



Field Notes

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Tracking sediment and phosphorus in Iowa watersheds

By Billy Beck

It has been said that the condition of a stream is a direct reflection of its watershed. In other words, what we do to the landscape has a direct impact on stream water quality. Nowhere is this more apparent than in agriculturally-dominated states like Iowa. Over the past few centuries, intensive land-cover conversion (e.g., prairie to row crop agriculture) and hydrologic alteration (e.g., stream channelization) have left our streams unnaturally straight, erosive, and with elevated nutrient and bacteria levels. Yes, Midwestern streams have significant problems. Nonetheless, current stream conditions present an exceptional opportunity for research, collaboration, and problem solving.

A main driver of water quality issues is the amount and timing of water entering streams. In the past (pre-settlement), the extensive root systems of Iowa's tallgrass prairie and forests produced highly porous soils that could soak up rainwater with ease, before releasing it slowly to the stream channel in the form of groundwater. Now, we have converted a majority of these landscapes to agricultural fields, parking lots, roads, and housing. These new landscapes have much less capacity to absorb precipitation because of the increased amount of impermeable surfaces. In addition, the ubiquitous



Billy Beck uses a water level meter to measure groundwater depth within an in-stream well. The project utilizes over 20 groundwater wells to monitor dissolved phosphorus transport. (Photo by Matthew Streeter)

practice of artificial subsurface tile drainage in agricultural fields further hastens water delivery to streams by piping groundwater directly to stream channels. As a result, when rainstorms hit our state now, a great deal of water runs directly off the landscape and enters our stream network in one rapid wave. To accommodate this wave, streams need to evolve, and they do this by getting deeper and wider. Unfortunately, getting deeper and wider means one thing – massive amounts of erosion. Next time you cross a bridge, or hike in a streamside area, take a look at the

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streambanks. Many are vertical walls, with the stream channel itself, far below the land surface. These “Midwest canyons” are simply the stream’s reaction to what we’ve changed to the landscape.

The stream evolution process described above has many detrimental effects. First, the vertical streambank walls are highly unstable and prone to erosion and collapse. The large amount of sediment that enters streams from this process has negative impacts on aquatic habitat because sediment fills microhabitats and spawning areas. Excessive amounts of sediment also impacts drinking water supplies in the form of increased treatment costs and lowered storage capacity of reservoirs.

If that weren’t enough, phosphorus is commonly attached to sediment, and the sediment will move this ecologically-limiting nutrient throughout watersheds. Phosphorus is concerning because it has the potential to encourage algal blooms and eutrophication. Algae love phosphorus, and when excessive amounts of the nutrient are delivered to waterways, algal populations can explode. Blooms are problematic for two reasons. First, when the extensive mass of algae dies, a great deal of oxygen is consumed by microbes during the decomposition process. The most famous no-oxygen aquatic zone occurs annually off of the coast of Louisiana, and is commonly referred to as “Gulf of Mexico Hypoxia”, or simply “the Dead Zone”. Secondly, certain algal species produce toxins during blooms that are harmful to humans and wildlife. Blooms have caused many lake closures within the Midwest and Great Plains in recent years – many times during holiday weekends. In addition, while working in Kansas, I became aware of several hunting dog deaths caused by these algal toxins. These lake closures and threats of pet injury have potential to cause large financial hits to local recreation-based economies.

The project I am working on was initiated in 2013 to unlock the mystery of sediment and phosphorus behavior, and is titled: *Processes controlling the source, movement, and release, of soil phosphorus in Midwestern streams from pasture and cropland.*

The study focuses on the Walnut Creek watershed, located in Jasper County, Iowa. Walnut Creek is a warm-water stream that drains a 14,000 acre, agriculturally-dominated watershed. Walnut Creek is an exceptional setting for research, primarily because the Neal Smith National Wildlife Refuge is present within its borders. The Refuge is unique for Iowa, in that



Midwestern streams must now accommodate huge, near-instantaneous pulses of water following storms. Walnut Creek rose nearly 10’ following a late July event, and receded within 24 hours. Note the debris in the trees, indicating the high water mark. (Photo by Hanna McBrearty)

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The long-range goal of the project is to develop locally acceptable, economically-viable watershed management systems that enhance stream water quality while simultaneously benefitting agriculture.

a percentage of its landscape has recently been converted from row crop agriculture to native tallgrass prairie. The best thing about Walnut Creek, however, is that researchers have a near-continuous record of water quality data dating back to 1995 – a true rarity in watershed research!

The long-range goal of the project is to develop locally acceptable, economically-viable watershed management systems that enhance stream water quality while simultaneously benefitting agriculture. In a nutshell, our objectives are designed to identify areas in the watershed that contribute, and store, the greatest amounts of sediment and phosphorus. Once these are known, we can effectively target restoration efforts to these areas of the landscape, such as streambank stabilization. Working on these objectives requires year-round data collection – which is great if you, like myself, enjoy walking miles and

miles of streams under a wide range of weather conditions!

To answer how much sediment is coming from eroding streambanks, we have installed over 2,400 erosion pins on 61 severely eroding streambanks. The metal pins, which are 30” in length and the diameter of a pencil, are hammered into streambanks horizontally. Streambank erosion is assessed by measuring the exposed portion of pins, from a reference length, monthly and after large streamflow events. When installing the pins, we aimed for placing pins in three visible soil layers present in the vertical streambanks. These layers were deposited at three different time periods following the last glacial period in Iowa, and vary greatly in color, texture, and makeup. Knowing the erosive rates of each of these layers is key to identifying erosive hotspots.



