KBS Program Posters 101

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Kellogg Biological Station
Michigan State University
July 10, 2018

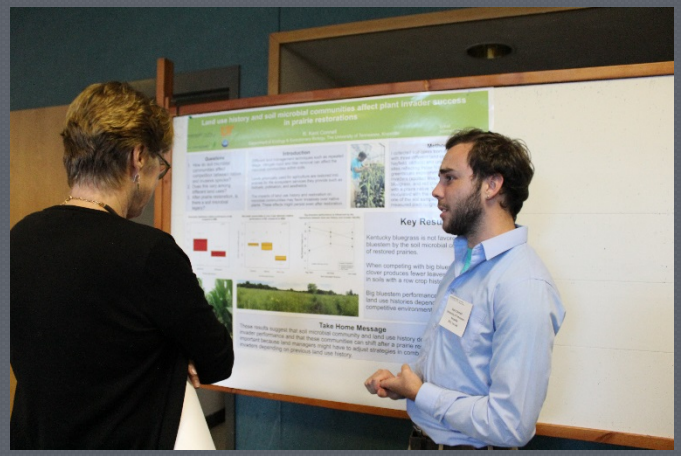
Housekeeping

- RCR – Certificate of Completion at PD on Thursday, August 2nd
  - Need total of 5 hours of "training"
  - PD provides 3: RCR (6/12), Authorship (6/19), Communicating Science (6/21)
  - Online training and conversations with mentors work for the additional 2 hrs!
- Thursday PD: Intersecting KBS and Crops – Discovering Ag in our Region (Dr. Brook Wilke & Kera Howell), meet in front of McCrary at 4:45 pm (or by 5 pm at the Farm Systems Center on 40th)
- Saturday, July 14: MSU SROP Group visiting for tours of the Farm & Sanctuary; BBQ, music, soccer & volleyball will start around 1:30 pm
- Next week!
  - Tuesday, July 17th, PD: Career Panel & Professional Etiquette & Networking Dinner, 5-7:30 pm, Manor House
  - Friday, July 20th: The snacks in your backyard: Wild edible plants of Michigan 4:30-6:30 pm
  - Saturday, July 21st: Beginning Grant Writing Workshop, Dr. Catalina Bartlett 9-11am, Terrace Room

Why present a poster?

Poster presentations are a great way for undergraduates to:

- Gain experience presenting your work in a formal setting
- Receive constructive feedback
- Share ideas, learn from others, form collaborations
- Enhance your resume…you have now given a formal poster presentation at a symposium!



Who is your audience?

- Your mentors
- Your peers
- KBS faculty, grad students and research associates
- KBS staff and Director's Advisory Board members
- MSU main campus faculty and administrators
- Your friends and family
- The public!

What does the audience want to know?

- Experience (Interns/URAs)
  - Describe your experience
  - Did you produce a product or complete a project this summer?
  - Did you gain valuable skills that will make you competitive for future opportunities?
  - Did you learn an extraordinary amount about your study system/organism that you think is worth sharing?
  - Did you take a course that enhanced your experience?
- Research (REUs/URAs) – traditional research poster
  - Abstract (not required on a poster…ask your mentor their preference/professional norm)
  - Introduction/Background
  - Methods
  - Results
  - Discussion/Conclusions
  - Acknowledgments
  - Lit cited (can be on poster, as separate hand out, or just has citations in text…ask mentor their preference/professional norm for your field!)

Effective Posters 101

- Title that captures interest
- Readable
- Legible
- Well-organized
- Succinct

(http://brandeis.libguides.com/content.php?pid=34557&sid=270241)

Posters 101: A well thought out title will go a long way!

- Make people want to talk to you
  - It is OK to give away the “punch-line” in the title

For example:

“Legume and rhizobia interactions under varying light and nitrogen regimes”

“Mean beans! Legumes punish their mutualists when resources are plentiful”

Posters 101 – Readable!

- You only have a few seconds to grab a readers attention, and just minutes to convey your message!
- Minimize long paragraphs
  - Use bullet points whenever possible
  - What is most important?
- Try to illustrate your experience with images whenever you can
  - A picture is worth a thousand words!
- Avoid jargon, or define it!
- Avoid spelling and grammar mistakes…work with your mentor and peers to help you catch these & improve your poster!

Posters 101: Legible!

- Light writing on a dark background typically doesn't work well for posters, unless there is **very little** writing
- Organize the poster to capitalize on how your eye wants to flow naturally across the page (in the US: from the reader's left to right)
- Use large font (30+)…can people read it from ~6-10 feet away

Posters 101: Well organized!

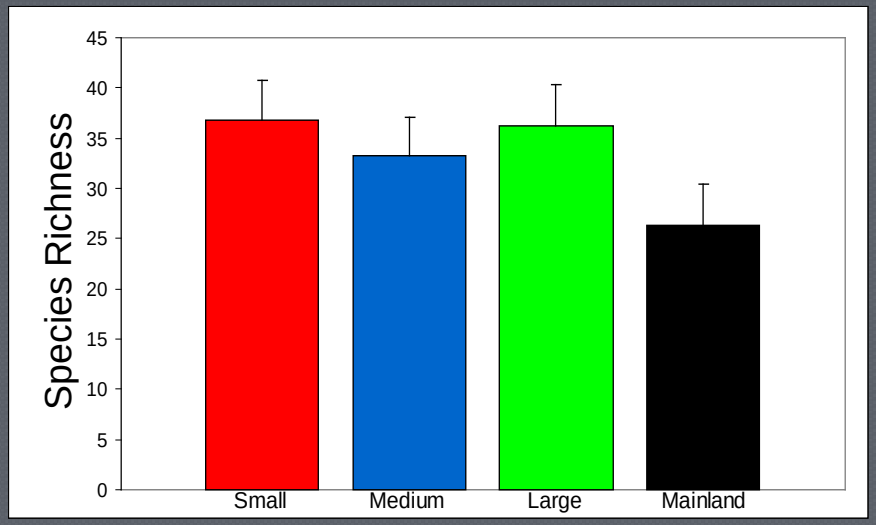
- Audience should not have to hunt for the main idea
- Space in-between sections should be visually pleasing/neat
- Titles, section headings and text should be concise and impactful
- Use of borders and text boxes will likely help organize your content

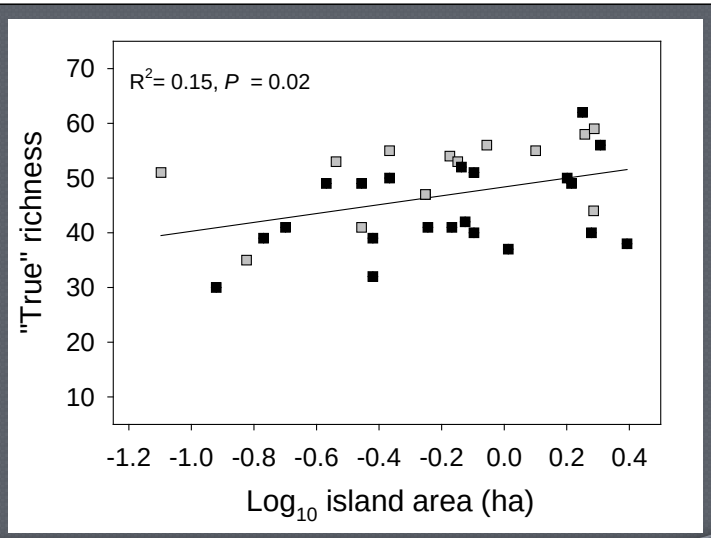
Posters 101: Succinct!

- Come up with a short canned speech that everyone will get when they say…”So, tell me about your work/project”
- When using text & section headings make them have impact…help inform & guide the audience!
- Images, images, images!

Creating an effective figure

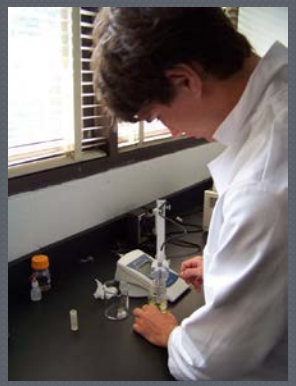
- Independent variable on the X-axis
  - Categorical (bar graph)
  - Continuous (scatter plot)
- Dependent variable on the Y-axis
- Font needs to be large enough to read from a distance
- Use color, but make sure to stay consistent

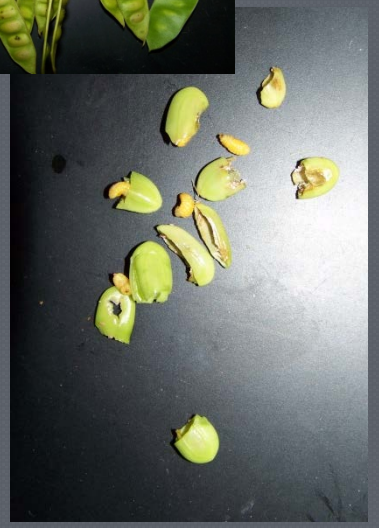




Figures continued…

- Captions are typically placed below, or to right side for figures
- Figures are not just for results!
  - Pictures that illustrate everything from methodology to outcomes are a lot more fun to look at than text!





Creating an effective table

- Make sure font is large enough so the audience can read it easily
- Must be able to stand alone with only a caption for explanation
  - Captions are typically above or to the right of tables
- Don’t replicate info already in the text, or in a figure, you’re wasting space!
- Use the smallest number of decimal places possible
- Make sure everything is aligned!

Tables continued…

- Try not to use gridlines unless absolutely necessary
- It is OK to have a big table
- **BUT** make sure its well organized and relevant!

http://www.ncsu.edu/labwrite/res/gh/gh-tables.html

Table 6. Nutritional Breakdown of Selected Foods by Calories and Major Nutrient

	Calories per Serving Size	Major Nutrient
Proteins		
Chicken breast	280	niacin
round steak	300	vit. B12
T-bone steak	412	vit. B12
lobster	160	vit. B12
shrimp	66	vit. B12
sirloin steak	260	vit. B12
turkey	230	niacin
salmon	300	vit. B12
pork	420	vit. B1
spinach	21	vit. A
swordfish	270	niacin
tuna	220	niacin
Carbohydrates		
tomato	32	vit. C
potato	300	vit. C
sweet potato	82	vit. A
cucumber	8	potassium
pumpkin	41	vit. A
beans (black)	136	potassium
beans (kidney)	109	potassium
corn	69	vit. B6
pasta	320	vit. B1
whole-wheat brea	67	magnesium
brown rice	116	vit. B6
apple	160	vit. C
orange	65	vit. C
Vegetables		
celery	14	potassium
broccoli	20	vit. C
onion	30	potassium
green peppers	12	vit. C
cabbage	16	vit. K
carrots	26	vit. A
peas	57	vit. C
lettuce	10	vit. A
cauliflower	14	vit. C
mushrooms	45	niacin
asparagus	24	vit. C

Note: Serving size=1/2 cup, or 8 oz.

A few more details…

- Always have an acknowledgments section thanking your mentors, funders and anyone else that helped you
- Use logos of your funders & sponsors around your title and/or near the acknowledgements
- Make sure to use the official logo of KBS…I forwarded these to the SummerVisitors-L list from our marketing and comm team

A few useful links…

- Excel tutorial

http://www.excel-easy.com/

- Deciding what type of graph to use

http://www.mindtools.com/pages/article/Charts_and_Diagrams.htm

- Creating an effective poster

http://www.ncsu.edu/project/posters/

Activity for July 24th Professional Development

- Trade computer/paper with at least two others outside of your peer group for review of abstracts & posters
- Sara & I will also be available to review your products!
- Abstracts due to us the next day, Wednesday, July 25th (email to KBSsummer@kbs.msu.edu)
- Practice elevator speech line-up
- Poster PDFs due by Monday, July 30th (email to KBSsummer@msu.edu)

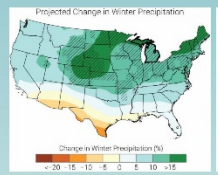
Example without results by Monday, July 30th!

