KBS K-12 Partnership

Fall Newsletter

Issue 16 Ecological Literacy in K-12 Classrooms November 2014

Inside

From the Directors

Dear KBS K-12 Partners,

The changing fall leaves have a special meaning for the K-12 partnership crew this year. As we enjoy the beautiful hues, we recognize this as the last year of the KBS GK-12 grant - and we are aiming high to achieve a golden last year! However, as with nature, we look forward to the dawning of a new spring. Though it may look a bit different, we expect the K-12 partnership will continue to grow and thrive with continued collaboration between partnership districts and teachers and KBS faculty, staff, and students. We are excited to share with you the activities of the GK-12 fellows in the classrooms this fall and the events we have planned in the following pages.

As always, we would love to hear from you. Contact the leadership team with any questions you may have and don't forget to visit our KBS GK-12 website at kbsgk12project.kbs.msu.edu for current news, event announcements, and lesson plans.

Until next time,

Tom Getty, Andy Anderson,
Phil Robertson & Sarah Bodbyl

GK12 Bioenergy Sustainability Project

http://kbsgk12project.kbs.msu.edu

KBS LTER
Kellogg Biological Station
Long-term Ecological Research

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The KBS K-12 Partnership (http://www.kbs.msu.edu/education/k-12-partnership) is supported, in part, by Michigan State University, and the National Science Foundation. Opinions expressed in this publication are those of the authors and do not necessarily reflect the views of these institutions.

Teachers come to KBS for research experience (RETs)

Five K-12 Partnership teachers spent the 2014 summer immersed in and contributing to KBS research as RETs. Funded by the National Science Foundation, the Research Experience for Teachers Program supports the active participation of K-12 teachers in research and education projects. A big thanks to the Lau and Litchman labs for hosting this year's teacher crew and to the KBS LTER for the majority of project funding.

My name is Connie High, I am a science instructor at Delton Kellogg High School. I spent the summer of 2014 in the Litchman Lab at KBS. I worked with several amazing people, including lab technicians Allyson Hutchens and Pam Woodruff, to continue the monitoring of water in Gull Lake, Lawrence Lake, and Wintergreen Lake. Monitoring included sending probeware from the surface to the bottom of each lake, recording temperature, dissolved oxygen, pH, salinity, conductivity, and chlorophyll. We also collected water to run tests on dissolved phosphorus, dissolved nitrogen, total phosphorus, and total nitrogen. In addition, a zooplankton tow was cast and organisms counted for each lake. I also had the pleasure of working with graduate student, Danny O'Donnell. I was able to help him with experiments on algae from Lake Baikal in Russia.

Hi, I'm Becky Drayton from Gobles Middle School. This summer I had the opportunity to work in Dr. Elena Litchman's lab. It was a great experience. I enjoyed meeting all of the people that work in her lab and I was fascinated by the amount of research everyone was involved in. I helped former GK-12 fellow Jake Nalley with his experiment on algae productivity. We put together several different combinations of algae to see which combinations would be the most productive. We then varied the temperature to see how a change in temperature would change the productivity of the algae. We had just finished all the sampling when the summer came to an end so I have not yet been able to see the results. I will be visiting the lab soon so I can see the results of the experiment. I am planning to get some algae samples from Jake to take back to my classroom. Middle school students do not realize that algae are plants and it will be helpful to have algae to experiment with.

Upcoming Events at KBS

November

11/12: KBS K-12 Partnership Workshop. Co-evolution and cross-cutting concepts. RSVP with Sarah at bodbyl@msu.edu.

11/19: Manners at the Manor. 4:30 – 6:30PM. Designed for students ages 5 to 13 years old, this course offers etiquette training by an industry professional. Cost is $13/person. A light snack is included. Reservations required. (269) 671-2160. kbs.msu.edu/manorhouse

11/21: Owl prowl. Join us on a family program night walk to listen to the sounds of the Sanctuary. Cost is $7/adult, $6/ senior or college student w/ID, $5/ages 2-17. (269) 671-2510. kbs.msu.edu/birdsanctuary

December

Weekends and various weekdays: Holiday walks, Manor house teas, and the Holiday Market. See MSU KBS Events Calendar for details.