Streambank pins, arranged in a grid, are used to monitor streambank erosion rates over time. Measurements of exposed pin length tell us how fast the bank is eroding. Morgan Davis, NREM Ph.D. student, points to two of the three distinct soil layers within the bank.

To investigate sediment storage in the channel, we are measuring channel cross sectional area, as well as the actual volume of sediment currently stored on the streambed. Channel cross sections provide an idea regarding how the shape of the channel changes over time. When we compared our 2014 cross section measurements to those taken from the same locations in 1998, we were able to confirm that the channel was still evolving (i.e., still reacting to landscape alterations from the past century), by getting

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wider and deeper.

Sediment storage was assessed by probing metal rods down until we hit a solid, less-erosive layer under the sediment. We covered 12,500 reaches throughout the watershed, and divided the storage up into stream feature categories (e.g., point bars, debris jams). We will repeat the assessment in a few years to judge storage change over time. We are also taking soil and sediment samples from all measured areas. Hundreds of samples are planned to be collected and analyzed for phosphorus and other soil characteristics such as bulk density.

It is our goal that the hotspot identification method become transferable to other agricultural watersheds across Iowa and the Midwest, and will act as the initial step towards collaborative, on-the-ground action to address water quality issues associated with sediment and phosphorus.



Joseph Klingelhutz (left), NREM undergraduate, and Billy Beck remove a soil bulk density sample from an eroded streambank. Hundreds of soil samples will be collected and analyzed for bulk density, phosphorus, and other soil parameters. (Photo by Hanna McBrearty)

Project funding is provided by the United States Department of Agriculture – Agriculture and Food Research Initiative (USDA-AFRI). Critical partners include the USDA National Laboratory for Agriculture and the Environment, the University of Iowa, the Iowa Department of Natural Resources, and the U.S. Fish and Wildlife Service.

Billy Beck is a second-year Environmental Science Ph.D. student, with Dr. Tom Isenhardt acting as his advisor. Billy holds degrees in Forestry (B.S.) and Forest Hydrology (M.S.) from Michigan State University and Southern Illinois University, respectively, and worked as the Water Quality Forester for the Kansas Forest Service / K-State Extension from 2010 – 2014.



Walnut Creek streambanks are composed of three very different soils, stacked horizontally like a giant layer cake. A key objective of the study is to determine the erosion rate of each layer. (Photo by Hanna McBrearty)

Using molecular ecology to inform wildlife research and management

By Lynne C. Gardner Almond

Ask most graduate students in the NREM Department why they chose a program in Natural Resources, and the majority will tell you that they want to work with animals and be outside. Not me.

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Field work is not always what it is cut out to be, and some of us just prefer the comfort of air conditioning, a soft mattress, running water, and being able to take daily showers over the rigors of field work. Instead we elect to spend endless hours at a bench top in a small room completely isolated from the daylight. Why? Because I am fascinated by our ability to use laboratory techniques in molecular ecology to understand things about animal populations that are nearly impossible to glean via field work. However, you have to use your imagination to conduct research in population genetics because you are working with things that can not be seen by the naked eye.

The field of molecular ecology has exploded over the past twenty years, and with it, our understanding of wildlife has deepened

considerably. For example, prior to molecular studies, it was the predominant assumption that many animals practiced monogamy. Using population genetics tools, molecular ecologists like me have found out that this is not true for most of those animals. Studies on animals ranging from birds to most mammals have identified multiple paternity as the norm, not the exception. This has not only changed the way wildlife scientists view animal mating behavior; it has also sparked several new lines of investigation in evolutionary biology regarding fitness and mating strategies. Thus, these types of studies can have far-reaching effects across scientific disciplines.

The tools of population genetics can be used to identify an individual for DNA profiling and fingerprinting, test for illegal smuggling or poaching of wildlife, understand social structure of wild species, examine movement across larger geographic scales, and many other things that just cannot be done using fieldwork alone. Although, things like relatedness can be inferred from behavioral interactions between individuals, relatedness can only be verified using molecular tools.

Relating Molecular Ecology to Wildlife Management

I began my journey as a wildlife ecologist as an undergraduate student studying timber rattlesnakes in the Ozark Mountains of Northwest Arkansas, but my involvement with

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population genetics studies began in 2003, when I started my M.S. program at Oklahoma State University in Stillwater. My project goal was to estimate the population size of black bears in the Ouachita Mountains of southeastern Oklahoma using non-invasive methods. These bears were moving west across mountain ridges from southwestern Arkansas in a natural recolonization event — which is rare in large carnivores.

The use of non-invasive methods — the collection of hair and feces of animals that are then subjected to forensic methods in order to extract DNA — has become very popular in wildlife studies of certain kinds of species. Non-invasive methods are mainly used on species that are too difficult or expensive to trap, like bears, elephants, otters, wolverines, lynx, and several others. There are several advantages to using non-invasive samples over those using traditional mark and capture techniques, such as sample collection, which is much easier and safer than traditional capture techniques for both handler and animal. For example, in field studies of black bears — concurrent with my study — we trapped individuals, which involved handling and administration of medication, tattooing of the animal, tooth extraction, ear tagging, and taking blood samples.

For the non-invasive portion of the study, we erected hair traps in a regular grid across the 3,420 km² study area in the Ouachita Mountains. Using only the information from non-invasive sampling of bears, we were able to estimate the population size of black bears by counting unique genotypes to establish hunting quotas, but we were also able to better understand their movement patterns across the study area.