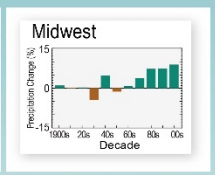
Impact of Changing Rainfall Patterns on Denitrification Nitrous Oxide Reductase Lag

Daimer Castro Vega[1], Kathryn Glanville[2] and Dr. G Philip Robertson[2]

[1]Department of Crops and Agroenvironmental Sciences, University of Puerto Rico Mayagüez, [2] W. K. Kellogg Biological Station, Michigan State University

Introduction



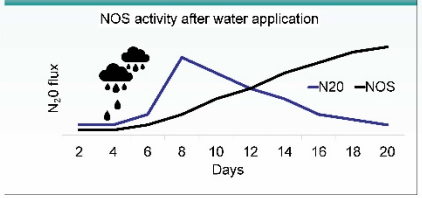


In the US, the predominant greenhouse gas emitted is carbon dioxide (CO2). However, since the Industrial Revolution emissions of other gases with greater Global Warming Potential have increased. Nitrous oxide (N2O) has 298 times the radiative forcing of CO2 in a 100 years lifespan. Anaerobic conditions are favorable for denitrification process in which part of N2O emissions occur.

Objectives

- Evaluate N2O production through field sampling in corn and switchgrass with different rainfall patterns.
- Understand the effects of a possible lag in the Nitrous Oxide Reductase (NOS) in the production of N2O

Hypothesis

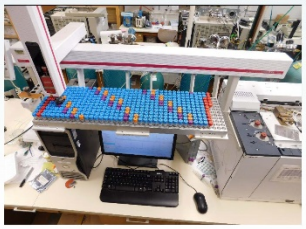


Methods

Nitrous oxide reductase

Bottles were flushed with N2 to create an anaerobic environment

Enzyme inhibition with acetylene



Gas Chromatograph

Results

Stop by my poster to find out!

References

Groffman, P. M., Davidson, E. A., & Seitzinger, S. (2009). New approaches to modeling denitrification. Biogeochemistry, 93(1–2), 1–5

Michigan State University. (2012). Climate Change Impact on Agricultural Production and Adaptation Strategies: Farmers' Perception and Experiences. Pauleta, S. R., Dell, S., Moura, I., Dell'Acqua, S., & Moura, I. (2013). Nitrous oxide reductase. Coordination Chemistry Reviews, 257(2), 332–349.

Pittelkow, C. M., Adviento-Borbe, M. A., Hill, J. E., Six, J., van Kessel, C., & Linquist, B. A

Acknowledgment

This material is base upon work supported by the National Sciences Foundation. Special thanks to Kevin Kamark for his help and encouragement.

Abstract/Summary for Symposium

- **Due to us (KBSsummer@kbs.msu.edu) by 5 pm on Wednesday, July 25th**
- 250 words max…make them count!
- Format title, names, and text EXACTLY like those in the 2017 program!
- Make sure to have your mentor read/edit before you turn it in….you are not only representing yourself, but also your mentor + lab/unit!!!!!

- Why?
  - Background/purpose
  - Why is your project important?
  - Why is there a need to complete the project?
- How?
  - How did you conduct your study/get your project done?
- What was the outcome?
  - What are the major results/outcomes/products?
- Why should we care?
  - Conclusions/implications
  - What is your “take home” message?

KBS Undergraduate Symposium Wednesday, August 1, 3:30-5:30 pm

- Symposium Program will include your abstract/summary for your poster
  - Due to us by ***5pm, Wednesday, July 25th***!!!! Email to KBSsummer@kbs.msu.edu
  - Max. 250 words, Ariel font, 12 pt
  - Include your name, your institution, your mentor(s), poster title in bold above summary (see 2017 Program for format)
  - Must be a WORD document – save as "LastName_2018abstract.docx"
  - Consult 2017 Program from last year for exact format of abstract
  - When you transmit your abstract let us know if you have any display needs beyond the poster board (table to display things, flat screen computer monitor, power for a laptop, etc.)
- Max dimensions: **36" H x 44" W**
- Poster printing – there will be a sign-up sheet by the 2 computers located in the IT office (Stack Rm. 225) and also by the computer that runs the poster printer in the computer lab (Stack Rm. 214).

****Print over the weekend & at night with your mentor, and at your own risk!

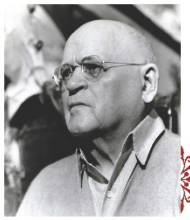
If something goes wrong, TELL SOMEONE!!!! helpdesk@kbs.msu.edu

KBS Undergraduate Symposium Wednesday, August 1, 3:30-5:30 pm

- Meet on hill outside the Terrace Room at 3 pm for group photos (all students & each program) with Bethany
- At 3:30 pm Dr. Gross will address the crowd, then everyone will give their 1 minute (or less) "elevator speech"
  - **PDF of your poster must be submitted to me by Monday, July 31st at 5 pm**
  - Must be a PDF, save as – "LastName_2018poster.pdf"
  - You will line up alphabetically, give your elevator speech at the podium, then walk to your poster
  - Don't forget to start off with your name, year, what school you attend, and your major!
- Wear professional/business casual attire
- Will be on your feet for 2+ hours, and it can get warm in the auditorium, so be conscientious of this!
- Food will stay out for a bit, so do not feel like you have to rush away at 5:30 pm if you are having good conversation with people
- Dinner will be served at McCrary that evening, but if there is a lull at your poster feel free to step away and grab a snack/drink to have at your poster

Experiential Examples

Welcome to Eagle Heights



Born on April 7th, 1860 to Seventh Day Adventist parents, Will Keith Kellogg began his childhood in Battle Creek. Though he was thought to be a poor student and rather dim-witted, W.K. would revolutionize the food industry. After working as a broom salesman from the age of 14 and taking on a management position in Texas, W.K. Kellogg believed he would never be a wealthy man. In 1880, he became employed by his older brother, John Harvey Kellogg at the Battle Creek Sanitarium. This would be the setting of W.K.'s change in fortune; the toasted corn flake was created by the two brothers. W.K. opened his first factory in 1906, and his business has grown and expanded into the legacy that it is today.

The Kellogg Manor House is a beautiful example of the Tudor Revival Style that was prevalent from 1890 to 1940. The style was generally ranked high in suitability for residences, and fit W.K.'s need for a gentleman's estate. The Manor House has the typical Tudor half-timbering, oversized fireplaces, and stucco siding, along with steeply pitched roofs and an asymmetrical floorplan. The house was made for sensibility and durability, as well as having an undercurrent of success, imbuing the house with tasteful elegance. Much of the interior and design is a quiet display of wealth.

The Carriage House was originally planned as a stable before the Kellogg Farm was built. Instead of housing horses and chickens, it became the chauffer's residence and garage. It had room for seven automobiles, and there were apartments above the garage used by visiting chauffeurs and other domestic staff. The house is a Tudor style that reflects the overarching architectural theme of the estate. Today it houses the outreach program and a conference room used for meetings. The Lakeside Cottage on the west side of the Carriage House offers a beautiful view of Gull Lake and is available for reservation.

Windmill Island is named for the authentic Dutch windmill that sits on the edge of the southwestern-most part of the estate, a small island that can only be reached by two arched bridges. The Kellogg windmill is actually comprised of two mills, both nearly one hundred years old. The original hailed from IJlst in the province of Friesland, The Netherlands, but had several faults which Benjamin & Benjamin thought would not meet Mr. Kellogg's expectations. A second mill was bought which originally stood on the east bank of the Palsepoel, a lake near Heeg and IJlst. It was a farm mill that was used to regulate water from the lake using the Archimedean screw. The two mills were shipped to Gull Lake in pieces to avoid taxation and reassembled onsite into one mill in 1927. A small tulip garden laid at the mill's feet, and the island was often used as a recreational area for W.K.'s grandchildren and his employees.

Benjamin & Benjamin, Kellogg's architects, subscribed to popular architectural opinion that greenhouses were essential to a gentleman's home as they helped create the illusion of a self-sufficient manor. Within the Kellogg greenhouse grew roses, a grape arbor, citrus fruits, and flowers which supplied the Manor House with fresh bouquets daily. Professor Nutting from Michigan State College "advised and furnished plants responsive to his grafting research" here, a scientific undertaking that W.K. seemed particularly interested in. Many of Professor Nutting's original tree grafting experiments remain on the estate.

Behind the Manor House is a rose garden, and at its edge is a classically inspired stone balustrade leading to a large Ohio sponge-stone and brick stairway that zigzags down to the lake. The Pagoda Garden can be found at the end of this scenic path. W.K. Kellogg reportedly enjoyed this staircase in particular and walked the stairway twice each day for exercise. The Pagoda, a four-posted awning sheltered by a green roof, sits on the lake. With its half-timbered and dog-tooth variant balustrade, it mirrors the aesthetic feel of the rest of the estate. The Pagoda is preceded by a beautiful symmetrically arranged garden complete with sundial, urns, and rose arbors. It is an ideal location to view sunsets on Gull Lake and is used as a landmark by boaters; when the family was in residence, the Pagoda was used as a docking and unloading point for lakeside visitors of the Kelloggs.

During the Kellogg family's years at Eagle Heights, this was the residence of their gardener, Walter Taylor, and his family. Taylor was the only year-round employee at the estate, residing at Eagle Heights even when the Kelloggs were away. The Cottage stands near the second entrance to the property, set back from the road to offer privacy. It was designed to reflect the general architectural scheme of the estate as well as being a charming residence for a valued employee.

The Boat House had two wells that could accommodate 26-foot powerboats. The wells housed W.K.'s sailboat and his Garwood wooden boat when they were not in use. The exterior echoed the architectural theme of the estate as well; it is a two-story, half-timbered structure that sits at the edge of the lake, northwest of the Pagoda. The second floor functioned as a bath with facilities to accommodate 10-12 people when it was still in use by the Kelloggs, a function that speaks to W.K.'s conception of Eagle Heights as not just his summer home, but a place of recreation for all who visited.

(credit: Emma Kukuk, KBS Manor House Intern)

Experiential Examples

July, 2015
Mentor: Sara Garnett

American Toad Tadpole Behavior
Rebecca Benedict

Michigan State University's
Kellogg Biological Station

Introduction

This summer I worked as a research assistant under my mentor, Sara Garnett, who studies American Toad tadpoles and how they strike a balance between cooperation and competition. Understanding how the tadpoles behave around their siblings versus non-relatives will provide insight into kin selection and animal interactions.

Tadpoles cluster together, presumably to maintain safety in numbers.[1] We conducted several studies this summer to see how tadpoles grouped with their siblings and how they dispersed when in close proximity to non-kin.

Early this summer, pairs of mating American Toads were collected from the ponds at the Kellogg Biological Station's Pond Laboratory and from Lux Arbor Reserve. Twenty pairs were collected, providing twenty large families of tadpoles to work with in our studies.

Later this year, the data we collected will be used to quantitatively analyze the tadpole behaviors.

[1]B Waldman, *Animal Behavior*, 1982, 30, 700-713

Acknowledgements

Thank you to the members of the Kellogg Biological Station, the Getty Lab, and the Pond Laboratory for all the resources and support. Sara Garnett for her mentorship and expertise, KBS for funding this research project, and BEACON for funding my position here at KBS!