KBS K-12 Partnership

2014 Summer Institute Review

This year's Summer Institute was a another smashing hit – full of fun, food, and of course, plenty of SCIENCE! Forty-one educators representing fourteen districts attended the three day event, held June 23 – 25.

Each day began with a plenary session highlighting current research at MSU; reviews hailed this year's trio of speakers as the 'best ever'! Dr. Gallant shared his delightful research on electric fish and how their shocking powers have evolved within and among fish lineages. Dr. White presented his research on evolution education, leading to an interactive Q&A session where participants shared various approaches teaching the subject. Dr. Urquhart wrapped up the series with an innovative talk promoting diversity in the classroom by linking it to his research on tropical biodiversity – with both types of diversity important for maintaining the vitality and function of classrooms and ecosystems, respectively.

Daily concurrent sessions, led by GK-12 Fellows, MSP/CarbonTime researchers, and partnership teachers, provided attendees with a plethora of new lessons and ideas for using current research to fulfill common core and NGSS standards in the classrooms. The sessions also gave this year's new crop of GK-12 Fellows the chance to introduce themselves and their science to the partnership. Session highlights reel (many more unmentioned): Helping hyenas disperse with least cost path modeling, growing plants in hydroponics systems, classifying soil using microscopes, monitoring phenological changes in local plants, and helping students determine whether or not the Pacific Tree Octopus is worth saving!

In addition to the typical concurrent session line-up, a brand-new plan for teacher-led, teacher-targeted sessions was unveiled to address current topics centered around the NGSS standards. In the upcoming workshop series, teachers will be sharing resources, tips, and experiences incorporating NGSS cross-cutting concepts into K-12 curricula spanning multiple subjects.

The summer institute was capped off by a cake and photo memories party celebrating 15 years of the K-12 Partnership!

Join us this fall, November 12, for the next workshop, titled, Co-evolution and Cross-cutting concepts. Hope to see you there!

My research focuses on all things soil related. Soil is the most biologically diverse habitat on Earth, containing millions of species of microbes. These microbes carry out all manner of important activities from decomposition to cycling of critical nutrients such as nitrogen. I work to understand how we can enhance soil biodiversity in farming systems and reduce heavy dependence on external inputs such as fertilizer. My research focuses on specific types of bacteria called Nitrifiers which play a pivotal roll in controlling how nitrogen flows through soils – either to plants or into the air or water as potential pollutants. The more nitrogen fertilizer we add to soils, the more Nitrifiers may consume, possibly leading to less efficient use by crop plants and greater nitrogen pollution. In addition to examining these minute processes, I work with Michigan farmers to understand how we can use a new generation of soil tests to guide growers towards better management. The goal of this work is to better understand how soil biodiversity shapes critical ecosystem processes, and to start to use this knowledge to inform better management of our crops.

Parchment and Gull Lake

By GK-12 Fellow Brendan O'Neill

As a new GK-12 fellow, I am learning a lot about how students think and respond to science at both Gull Lake Middle School and Parchment High School. As a way to introduce myself to the classrooms, I first asked students to participate in a 'draw a scientist test' (DAST). I gave students a blank sheet of paper and 5-10 minutes for them to draw what popped into their head when they thought of a scientist. Society has deeply held perceptions of what a scientist looks like and does. Most students stuck with common themes, including white lab coats, bubbling liquids, thick glasses and crazy hair. Most of the figures were male, indoors, and tended toward the 'mad scientist' theme of science. I then let students know that in my experience, I almost never see my colleagues in lab coats, let alone working with explosive chemicals. A lot of science is based on outdoor experiments and involves lots of teamwork among colleagues who are also enthused by their research. Science can be in a jungle in the middle of the Amazon, down the road at KBS, on a farmer's field, or in their back yard. I will ask the students at the end of the year to complete another DAST and see how their attitudes change.