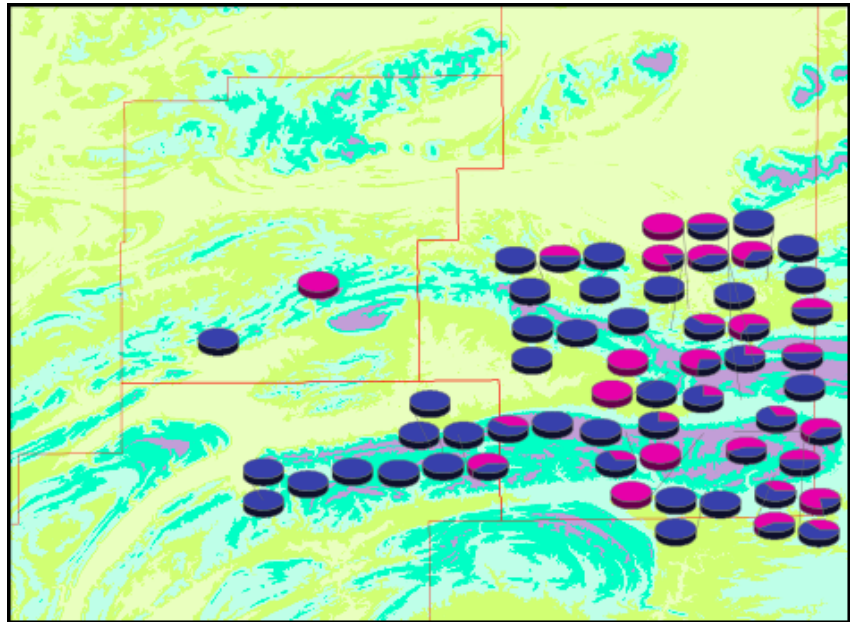


Figure 1. Proportion of male (blue) and female (pink) black bears initially captured at each trap during the 3-year expanse of the study.

We found that female bears were more concentrated near the state line, closer to the original Arkansas bear population, whereas males were distributed further west from the state line (Figure 1). These results align well with black bear ecology and social structure in which females form related groups that stick together and generally stay in one place, while males are the dispersers (social structure common to many mammals), and illustrates the power of using molecular tools to understand movement patterns in wildlife populations.

Besides providing basic information on natural movement patterns and demography of wildlife populations, genetic information can also be used to understand the ramifications of management actions by examining geographic distributions of dissimilarities in different types of molecular markers between individuals to elucidate patterns related to historical translocations. Due to unregulated hunting in the late 19th and early 20th centuries, many large game species were extirpated through vast areas of the United

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States. As a result, in the mid-20th century, huge efforts were made to re-establish populations of bears, deer, and many other game species via translocation of animals from known populations to areas where they once thrived, but individual translocation records from this time period are hard to find.

This was true of black bears in the central U.S., and is important information because the south central U.S. contains an endangered subspecies of Louisiana black bears. We were able to sample bear DNA from the originating populations in Minnesota and Canada and use molecular markers to determine that Louisiana black bears were not affected by translocation, but that the Arkansas and Oklahoma black bears were (Van Den Bussche et al. 2009).

As you can see, understanding animal movement, whether by natural or anthropogenic means, is important ecologically and for management purposes, and much easier to do across large geographic scales using molecular methods than when using small, concentrated field studies. Another very interesting way that understanding animal movement on a large geographic scale can help wildlife managers is the understanding of the potential for spread of directly-transmitted wildlife diseases. This is of particular interest to me, and is important especially when disease either affects game species of

economic importance, like white-tailed deer in Iowa.

At Iowa State University, my dissertation research involves the use of population genetics techniques to estimate the amount and extent of movement of deer in Iowa and the Midwest to understand how directly-transmitted disease is spread by deer on several geographic scales.

Specifically, I am using molecular tools to determine how deer movement patterns may influence the maintenance and spread of Chronic Wasting Disease (CWD), a fatal neurological disease of deer and other cervids that is transmitted both directly and indirectly via shedding of infectious prions. White-tailed deer move around more and move longer distances in agricultural areas, such as Iowa, and also aggregate when feeding on crops, both of which increase the possibility that disease will spread to other deer, livestock, and humans.

In this study, I attempt to elucidate relationships between deer population density, landscape factors, and levels of genetic structure in white-tailed deer across Iowa in order to better understand the potential for CWD spread across the state. I am also comparing genetic

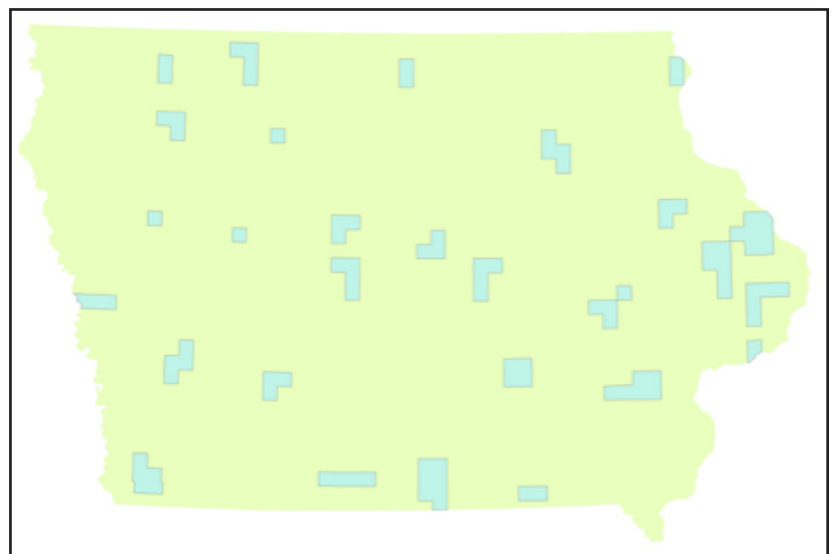


Figure 2. Locations of 29 sites across Iowa where white-tailed deer are being sampled to better understand connectivity of deer across the state.

