well. We hypothesize that the irrigated soils with nitric acid and lime will be a stronger source of CO_2 than their rainfed counterparts, because groundwater has a high amount of bicarbonate that can also react. Preliminary results suggest that the *rainfed* soils may actually be a stronger source of CO_2 than the irrigated.

Family or foe? Interspecific predation of adult notonectids on juveniles
Bana Kablan, Wayne State University, REU – Steiner Lab
Mentors: Mitra Asgari and Dr. Chris Steiner (Wayne State University)

Notonectidae are one of the most common aquatic insects in ponds of North America. Prior pond surveys have revealed that the two most abundant species in southwest Michigan, *Notonecta irrorata* and *Notonecta undulata*, have uneven spatial distributions, with some ponds containing only one of the two species, and others having both. Previous studies showed that adults of these organisms can be cannibalistic towards their own juveniles and change juvenile behavior. How *N. irrorata* and *N. undulata* adults impact congeneric juveniles and whether such interactions are mediated by habitat complexity are unknown. To address this, we performed a field mesocosm experiment in which we examined the effects of complexity (vegetation) and adults of one species on the survival and behavior of juveniles of the other species. The presence/absence of vegetation and adults of the opposite species were manipulated to test their effects on juvenile survival and habitat positioning over 48 hours. *N. irrorata* juveniles survived less, regardless of adult presence/absence and vegetation presence/absence. Overall, behavior of *N. irrorata* juveniles was more strongly affected due to the presence of *N. undulata* adults compared to *N. undulata* juveniles with *N. irrorata* adults. *N. irrorata* juveniles positioned themselves in the water column more than at the surface, and utilized the edges of the mesocosms more than their center. Vegetation had no effect on juvenile survival. Our findings suggest that stage-structured predator-prey interactions between these species might be a possible driver of their heterogeneous spatial distributions among ponds in the region.

Kellogg Biological Station historical interpretive signage
Jackson C. Kennedy, Michigan State University, Intern – W.K. Kellogg Manor House
Mentors: Jim Allen & Nicole Kokx

The W.K. Kellogg Biological Station and Conference Center (KBS) is seeking to install historical signs for 3 buildings/areas on the W.K. Kellogg Estate grounds. The Caretaker's Cottage, the Carriage House/Lakeside Cottage, and Windmill Island will be receiving new historical signs. The intent of these signs is to increase the historical value of these structures and to contribute to the historical narrative of the Gull Lake estate. The cost of each sign will average around $4,000 and a possible source of revenues to pay for the signs is the W.K. Kellogg Foundation Endowment to the Kellogg Biological Station. The story told by each sign will contribute to a greater understanding of the estate and its transformation over the years. Mock-ups of the signage and details on the design and production process will be presented.

Who are agricultural consultants? Interviews with agricultural retailers and crop consultants
Andrew Konieczny, Augsburg College, REU – Robertson Lab/LTER
Mentor: Dr. Adam Reimer and Dr. G. Philip Robertson

Row crops such as corn require large amounts of nitrogen fertilizer to fuel growth and production. Increased use of nitrogen fertilizers nationally has contributed to a number of environmental problems, including coastal hypoxia zones and ground water contamination due to nitrate leaching, as well as contributing to climate change through production of N_2O gas. Farmers are faced with many logistic factors when making decisions on nitrogen management, including fertilizer formulation, timing, and placement. Previous research on farmer nutrient decision making has documented the importance of recommendations from advisors, including private sector consultants (Osmond et al. 2015; Stuart et al. 2014). However, we do not know much about the recommendations given or who the consultants are that make these recommendations. I performed key informant interviews with six consultants of different backgrounds over the span of two months, and generated 67 pages of verbatim transcriptions. Thematic analysis was then used to code out central themes from the key informant interviews. Central themes seen in all of the interviews were: trust is a key factor for farmers; there is a constant balancing act between economical, logistical, agronomical, and environmental factors; and farmers consult multiple recommendations, and ultimately do what they think is best or the best they can do. This research is a first step in understanding the knowledge, motivations, and professional networks of private sector advisors. Further research in this area is necessary to increase communication between research/extension and private sector consultants.