Speaking of science in the backyard, my other activities at Gull Lake Middle and Parchment HS have centered around the Bioenergy and Sustainability (BEST) plots, established at each school. We talked about energy as fossil fuels and biofuel. Students were surprised to know how much of the corn growing in fields around Michigan goes to biofuel production (about half the U.S. crop). The BEST experiment focuses on alternatives crops for biofuel production, prairie and switch grass, that is either fertilized (or not) and harvested or left un-harvested. Using these plots we are examining how biodiversity changes given these three experimental variables. For the case of invertebrate diversity, most students had a thought about what plant types would have more insect diversity. However, the question of the effect of fertilizer on diversity caused some head scratching. These questions will take greater shape as we examine plant and soil characteristics on the plots in the coming months. As we engage in these activities, a goal will be to cross from a perception of science (and scientists) to participation and practice.

Gobles and Comstock

By GK-12 Fellow Susan Magnoli

My name is Susan Magnoli and I'm a second-year GK-12 fellow and a fourth year graduate student at KBS. This year I'm working with Becky Drayton at Gobles Middle School and Caleb Fisher at Comstock Northeast Middle School.

This fall has been filled with BEST plot protocols at both Gobles and Comstock. Mrs. Drayton's 7th and 8th graders did both the insect and plant biodiversity surveys in the two BEST plots at Gobles. Many of Mrs. Drayton's students remember helping to plant the BEST plots when they were 3rd graders, so they're excited to see what the plots look like now. Counting slugs from our pitfall traps proved to be a fun (albeit stinky) activity. We encountered some unexpected invertebrates right next to one of our plots—a rather large wasp nest—which cut our plant biodiversity activity short, but we hope to finish our survey soon. We also plan on harvesting biomass from the plots before it gets too cold.

At Comstock, Mr. Fisher's 7th graders did a great job with the plant biodiversity protocols in the BEST plots. Doing the biodiversity protocols tied in well with Mr. Fisher's lessons on classification and tree identification. Students learned how to use dichotomous keys by practicing with jelly beans (an activity from a previously developed GK-12 lesson), and then took dichotomous keys outside to identify tree species around the school. It's fortunate that Comstock is surrounded by lots of different tree species! Mr. Fisher and I are also excited to start a species interaction experiment with his 7th graders that we came up with during the summer institute. We plan to have students observe plant-insect-bacteria interactions in a simple experiment involving bean plants, slugs, and rhizobia bacteria that we will set up in the classroom. Students will ask questions, come up with hypotheses, make observations, and collect and analyze data from the experiment.

This year has been going well so far, and I'm excited for all the activities I'll be doing at both Gobles and Comstock for the rest of the year!

I study how plant species establish in new habitats. Understanding the environmental factors that influence species establishment is particularly important for understanding restorations and biological invasions. A basic question underlying restorations is 'how do we get this species to establish here?' Whereas with invasions the question is 'why is this species so good at establishing here?' The questions are different, but the explanations could be very similar. I'm particularly interested in how the genetic diversity of a colonizing population of plants affects their establishment success.

Much of my current work focuses on how the number of source populations contributing to a founding population affects establishment success. In other words, if a species is introduced to a new area, will it be more successful if the whole population comes from a single source population, or from several sources populations? Previous works suggests that multiple sources populations lead to better establishment, but we're not totally sure why. I'm conducting experiments with Partridge Pea (Chamaecrista *fasciculata*) to try and figure out what makes more diverse populations more successful.

As a community ecologist, I am broadly interested in the biological processes that control how and why we see species where we do. I conduct research primarily in freshwater ecosystems studying natural ponds in the field and in the lab using replicated miniature experimental pond units called mesocosms. I have also worked with the process of biotic invasion and homogenization in terrestrial plants and with the Lyme disease system. My current Ph.D. research centers on understanding the role of dispersal in shaping the dynamics of metacommunities (sets of linked biotic communities). Although understanding the causes and consequences of dispersal is necessary to understand how species distribute and sort across ecological gradients, it is difficult to quantify the simultaneous movement rates of multiple interacting species in many natural systems. My research has generated large sets of empirical data on hundreds of freshwater plankton and invertebrate species that can be used to refine how metacommunities are modeled to better understand (1) how dispersal alters community and metacommunity trajectory, (2) how species balance tradeoffs between dispersal and local community interactions such as competition, and (3) how the impact of dispersal varies across spatial and temporal scales.