Marking the Tadpoles

- To differentiate between siblings and non-siblings, we marked a sub-sample of each family with a colored tag.
- The tags, called Elastomer, are injected into the skin of the tadpole's tail.

- The tags didn't inhibit growth, and are easily seen with a black light.

Outdoor Sampling

- Do tadpoles in the wild gather with their siblings?
- To find out, we collected tadpoles that were clustered together in outdoor ponds. Later, we can test tissue samples to see if they're genetically similar.

- We took samples from the Kellogg Biological Station's Pond Laboratory and from Lux Arbor Reserve.

Behavioral Observations

- After measuring the tadpoles' mass, snout-vent length, and stage of metamorphoses, we combined families in outdoor tanks. Kinship and density varied in each tank.
- We watched a single tadpole for 15 minutes, recording its behavior after every 60 seconds.
- After many replications, we could determine the percentage of time tadpoles spend performing different behaviors.

How do tadpoles distribute in their natural environment?

- We released siblings from one family on one side of a pond, and siblings from another family on the other side.
- Every hour, we marked the tadpoles' location by placing popsicle sticks in the bank of the pond.
- We measured the distances between popsicle sticks to see how far they had gone.

(credit: Rebecca Benedict, KBS URA)

Experiential Examples

Bird is the Word: My Internship in Avian Care

Brenden Kokx ◇ Kellogg Bird Sanctuary ◇ Michigan State University

Time flies Wren you're having fun

It's Owl in a day's work

- Maintain clean holding and display enclosures
- Feed the Sanctuary's resident birds
- Provide health checks for the Sanctuary's resident birds
- Help with bird surveys and citizen science projects such as BioBlitz
- Train to glove handle the Sanctuary's Red Tailed Hawk, Toby
- Create housing and perching for the new Bald Eagle Enclosure
- Leading educational tours like the undergrad SROP tour
- Updating enclosures with new perches, stumps, or substrate

Fig.1 (above), Returning a juvenile Osprey to the MDNR nesting platform
Photo Credit: Roy Van Loo, Jr.

Fig.2 (above), Catching the biggest fish of the day to feed Liberty and Patriot

Fig.3 (above), Training to glove handle Toby, the Red Tailed Hawk

Fig.4 (below), Birding at Lux Arbor before checking the Osprey platform

Fig.5 (below), Modeling the frog gear for Taryn's Wild Wednesday

A Gander at my favorite memories

- Making lasting relationships with Sanctuary Staff
- Helping the MDNR with their Osprey Banding project
- Going on walks with Toby, the education Red Tailed Hawk
- Building the Bald Eagles' new home
- Representing the Sanctuary at the Binder Park Zoorific Kids Day
- Going out and catching fish to feed the Bald Eagles
- Going to Pierce Cedar Creek to sample Eastern Massasauga Rattlesnakes
- My first trip to Chicago's Field Museum of Natural History

(credit: Brenden Kokx, KBS Intern)

Experiential Examples

Examining consistency of foraging behavior traits in bluegill sunfish

Emily Gauci, Michigan State University

Purpose

The Undergraduate Research Apprentice (URA) program at the Kellogg Biological Station (KBS) partners ecological researchers with Michigan State University undergraduates. While at KBS, URAs work closely with their mentors on research projects while also participating in summer courses. For my URA, I worked in Dr. Gary Mittelbach's lab with Melissa Kjelvik and took *Wetland Ecology and Management* and *Nature. Environmental, and Travel Writing* courses.

Project Background

The effects of individual differences in foraging behavior of juvenile bluegill sunfish (*Lepomis macrochirus*) have been examined over multiple years at the KBS Experimental Pond Facility. These studies have investigated how variation in "bold" and "shy" foraging behaviors observed during behavioral assays have impacted factors such as growth rates, survival, and habitat use. An important element of this research was conducted this summer– examining whether these observed traits were consistent over time. To test consistency of foraging boldness, bluegill were run through behavioral assays multiple times, first to assess initial foraging risk-taking traits, and then again to determine consistency. Fish were also placed back into the pond for three weeks and recaptured to run another round of assays on the surviving fish.

Methods

- Juvenile bluegill collected from experimental ponds (Figure 4)
- Fish run through initial behavioral assays
  - Three fish placed into tank with largemouth bass behind clear barrier (Figure 3)
  - Behavior of bluegill observed and recorded for 10 minutes
    - emerging from vegetation
    - advancing/retreating
    - consuming food
    - returning to vegetation
- Assays repeated second time with fish in original group or random group
- Bluegill and bass returned to pond for ~3 weeks, collected, assay repeated on remaining fish in random groupings

Figure 1: Seining a partially drained pond

Figure 2: Individually marking a juvenile bluegill with elastomer

Figure 3: Tank setup for conducting behavioral assays with largemouth bass

Figure 4: KBS Experimental ponds
(Photo from www.kbs.msu.edu)

Figure 5: Collecting zooplankton for daily feeding of housed bluegill

Field and Lab Techniques

- Field Experiments
  - Fish sampling
    - ponds were drained and seined to collect juvenile fish (Figure 1)
  - Growth measurements
    - length and weight measurements were taken before returning fish to pond and after recapturing and running through a third round of assays
  - Fish marking
    - each fish marked with unique elastomer color bands (Figure 2)
- Behavioral observations
  - Foraging boldness assays
    - tanks set up with largemouth bass and clear divider, food dropped in tank and bluegill behavior recorded (Figure 3)
- Housing Fish
  - Zooplankton collection
    - zooplankton collected daily from a fishless pond to feed the fish in the lab (Figure 5)
  - Water quality maintenance
    - dissolved oxygen, temperature, pH

Transferable Skills

- Responsible conduct of research training
- Independent work ethic
- Experience working in variable field conditions
- Ability to execute field techniques specific to aquatic research
- Understanding of scientific research process

Acknowledgements

Funding for this summer research experience provided by BEACON and Michigan State University. Thank you to Melissa Kjelvik and Dr. Gary Mittelbach for mentoring this project, Zachary Davis for assisting, and Danielle Zoellner for organizing the URA program.

BEACON

MICHIGAN STATE UNIVERSITY | W.K. Kellogg Biological Station

(credit: Emily Gauci, KBS URA)

ADVICE FOR MAKING POSTERS

Slide Setup

Use Power Point to create your poster as ONE SLIDE. (There are better design programs, but most people are familiar with Power Point and the PPT format works with both of our poster printers). If decide to use another program, convert the poster to a PDF before you bring it up on the printing computer to try to print!

Start by changing the slide size to **44 (this is the horizontal length/width) x 36 (this is the vertical height) inches, landscape mode**. Your poster may be distorted if you design your poster first and then change the page size later. Be sure you have a small margin around the edges of the poster.

Talk to your mentor! Do they have a template/format they prefer you use?

Lots of poster templates and advice are available online….simply Google "conference poster design". These are a few good online references:

http://colinpurrington.com/tips/poster-design

https://guides.nyu.edu/posters

https://www.nature.com/nature/journal/v536/n7614/full/nj7614-115a.html

Poster Design Tips

- Concentrate on using images effectively to tell your scientific story: photos, figures, diagrams, maps, etc…
- Keep the amount of text to a minimum to explain your project. (Abstracts are not always necessary.)
- Summarize your scientific question or goal in one sentence and display it in a prominent location.
- All figures and tables should be self-sufficient. Each should be able to stand alone.
- Is there sufficient and interesting background information (without using too many words)?
- Is the flow of information easy to follow? Remember that it is natural to read posters from left to right, like a book, though you don't have to always follow this rule.
- Are the "take-home" messages (conclusions) clearly stated?

POSTER DESIGN TIP: The 3-30-3 rule

Generally you can put visitors to your poster into THREE categories:

3 seconds: Many people might just glance at your poster. Convey your project with a good title and good pictures/figures. If you grab their attention they might stay for ….

30 seconds: Put your key points into a few sentences and concentrate on concise captions for figures. Use bullets effectively, highlight your main question and findings. Try to get them to stay for …

3 minutes: People who are really interested will stay longer and read more. Give them enough detail to satisfy their curiosity, but remember that too much information will overwhelm most people.

Graphics

Select a good contrast between the background color and the text color (a light-colored background and dark text is typically the best choice).

Check the quality of images/photos you are using by magnifying them. Images copied from the web are usually low resolution (72 dpi) images and are not proper quality for inclusion in your poster.

Limit image resolution to around 220 dpi to keep your file size relatively low.

All graphics should be pictures (e.g. .tif, .gif for transparency, .jpg for non-transparent images) inserted directly into PowerPoint (NOT linked from another program). The preferred image format for all inserted images is JPEG if you do not need a transparent background.

If you have graphs or charts from Excel to include in your poster, simply copy in Excel and paste into PowerPoint.

To adjust an image and retain proportion, hold down the Shift key on your keyboard and click and drag with your mouse on one of the corners in order to scale it.

Text

The title should be approximately the entire width of the poster.

The most common fonts are Times New Roman, Arial and Sans-serif. Other fonts include Arial Black, Franklin Gothic Heavy, Tahoma, Trebuchet, Verdana, Garamond, Book Antiqua, or Bookman Old Style, just to name a few.

For readability from a distance, you should generally not use a font size any smaller than 30.

Font Size recommendations:
Title 72-120
Section Headers 36-72
Body Text 30-48

***No matter what program you use, it is best to save your poster as a PDF when completely done. Open it in a viewer to make sure it looks right. Be sure to keep your original Power Point (.ppt) file in case you need to edit it again.

GROUNDWORK
Furthering the Influence of Earth Science

Strategies for Creating a Conspicuous, Effective, and Memorable Poster Presentation

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INTRODUCTION

Many of the major geoscience conferences are experiencing increased attendance, making it impossible to feature all oral presentations. Hence, the number and value of poster presentations are on the rise. For example, during the past 10 years, posters consistently comprised ~66% of the presentations at the American Geophysical Union (AGU) Fall Meeting, but overall poster numbers grew rapidly and now represent thousands of presentations each day (Fig. 1). Similarly, the European Geosciences Union (EGU) General Assembly is now made up of 66% poster presentations, also resulting in thousands of poster presentations each day. Posters at the Geological Society of America (GSA) Annual Meeting comprised an average of 37% of presentations during the last decade.

In light of the increasing number of posters at large geoscience conferences, authors must work hard to give conspicuous, effective, and memorable poster presentations. In all the chaos of the poster hall at large conferences—socializing, searching for beverages and bathrooms, and the hundreds to thousands of simultaneous presentations—you have a lot of competition for people's attention. Here, we provide a "road map" of strategic steps for presenters who want their science to stand out among the rising sea of posters. We also point out some key open-access resources that will further improve posters when paired with these strategies.

CONTEXT: ORAL VERSUS POSTER PRESENTATIONS

Oral and poster presentations are very different formats in terms of preparation, execution, and professional interaction. Oral presentations provide an opportunity to *disseminate* well-developed scientific findings or hypotheses within a short timeframe (10–20 min.), followed by a brief question and answer period (2–5 min.). The oral presentation format does not allow much social interaction or opportunity to receive immediate insights about your research from the community. On the other hand, posters allow you to *give and receive* in-depth information and feedback about your research. The poster presentation is social and enables extended professional interactions that can greatly benefit your research and career. Thus, posters deserve much respect and care in their creation and delivery, and should not be considered second-class presentations.