Techniques to improve pasture management
Chelsea Kronemeyer, Michigan State University, Intern - MSU Extension
Mentors: Dr. Brook Wilke & Dr. Dean Baas

During the summer at KBS I got the opportunity to learn how to manage an intensive rotational grazing system. Tools available for pasture measurement include a grazing stick, rising plate meter, and a C-Dax pasture meter. Over the summer I familiarized myself with each tool to find out their respected pros and cons. I looked at how easy the tool was to use and how much labor it requires. I also considered who can use that tool without affecting the outcome of data you collect. The grazing stick and rising plate meter are both time consuming and the data is dependent on the user. Additionally, accuracy of the data from that tool was considered. The size of sample you receive from the C-Dax can equal hundreds of samples per pasture, whereas the grazing stick and rising plate meter could only take a small sample size. All three of these tools can improve farmer's decision making in their grazing operation, including when to start and stop grazing, how much feed is in the pasture, and how many animals can be grazed given the cover of the pasture. These tools differ in many ways, and each farmer's situation is unique. My goal with this data is to help farmers pick the best tool for their operation's needs.

Patterns and controls on cellulose decomposition rates within thick accumulations of flocculent sediment in diverse shallow freshwaters
Nicolas A.H. Lara, Oberlin College, REU – Hamilton Lab
Mentors: Dustin Kincaid and Dr. Steve Hamilton

Thick accumulations of flocculent organic sediments are common in shallow, freshwater ecosystems, but their biogeochemical and ecological importance are understudied. Investigating decomposition processes in organic-rich floc layers is necessary to understand how these thick accumulations are maintained over time and how they contribute to organic carbon storage in freshwaters. We hypothesized that temperature and depth in the floc layer are primary controls on the rate of decomposition rates. To test these hypotheses, we deployed vertical arrays of cotton canvas strips in floc layers at 15 shallow freshwater sites with diverse physicochemical conditions. After 21 days we retrieved the cotton strips and measured tensile strength loss as a proxy for decomposition. We also measured surface water and porewater chemistry, temperature, and dissolved oxygen to determine which factors influenced the decomposition rates. Our results showed that site characteristics play a role in how quickly carbon decomposes. For instance, there seems to be an optimum temperature around 19 °C at which decomposition occurs, and lower depths tend to decompose a little more slowly. Surprisingly, in water just above the floc layer the cellulose decomposed much more slowly.

My avian care experience

Olivia Lefere, Michigan State University, Intern- Kellogg Bird Sanctuary Avian Care
Mentors: Sara Bäby and Lisa Duke

I am Olivia Lefere and I will be starting my junior year at Michigan State University this upcoming fall. I am getting my degree in Zoology in hopes to one day become a Veterinarian. I have had the unique opportunity to be the avian care intern at the Bird Sanctuary this summer. This internship allowed me to obtain a deep understanding and knowledge of birds that I have never had been able to before. Overall at the sanctuary, I was able to get great hands-on skills with the raptors, gamebirds, and waterfowl. Some of the skills I was able to gain experience in included glove training a red-tailed hawk, giving physical exams, and learning husbandry skills. The main project I was responsible for was creating and designing 3 new raptors houses. The houses I designed will help the raptors have better protection in Michigan's unpredictable weather conditions. I also was responsible for making a sign about Purple Martins, so the public could be educated about these wild birds.