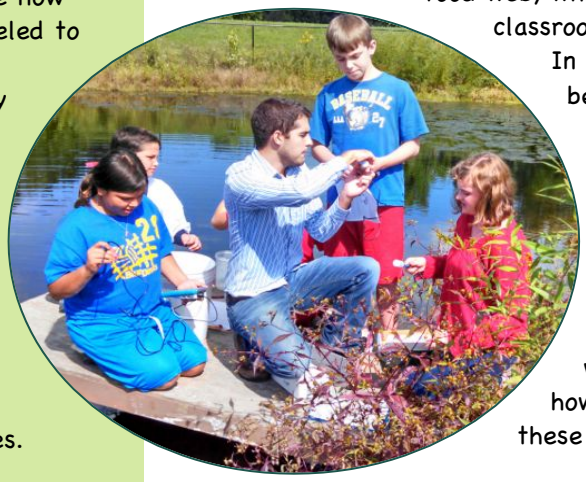
Lawton

By GK-12 Fellow Patrick Hanly

Hello, I'm Patrick Hanly and I'm a 5th year PhD student at Michigan State University and KBS. This is my first year working as a GK-12 fellow. I work two full school days a week in Marcia Angle's 7th and 8th grade general science classes at Lawton Middle School.

Although the school year has just started, Mrs. Angle and I have been hard at work getting our students outdoors for experiments and observations before winter hits. Both 7th and 8th grade classes started out the year by learning the scientific method and designing week long research projects centered on the pond located at Lawton Middle School. The 7th grade classes designed predator-prey experiments using backswimmers (a type of insect predator in ponds and lakes) that were fed different prey items. For example, one class asked whether camouflaged prey (phantom midges) would be less susceptible to predation than more conspicuous prey (mayfly naiads). The 8th grade classes asked questions about the relationship between habitat diversity and freshwater invertebrate biodiversity by placing out different types of leaf litter bags in the Lawton Middle School pond and then identifying and counting the species that utilized their bags two weeks later. All classes then finished executing the scientific method by sharing their data, making graphs of their results, and making claims about the validity of their hypotheses based on their evidence.

More recently, I have taken the students outside to do a full sampling of the biological, physical, and chemical factors of their school's pond. The students collected and identified aquatic and terrestrial insects, amphibians, and plankton, as well as the plants in and around the pond. They also measured dissolved oxygen, pH, chlorophyll a, and temperature. At the end of the exercise, the students produced posters of the pond's food web, which now hang in the hallway outside the classroom.



In addition to teaching biology, I have also been doing lessons on chemistry and physics. The class has covered why things burn, which included a demonstration where a dollar bill soaked in isopropyl alcohol and water was lit to generate a discussion about ignition and flame temperatures. I also led a lesson on the types of seismic waves generated by earthquakes and how we can use the differences between these waves to pinpoint epicenters.

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Harper Creek

By GK-12 Fellow Amanda Charbonneau

I'm at Harper Creek full time this year, and you can find me there every Thursday doing lab experiments, helping with lectures, and taking the kids out to visit the Biofuel plots. Speaking of which, we've put a lot of effort into getting all our BEST plot protocols underway while the weather is still nice. I took Mr. Converse's Biology classes out, and we caught and identified hundreds of insects that were prowling around the schoolyard. Later, Ms. Hawkin's biology classes and I ventured out and identified plants in the plots, and cut some down to measure just how much biomass we had accumulated this summer.

When we're not interacting with the out-of-doors, my classes have done all sorts of fun experiments and activities. Most recently, we all pretended to be carbon atoms, and wound our way through the ecosystem on an epic journey to see just where and how carbon moves. By rolling a die and consulting a rule card, each person went on a different journey through the ecosystem. From the atmosphere, you might get inhaled by an animal, pulled into a plant and used for photosynthesis, or just float around as CO_2.