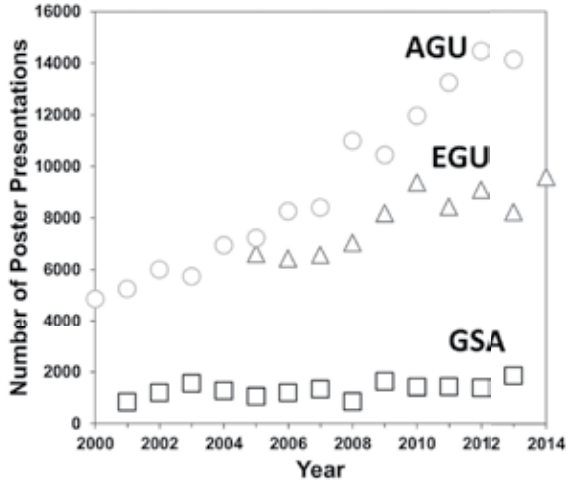

Figure 1. Number of recent poster presentations for three major geoscience conferences: GSA Annual Meeting, AGU Fall Meeting, and EGU General Assembly. Data provided by GSA, AGU, and EGU.

PREPARING TO CREATE THE POSTER

Choose a Meeting Session Carefully

Submit your abstract to an appropriate session by anticipating the audience that you want to attend your poster. Use your knowledge of the topic and your network (peers, colleagues, and mentors) to help you choose a session. This can be achieved by searching for keywords and convener names in the session descriptions of most meetings.

Be Strategic in Choosing a Title

Your presentation title is very important and should be selected carefully. Many people will decide to attend your presentation based upon the title alone. Make sure your title is concise and precise. A title that states the key findings can be a powerful draw

GSA Today, v. 25, no. 5, doi: 10.1130/GSATG228GW.1.

(Hess et al., 2011). If appropriate, you can enhance your title and make it visible to a broad spectrum of people by using keywords that link your work to major issues or debates in your field of geoscience.

Formulate Your Poster Storyline

Before starting poster design and construction, you should formulate your storyline with the "give and receive" opportunity in mind. For example, include data and findings that you want to discuss because they either support your ideas or perplex you. Although guidelines may vary by meeting, an organized poster in the geosciences usually follows the format of a scientific paper: introduction, methods, results, discussion, conclusions, references, and acknowledgments. Again, remember to anticipate your audience. Make your presentation relevant and tangible to this group of people. For example, if you know that the session audience will be less quantitatively oriented, you should use model schematics instead of systems of equations.

MAKING THE POSTER

Follow the Guidelines

Always know the conference regulations and obey them. Pay particular attention to allowable dimensions, because they vary between GSA, AGU, and EGU. This easily avoidable mistake is probably one of the most frequently made. You do not want to show up and realize your poster is intruding on your neighbor's space.

Use Appropriate Formatting

The layout and formatting of your poster content is immensely important. You must obey guidelines for the inclusion and style of text and figures (e.g., amount of text, minimum font sizes, figure resolution, visualization design, and color selection). This topic is discussed thoroughly in other resources (see these open-access references: Miller et al., 2002; Faulkes, 2011; Hess et al., 2011; Purrington, 2011). Use these resources to avoid the cardinal sins of poster design and formatting (e.g., fonts and figures that are too small). In general, less is more when it comes to posters, especially for text. The most effective posters contain only the most fundamental and interesting material from the study (Hess et al., 2011). Your poster does not need to contain all the details, because you will be at the poster to enhance the presentation.

Create a "Brand" That is Memorable and Visually Appealing

Keep an eye out for engaging and inspiring designs—you do not have to reinvent the wheel, but you do want to find a functional, reproducible design that can become your "brand." There are effective and ineffective posters all around you (e.g., in your institution's hallways), so learn from these examples and Web resources (e.g., Faulkes, 2011, Hess et al., 2011, Purrington, 2011). Rather than copy a specific format, pick and choose pieces of style and design that appeal to you, while avoiding common design pitfalls.

Get Coauthor Support

Make sure all of your coauthors review and approve your poster prior to printing. Build this step into your schedule so that there is time to include their valuable input.

PREPARING TO PRESENT THE POSTER

Practice

Always rehearse the "walk-through presentation"—your 2–3-minute oral presentation of your poster—with your peers and colleagues. Rehearsal will immensely improve your delivery at the conference. Get and incorporate feedback from your peers and colleagues. You are likely to give this walk-through many times during your session; deliver it with enthusiasm every time.

Provide Handouts

Bring "mini-posters"—letter-sized versions of your poster. Make sure your poster content is still legible in this smaller format. If it is not, your text and figures are probably too small on your full-size poster. Make these mini-posters available by your poster and carry some with you so that you can hand them out at opportune times. If applicable, it also helps to have supporting materials on the back of your mini-poster (e.g., additional figures, equations, or a list of your related publications). These mini-poster handouts also serve as valuable reminders for people to follow up with you.

PROMOTING AND PRESENTING YOUR POSTER

Self-Promote and Be Outgoing

Enlist help from peers, colleagues, and advisors to send folks your way before and during your session. Coordinate with colleagues who present before you to advertise your poster during their poster or oral presentation—and then do the same for those presenting after you. Most people wait for you to engage them at your poster, so be outgoing and welcoming. An easy first step to engaging someone is to smile and make eye contact. You do not want to spend many hours standing alone, especially after you have invested the time and money to attend the conference. Science is fundamentally about sharing ideas, and these social interactions are necessary for advancing science.

Hook Your Audience

When new audience members arrive, introduce yourself with your affiliation. Make sure to note their names and briefly learn about their research. Ask them if they would like the "walk-through" or have questions. Connect your research to the interests of the audience quickly so as to "hook" them. During your walk-through, always start broad and work toward specifics, while gauging your audience's level of knowledge on the topic and adjusting your presentation accordingly. It helps to bookend your brief presentation with the motivation for the study, because that is likely the common scientific thread between you and your audience.

Maintain an Audience

Be interactive with your audience and use questions and frequent eye contact. Continually check in with your audience and make sure they are still engaged. This is very important, because a poster with an interested audience will draw other curious attendees from the crowd and give your science more exposure. Be prepared to take notes on feedback and names, but do this during your breaks so you do not disrupt the flow of your presentation or interactions with your audience. As you part ways

with audience members, always thank them for their thoughts and time. With rare exception, stay by your poster during the entire session to maintain your momentum and audience levels—avoid the temptation to leave early for other talks and posters. This also means not wasting time in the complimentary beverage line during your session; have a peer bring you something (*you have earned it!*).

Follow Up

After the conference, make sure to continue your interactions. Follow up with those who had a key question or comment. This will expand the impact of your science and reinforce the connection between you and your scientific community long after the conference is over.

SUMMARY

Here we have provided a road map of strategic steps that will help you create and deliver a poster presentation that is conspicuous, effective, and memorable. These key steps are (1) know and embrace the value of a poster presentation; (2) carefully choose your session and title; (3) create a storyline and format for your poster that facilitates *giving and receiving* information; (4) obey the fundamental published guidelines for formatting the content, text, and visualizations of a poster; (5) practice, practice, practice the presentation and get feedback before the conference; (6) self-promote and be outgoing before, during, and after your presentation; and (7) appreciate, interact with, and maintain your audience. Execute these steps and you will be an effective communicator and your science will be memorable.

ACKNOWLEDGMENTS

We thank our past and present mentors, colleagues, and students for help in developing these strategies, and George Hess and anonymous reviewers for their many constructive suggestions.

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WK Kellogg Biological Station Undergraduate Internship and Research Symposium

Wednesday, August 2, 2017

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 2017 Kellogg Biological Station programs:

National Science Foundation (NSF)

MSU College of Agriculture and Natural Resources (CANR)

MSU College of Natural Science (CNS)

KBS NSF Long Term Ecological Research (LTER)

Great Lakes Bioenergy Research Center (GLBRC)

BEACON Center for the Study of Evolution in Action

MSU DOW STEM Scholars Program

MSU Extension (MSUE)

CNS Dept. of Integrative Biology

CANR Dept. of Fisheries and Wildlife

Endowed Scholarships and Funds to CANR, CNS, and KBS

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Gustafson Scholarship (CANR)

Joe Johnson Endowment for Wildlife Conservation (KBS)

George H. Lauff Scholarship (KBS)

Harris Trusts to the Kellogg Farm and Kellogg Bird Sanctuary

Brunt Family Scholarship (KBS)

Noall Scholarship in Biological and Environmental Science (KBS)

*****Abstracts/summaries are in alphabetical order by student last name.**

How diversity affects the growth of our next energy source
Torel Beard, Michigan State University, URA – Gross Lab
Mentors: Dr. Karen Stahlheber and Dr. Kay Gross

Developing biofuels using perennial bioenergy crops sparks a high interest among researchers because perennials are thought to be more environmentally sustainable than annual crops. Switchgrass (*Panicum virgatum*), a candidate perennial for biofuel feedstock, has a large range and is adapted to many environmental conditions. It can be grown on marginal lands unsuitable for other crops, and harvested many times without being replanted. There are morphological and physiological differences between switchgrass varieties that correlate with their productivity. Preliminary research suggests that diverse mixtures of these plants could have positive effects on productivity, including increasing resilience to climate change. This project asked how intraspecific biodiversity affects the growth of the Dakota variety of switchgrass, as well as the influence of the neighboring weed species on Dakota productivity. Dakota was selected because it was shown to be a low performing switchgrass variety in a previous study comparing traits of 12 different switchgrass varieties. Height, circumference, and SPAD were measured on Dakota plants in an experiment planted in summer 2016 in the KBS Plant Ecology Field Lab, consisting of 88 plots with 4 different switchgrass varieties and 11 biodiversity treatments. Change in height, circumference, and SPAD over time were calculated and compared between the 5 different biodiversity treatments for Dakota. These were monoculture, bi-culture (Alamo-Dakota, Trailblazer-Dakota, Cave-in-Rock-Dakota), and polyculture (all four). An inventory of neighboring weed species growing within the plots was also made, and a comparison of the change in height, circumference, and SPAD over time was also made between plots with differing weed species.

Mapping invasive species at the Kalamazoo Nature Center
Torel Beard, Michigan State University, FW419 (GIS)
Mentors: Dr. Alexandra Locher, Josh Green, and Lisa Vormwald

According to the Michigan DNR, invasive plant species can greatly diminish habitat quality, which has major economic and ecological consequences. These invasives can out compete native species, disrupt the food chain, disrupt mutualisms between native species, deplete the quality and opportunity for recreational activities such as hunting, backpacking, or wildlife watching, etc. Examples of a few invasive of high interest in Michigan are garlic mustard (*Alliaria petiolate*) and glossy buckthorn (*Frangula alnus*). Garlic mustard is an herbaceous plant that grows in wooded areas, and in the US, has spread throughout the Northeast, Midwest, and Northwest. It out competes other understory plants by producing allelopathic chemicals that hinder germination of other species. The Kalamazoo Nature Center, located in Kalamazoo County, MI, works with researchers and volunteers to manage the spread of invasive species. One method is by conducting garlic mustard pulls on KNC property. These are done wherever garlic

mustard patches are found; therefore, managers must note where garlic mustard is found along and off trails. The goal of this project was to use GIS to track the growth of garlic mustard patches on the KNC main property, and make a map showing the locations. The finished map is intended to aid managers in the removal of garlic mustard.

It's ok to be short and fat: temperature dependent evolution of cell geometry in a marine diatom.

Sophia Beery, Ohio Northern University, REU – Litchman Lab
Mentors: Daniel O'Donnell and Dr. Elena Litchman

All organisms must evolve to meet their resource requirements, given myriad environmental challenges. For example, when phytoplankton are nutrient-limited, they may become smaller to increase their surface area:volume ratio and enhance their ability to meet nutrient demands. Some studies have shown that cell size correlates negatively with temperature in phytoplankton, a possible adaptation to increase surface area:volume ratio for enhanced CO_2 uptake).