Bad bugs: Seed predation in first-year prairie restorations

Mary Linabury, Michigan State University, REU – Brudvig Lab
Mentors: Nash Turley & Dr. Lars Brudvig

Across the United States, prairie range has been reduced to a fraction of historic values. To restore these ecosystems, seeds are first sown, but seed predators, or granivores, can impede these efforts. These predators influence biodiversity and community structure through differential predatory behavior towards habitat type and seed species; however, the exact nature of these preferences is not well understood. In this experiment, we investigated how distance from habitat boundaries, granivore type (arthropods and mammals), and seed preference affects seed predation in prairie restorations. To study these influences, we deployed trays containing seeds from ten focal prairie plant species into twelve first-year prairie restoration sites. Trays also assessed the specific impact of granivore type; one tray type allowed access to only arthropods, while the other allowed in all granivores. Trays were placed in pairs at three distances from habitat boundaries, allowing us to study whether these boundaries created a gradient of granivore activity. After 26 days, seeds were recounted to determine granivory. First, no difference was observed in seed removal across trays at different distances from habitat boundaries. Second, arthropods accounted for the majority of seed removal, consuming an average of 22.24 seeds per tray, compared to mammals, which removed 12.40 seeds. There were also obvious seed preferences among granivore types. Small mammals consumed the seeds *Echinacea purpurea* and *Elymus canadensis* at a faster rate than arthropods, while arthropods were responsible for removing nearly all *Rudbeckia hirta* seeds.

A Quantitative Genetic Analysis on the Divergence of *Panicum Virgatum* ecotypes
Joshua McCauley, University of Texas, REU – Lowry Lab
Mentors: Dr. David Lowry and Marisa VanDamme

Panicum virgatum (switchgrass), a C_4 perennial grass native to North America, is the leading cellulosic biofuel crop in the US. Within the wide range of latitudes on which switchgrass grows, there are two distinct ecotypes noted that vary vastly in their morphology: northern uplands and the southern lowlands. In this study, we investigated the genetic basis of the evolutionary divergence between these ecotypes, specifically the traits that diverged, their genomic locations, and the allelic effects at each QTL. By mapping these traits, we can genotype seeds and predict their values before planting. We measured a number of fluorescence parameters, the growth rate, and the Specific Leaf Area (SLA) of ~750 individuals from a four way cross between two upland and two lowland Switchgrass varieties. There was a significant difference between the upland and lowland parent varieties' SLA ($P<2e-16$), and a negative correlation with the vertical growth rate in the parents (-0.06917 cm/day per increase of $10cm^2/g$ SLA). Six significant Quantitative Trait Loci (QTL) were mapped for SLA using known genetic marker data, and the allelic effects at each QTL were calculated. Of the fluorescence parameters measured, two significant QTL for a chlorophyll measurement (SPAD) were mapped on chromosome 2. In further study, we plan to compare the results herein to those of nine other plots with clones of the site observed in this study. These nine sites were planted at varying latitudes in the United States, and should give insight into the variance of QTL expression as a function of the varying latitudinal environments.

Brewery wastewater bioremediation with algae and cyanobacteria
Katie McCullen – Michigan State University, Independent Study – Litchman Lab
Mentors: Jakob Nalley and Dr. Elena Litchman

The process of brewing beer generates approximately 10 gallons of wastewater for every gallon of beer. Wastewater treatment can be a long process and extremely costly, both energetically and monetarily. Microalgae present an elegant solution to this issue. Microalgae are photosynthetic single-celled organisms that thrive in almost all aquatic environments, including various wastewater sources. Algae populations rapidly increase in this nutrient rich environment, taking up these excess nutrients, ultimately "cleaning" the wastewater. The microalgae in these environments generate large quantities of biomass that can be harvested for animal feed, fertilizer or biofuel production. Brewery wastewater is ideal for algae cultivation due to its limited pathogens and toxic materials, while containing high levels of essential nutrients. We have tested a two-stage process for water treatment, using green algae and cyanobacteria in succession to clean wastewater from Bell's Brewery in Comstock, Michigan. Green algae and cyanobacteria have different nutrient requirements, making them an ideal pair for our two-step approach. Tapping into the differing nutrient requirements between these two algae groups, the overall nutrient removal will be higher than what could be achieved with a single species. After growing for 10 days, our initial green algal communities were removed and replaced by a polyculture of cyanobacteria. We sampled our treatments

every 3 days for biovolume, lipid content, fatty acid composition, total nitrogen, and phosphorus content. Our two-stage approach successfully removed high levels of both nitrogen and phosphorus. Lipid production was extremely high during the green algae stage of remediation, while the cyanobacteria did not produce high levels of the biodiesel precursor. Rapid growth was also observed throughout both stages of the experiment.