We also spent a day getting slightly damp while transferring water from person to person down a long chain and into a collection bucket. Each student had a cup with a hole in the bottom, and everyone raced to get as much water as possible from one end to the other. In this activity, water represented energy flowing through an ecosystem, which leaks out at every trophic level due to things like generating body heat. This was to demonstrate, among other things, why any given ecosystem can only support a few top predators; the longer the energy chain, the less energy that can make it all the way to the end.

I'm really enjoying my classes and new students, and I'm looking forward to all the exciting experiments we'll get to do the rest of the year. Up next is microscopes! Then the fun can really begin.

Greetings! I'm a fourth-year graduate student in the Genetics department at MSU, and I'm excited to be starting my second year as a GK-12 fellow. By day, I'm a mild mannered scientist studying weed evolution, and how plants invade new ecosystems. By night, I volunteer at Potter Park Zoo, where I teach about ecology and conservation and train the birds of prey.

Do you hate weeds? Think of how quickly weeds sprout in your garden and how your driveway cracks and fills with undesirables. Weeds grow in all sorts of weird places, but have you ever seen rose bushes or tulips growing in the cracks of a sidewalk? So what allows weeds to live in new places?

I'm trying to understand how weeds can cope with new environments by studying the evolution of weedy radish. Unless you're a wheat farmer, you've probably never heard of weedy radish, but it's one of the worst agricultural weeds in the world. Of course, not all radish are weeds, there are really 3 types: weedy, crop and natives. These 3 types are closely related, but act very differently from one another. The weeds grow very quickly, and live only about 40 days, but the natives grow slowly and can live more than a year. The crops are in the middle, with some growing very quickly, and others acting more like natives.

By comparing the genomes and physical characteristics of these plants, I hope to determine which genes make the weeds different from the natives and where those genes came from. I also plan to compare these 'weed' genes to the ones in fast growing crop radishes, to see if radish breeders and natural selection used the same path to fast growth. My research will help us to better understand the origin of weeds, and may help us to find better ways to control them.

I'm very fortunate to work with Dr. Kay Holekamp and her decades-long spotted hyena research project in Kenya. My current research focuses on male spotted hyenas and how their dispersal process (moving from the social group a hyena was born in to another group in a different territory, with the hope of finding a mate) works. In spotted hyena society, males are at the bottom of the pecking order (and smaller than females, too!), so they sometimes have a rough time moving from one group to another. They can be aggressed upon by the females in the new group and also by other males that moved to the new group first and don't want other males moving there to compete for mating opportunities. Dispersing males also have to worry about getting killed by humans or lions along the way.

What I want to know is what male spotted hyenas are looking for when it's time to disperse. They're highly mobile so they have lots of new territories to choose from, but what are their criteria when comparing all of their options? Males don't always succeed when they try to join a new group either, so I also want to know what separates the males that succeed from those that fail. By answering these questions, I hope that we'll know a little more about how hyenas move across the landscape and what they need in their habitat in order to stay healthy and avoid becoming endangered.

Thornapple Kellogg

By GK-12 Fellow Andy Booms

Hi, I'm Andy Booms and I'm a first-year GK-12 fellow and a sixth year PhD student in the Department of Zoology. This year I have the pleasure of working with Jamie Bowman and Shaun Davis at Thornapple Kellogg Middle School.

I started off my year in the classroom by talking with all of my students about my research. While many people are familiar with spotted hyenas from things like The Lion King, fewer people know much about what these animals are really like and how wrong the Lion King reputation is. I always love the opportunity to show the true side of spotted hyenas through the photos, videos, and experiences I've collected. It also helps that I can catch students' attention by talking about my everyday life as a scientist in a remote part of Kenya – being stared down by a lion in the middle of camp, waking up to a herd of elephants right outside my tent, driving through a river and seeing a crocodile floating right outside my car window. I realize that not everyone shares my passion for wildlife research, but I hope that hearing what I do as a scientist will inspire students to follow their own passions just like I've followed mine.