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characteristics of deer among different areas to understand the amount and extent of deer dispersal. For example, the more genetically similar deer are from different areas, the more likely male deer are to carry directly-transmitted diseases across broad geographic areas since they are the dispersing sex.

On top of that, I am also estimating levels of relatedness between pairs of deer and comparing genetic similarity. I am trying to identify whether factors such as deer density influence structure of female social groups and thus influence the geographic scale of CWD transmission, since females tend to form related groups that stay in one area rather than disperse and closely-related females have higher contact rates with individuals within their social group than outside of their social group. If directly-transmitted disease is present, it will be concentrated within a very small geographic scale. I am currently sampling about 600 deer from 29 sites across Iowa (Figure 2) and around 400 deer from nine states in the central U.S. to address these questions. My goal is to help wildlife managers in the state Iowa and across the Midwest understand deer population connectivity and the potential for spread of CWD and other directly-transmitted diseases across broad geographic scales.

I know I probably have not won any converts from field work to laboratory work, but hopefully I have shown you the valuable contributions us “lab rats” can make to the field of wildlife ecology.

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References:

Van Den Bussche RA, JB Lack., DP Onorato, LC Gardner-Santana, BR McKinney, JD Villalobos, MJ Chamberlain, D White, and EC Hellgren. 2009. Mitochondrial DNA phylogeography of black bears (*Ursus americanus*) in central and southern North America: conservation implications. *Journal of Mammalogy* 90: 1075-1082.



Lynne Gardner Almond is a Ph.D. Candidate in Ecology and Evolutionary Biology studying under Dr. Julie Blanchong. She received her B.S. in Biology, cum laude and B.S. in Microbiology, cum laude from the University of Arkansas, and her M.S. in Conservation Science (Wildlife Ecology Emphasis) from Oklahoma State University. She is a broadly trained ecologist whose primary interest is the application of molecular tools to aid in understanding the dynamics of disease in wildlife populations.

NREM Welcomes New Faces

Dr. Michael Rentz

I come to Iowa State University as a committed educator, though this is not where I imagined my career would go when I was a student. Like many of our students I feel most at home outside, in the forest, the prairie, the marsh. I have a t-shirt with a quote I like: “I would rather be lost in the wilderness than found in the city.” This passion, or rather a core need, led me to study biology during college at the University of Minnesota-Morris. At Morris I learned more about the actual science of ecology, but also became more and more involved in the politics and activism of the environmental and social justice movements. I had a hard time separating out my desire to study nature from my desire to see it preserved.

After a few years working for environmental non-profits and an unsuccessful run for political office (if you can't beat 'em from the outside, beat 'em from the inside) I started in a Masters of Public Policy program at the University of Minnesota, with the aim of either working for the government as a natural resource policy analyst, or for an NGO as a policy advisor. Despite learning way more about policy, law, ethics, and social science than I ever expected, it became clear to me that what was most missing from policy discussions was an actual understanding of science. With that in mind I transferred from the Public Policy school to the PhD program in Conservation Biology. I wanted to marry my knowledge of policy and politics, my love of the outdoors, and my passion for science by becoming a staff scientist with an NGO, helping to shape positions on environmental issues by sharing the best science I could.

During graduate school I was lucky enough to be hired as a TA, and discovered teaching. Far from being

an onerous chore or just a way of making money, I found I really enjoyed it. After years of searching, and wandering down various career paths that never seemed quite right, I had finally found the reason I was put here: to teach. This satisfied all of my competing goals: to explore the natural world, to influence policy, and to make a difference for the natural world.

I am still enthralled with teaching, and have been able to practice my craft at five Universities. In addition to my teaching at Minnesota, I also held short-term adjunct positions at St. Cloud State and two private colleges in the St. Paul area. I hope I have my “forever home” here at Iowa State, but regardless of what the future brings I want to squeeze every drop of fun I can out of my experience here, and help as many students as I can. If I can do some research along the way, great. I do still love research, and I especially love chatting about it with students of all levels. So stop by and shoot the breeze!

I also retain my core need to get a wild “fix” now and then. If I am gone, I am usually GONE. And if you are going anywhere cool and want company...



Nitrogen removal in saturated riparian buffers: A hot topic

By Tyler Groh

Driving through the Midwestern states can be a bit of a boring drive. For instance, if you are cruising along I-80 from Des Moines to Chicago, what do you notice? Most people would say corn, field after field of corn. Today's society has created a demand for this dominant, single-crop system of agriculture. It is difficult to go into a grocery store and not find some product made from this tall, yellow kernel-producing plant. Corn is a profitable, multipurpose crop, but why does US corn production center around the Midwest? Simply put, it's all about the soil.