Promoting KBS: Where women, science, and fundraising meet
Lindsay Mensch, Michigan State University, Intern – KBS Communications and Development
Mentor: Sarah Carroll

The female experience, cutting-edge research, and grantseeking might not seem like the most likely combination, but those three themes encompass the work I've completed as the Development and Communications Intern at KBS. With my main goal of promoting KBS through MSU Brand standards in mind, these three ideas were central to each of the major projects I worked on. I was able to apply the analytical, technical, and rhetorical skills I learned in the English and Professional Writing Programs at Michigan State University, as well as improve them over the course of my internship. One of my main projects was to draft a grant proposal to fund a volunteer training program for the Kellogg Bird Sanctuary in Fall 2016. I also created a table tent card for display in McCrary Dining Hall to promote KBS research and outreach programs. Lastly, I spent time researching and writing about two female scientists at KBS for the monthly e-Station to Station newsletter. These Science Spotlight articles highlighted not only the empirical aspects of their work, but also the unique perspectives that they bring to their fields as women. My projects, although vastly different, challenged me as a storyteller and changed how I thought about communicating science to a public audience.

The effect of plant density, community composition and pollinator identity on pollination success of *Chamaecrista fasciculata* (Partridge pea)
Balindile Motsa, Michigan State University, URA - Lau Lab
Mentors: Susan Magnoli and Dr. Jen Lau

Plants and pollinators form important mutualistic interactions that are beneficial to the survival of both species. Many factors including plant density, plant community composition and the identity of pollinators can influence the success of these interactions. *Chamaecrista fasciculata* is a native annual legume that is commonly used in prairie restorations. It has mutualistic interactions with bumble bees and sweat bees which act as pollinators for the plants and they get pollen in return. I explored how density, competition for pollinators and identity of pollinators affects pollination success. A pollination observation was conducted at the Kellogg Biological Station Great Lakes Bioenergy Research Center site (KBS GLBRC) using two restored populations that vary greatly in plant density and flowering plants. The experiment looked at the success of

pollination in naturally occurring plants on the two different sites and looked at the diversity of pollen deposited by bees on *Chamaecrista*. Additionally, in a separate experiment I examined the effect of different pollinators on seed set. The success of plant-pollinator interactions can have important effects on plant population establishment and persistence. The findings of this research can be used to inform efforts to establish populations in ecological restorations.

Effects of Warming and Herbivory on Flower Abundance

Tori Niewohner, Western Washington University, REU – Zarnetske Lab/LTER
Mentors: Kileigh Welshofer and Dr. Phoebe Zarnetske

There is a lack of scientific consensus on how warming and herbivory impacts the reproductive effort of plants because both factors can lead to increased or decreased reproductive effort. We investigated whether or not the individual and/or combined effects of climate warming and herbivory impact the maximum relative flower abundance (MRFA; flower abundance standardized by percent cover) of plants in an old agricultural warming experiment at the Kellogg Biological Station Long Term Ecological Research site. We manipulated temperature with open top chambers, small mammal herbivory with exclosures, and insects with insecticide treatments. To determine MRFA, we visually assessed the number of viable flowers and percent cover of several species every three days from mid-June to late July, 2016. We then performed a total flower count at the end of the sampling time to capture maximum flower production throughout the season. We found that *Trifolium pratense* had a significantly higher MRFA in warmed plots. It is possible that warming increased the growth rate of *Trifolium pratense*, causing a higher maximum relative flower abundance. *Centaurea stoebe* had a significantly higher MRFA in plots with small mammals compared to plots with reduced small mammals. Potential explanations are that either the small mammals preferentially ate other species and allowed it to outcompete the other species or it was eaten by small mammals which caused it to overcompensate. Clarifying how the reproductive effort of plants varies with warming and species interactions will allow us to most accurately predict changes in a warmer climate.