I could spend lots of time talking about spotted hyenas if Mrs. Bowman and Mr. Davis would let me, but I realize that my role in the classroom requires much more than that. Over the course of the school year I'll be leading and assisting with various lessons and activities across the full range of science topics the students normally cover. For example, Mrs. Bowman's seventh graders recently began learning about the Earth's atmosphere. To get them started on the subject, I led them through an activity where they learned a bit about each layer of the atmosphere and then drew those layers to scale on graph paper, adding pictures of clouds, satellites, airplanes, and other things to indicate what goes on in each of the different layers. Students then scaled the atmosphere up to the size of the classroom and found that if we squeezed the atmosphere in vertically, the troposphere – the lowest layer, where we live and where weather occurs – would barely take up the space between the floor and the tops of our feet!

I look forward to working with Mrs. Bowman, Mr. Davis, and all of their students throughout the school year. Together, I hope we can spend lots of time "doing" science in ways that are fun and educational at the same time, and hopefully in ways that make science less scary and more enjoyable as a subject too. And if there's any time left I might try to talk about hyenas some more – I still have stories the students haven't heard yet.

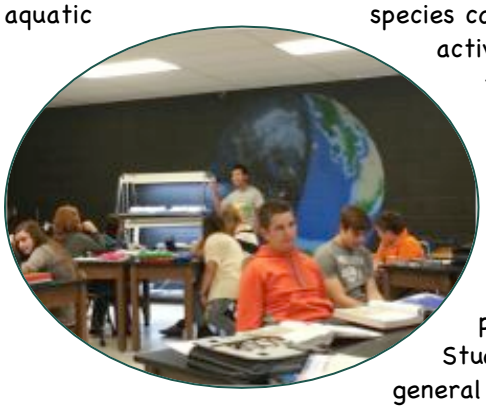
KBS K-12 Partnership

Plainwell

By GK-12 Fellow Di Liang

Hello! My name is Di. I am a third year PhD student. This year I am working at Plainwell Middle School with my partner teachers Mr. Green and Mrs. Wininger. We hope to together create an inspiring and interesting environment for science class. GK-12 means a lot to me because I have been dreaming of becoming a teacher since I was a child. I am very excited about this opportunity to share my expertise with my students.

My teaching for this year can be split into two parts. In Mrs. Wininger's class (6th and 7th grades), I will help to arrange several field trips for my students. My philosophy is that learning outside of the classroom is equally important as sitting at the desks, especially for science class! On field trips, students will be challenged to reflect on and understand what they have read in textbooks. On Oct 2, 2014, we had our first field trip to the Pierce Cedar Creek Institute (PCCI) for Environmental Education. With the help of the PCCI educator director and volunteers, our students learned how to classify macro-invertebrates in aquatic ecosystems and how to monitor water quality. Most importantly, they had chances to collect some initial data outside. My expectation is that students will form their own hypotheses from this data and test them with future return trips Mrs. Wininger and I have planned. Our goal is to help students to understand seasonal variations associated with water quality and aquatic species composition. We believe this activity will lead our students to think of water, especially the comparison between drinking water and lake water, in a different way.



In Mr. Green's earth science class (8th grade), we will practice hydroponics this year. Students at this level have had a general background of how soil forms and what constitutes soil. Although they are aware of the existence of elements in soil, the interactions between plants and soil nutrients, and the roles of mineral elements in plants (especially macronutrients, e.g. N, P, K, etc), are still unclear for most of the students. Mr. Green and I will first give lessons about hydroponics techniques. Then our students will grow plants in nutrient solutions that are lacking certain elements. Our goal is to have our students observe certain symptoms of nutritional deficiency when plants suffer from malnutrition, which will allow students to gain a better understanding of the functions of elements and fertilizers.

My research doesn't look very ecological: no birds, no plants and no lakes. That means you won't see me in Discovery cuddling a polar bear or a baby snake, crying over the loss of their habitats. Instead, I focus on isotopes—I study the intra-molecular distribution of 15N in nitrous oxide (N2O) molecules. So why should we care about isotopes? And why do I study a gas that is invisible? I have been continually asked these questions over and over again over the past few years.