Simply put, it's all about the soil

In the Midwest, the dark soil beneath your feet is very fertile, and in Iowa, most of it is in the USDA taxonomic soil order of Mollisol. Mollisols are soils that have thick, dark surface layers that were formed under Iowa's historic prairie vegetation. The extensive fine rooting structure of prairies created soil with a high organic matter content. Because of this high organic matter content, Mollisols are among the most fertile soils in the world, and therefore are well suited for growing nutrient-demanding, high-yielding crops, like corn. Even with this high fertility, the Mollisols of the Midwest were not always ideal for growing crops. In fact, a large portion of the Midwestern corn belt used to be wet prairie, which was inundated with water for a good portion of the year. The poor drainage of these fertile Mollisols required the installation of artificial subsurface tile drains. Tile drains were at one time clay tile, however now they are perforated plastic tubes which allow for lowering of the water table and drying of these highly

productive Mollisols. Basically, tile drainage allows farmers in the Midwest to take advantage of the fertility of the Mollisols – ultimately to provide valuable feed and fuel.

Nonetheless, there are unintended consequences associated with using tile drainage. The main consequence is the loss of nitrogen fertilizer, as nitrate, from agricultural fields. Nitrogen applied as fertilizer can be readily leached from the soil as soluble nitrate if not taken up by growing plants. This leached nitrate can find its way into tile drainage pipes beneath agricultural fields, and ultimately empty into adjacent streams where tile drain pipes terminate. This excess nitrate in the environment from agriculture is considered a nonpoint source pollutant, a pollutant where the origin of the contaminant is not well defined.

Elevated levels of nitrate lead to both local and downstream problems. Locally, elevated nitrate levels greater than the Environmental Protection Agency, EPA, drinking water standard of 10 mg L⁻¹ in the surface water supply for Des Moines residents, means that the city's water utility company, Des Moines Water Works, must spend money to remove excess nitrate to meet the EPA standard. Because of these additional costs, Des Moines Water Works is currently suing ten drainage districts in three upstream counties, including Buena Vista, Calhoun, and Sac counties. Further downstream, where the Mississippi River empties into the Gulf of Mexico, excess nitrate leads to a large, low-oxygen zone at the bottom of the Gulf of Mexico, called the benthic hypoxic zone. This hypoxic zone is a rather inhospitable place to live because of the lack of oxygen present, and organisms unable to move away from this hypoxic zone can die. Both local and downstream nitrate issues have been

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gaining increasing attention in the past few years, and there has been growing support for nitrate removal practices in agricultural fields in the Corn Belt.

Nitrate removal practices can take place both in the field and at the edge of the field. In-field practices include: reducing the amount of nitrogen fertilizer used, improving the timing of the nitrogen fertilizer application, using nitrification inhibitors, using slow release nitrogen fertilizers, and applying a cover crop to the field in between the regularly rotated main crops (e.g., corn and soybeans). These practices can be tricky for the farmer to implement, and can involve changing the timeline of a farmer's cropping system. This is not to say that in-field practices are not useful; rather, farmers may be hesitant to use them if it means they have to change the way they farm.

Edge-of-field practices may be a more attractive alternative for the farmer that wants to reduce their nitrate loss without having to worry about altering their farming schedule. These practices include: drainage water management, wood chip bioreactors, constructed wetlands, two-staged ditches, and a new practice called saturated riparian buffers (SRBs). The main objective of all of these edge-of-field practices is to slow the nitrate-rich water down enough to allow some of the nitrate in the water to be removed through vegetation uptake and a microbial process called denitrification. This is the basis for my dissertation work.

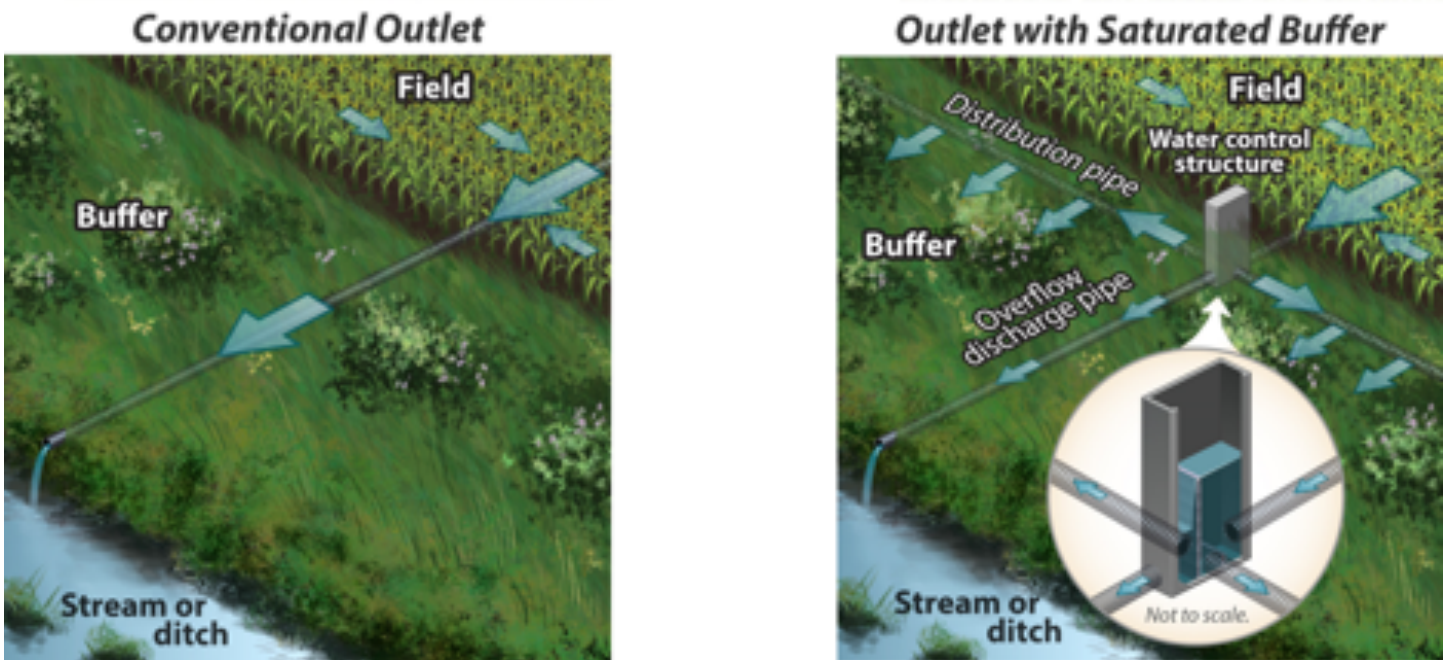
My main research work at Iowa State focuses on SRBs and their ability to remove nitrate. This work is funded with an Agriculture and Food Research Initiative (AFRI) grant through the USDA. The main objective of this project is to provide empirical evidence to the Natural Resources Conservation Service (NRCS) to upgrade the interim SRB standard practice to an official standard practice. This is necessary if this practice is going to be covered under cost-share, where a portion of the installation costs