Diatoms are unique among phytoplankton in having a glass shell (frustule), a barrier to nutrient uptake that necessitates pores (punctae) through which to access nutrients. The frustule consists of two porous valves, joined by a typically non-porous girdle; in centric diatoms, the resulting shape is a near-perfect cylinder, with the valve faces forming the circular ends. We measured the marine centric diatom *Thalassiosira pseudonana* to examine the relationship between temperature and valve diameter versus girdle length in strains experimentally adapted to 16°C versus 31°C. We predicted that warm-adapted strains would have greater valve diameters relative to girdle lengths, compared to cold-adapted strains, regardless of cell volume. We also predicted that, when grown at warm temperatures, both groups would increase diameter:length ratios.

16°C-selected strains had larger cell volumes than 31°C-selected strains in nearly all cases. Evolved differences in length:diameter ratios were small and inconsistent between 16°C- and 31°C-selected populations, but length, diameter, volume, and their various ratios varied consistently across assay temperatures. While decreased cell volume may be an adaptation to warm temperatures, phenotypic plasticity in volume, length, diameter, and their ratios has apparently evolved little in these populations.

The experience
Paul Blakey, Michigan State University, URA – Landis Lab
Mentors: Andrew Myers and Dr. Doug Landis

I applied to Kellogg Biological Station (KBS) because it was a clear opportunity to move myself forward. Attending as an Undergraduate Research Assistant, a student, and a peer amongst other students and researchers, I received a wide array of new exposures. My main purpose for entering the program was to finally get that research and field work experience, but I also wanted to use the opportunity to develop as a person. I do believe I have completed both objectives thanks to the KBS community, my professors, and my mentor Andrew Myers along with the Landis Lab. Yet, in its conclusion I developed another. Which was to give higher exposure of the worth behind programs here at KBS through my experience. With more exposure, more aspiring scientist in state and abroad can experience a hand-on and realistic research environment.

The consequences of intra-crop defense diversity on insect herbivores
Nana Britwum, Cornell University, REU—Wetzel lab
Mentor: Dr. William Wetzel

Insect herbivory is detrimental to the production of agricultural crops. A key component of sustainable pest management programs is breeding and the use of crop varieties that are resistant to attacks by insects. This work focuses on average resistance levels in monocultures, but it overlooks the effects of plant trait diversity on insects. We investigated the consequences of intraspecific trait diversity in tomato (*Solanum lycopersicum)* for the preference of an important agricultural pest, *Trichoplusia ni*. We hypothesized that exposing larvae to a diet with intraspecific plant diversity would decrease insect growth and survival. We used *Solanum pennellii* x *S. lycopersicum* (cv. M82) introgression lines (ILs) to test larval preference. This system is ideal for testing the effects of intraspecific trait diversity on herbivore performance because the ILs have an M82 background, but only vary genetically at specific sites, which leads to variations in traits such as acyl sugars, terpenes, alkaloids, and trichomes. In the trials, we grew caterpillars on constant diets of one or two genotypes or forced caterpillars to switch between genotypes, and we recorded larval growth, survival, and development. Preliminary studies between IL 8-1-1 and IL 2-2 resulted in adequate performance on each monoculture, but the caterpillars had low performance when they were switched from one line to the other. The switching treatment mimics what happens when larvae move to a neighboring host plant in a field with intra-crop diversity. Focusing plant breeding efforts on diversity relevant to insect pests through incorporating intraspecific diversity holds potential for increasing the sustainability of agroecosystems.

Weed control in high stocking density pastures

Alycia Burch, Michigan State University – Intern, KBS Pasture Dairy Center and FW419 (GIS Applications in Natural Resources)
Mentors: Dr. Book Wilke, Howard Straub, Dr. Alexandra Locher, Josh Green, and Lisa Vormwald

Weed control is important in pasture based grazing systems of dairy cattle because if the weeds out-compete the grasses for important resources, there could be less nutritious feed for the cattle. To better understand how to manage an invasive weed, we need to locate where they are growing in the pasture. At the KBS Pasture Dairy Center, I mapped the locations of several problem weed species in a section of pasture for the lactating cows (Robot 1's pasture space). My hypothesis is that the distribution of weeds in Robot 1's pastures are more common along the fence line than in the middle of the pastures and that certain species of weeds are located in specific grass mixes. The methods that I used included GPS coordinates of specific weeds found and overlaying that on the outlines of the pastures in the software ArcMap. The results will infer whether or not the weeds are primarily located in the fence lines or if they are dispersed throughout the whole pasture and what types of grass mixes that the weeds are located in. This data will help understand the effect on the cattle's amount of feed in the pasture and to help to better manage the weeds.

Adverse effects of algal blooms on Lake Erie

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

Lake Erie has been experiencing a significant algal bloom problem over the past 10 years. The algal blooms have caused major concerns for the surrounding towns and cities, including limiting water use, and restricting recreational use of the lake. They have also had an impact on the ecosystems along the western shore of the lake. My objectives were to understand how the dynamic of the algae changes from year to year, and the possible warning signs leading up to these major blooms that cause problems. Spatial analysis was used to determine the extent of the coverage along the coast of Lake Erie, and to determine the effect on the local habitat. Land cover photos were used to specify what types of vegetation were present, and how much area the algae covered. The analysis showed that there was a major impact on the local ecosystem due to the extent and duration of the more severe algal blooms. However there was some evidence of patterns that could be seen through the years in question. These blooms have caused entire cities and townships to be unable to use their water, requiring citizens to purchase bottled water. The aquatic vegetation had also seen a dramatic change over the past 10 years of algal blooms; this is causing native fish to lose vital areas along the bank used for spawning and protection from predators.

A parasitic flatworm changes abundance on bluegill in different habitats. Sharon Carpenter, Michigan State University, URA – Evans and Mittelbacj Labs
Mentors: Robert Logan, Dr. Sarah Evans, and Dr. Gary Mittelbach

The black spot flatworm, *Uvulifer ambloplitis,* is a parasite of freshwater fish in Michigan. Though not generally harmful to fish (or the people who eat them), this trematode worm often infects bluegill (*Lepomis macrochirus*) and other fishes by burrowing into the skin. Once in the fish, *U. ambloplitis* transitions into its metacercariae stage that produces black pigmented cysts in the muscle of their host (hence their common name, "blackspot"). A previous study in a small pond from North Carolina suggest a correlation between the habitat preference of bluegill and the number of *U. ambloplitis cysts* per fish. To further study this relationship, I collected bluegill from Gull Lake to see if bluegill habitat use was associated with parasite infection. Bluegill were captured by angling in different habitats in Gull Lake and each fish was measured for length, body mass, and cyst abundance. The results of this study will help us better understand how the abundance of *U. ambloplitis* cysts per fish is associated with fish habitat use and if bluegill found in open water versus littoral habitats differ in the number of parasites they receive. In the future, this study could benefit research on managing parasitic relationships in lake ecosystems.

Impact of changing rainfall patterns on denitrification nitrous oxide reductase lag
Daimer Castro Vega, University of Puerto Rico Mayagüez, REU– Robertson Lab/LTER
Mentors: Kate Glanville and Dr. G. Philip Robertson

Climate change disturbs natural cycles in ecosystems throughout the planet. Increasing temperatures and changing rainfall patterns impact agriculture by decreasing crop yields, while increasing plant disease and soil degradation. Greenhouse gas emissions cause climate change. In the United States, the predominant greenhouse gas emitted is carbon dioxide (CO_2). However, since the Industrial Revolution emissions of other gases that have greater Global Warming Potential than CO_2 have increased. Nitrous oxide (N_2O) has 298 times the radiative forcing of CO_2. Managed ecosystems like agricultural fields are the main anthropogenic N_2O source.

Anaerobic conditions are favorable for denitrification, the process in which N_2O emission occurs. Denitrifying organisms perform the reduction of inorganic NO_3^- in a sequence of steps, catalyzed by different enzymes. Previous studies have shown that the changes in rainfall patterns influence the time enzymes take to become active. This results in slowing the denitrification enzyme induction, which allows for greater production of N_2O. This research focuses on the understanding of different rainfall patterns associated with climate change affecting the nitrous oxide reductase (NOS) enzyme induction during denitrification.

Rainfall manipulation shelters were used to create soils exposed to same amount of rainfall delivered at different intervals (2, 7, 14 and 28 days) in plots of corn vs

switchgrass. Previous results have shown a greater N_2O fluxes in the 28-day rainfall treatment. Results from summer 2017 measuring NOS will be reported. We test the hypothesis that longer periods between rainfall events will slow NOS activation. This will result in a greater N2O production.

The Widey Tidy Test: How active is the soil?

Brei Davies (Extension Intern) and Alycia Burch (KBS Dairy Intern), Michigan State University
Mentors: Dr. Brook Wilke and Dr. Dean Baas, Kellogg Farm and MSUE

The soil biology is crucial to obtain healthy plant life. To better understand the crop and soil interaction we must look at the activity of the soil in various settings. At the Kellogg Biological Station farm, we buried men's 100 percent cotton briefs in six different locations varying from tilled to no tilled fields, as well as fields with manure and no manure fertilizer. Burying these is a demonstration to show soil biology in relation to the cotton in briefs, which is a source of carbon. The soil microbes will eat away at the cotton which will give an estimation of soil activity. Our hypothesis is that manure fertilized in an annual crop system that is undisturbed (no till) will have the most soil activity. We expected to see more cotton eaten away from the briefs in the manure no tilled fields, rather than the tilled no manure fields. The methods we used included burying cotton briefs approximately six inches deep, drying the briefs for 48-52 hours and after drying weighing them to assess cotton loss. The results will show which combination of tillage and manure have on the soil activity. This data will help determine which soil types have the most activity and indicate whether or not that matters for crop success.

***Rhizobia* affects on nitrogen levels and herbivore consumption**

Lauren Davis, Alcorn State University, REU – Lau Lab
Mentor: Dr. Jen Lau

Bacteria, such as *Rhizobia*, can have a mutually beneficial relationship with leguminous (pea family) host plants. The benefit to the plant is that *Rhizobia* can fix nitrogen directly from the atmosphere and make it available to their plant. However, the different effects that the presence of resource mutualists can have on plant-herbivore interactions is unknown. To address this question, I inoculated mesocosms stimulating old field communities with 1.) High quality *Rhizobia* (6 mesocosms) or 2.) Low quality *Rhizobia* (6 mesocosms). Eight mesocosms did not receive any *Rhizobia* and acted as controls in this experiment. I found that both high and low quality *Rhizobia* increased chlorophyll content, indicating higher nitrogen in the leaves. I then placed five slugs in each of the mesocosms to determine whether the presence of *Rhizobia* has an impact on slug growth rates. I predicted that the mesocosms with *Rhizobia* would result in slugs having a higher growth rate. My results may show that nitrogen fixation continues to be

beneficial to plants as well as the herbivores that feed on them. Having higher nitrogen levels could possibly be harmful to the host plant, because it could attract more herbivores potentially causing a negative impact.