So here is the deal: when you complain about the sticky and hot summer, a burning topic probably will float through your head—global warming. Global warming is caused by greenhouse gas and I happen to study greenhouse gas emission, yay! As you may know or not, there are multiple greenhouse gases, such as CO2, CH4, N2O and O3. My research is based on how to better control N2O emissions from soil.

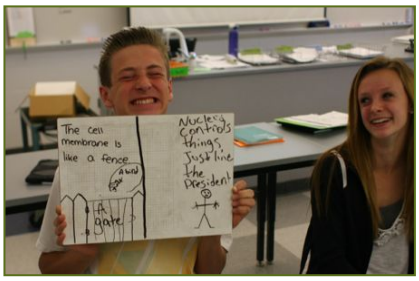
N2O emission: you gotta know when to hold 'em and when to fold 'em. To reduce the amount of N2O emitted from soil, I decided to start my research by tracking where N2O comes from. Considering most N2O is produced by microbes, it is important to gain some insights from the microbial world. Thus, the method I am using—isotopes, or more specifically, site preference—is a very effective tool of separating different sources of N2O from soil. My hope is that my research will be able to tell which biological process in the soil contributes most to the production of N2O so that further actions will be taken to reduce N2O gas emission.

Do you ever stay up at night wondering how agricultural liming contributes to the flux of carbon to our atmosphere and rivers? My research traces the fate of inorganic carbon as it is applied to agricultural soils as either crushed lime (calcium carbonate) to buffer soil pH or as bicarbonate dissolved in groundwater irrigation. In the soil these carbonates can act as either a source of CO_2 to the atmosphere or a sink for keeping CO_2 out of the atmosphere, but the relationship between nitrogen fertilizer amount, irrigation, and carbonate fate is not well understood. I hope to learn something about it through my research at the KBS LTER. I'm also interested in how groundwater irrigation is touted as an adaptation tool for farmers, however, the sustainability of groundwater resources in the face of climate change is not well understood, especially for those aquifers that rely on annual recharge. I will be doing interviews of agricultural irrigators in southwest Michigan to explore their perceptions of groundwater and how they make decisions about using it. I am excited that the GK-12 program gives me the opportunity to bring my enthusiasm for ecology and science to a high school biology classroom, and I hope the experience will help me become a better teacher and communicator of science to diverse audiences. Go Plainwell Trojans!

Plainwell

By GK-12 Fellow Bonnie McGill

Hi there! My name is Bonnie McGill. I am a new GK-12 fellow and a third year PhD student at Michigan State University's Kellogg Biological Station. I am working with Ms. Sandy Breitenbach and her Biology A (freshman biology) and AP Biology students at Plainwell High School. Before graduate school I worked for several years as a lab manager / research assistant in an ecology lab. I really enjoy the entire process of science—being inspired by the mysteries of nature, turning that inspiration into research questions and testable hypotheses, finding ways to quantify those mysteries, and generating results to share with others. I hope to share my enthusiasm for nature and science with the students and bring more data-driven class activities into Sandy's already top-notch biology classroom.



Throughout the year I plan on working on basic data analyses with the AP Biology students. Nearly every week they are in the lab collecting their own data—already they have collected data on Daphnia (a zooplankton) heart rates, optimal pH for lactase enzyme activity, and diffusion rates for model cells with different volume to surface area ratios. But collecting the data is only the beginning! Then we have to organize and analyze the data to answer the research question we designed the experiment for. I have done two lessons with the students introducing them to descriptive statistics (e.g. mean, distribution, standard deviation). Later we will learn about the chi-square test and the t-test.

Also, I did an activity with the freshman biology class where the students worked in groups to develop and draw analogies for different cell parts and their functions. Traditionally, learning about cell structure and function requires a lot of cold memorization. But analogies are a great way to apply knowledge you already have about something to something new and create new connections in your mind. The students seemed to enjoy this activity where they were able to let their creative juices flow (in a science class!). Highlights include: "Ribosomes are like an oven baking a pie" (the pie was a protein), "The Golgi apparatus is like a post office", "The DNA is like an instruction manual", and "Mitochondria are like a nuclear power plant".

Just in these first few weeks I have learned so much from Sandy and her students. It's going to be a great school year!