...microbes use nitrate to "breathe" instead of oxygen in soils that have very low oxygen levels.

will be provided to the landowner. This involves doing research to understand how much nitrate SRBs can remove. I am not only interested in how much nitrate is removed, but also how it is being removed. There are two main pathways for nitrate removal, vegetation uptake and microbial denitrification. The microbial denitrification pathway is the only way to completely remove the nitrate from the system without converting it to organic matter and harvesting that organic matter from riparian buffers.

Microbial denitrification happens when microbes use nitrate to "breathe" instead of oxygen in soils that have very low oxygen levels. Microbes convert nitrate to nitrous oxide or dinitrogen gas, just like humans convert oxygen to carbon dioxide when they breathe. In order for denitrification to occur, microbes need access to nitrate, organic carbon, and low oxygen conditions. All of these conditions are potentially present in a SRB.

SRB designs may vary, but their basic layout is the same. Aboveground, a riparian buffer of grasses, forbs, shrubs, and/or trees is planted in a strip adjacent to the stream. Underground, a tile drain pipe coming out of an agricultural field perpendicular to a stream is intercepted by a control box connected to more tile running parallel to the field and adjacent stream edge, called a lateral tile. This control box forces water to flow through the lateral tile, parallel to the stream and eventually, the water seeps out of the lateral tile and into the organic-rich, topsoil of the riparian buffer. This places the nitrate in the tile water in contact with the organic carbon and microbes, while the water displaces the oxygen in the soil. Therefore, SRBs are prime locations for denitrification to occur and have high potential to remove excess nitrate from agricultural fields.



Layout of a saturated riparian buffer compared to a conventional riparian buffer. (Source: Christianson et al., unpublished.)

I am measuring denitrification using two methods. The first method involves taking soil cores down to 3.28 feet with a hydraulic soil probe attached to a tractor. This soil core is divided up into 5, 7.87 inch sections and is incubated with acetylene gas. Acetylene gas allows whatever nitrate that is denitrified to be converted to nitrous oxide, which is more easily measured than dinitrogen gas. Using this method, I can measure a rate of denitrification for each of the five sections of the core.

The second method involves using wells that are screened at a specific depth called piezometers. Using these piezometers, I can pump a solution filled with isotopically labeled nitrate into the ground, allow this solution to incubate, and then pump the solution out of the soil. The solution is analyzed for dinitrogen and nitrous oxide gas to determine the total rate of denitrification, minus any dilution from surrounding groundwater already present in the soil.

Both methods measure denitrification, but the piezometer method is an in-field method that allows denitrification to be measured in the soil conditions (temperature, saturation, nitrate concentration, etc.) for that specific day. The soil core method is an out of field method that allows denitrification to be measured external of soil conditions. It is part of my job to determine which method produces denitrification rates that are more representative,



Hydraulic soil probe mounted to a tractor. This unit is used to collect the 3.28 feet deep cores in order to measure denitrification.

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and ultimately describe what is going on with nitrate removal in the SRBs. In addition, since denitrification varies depending on the soil conditions of the SRBs, I am measuring the rate of denitrification as often and in as many places in the SRBs as I can, in order to provide an accurate rate of denitrification. This is a difficult and time-intensive task, but that is life in environmental science. The main goal is measuring denitrification, and the evidence of this rate has to be collected through hard work and determination.



Pumping the solution of isotopically labeled nitrate into a piezometer using a peristaltic pump.

This is a difficult and time-intensive task, but that is life in environmental science.



Tyler Groh is from Jackson, Wisconsin and is a second year Ph.D. student in Dr. Isenhardt's Lab. He received his B.S. (2011) from the University of Wisconsin Stevens Point in Watershed Management, and his M.S. (2014) from the University of Illinois Urbana Champaign in Natural Resources and Environmental Sciences. Tyler is interested in environmental biogeochemistry, and hopes to one day become a professor.