Effects of different rainfall amounts on N2O fluxes

Patrick Delisle, Westfield State University, REU – Robertson Lab/LTER
Mentors: Kate Glanville and Dr. G. Phillip Robertson

One of the contributing factors to global climate change is the 18% increase of Nitrous oxides in the atmosphere since the industrial revolution. The majority of the increase in N_2O in the atmosphere originates from agricultural soil emissions, and is the product of microbial activity in the soil. Climate change will impact rainfall patterns and Michigan is predicted to receive a higher frequency of precipitation events with greater intensity. Microbes in soils also respond directly to the water content in the soil. This study will simulate the effects of the predicted rainfall patterns in Michigan, and will analyze these effects on N_2O production from these soils. To do this, rainfall manipulation shelters will be placed into the corn field in the Great Lakes Bioenergy Research Center at the Kellogg Biological Station. The soils inside the shelters will be kept dry for 28 days and two different amounts of water will be given to simulate two different rainfall amounts. Gas samples will be taken with the static chamber method. I hypothesize that with larger rainfall events, there will be a greater degree of N_2O production, due to more active denitrifying microbes in the soil due to changes in the available nutrients in the soil.

Quantifying the abundance of extracellular DNA in soil

Francisca Donkor, Harris-Stowe State University, REU – Evans Lab
Mentors: Heather Kittredge and Dr. Sarah Evans

Dead cells are an important and often overlooked component of the soil environment. It has previously been shown that 40% of DNA extracted from soil can be from outside intact cells and considered to be eDNA. However, it is relatively unknown how management practices affect the abundance of eDNA. We quantified eDNA in fertilized and unfertilized deciduous forest plots at the Kellogg Biological Station's Long Term Ecological Research (LTER) site. We used a chemical treatment that isolates extracellular DNA from intracellular DNA and used quantitative PCR to determine the abundance of extracellular 16S rRNA gene copies in the soil. We hypothesized that disturbances such as nitrogen fertilization would cause cell death leading to an increase in eDNA. We found that fertilization actually significantly reduced the amount of eDNA in deciduous forest soil. We also found that eDNA is quickly degraded after soil collection. We speculate that degradation of eDNA is a result of enzymatic degradation or consumption after nutrient limitation. Future studies need to be conducted to distill the mechanisms behind eDNA degradation and to determine how the abundance of eDNA

changes in response to soil treatment. Together, these findings indicate that removal of eDNA before microbial community analysis may provide more accurate estimates of community function, treatment effects, and spatiotemporal patterns.

The effects of the Kalamazoo oil spill cleanup on river topography
Dan Durbin, Michigan State University, FW419 (GIS)
Mentors: Dr. Alexandra Locher, Josh Green, and Lisa Vormwald

In 2010, the largest inland oil spill poured hundreds of thousands of gallons of oil into the Kalamazoo River. The restoration project was extensive, and part of the process was dredging the river to remove the oil. One of the effects of this was the alteration and removal of some of the river's topography. Wetlands, islands, and deltas were lost. My objective was to use aerial imagery from before and after the spill to map and quantify the changes. I wanted to know what percentage of land cover has changed and how, what the lasting effects of this change were, and how did this effect the river's ecology. I used digitizing and land cover classification methods on satellite imagery from multiple years in multiple locations. I expected to see about a 50% loss in the size of the deltas and islands and a notable change in erosion altering the banks. This project could be extremely important in understanding the effects of restoration projects after large disasters. With more and more pipe lines being put in it's just a matter of time before we have another problem. This project will help us understand the repercussions of cleanup efforts and methods.

Talmadge Creek rejuvenation after the 2010 oil spill
Alexis Edge, Michigan State University, FW419 (GIS)
Mentors: Dr. Alexandra Locher, Josh Green, and Lisa Vormwald

Oil spills are extremely detrimental environmental disasters and measures are often not taken to prevent them. The 2010 Kalamazoo River oil spill is no exception. Most notably, the Talmadge Creek watershed was significantly impacted. Talmadge Creek wetlands host a diverse land cover that provides habitat to wildlife within the ecosystem. This land cover also contributes to the area's sustained drinkable water quality. Talmadge Creek feeds into the Kalamazoo River, the primary water source of Kalamazoo, Michigan. Polluted water is filtered through the wetland and released in a more purified state. Over 1 million gallons of heavy crude oil were released during oil spill in 2010, and as a result, land cover was greatly diminished. I conducted a spatial analysis to determine the trend of land cover rejuvenation after the spill using raster images of Talmadge Creek during 2008, 2012, and 2016. Training samples were collected for each land cover type between Division Drive and I-69 highway and classified respectively. The spatial analysis revealed that Talmadge Creek land cover had significantly decreased between 2008 and 2012. The 2016 data revealed that some forms of land cover had begun to reappear. This information is important to the

Michigan Department of Natural Resources; whose role is to monitor areas affected by the oil spill. Ecosystem productivity and water quality trends are directly proportional. This spatial analysis can aid in further efforts to rebuild the Talmadge Creek watershed, protect its wetlands, and hydrological system.

Priority of invasive species removal

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

Zebra mussels have found a home in the Great Lakes and many other bodies of water within Michigan. This is especially problematic as they're an invasive species that can cause significant ecological and economic complications. The goal of this analysis was to identify streams and rivers within southeast Michigan that should be prioritized for zebra mussel removal. The streams and rivers of southeast Michigan were chosen for this map due to their proximity to Lake Erie, which is the most heavily infested Great Lake with regard to zebra mussels. The objectives of this analysis were to determine which streams and rivers are infested with invasive species, and classify them as high priority, medium priority, or low priority. The priority of each removal class will be correlated to the number of adjacent tributaries to the infested river or stream and their proximity to areas of human settlement. I used spatial data from various sources in order to construct the necessary map, with the counties of southeast Michigan, their streams and rivers, industrialized areas, and zebra mussel location data. I expect that areas closer to Lake Erie will be more heavily infested, and that the majority of streams mapped will have this invasive species within them. Determining which areas have been most heavily affected by zebra mussels will aid efforts to control and minimize their effects on both human and ecological communities.

Hungry hungry… microbes? Effects of plant identity and nitrogen availability on soil microbes carbon consumption

Harry Ervin, Calvin College, REU –Evans Lab
Mentor: Tayler Chicoine and Dr. Sarah Evans

Nitrogen (N) is a limiting nutrient in temperate grasslands. When N is limited, plants compete with neighbors and microbes for N. Many plants exchange labile sugars, root exudates, as energy for bacteria which, in turn, improve N availability. Root exudates differ among species and change with environmental conditions. Shifts in exudate composition or quantity alter the microbial community, yet the rate or intentionality of changes is unknown. Studies on these interactions must minimize confounding plant-microbial feedbacks; this study explored two facets to improve the design and methods of future research. First, imbibing (cold water soaking) time, solution, and light conditions were tested to identify an improved method for sterile germination. Second, we investigated the short-term effects of Switchgrass, Big Bluestem, Black-Eyed Susan,

and N levels on soil microbe carbon consumption; changes in microbial carbon utilization could indicate exudates priming microbes to use specific compounds. We found the highest germination when Switchgrass seeds were imbibed at 4°C for at least 10 days, with a water solution, and in a lit growth chamber at 30°C. Results of the microbial test suggests that plant species may support distinct microbial carbon utilization; however more time is need to observe plant-specific selection. Black-Eyed Susan's microbial community utilized significantly more carbon sources. These results will improve sterile Switchgrass germination protocols and support a larger study investigating how N competition and neighbor identity influence soil microbial communities.

Lability of dissolved organic carbon leachates from disparate sources in stream microcosms

Rachel Geiger, Western Washington University, Bellingham, REU- Zarnetske Lab/LTER
Mentors: Dr. Jay Zarnetske and Dr. Joe Lee-Cullin

Organic carbon regulates nutrient cycles, energy transfer, and water quality in surface waters. Disparate sources of carbon are biogeochemically characterized their structure and signatures, resulting in differing optical properties (e.g., aromaticity) and lability (i.e., ease of degradation). Here, we tested how surface and subsurface waters degrade and change these sources of dissolved organic carbon (DOC) to examine how degradation was affected by the DOC signature. We used a batch reactor model to isolate the areas of potential DOC decomposition including microbial oxidation in stream water or stream sediment, compared to a control medium of ultrapure water. Concentrated solutions (leachates) were created out of elm leaves, tamarack needles, and flocculent material (floc) collected in Augusta Creek and from lab grade acetate. We predicted that acetate would degrade most rapidly due to its simple structure and known lability, while we expected floc to degrade slowly given its prior association and leaching time in the streambed where it was collected. Contained in amber jars, abiotic factors were limited. The results identified the elm and tamarack DOC sources as the most labile, with the stream water and sediment reactors producing the greatest amount of degradation. The floc leachate showed minimal degradation of DOC over this time period, while acetate did not exhibit expected degradation patterns, showing less decomposition as compared to elm and tamarack. Further studies will elucidate how different sources of DOC interact with the stream-groundwater interface, and the endmember characteristics of the DOC optical properties.

Induction of and use of nitrogen in exoenzymes produced by free living diazotrophs

Jonathon Hileman**,** Eureka College, REU – Friesen Lab/LTER
Mentors: Dr. Jeffery Norman and Dr. Maren Friesen

Diazotrophs are a type of bacteria in the soil microbiome that can convert atmospheric nitrogen to ammonia. This ability enables other organisms to access nitrogen. Bacteria also need nitrogen to make exoenzymes, a type of catalyst that works outside the cell to break down substances like proteins. We wanted to know if we could induce enzyme activity and where the nitrogen to build these enzymes came from. Having an answer to these questions could help agriculture how to best maximize production and give better insight into how these bacteria function. We used soil from the Kellogg Biological Station's Resource Gradient Cornfield to do this. We used the treatment with the lowest amount of nitrogen and the treatment with the highest amount of nitrogen. We took samples and inoculated half of them with gelatin and $^{15}N_2$ gas, which allows us to track nitrogen fixation, was added to one container per treatment per plot. After incubation, we used a microplate reader to analyze exoenzyme activity. We found that exoenzyme activity was higher in the samples that were inoculated with gelatin than the samples without gelatin. The fertilizer treatment did not affect the level of exoenzyme activity in any of the plots. ^{15}N incorporation data, which allows us to measure the response of nitrogen fixation to gelatin addition, is still in the process of being analyzed. This means that exoenzyme activity can be boosted by the addition of gelatin, even in the presence of fertilizer.

Extending science through the teaching community

Emma Hollowell, Michigan State University, Intern – KBS Science Ed & Outreach
Mentor: Kara Haas, KBS Education and Outreach

My summer experience as the KBS Science Education Intern has consisted of being immersed in the KBS community, leading and participating in teacher professional development, and broadening my horizons professionally and personally. My biggest project this summer was learning about the education community and helping with the teacher professional development program, Teaching Science Outdoors. From this program, I have learned how important it is to keep students engaged through learning. The program has also provided me with the tools to share with teachers how to alter their teaching styles to incorporate hands-on science. When creating presentations and lesson plans for teachers, I extensively studied the Next Generation Science Standards, referenced previous elementary schoolyard investigations, and became a master at iNaturalist, a citizen scientist project. From this research, I was prepared to lead Teaching Science Outdoors activities, educate teachers in iNaturalist, and prepare best practices for outdoor education. All my work over this summer has cultivated my love for outdoor education and given me new experiences and materials to go forth and share what I have learned with others.

The effect of freezing and fridge storage on soil nitrification

Wissam Jawad, Michigan State University, URA - Robertson Lab
Mentor: Di Liang and Dr. G. Philip Robertson

Studies of soil microbial activities would ideally be carried out with fresh samples. However, this is not always practical. Storing soil in a refrigerator or freezer before analysis is the common practice to keep microbial activity to a minimum, usually at 4°C and -20°C, respectively. Little is known about the response of microbial processes, such as nitrification, to different storing methods. In this experiment, we took soil samples from six ecosystems including two annual crop ecosystems, one perennial crop ecosystem, one prairie ecosystem, and two native successional ecosystems of the Long Term Ecological Research (LTER) site. Soils were stored in either a 4°C fridge or a -20°C freezer for a week and then thawed for either two or five days. We tested soil nitrification potential under these different freezing-thawing scenarios. The data shows that the conventionally managed ecosystem had a significant decrease in nitrification potential for both freezer and fridge methods. In general, the other ecosystems showed no significant difference in nitrification potential. This could mean that the microbial communities found in conventionally managed ecosystems are less resilient to change in the environment. Tilling and lack of cover crop in the conventionally managed ecosystem could be the major causes for the microbial communities to be less established, leading to less resilience to different storing methods.