KBS K-12 Partnership

Olivet

By GK-12 Fellow Emily Dittmar

I'm excited to be returning for a second year as a GK-12 fellow! This year, I'm working at Olivet middle school with Russ Stolberg's 8th grade Earth Science classes!

To kick off our first lab, we dropped eggs in water as students were learning about density. In fresh water, eggs will float, while eggs will sink in very salty water. However, the older the egg is, the larger the air pocket it will have inside due to evaporation through the permeable shell. Therefore, we wondered whether it would take lower amounts of added salt to get older eggs to float in water compared to newer eggs. Mrs. Herlein was nice enough to bring in eggs for us to test from her own chickens, which she collected on different days throughout the week. I brought in some store-bought eggs, half of which were left out of the refrigerator for a week. It was a fun lab to do, although the students did learn one of the first lessons of real science- data can be messy! While no clear pattern was observed, the students had good ideas for possible improvements!

One of my favorite topics at the intersection of Earth Science and Evolution is fossils! To investigate how fossils are formed, I had students make their own fossils using clay and Plaster of Paris. Each class had a chance to go outside first to find items to fossilize. They came back with quite an assortment of leaves, sticks, fruits, acorns, ferns, and mushrooms! A snail shell and animal bone were among our most unique finds! Each student made an imprint of their item in the clay, and then filled it with the Plaster of Paris. When the plaster dried, the clay was peeled off, revealing the fossil! We discussed how real fossils are often formed in a similar manner, with minerals replacing the organic material over time.

Recently as the students were learning about earthquakes, they looked at data from real earthquakes that occurred in the last day or two around the world. The locations of these earthquakes were mapped to see if any patterns emerged and whether or not they could predict where earthquakes may be more likely to occur! They found them to be occurring around the edges of tectonic plates, which is a nice segue into their next unit where they will study tectonic plates and the history of the earth.

I study the process of adaptation and why a population adapted to a particular environment is typically unable to thrive in a different environment. It appears that there are limitations to adaptation because there are very few species that are able to be simultaneously adapted to multiple environments, but why is that and what causes these limitations?

It is thought that adaptive trade-offs are a driver of biological diversity, therefore understanding their mechanisms adds to an understanding of how diversity originates. Furthermore, having this understanding may help improve crop breeding for particular habitats, or help combat bacterial antibiotic resistance.

To investigate the mechanisms underlying adaptive trade-offs, I study a group of California wildflowers and their adaptation to a harsh soil environment. Populations of one species, Variable linanthus, grow on two different soil types in close proximity to one another. Despite this close proximity and the fact that these populations are interbreeding, when planted on both soil types, each population performs best on its native soil. I am investigating how and why traits that increase fitness on one soil type also decrease fitness on the other soil type.

My research involves many different methods, including fieldwork in California, controlled experiments in the greenhouse, and lab work to address trade-offs at the molecular level.

Tom Getty, Co-Director
Tom is a professor of behavioral ecology and the chair of the Department of Zoology at MSU. His research focuses on the role of information in various aspects of behavior, ecology, and evolution including: mate choice, aggression, cooperation, predator-prey interactions, and habitat choice.

Sarah Bodbyl, GK-12 Coordinator
Sarah is a postdoctoral research scientist at KBS and the Department of Teacher Education at MSU. Her interests are in mating system evolution, particularly of plants and birds, restoration, conservation, and science education. Sarah meets with fellows, visits schools, supervises the K-12 Partnership, maintains web pages, and plans workshops.

Charles (Andy) Anderson, Co-Director
Andy is a professor of science education in the Department of Teacher Education at MSU. His research centers on the classroom teaching and learning of science. He studies how students' prior knowledge, language, and social relationships affect their engagement in science learning and the development of environmental science literacy.

Phil Robertson, Co-Director
Phil is a University Distinguished Professor of ecosystem science in the Department of Crop and Soil Sciences at MSU. His research interests include the biogeochemistry and ecology of field crop ecosystems. He studies how nitrogen and carbon cycle in terrestrial systems and their impacts on crop yield, water quality, and atmospheric chemistry.

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