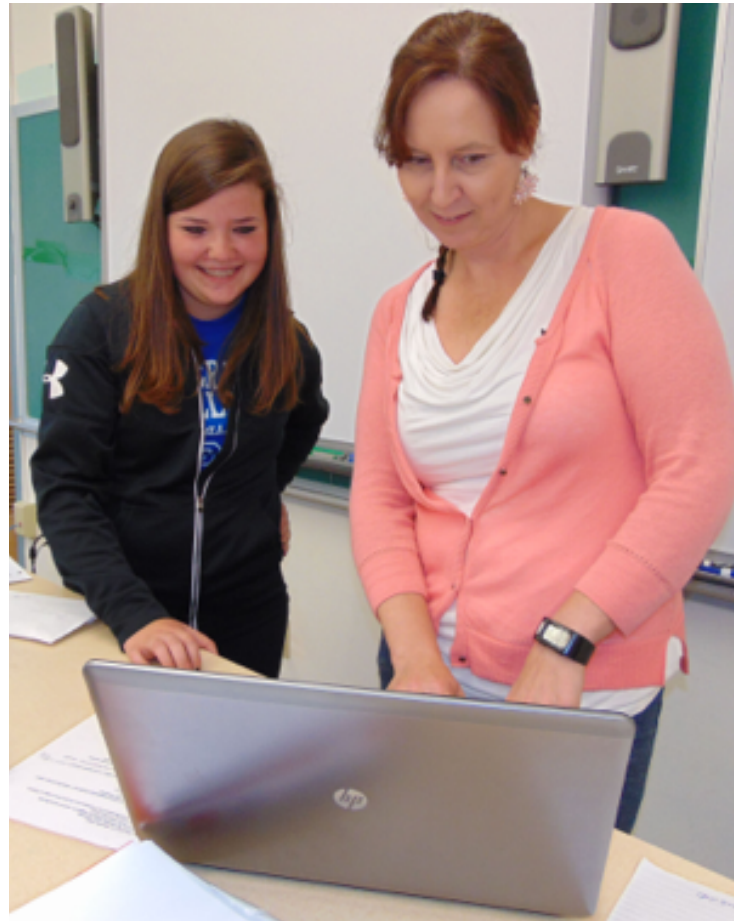
Where am I now?

By **Michaeleen Gerken Golay**

What seems like ages ago... 2007... I started my first “real” career out of grad school. I was working for Extension in the Midwest and running a nature center. I had a beautiful office on a lake in the woods and was excited to share all I had learned about ecology and natural resources during my Master’s in forest biology at Iowa State University. Oh my gosh, I knew so much then. I quickly realized there was more to my work than I was prepared for, especially in terms of communicating with the public about natural resource management.

I had to learn to put aside all the Latin names, the citations, and the standard deviations to tell a compelling, engaging story... to grandmothers, 4th graders, and CEOs. But I wasn’t about to dumb it down, I had to interweave research-based science in an approachable way to all ages. Grad school had taught me much about forests and ecosystems that I knew would be meaningful for all of these people, only I didn’t have the skills to write or speak about it in a way that they could get excited about. I had no idea about the challenges of outreach education.

A couple of years later, I was back to finish my PhD at ISU in NREM... (still passionate as ever, but more clearly focused on the type of education I wanted to do. More on that later!) With my work experiences still fresh in my mind, I knew I wanted to help fellow grad students who intended to pursue similar careers in public agencies or non-profits learn how



Working with a freshman in General Biology to input data from transpiration experiments.

to communicate their research to landowners, families, and voters in a way that was true and effective.

I also wanted to know what my classmates were up to. Foresters, animal ecologists, fisheries folk... we were usually out in the field or stuck in our labs. Many of us had a hard time finding

Many of us had a hard time finding time or figuring out how to share what we were working on and build collaborative relationships. We knew we should work together for a better ecosystem, but... how do we do that? And that was how Field Notes was born.

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time or figuring out how to share what we were working on and build collaborative relationships. We knew we should work together for a better ecosystem, but... how do we do that? And that was how Field Notes was born.

I had guidance from Dr. Rebecca Christofel who had been involved in a similar project at her alma mater, and support from my advisor, Dr. Jan Thompson who helped me understand the value of communication with the public and collaborative working relationships. I enlisted a few dedicated peers to join me in learning to write, edit, and present our research stories in an attractive, easy-to-read format. We wrote proposals for funding and prepared ourselves to ask the Chair for departmental support. We believed in our purpose and learned how to make it work. Many of us also gained leadership and organizational skills that would not only enhance our resumes, but help us feel confident in our future (and current) careers. We worked together to practice peer review and giving feedback, meeting deadlines and juggling priorities, building supportive teams and becoming leaders. I am very proud of those I helped train to take the reigns of Field Notes, and I eagerly read each new volume knowing the experiences are being passed on.

When I graduated with my PhD in 2013 (hey, back to me, since what the editors actually asked for was a “where are they now” piece...) I accepted a position teaching at Silver Lake College, and my husband Bryan, and I moved to northeast Wisconsin. I teach biology, ecology, environmental science, and even some animal classes to undergraduates. I get to learn along with my students every day, which is so exciting to me! I do outreach presentations to the public and am involved with several non-profit boards to continue to share what I’ve learned and provide guidance to organizations.

Some of my most rewarding work is mentoring students in their research and helping them learn how to share their stories, to communicate their passion for stewardship of the natural environment to the scientific community as well as their family and friends.

Some of my most rewarding work is mentoring students in their research and helping them learn how to share their stories, to communicate their passion for stewardship of the natural environment to the scientific community as well as their family and friends.

If you are reading this, you are a fan of Field Notes and the stories and research within it. I hope you see the extra effort these contributors have made to learn a new way to share their work. They are striving to become better professionals, better communicators, and better stewards of our precious natural resources. I hope future editions will find these folks where they need to be.



Students in Invertebrate Biology developed interpretive posters to hang in the public library.

Where are they now?