Bird is the word: my internship in avian care

Brenden Kokx, Michigan State University, Intern- W.K Kellogg Bird Sanctuary
Mentors: Sara DePew-Bäby and Lisa Duke

I am Brenden Kokx and I am a Junior at Michigan State University. I am getting my bachelor’s degree in Fisheries and Wildlife Management, with a concentration in Wildlife Biology in hopes of someday working in National Parks. This summer I received the opportunity to work in Avian Care at the W.K. Kellogg Bird Sanctuary. This internship provided opportunities I would never have had otherwise, such as working with the MDNR to help band Osprey chicks. During my summer, I have been able to gain extremely valuable hands-on experience with various types of birds including; raptors like Bald Eagles, waterfowl like Trumpeter Swans, and gamebirds such as the Lady Amherst Pheasant. On a day to day basis I provided enclosure maintenance, practiced raptor husbandry skills, and fed and monitored the Sanctuary’s flock. I also was given the opportunity to learn glove training with the Sanctuary’s Red-Tailed Hawk. My project this summer was to help remove old waterfowl pens left over from Trumpeter Swan reintroduction to clean up the lagoon. I also helped build the new Bald Eagles’ shelter and propping, prior to going on exhibit.

Communicating science
Evan Kutz, Michigan State University, Intern - KBS Marketing and Communications
Mentors: Bethany Bohlen, KBS Marketing and Communications

My poster represents my summer as the Communications & Media intern, learning valuable skills relating to my career field of interest. This position provided unique work opportunities which advanced my hands-on experience, reinforcing my abilities in meeting the expectations of this field. I used professional equipment and editing software to produce a video on exciting research taking place here at KBS, learning standard development practices. As a result, this video is accessible to a general audience, intended to inform the public about an ongoing study granted by the US Department of Energy (DOE) while representing the KBS mission. I was taught ways to promote an organization's mission and brand through writing and media for promotional outreach. By using this experience to strategically create content, I can advocate environmental research to the public. This will help me advance my career science communication.

Landcover assessment at Kellogg Experimental Forest
Lucas Leibold, Michigan State University, FW419 (GIS)
Mentors: Dr. Alexandra Locher, Josh Green and Lisa Vormwald

It is difficult to grasp the entirety of an area when you are standing amongst trees in a forest, however, aerial imagery provides a unique perspective and analysis tool for these locations of interest. The purpose of this project is to produce a comprehensive and current land cover map of the Kellogg Experimental Forest, showing forest types and distribution of vegetation. As the last accessible land cover assessment was completed in 1990, and plantation list occurred in 1998, a current assessment will provide recreation enthusiasts and the academic community with an encompassing display of what species exist on this property today. With this information foresters and researchers through KBS and MSU will be able to assess which locations on the property can be managed for wildlife habitat or research. For this project I used the Michigan State University network and ArcMap, and high resolution 1x1 m satellite imagery of Michigan, from 2016. Infrared imagery shows reflectance from land cover with unique values. With minimal ground truthing I set standards for each reflectance and compiled the data into a functional and accurate representation of the forest. The complete assessment shows the distribution of land cover types such as hardwood, deciduous, coniferous, and open land in Kellogg Forest. As this 716 acre forest is utilized by the public, as well as for genetic and breeding tree research, this map will help to facilitate outreach as well as accessibility.

Rapid evolution does not affect decomposition rates of *Chamaecrista fasciculate*
Andrea Lescoe, Michigan State University, URA – Lau Lab
Mentors: Susan Magnoli and Dr. Jen Lau

Rapid evolution, or evolution that occurs on a timescale observable by humans, has been shown to occur in many different species across a wide range of ecosystems. However, less is known about how rapid evolutionary changes in a population can affect ecological factors such as species interactions or ecosystem processes. In a previous study two recently restored populations of partridge pea (*Chamaecrista fasciculata*) were compared to their original source population. Evidence of rapid evolution was found in these populations in the form of flowering time changes and increased root nodule production. In this study we examined whether these evolutionary changes had any effects on decomposition rates of *Chamaecrista* biomass. We predicted that populations with greater root nodule production would decompose faster. We placed litter bags containing biomass from *Chamaecrista* individuals from each population in the prairies where the populations originated to decompose for two months. We found that although decomposition rates differ between the prairie sites (Lux and Marshall) they do not differ between populations of *Chamaecrista*. This suggests that although populations have undergone evolutionary change this rapid evolution does not have effects on the decomposition rates for this species.

People, science, and social media: communicating KBS
Madeline Marquardt, Michigan State University, Intern – KBS Marketing & Development
Mentor: Sarah Carroll, KBS Marketing and Development

This summer at KBS, I worked to translate the KBS mission and communicate science to the public with the goal of strengthening relationships with both donors and the community. To meet this goal, I communicated about events, blogged, developed a social media campaign, and created a piece for the KBS annual report. I worked and gained skills in social media strategy, communicating science across various platforms, and working with a branded organization.

Land cover changes on family property from 1980 to 2017
Zachary Moon, Michigan State University, FW419 (GIS)
Mentors: Dr. Alexandra Locher, Josh Green, and Lisa Vormwald

During the late 1970s my grandfather purchased 104 acres in Dansville, MI. Originally it had about 60 acres dedicated to corn, and the rest of it forest. My family started to plant Christmas trees around 1980 on this property which greatly altered the land cover. In fall 2016 a timber harvest also took place which took out over 240 trees and created large gaps in the canopy. With this in mind, I examined land images dated back to when the trees were first planted on the property to compare them to the current condition. I

also examined the land cover change before and after timber harvests. I digitized the imagery in order to separate the land cover types such as open fields and the forested areas. I expect to see a much higher percentage of forested area versus non-forested in present day. This project is important because the property has been owned by my family for over 40 years and it will be interesting to see how much that land has changed over the years. By looking at a map as well as calculating the percent change in acres of each land cover type, we can see the influence we have had on the landscape.

Updated trail system map of Kellogg Experimental Forest

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

Kellogg Experimental Forest is a 716-acre plot of land operated by Michigan State University in Augusta, Michigan. It is used for various services such as research on tree breeding and genetics, maple syrup production, and public recreation. The forest itself contains a fairly extensive trail system that has not been digitally updated recently, leaving plenty of time for new trails to be created and old trails to become overgrown. For obvious reasons, this can be frustrating or even dangerous for those who enter the forest. My goal was to create a quality and detailed map that can be used by anyone to successfully navigate Kellogg Forest, and to help the foresters manage the land. To do this, I walked the trails in order to collect data via GPS receivers and displayed the data using ArcMap. I overplayed tracks and points onto aerial imagery, calculated trail distances, and labeled individual trails and important areas within the forest. Important map items included updated trail information, locations of various forest management information signs and other places of interest, trail names and distances, as well as trail quality. Once finished, it should prove useful to those who recreate and work in the forest, and even potentially to help emergency services locate those in need.

Local phenotypic differentiation matches environmental variation within stream and lake populations of rainbow darters

Daniel Oliveira, Clark University, Worcester, REU – Fitzpatrick Lab
Mentor: Dr. Sarah Fitzpatrick

Populations inhabiting varying environments often display differentiation associated with local conditions. Many well-known examples of local adaptation come from freshwater fish populations occupying different environments. However, local differentiation has rarely been documented in darters, one of the most species-rich groups of fish in North America. In this study, I examined fine-scale intraspecific variation in a suite of phenotypic traits across multiple populations of *Etheostoma caeruleum* (Rainbow Darters) that occupy different environments. Specifically, I quantified variation in thermal tolerance, body size and shape, body condition (length divided by mass), and parasite

load. We collected 18 individuals (range: 15-19) from five sites throughout the Kalamazoo River basin, including Gull Lake, one of the only documented lake populations of Rainbow Darters. DNA samples were collected from each individual for future work with restriction site-associated DNA sequencing. As hypothesized, I found a positive trend between water temperature and thermal tolerance. Darters from Gull Lake differed from stream populations in all measured traits, but phenotypic differences were also found among stream sites in thermal tolerance, parasite load, and body condition. These results showcase the first finding of lake and stream phenotypic differentiation across multiple traits within any species of darter. Eventually, the addition of genomic data will reveal levels of genetic diversity within populations and patterns of gene flow among populations, enabling an understanding of how gene flow contributes to the observed phenotypic patterns as well as the ability to target specific loci that are potentially involved with local adaption.

Do slugs (*Arion subfuscus*) have the hots for artificially warmed plant matter?

Elizabeth Postema, Denison University, REU - Lau Lab/LTER
Mentors: Dr. Jen Lau and Dr. Phoebe Zarnetske

Rising global temperatures have the potential to dramatically alter fine-scale species interactions. The feeding patterns of invertebrate herbivores, in particular, appear sensitive to warmer environmental conditions; previous literature suggests artificially warmed plants receive a higher degree of herbivore damage in the field. The mechanisms behind the effects of warming on invertebrate herbivory are influenced by a myriad of intersecting factors, from the herbivores' metabolic rate to the palatability and chemical composition of the plants themselves. As a part of elucidating these mechanisms, I tested whether a generalist invertebrate herbivore would prefer to feed on warmed or un-warmed plant matter when given the choice between the two. To determine preference, wild-caught *Arion subfuscus* slugs were exposed to two randomly paired *Achillea millefolium* samples: one leaf harvested from an open-top warming chamber, and one leaf harvested from an ambient (un-warmed) plot. After a 24-hour feeding period, I visually estimated the percent of each leaf eaten to the nearest 5%. Though there was no statistically significant difference between treatments, the data suggest a weak herbivore preference ($p = 0.09$) for the warmed *A. millefolium.* This weak trend may be due, in part, to differences in leaf C/N ratios between treatments; however, further analyses are needed to support this hypothesis.

Effects of experimental warming on locally extinct and extant prairie species

Katarina Renaldi, Michigan State University, URA – Lau Lab
Mentors: Meredith Zettlemoyer and Dr. Jen Lau

Since the Industrial Revolution, global temperatures have increased dramatically. Mean annual temperatures have risen 0.85°C since 1880, and will likely rise another 0.3-1.7°C

by 2100. Warming is expected to influence plant communities by altering growing season conditions and length, species composition, and growth rates. Extinction risk is also expected to increase with future rising temperatures, which will result in decreased biodiversity and lower the inherent value of an ecosystem. As such, we predict that warming may influence species declines in Kalamazoo County, MI. Studies show that extant species have faster growth rates relative to locally extinct species; these differences in growth rate likely contribute to population decline. Additionally, locally extinct species may demonstrate higher mortality and reduced growth in response to warming temperatures relative to extant species.. Using an experimental warming array at Kellogg Biological Station, we examine differences in mortality and growth rate in confamilial pairs of locally extinct and extant species under ambient and warmed (+3°C) conditions. Locally extinct species experienced significantly higher mortality (X^2=8.61, p=0.003) and reduced growth rates (X^2=11.92, p<0.001) regardless of temperature. Warming increased mortality (X^2=35.24, p<0.0001) and tended to reduce plant growth, indicating that climate warming could potentially influence local population declines. Therefore, global warming may contribute to species loss in Kalamazoo County. Predicting future extinction risk under warming climates will be critical to managing biodiversity.