Effects of temperature on growth and nitrate uptake and affinity in *Chlamydomonas reinhardtii* (Chlorophyceae)

Olivia Porth, Michigan State University, URA – Litchman Lab
Mentors: Danny O'Donnell and Dr. Elena Litchman

The objective of this laboratory experiment is to more accurately explore the ways in which the population growth rate, uptake rate of Nitrogen and affinity for nutrients are affected by temperature change in diatom *Chlamydomonas reinhardtii*. Mentor Danny O'Donnell hypothesized that all three of these variables would exemplify similar trends as a function of temperature. To test this, six batches of WC Media were made, each

with a different Nitrogen concentration. Post Nitrogen starvation period, flasks containing *Chlamydomonas reinhardtii* and WC Media with a controlled Nitrogen concentration were placed into five different temperature chambers. Each day proceeding this, a destructive sampling method was used to decrease the initial volume by 1.5 mL, cell counts and wavelength corresponding to the amount of remaining Nitrogen in the system were also measured. These assessments revealed that these variables are a left skewed unimodal distribution as a function of temperature; meaning that as temperature increases to a certain point, population growth, Nitrogen uptake rate and affinity for nutrients also increase. This information can lead us toward several conclusions geared toward enzyme functionality in the membrane of these organisms.

White-tailed deer habitat suitability at Lux Arbor Reserve

Holly Reed, Michigan State University, FW419 (GIS)
Mentors: Dr. Alexandra Locher, Josh Green and Lisa Vormwald

A white-tailed deer habitat suitability assessment has never been completed for Lux Arbor Reserve of southwestern Michigan. This assessment is important because deer affect vegetation composition and structure through browsing. The property is over 1,500 acres and is comprised of open grassland, agricultural plots, oak, hickory, maple, blue spruce, and black cherry stands. The first step to understanding how to manage the deer population at Lux Arbor is to apply a habitat suitability model. I modeled habitat suitability using satellite imagery, remote sensing, and geographic information systems (GIS). The habitat suitability index (HSI) model used known habitat requirements of white-tails, such as: deciduous stands, conifer stands, forest edges, and wetlands. Using the HSI, I generated a habitat model indicating the most and least suitable areas of Lux Arbor. As a result of a diverse amount of cover and stand types on the property especially that of hardwoods, conifers, and fields, much of Lux Arbor Reserve is highly suitable for white-tailed deer. Though this be the case, a management plan would be best to ensure a suitable habitat for the species in the future. In a reserve such as Lux Arbor, habitat models are important for creating the most suitable, sustainable, and efficient management plans for the land and wildlife living within it.

Maintaining the outdoors

Julia Reigler, Michigan State University, Intern – Kellogg Manor House Landscaping
Mentor: Stu Bassett

Working outdoors this summer has made my job so fun! I have enjoyed watering, planting, mulching, weeding, and pruning for weeks this summer. All of these activities have brought me closer to my passion of plants. The trees here on campus are my favorite part of KBS because of their age and glorious beauty. Many of them are state champions which means they are the biggest trees of their species in the state. I designed a few beds by the manor house and it was really exciting to pick out native

species for that area. I hope you enjoy the ground here at KBS because a lot of hard work has been put into making this place beautiful.

Complementarity and competition among switchgrass varieties in different soil conditions

Bibiana Rodriguez, California State University, Sacramento, REU – Gross Lab
Mentors: Dr. Karen A. Stahlheber & Dr. Katherine L. Gross

Switchgrass (*Panicum virgatum* L.) is a perennial, warm-season grass native to North America typically planted for hay and grazing purposes. There is growing interest in using switchgrass for liquid biofuel production instead of corn, due to its resilient nature that allows it to grow well in marginal lands. Given its wide range across the continent, switchgrass also has extensive trait variation allowing it to adapt to many environments. This experiment looked at whether planting multiple switchgrass varieties together (increasing genetic diversity) affects total productivity. Our goal was to discover how mixtures and monocultures of different varieties respond to changes in soil texture, specifically whether or not the effects of genetic diversity are stronger or weaker in marginal soils. We planted switchgrass of four varieties (Alamo, Cave-in-Rock, Dakota and Trailblazer) in pots with two different types of soils: standard potting soil and potting soil mixed with 50% sand by volume. Preliminary analysis show that Alamo plants were tallest in all soil types, but produced the fewest number of tillers. Neighboring diversity had an effect on height for some varieties, but no impact on tiller count. For example, Alamo and Cave-in-Rock individuals in polycultures grew taller than those in monocultures when planted in potting soil, but not in the marginal sandy soils. These results suggest that growing switchgrass in mixtures could offer yield benefits, particularly in fertile, well-drained soils. Further analyses of total biomass production above and belowground will clarify these patterns.

Effect of altered rainfall patterns at different topographical positions on N_2O fluxes

Rebekah Sánchez, University of Puerto Rico, Mayagüez, REU – Robertson Lab/LTER
Mentors: Kate Glanville and Dr. G. Philip Robertson

Soil management in agriculture is the highest anthropogenic source of nitrous oxide (N_2O), a greenhouse gas that is almost 300 times stronger than carbon dioxide. Nitrogen is an essential element for crop growth and the most commonly applied nutrient. However, it becomes the atmospheric pollutant N_2O mainly through the incompletion of denitrification. Denitrification is affected by conditions often correlated with topographical positions: moisture, nitrogen, carbon, and oxygen. Research from last summer showed N_2O fluxes increased with longer dry periods and more intense rainfall events since these climate patterns have been predicted. This summer we conducted an experiment to see how changing rainfall patterns at different landscape positions affect N_2O production. To test our hypothesis, rainout shelters were placed at summits and depressions in corn plots. These were wetted at different intervals, considering the thirty year precipitation

average, to simulate the altered rainfall patterns at 2 day, 14 day and 28 day intervals. Gas fluxes were measured using stainless steel chambers with a Quantum Cascade Laser. Moisture was measured with sensors and soil samples were collected to see resource availability. As expected, results indicated that there were cumulatively higher fluxes in depression than summits. We also found moisture was consistently higher in those lower positions. Additionally, soil samples are yet to be analyzed regarding texture, carbon, and nitrogen. For a more comprehensive study, pH and temperature variation effects may also be considered. This will be useful to design accurate predictions of greenhouse gas emissions in agriculture and develop mitigation practices.

Preferred ecotype for biofuel?

Ivori Schley, North Carolina A&T, REU – Robertson Lab/GLBRC
Mentors: Dr. Sarah Roley and Dr. G. Philip Robertson

Switchgrass is a great potential biofuel crop because it is found across North America, is capable of fixing nitrogen (N), and can be used as a transportation fuel without emitting extra harmful gasses in the environment. While studying switchgrass's potential, scientists are yet to analyze the N status of various switchgrass varieties. I have attempted to answer the question: How does switchgrass variety influence plant and soil N?

I have addressed this question by utilizing twelve fertilized switchgrass varieties at the W.K. Kellogg Biological Station. I have measured N concentration in roots and leaves, calculated N translocation among leaves, and measured soil N mineralization using a seven day incubation.

Data has shown that Dakota and Trailblazer varieties resorbed the least amount of Nitrogen. In regards to efficiently translocating N, they performed significantly lower than the other varieties, which suggests that they are the least sustainable in terms of N use. Besides the Trailblazer and Dakota varieties, the N resorption efficiency of the switchgrass varieties are quite similar. Ecotype has not proven to be a determining factor of N efficiency. Thus, research suggests that there may be no need to cross-breed upland and lowland varieties to get the ideal switchgrass biofuel; the original varieties happen to retain nitrogen adequately.