Gibberillic acid and the flowering pathway of native and weedy radish

Daijah Scott, North Carolina A&T, REU – Conner Lab
Mentors: Ava Feirer- Garrison and Dr. Jeff Conner

Weedy radish, a direct descendent of native radish from the Mediterranean, is one of the world's worst crop weeds. The traits that make weedy radish such an effective crop weed and set it apart from its native ancestor are the ability to flower fast enough to reproduce between plowing and the harvesting of agricultural fields and the loss of a large overwintering rosette. We seek to understand how native radish evolved to become the dreaded weedy radish. Gibberillic acid (GA) is a plant hormone involved in the flowering pathway. We applied GA to our plants to see if it had any effect on our traits of interest, flowering time and rosette leaf number. The preliminary results show that GA has had an effect on the flowering time of the radish, as well as the number of rosette leaves. We found that with the application of GA, the number of rosette leaves on average, decreased. We also found that flowering time was faster in plants that had the application of GA. These results suggest that GA might have had an impact on the flowering time and rosette count in the evolution of native to weedy radish. This possibly means that the evolution of weedy radish from native radish was affected by GA which may have caused faster flowering to occur and the loss of overwintering rosette leaves. This helps us understand the mechanisms of how weedy radish evolved.

Analyzing the dynamics of thermal evolution in a marine diatom
Ayley Shortridge, Michigan State University, URA – Litchman Lab
Mentors: Danny O'Donnell and Dr. Elena Litchman

Life as we know it would not exist without phytoplankton: they support ocean food webs and provide roughly half the oxygen we breathe. Climate change poses a novel challenge to these important marine flora, and may drive rapid adaptation to rising ocean temperatures. In all microorganisms, population growth rates increase with temperature up to a thermal optimum, then decline rapidly. This results in a stereotyped asymmetric, unimodal curve: the thermal reaction norm. D. O'Donnell has maintained replicate populations of the marine diatom *Thalassiosira pseudonana* at 16 and 31°C for ~500 generations. After 350 generations, *T. pseudonana* showed significant divergence between the 16-and 31-selected strains in thermal optima and other traits. In this experiment, we compared thermal traits again after 500 generations to determine whether, and to what extent, evolution would persist. We monitored optical density over time to estimate population growth rates at 10 different temperatures, spanning the thermal niche of the diatom. Results indicate that the thermal optima of 31-selected strains increased dramatically between 350 and 500 generations, indicating that thermal adaptation was ongoing. This research will improve scientific understanding of how algae evolve in response to higher ocean temperatures. It will inform predictions about how climate change may impact marine phytoplankton and the living systems that depend on them.

Effect of nitrogen fertilization on extraradical hyphae in hybrid poplar stands
Khalilah Smith - Michigan State University, URA – Evans Lab
Mentors: Steven Gougherty and Dr. Sarah Evans

Mycorrhizal fungi are a part of the microbial community in soils that utilize extraradical hyphae to transfer mineral nutrients to plant roots in exchange for energy in the form of soluble organic carbon (C). Hyphae access soil nutrients and connect conspecific and heterospecific plants together to cycle nutrients. Mycorrhizae in soil is vital for plant mineral nutrition and maintenance of diversity, because with a healthy soil microbial system many plants could thrive. However, mycorrhizae are sensitive to changes in nitrogen (N) that result from human activities such as fertilizer application and N-deposition. To test the effect of N application on hyphal abundance we sampled stands of hybrid poplar clones (*Populus nigra x Populus maximowiczii*) in order to control for host genotype. We sampled at an ongoing marginal land experiments at Lux Arbor Reserve and Lake City Research Center. I collected twenty-four soil samples from each site in both N fertilized and unfertilized plots. Hyphae were extracted from soils, stained, mounted on slides and quantified using the grid intersect technique. We also assessed percent ground cover, along with nitrate and ammonium concentrations in soil. We expect our results to show that N fertilization has a negative effect on hyphal abundance across both sampling locations. Differences in hyphal abundance between fertilized and unfertilized plots can impact plant C allocation and more broadly affect the diversity of

plant communities. By gaining a better understanding of the impact of N fertilizer on microbial communities we can move towards better management of nutrient availability and composition in soils.

White-tail deer habitat suitability within the Allegan State Game Area
Nicole Timmreck, , Michigan State University, FW419 (GIS)
Mentors: Dr. Alexandra Locher, Josh Green, and Lisa Vormwald

There is a 10-acre parcel of red pine and oak forest in Allegan, Michigan. The land borders the Allegan State Game Area on two sides. The primary uses of this property are recreational deer and turkey hunting, but eventually a retirement home will be built on the property as well. The property owners have yet to develop a land management plan for their parcel of land. As responsible land owners, it is important that a thorough assessment of the land be executed so that the owners can confidently prioritize their goals for the area as well as have a clear guideline for maintaining the ecological integrity of the property. The main purpose of this project was to provide an initial habitat suitability assessment for white-tailed deer, which was necessary to determine how likely deer are to be in the area. To do this I used vector and raster data in ArcMap and a canopy cover assessment using iTree Canopy, a free online canopy cover assessment tool. Forest density was expected to be high since the Allegan State Game Area and private property have not been actively managed. Ideal habitat suitability for deer was expected to be sparse as dense canopy cover would shade out much of the forage and cover production potential at surface level. These assessments will help to guide the land owners in building a land management plan for the property and to determine how best to manage their land for higher deer population density in the immediate area.

Climate change, faster species, and food web instability
Tyler Treakle, The College of William & Mary, REU – Mittelbach and Zarnetske Labs
Mentor: Laura Twardochleb, Dr. Gary Mittelbach, and Dr. Phoebe Zarnetske

Water temperatures are forecasted to increase by 3 to 7 °C in Michigan lake ecosystems over the next century. Rising temperatures have direct metabolic effects on aquatic species, and indirect effects on their behaviors and trophic interactions. Current theory predicts that as temperatures increase, predator's attack rates will increase as a function of both increasing predator and prey movement rates. I studied how interactions between predatory *Notonecta undulata* with their prey species *Daphnia pulex* changed as a function of their movement rates with increasing temperatures. I hypothesized that *Daphnia pulex* velocity would differ significantly across a 10 - 40 °C temperature range, with its peak being 23 °C. This hypothesis was tested by collecting *Daphnia pulex* from ponds at Lux Arbor Reserve, Southwestern Michigan, acclimating them to various temperatures in growth chambers, and video recording their

movements to be analyzed with video imaging software. I used a one-way ANOVA test to show that there was a significant difference in velocity across the temperature range. I found that *Daphnia pulex* velocity increased exponentially between 10 °C and it's thermal peak, 37 °C, beyond which temperatures became lethal. Once changing *Notonecta undulata* velocity is determined using similar methodology, predation rates as a function of changing predator-prey movement rates can be more accurately modelled under climate warming scenarios. Understanding how predation rates will change with climate warming is crucial towards predicting trophic cascades and shifts in aquatic community structure over the next century, along with promoting more effective management of these systems.

The science of storytelling
Lauren Utykanski, Michigan State University, Intern – KBS Manor House
Mentor: Kara Haas, KBS Education and Outreach

In my symposium poster, I discuss my internship experience as the Environmental Education & Outreach intern at the Manor House. It was the goal of my internship to increase the visitation and exploration of the Estate, which is the main campus of the Kellogg Biological Station. This includes the projects that I have completed, as well as the experience of working and studying with peers and professionals of many disciplines and backgrounds. I have completed three main projects: a scavenger hunt game as a companion to the Historical Walking Tour brochure, a table tent design for McCrary Dining Hall, and a redesign of the KBS History website (history.kbs.msu.edu). To complete this portfolio of work, I studied KBS history, shadowed and led KBS tours, met with museum professionals from the MSU Museum and the Chicago Field Museum, designed documents and websites, and handled KBS artifacts, all while discovering how to best interpret the KBS legacy to a specific target audience.

Investigating *Daphnia pulex* locomotion in light of global warming
Jacob Wahl, Michigan State University, URA – Mittelbach Lab
Mentor: Laura Twardochleb and Dr. Phoebe Zarnetske

Surface water temperatures for freshwater environments in Michigan are expected to rise between 3-7°C over the next century and it is unclear how this warming will impact Michigan's pond ecosystems. Certain species traits such as locomotion may change with temperature, which could then affect the species dynamics of Michigan's ponds as a whole. In this study, I investigated how increasing temperature would affect the locomotion of *Daphnia pulex*, a planktonic crustacean and food source for many pond organisms in Michigan. I exposed *D.pulex* to a range of 3 different temperatures (10°C,20°C and 30°C) for 3 trials each. By watching a fixed point of reference, I was able to observe how many times they crossed it within a period of 20 minutes at a concentration of 8 individuals/200ml of water. The mean number of crosses/minute for

each temperature then served as the metric for locomotion. At first, it appeared that locomotion did increase with temperature. However, testing for heteroscedasticity revealed there was significant variance in the mean locomotion rate at each temperature. Running a Welch ANOVA test revealed that there was in fact no statistically significant difference in mean locomotion rates among the 3 temperatures. Although no significant relationship could be proven, it's possible that if more data had been collected, locomotion rates would be less variable and support a significant relationship. If locomotion does actually rise with temperature, *D. pulex* could interact with and be consumed by certain predators more than others, which could alter the structure of Michigan's pond food webs.

Litter decomposition: An examination of natives and exotics under global warming

Christopher Williamson, Clemson University, REU- Lau Lab
Mentor: Dr. Jen Lau

Litter decomposition is a contributor to excess greenhouse gas emissions and an important part of healthy ecosystem functioning. As this process occurs arthropods also play a role, contributing heavily to the breakdown of the litter. To understand the role of these processes it is necessary that it be studied wholly in its various ecological contexts. This research examined 1) the effects of global warming on decomposition 2) how natives and exotics differed in litter decomposition and 3) how arthropods affect decomposition of natives and exotics differently. The design of the experiment used biomass of 11 plant species (4 exotic, 5 native, 2 invasive) grown in both ambient and temperate field environments which were then placed into a warming experiment at the Kellogg Biological Station LTER site. Litterbags either had holes or no holes to include or exclude arthropods. The bags were weighed at the end of 3 weeks, then placed outside again for 10 days. So far, exotics decompose faster in both ambient and increased temperature environments in the litterbags both with and without holes. As exotics are a sign of the ever-increasing changes to our environment due to human activity, there is increased focus on their role in ecological functioning. Our current work shows exotic leaf litter not only decomposes faster than natives now but will continue to do so as temperatures increase. This work is important not only to our understanding of nutrient cycling and carbon storage, but also shows the effect of both exotic plant species and global warming on our ecosystems.

Environmental education internship

Taryn Withers, Michigan State University, Intern – Kellogg Bird Sanctuary
Mentor: Misty Klotz, KBS Outreach and Education

Environmental education and interpretation connects the public with the natural world in both formal and informal settings. While important at all ages, this kind of science education is especially important for young children because it helps shape a positive attitude towards nature from a young age. Informal environmental education uses interpretation to inspire kids to ask questions about the natural world around them, setting the foundations to make them curious and informed citizens in the future. As the environmental education intern at the Kellogg Bird Sanctuary this summer, I developed informal programs for various age groups, including the youngest children at Wild Wednesdays, the oldest kids at the KNC and Tollgate camps, and the adult visitors that I gave tours to. I also furthered my interest in working with animals by helping with avian care one day a week and training to handle Toby, the red-tailed hawk, on the glove. Through my experiences this summer, I have gained a better understanding and appreciation for interpretation as a means of communicating science, and I hope to work more with it in the future.

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