Lignin's impact on greenhouse gas emission by switchgrass microbes

Kelechukwu Ukachukwu, Michigan State University, URA – Evans Lab/GLBRC
Mentors: Dr. William West and Dr. Sarah Evans

Switchgrass is one of the most promising bioenergy sources to potentially replace corn. It is more resilient, requires little fertilizer and has a higher potential bioenergy output than corn. This experiment was conducted as an edition to a larger experiment that tested the impacts of the quantity and quality of carbon on denitrification by switchgrass

microbes. The carbon compound I tested was lignin. Lignin is important because it is a highly complex carbon structure that composes 40% of plants. Microbes often find it in the leaf litter and it is an essential carbon compound that plants interact with.

The experiment was ran by collecting soil from the Lux Arbor reserve's switchgrass plots. The soil was measured out into vials along with adding or not adding acetylene. Acetylene was added to inhibit N2 production. High and low concentrations of NO3 were also added, as nitrate is essential for amino acid production. Finally, the carbon compound, lignin was added. The vials were left and timed and the soil microbes were activated. Then gas samples were taken at various 2 hour intervals to measure the N2 and N2O levels.

Predator-prey population dynamics in a warming world
Jessie Ventzke, Michigan State University, URA – Mittelbach Lab
Mentors: Laura Twardochleb and Dr. Phoebe Zarnetske

Every organism will be affected by climate change but not all will be affected in the same way. To explore predator-prey dynamics under warming temperatures, we collected baseline data about the inhabitants of freshwater ponds. Our focus was on predatory *Notonecta* backswimmers and *Enallagma* damselflies and their prey, the planktonic crustacean *Daphnia*. We sampled each of four Lux Arbor ponds every other week for nutrients, chlorophyll a, and several parameters of water quality and took quantitative samples of zooplankton and invertebrates.

Although the organisms in question may be small, warming effects on predator-prey dynamics will scale up to ultimately affect whole ecosystems. Information relating to how changing predator-prey dynamics affect survival in rising temperatures could increase understanding of which species will be able to endure climate change and how dynamics will shift as temperatures rise.

Vertical profiles of chlorophyll in loosely consolidated organic (flocculent) sediments in shallow water bodies of southwestern Michigan
Jezreel Wallace, Michigan State University, URA - Hamilton Lab/GLBRC
Mentors: Dustin Kincaid and Dr. Stephen K. Hamilton

Benthic algae, or algae that grow on or near substrate at the bottom of a water body, regulate processes such as nutrient exchange and oxygen production at the sediment-water interface. Because of their contribution to these ecosystem processes, it is important to understand their distributions in aquatic ecosystems. In shallow water bodies where aquatic plants are not dominant, light often reaches the sediment surface and promotes the growth of benthic algae. As you move into the sediment layer, light is attenuated and algal biomass typically decreases rapidly with depth. Loosely consolidated organic, or flocculent, sediments are abundant in shallow freshwater

ecosystems in southwestern Michigan and are understudied. To characterize the vertical distributions of algae in flocculent sediments, we collected sediment cores in a variety of water bodies and measured chlorophyll concentrations, a proxy for algal biomass, throughout the sediment profile. Our results show how vertical distributions of chlorophyll differ among water bodies and sediment characteristics.

Comparing trait differences in prairie seed sources

Alexandria M. Walus, Michigan State University, URA - Brudvig Lab
Mentor: Chad Zirbel and Dr. Lars Brudvig

Throughout North America, native prairies have all but been destroyed for the use of agricultural land and urban development. With this, it is increasingly important to restore native prairies onto former agricultural lands to make up for the increase in habitat destruction and fragmentation of native landscapes. However, restoration outcomes can often times be unpredictable. Two key considerations that are often overlooked during restoration and may lead to more predicable outcomes are local adaptation and seed source. In this study, we measured functional traits on 12 prairie species from 3 seed sources (local, Midwestern, and southern) to answer the following questions: (1) Are there trait differences between the 3 seed sources? (2) Do trait correlations differ between the 3 seed sources? We measured growth rate, chlorophyll content, root length, and seed mass and compared them between the sources. We also assessed the correlation between traits within each of the seed sources. We found significant trait differences between the seed sources. For example, the southern seed source had a faster growth rate than both the local and Midwestern source in four of the species. These results are important because they can have implications for restoration success especially relating to climate change which may cause species adapted to warmer conditions to be more likely to survive into the future.

Chemical warfare: From the forest to the prairie

Adrienne Wayne, Eastern Michigan University, REU – Grman Lab
Mentors: Dr. Emily Grman (Eastern Michigan University) and Dr. Lars Brudvig

Garlic mustard (*Alliaria petiolata*) has been a problematic invasive in many forested areas of North America. Effects of the chemicals released by the mustard that repress microbes have not been commonly studied in prairies since the invasive species prefers to live in the forest understory. This species has invaded first year prairie restoration sites located in southwest Michigan. Since many prairie species, such as *Chamaecrista fasciculata*, depend on microbes to fixate nitrogen, the suppression may lessen the success of restoration efforts. The aim of this study is to observe the effects of garlic mustard presence through the soil by comparing the establishment of prairie species in high- and low-density garlic mustard areas. To observe the effects of garlic mustard in

prairies, soil was collected from 6 first-year restoration sites. At each site, four low-density (<10% cover) and four high-density (>50% cover) 1x1m plots were established. Soil was then collected at the plot level to observe soil effects on nine of the species sown into the prairies in a greenhouse setting. Preliminary data showed that there was no significant difference between the establishment of grass or herb species in the high and low treatments. However, further analysis may illuminate differences that become more evident through time. A better understanding of how garlic mustard effects prairie species could improve restoration and management practices.

Garlic Mustard Effects on Prairie Species Seedling Competition
Daniel Xie, Michigan State University, Intern - Lau Lab
Mentors: Tyler Basset, Mark Manuszak and Dr. Jen Lau

Past experiments have established that many plant species release chemicals into the soil (this is called allelopathy) which inhibit the vitality of soil biota in order to increase their own competitive ability in the ecosystem. The common invasive species *Alliaria petiolata* (garlic mustard) is one such species, and is the subject of our experiment. While there have been a fair number of studies on how *A. petiolate* allelopathy gives itself a competitive advantage, a subject that remains largely unstudied is how the effects of allelopathy may affect competition between other species. The negative effects of allelopathy in the soil may alter competitive outcomes between species, native or invasive. That is to say that some species which under normal circumstances may have the competitive advantage may become much less competitive when allelopathy occurs. Our primary purpose is to discover how the effects of allelopathy in the soil will alter the competitive hierarchy of an ecosystem. Some other questions that we studied were how garlic mustard allelopathy might affect the competitively of other invasive species and whether or not the presence of species known to improve soil biota, such as legumes, could buffer the negative effects of allelopathy. These questions were tested by planting several prairie species in pairwise competition experiments with garlic mustard leachate added in half of the samples to simulate the presence of garlic mustard.

Insights on prairie restoration efforts from historical land cover change
Thomas Yazbeck, Michigan State University, FW419 (GIS)
Mentors: Dr. Alexandra Locher, Lisa Vormwald, Josh Green

Tallgrass prairies were once a widespread ecosystem in southern Michigan. Over time, they have all but disappeared since European settlement began, being converted to agricultural land or to forest due to fire suppression. These changes impact attempts to study and restore prairies in contemporary programs. Historical aerial photographs of the Gull Lake (Kalamazoo Co.) region were digitized and georeferenced to represent changing patterns of land cover. Efforts to restore prairies began in fall of 2015, when 12 plots were established using native seeds, within former agricultural fields in the vicinity of Gull Lake on Kellogg Biological Station property. Knowledge of historical land

cover change is very valuable for these undertakings. In places adjacent to research plots, there has been an increase in forest habitat and a decrease in cultivated fields. These results provide valuable information to those supervising prairie restoration efforts, such as the size of the restored prairies, the variety of land cover types within close proximity of the prairies, temporal changes in land cover, and the potential of different habitats to support revived historical prairie in southern Michigan.