Recent graduates find exciting careers



Rayma Cooley completed her MS degree in Forestry in 2014. She studied vegetation recovery following wildfire in the Boundary Waters Canoe Area Wilderness in northeast Minnesota, working with Dr. Peter Wolter. Since graduating, she has worked for a season with the Sierra Cascade Ecology Program in the northern Sierra Nevada mountain range, for the USDA Forest Service. She is currently working in the beautiful Six Rivers National Forest in northwest California. As a Forester and Natural Resource Staff Officer, for the Forest Service, Rayma contributes to land management projects, including treating areas with disease, such as sudden oak death (*Phytophthora ramorum*); oak woodland restoration; timber projects; research; and as a Resource Advisor during wildfire events. She has recently submitted a manuscript for publication on the use of remote sensing images as a tool for quantifying early-seral forest structure with Dr. Peter Wolter and Forest Service Landscape Ecologist, Dr. Brian Sturtevant.

Dr. Pete Eyheralde received his PhD in Ecology and Evolutionary Biology from ISU in 2015. Under the direction of Dr. Sue Fairbanks, Pete studied the role of bison as seed dispersal agents in tallgrass prairie ecosystems. Currently, Pete is an Assistant Professor of Biology at William Penn University in Oskaloosa, Iowa. He teaches a variety of courses from introductory Biology courses and labs, to Ecology, Vertebrate Biology, Microbiology, Field Botany, and Outdoor Recreation. Pete also teaches an Ecology Field Trip course that studies local Iowa ecosystems and wilderness areas in the northern Rocky Mountains, by foot, kayak, and horseback. Pete is continuing with research of bison impacts to tallgrass prairie ecosystems, as well as working with undergraduate students on ecology projects involving spotted skunks, mammoths, and wildlife response to local habitat management.



Dr. Todd Ontl earned his PhD in Ecology and Evolutionary Biology (EEB) in 2013 where he worked with Dr. Lisa Schulte Moore and Dr. Randy Kolka (USFS Northern Research Station) studying soil carbon cycling in agroecosystems. His research looked at the root systems of bioenergy cropping systems and their interactions with soils to impact changes to soil organic matter levels. He is currently a post-doc in the School of Forest Resources and Environmental Science at Michigan Technological University, where he studies the impacts of climate change on carbon cycling and greenhouse gas fluxes in peatland ecosystems. Todd recently traveled to Senegal with his wife Kelly Boyer Ontl (currently a PhD candidate in EEB at ISU) to begin a project assessing impacts of gold mining on ecosystem mercury levels (pictured, sampling termites). Todd and Kelly enjoy many outdoor activities in the Upper Peninsula, including trail running, cross country skiing, and kayaking.

What's the buzz about the bees?

By Amy Moorhouse

Did you know there are over 200 species of native bees in Iowa? There are green bees, blue bees, sweat bees, bumblebees and many more! These bees are providing the key ecosystem service of pollination. Numerous native prairie plants require insects in order to reproduce as well as vegetables and some crops. But, did you also know that there is a general decline occurring in these bee populations? We've all heard about the honey bees and how they're dying, numerous newspapers and TV news shows are reporting on the issue. But, honey bees only represent one species and they are not native; they were imported here by European settlers. Much is known about the declines in honey bees, while little is known about what is happening to the 200 plus native species that previously had pollinated our diverse native tallgrass prairie plants.

Bees need pollen and nectar to eat and feed their offspring, they are active during the entire growing season foraging for these resources. Some species (e.g. several *Andrena* species) are active in the early summer from April to June, others like *Melissodes* species. are more active in the late summer from July to September. To maintain a sustainable bee community, it is important to have pollen and nectar available for them throughout the summer. Unfortunately, corn and soybeans, the main plant species in Iowa, provide little forage for bees. Bees need other flowers in order to survive and by planting a diverse mix of prairie plant species in the crop



Black Eyed Susan is a common prairie plant in bloom starting in June. It provides both pollen and nectar to many bee species and is found in many high diversity vegetation mixes.

fields, these prairie flowers that bloom at various times of the year could provide continuous pollen and nectar availability for bees for the entire growing season.

Most bee species do not nest in a hive like honey bees. The majority of species actually nest in the ground, while others nest in cavities or wood. For a bee to live in a particular area there must be food resources and nesting resources within a particular distance of each other, and that distance varies depending on the bee species. Bees can only travel so far from the nest to gather these resources and their populations will decline if there are not sufficient food sources near the nest.

STRIPS (Science-based Trials of Rowcrops Integrated with Prairie Strips) is a project through Iowa State University that incorporates

...by planting a diverse mix of prairie plant species in the crop fields, these prairie flowers that bloom at various times of the year could provide continuous pollen and nectar availability for bees for the entire growing season.

continued...



A contour strip consisting of only grasses between rows of corn. Without flowers, there are no food resources available to bees in this strip.

prairie vegetation into annual corn and soybean fields. The idea being that adding a small amount of perennial vegetation into annual cropland will provide disproportionately greater benefits to the land than the land area covered. The original study took place at Neal Smith National Wildlife Refuge in Prairie City, Iowa. While improving quality of soil and water in the crop fields, the strips also have potential benefits, such as providing habitat and food resources, for wildlife.

For bees in particular, the species found in the prairie strips in rowcrop fields at Neal Smith were compared to bee species found in nearby reconstructed prairie. There were equal numbers of bee species found between the two areas: a total of 107 over a two year period. Some bees have specific nesting or food requirements, such

as preferring wetlands or rare plant species which may not be available in these strips; finding 107 species is a good representation of the species that can utilize these strips of prairie vegetation. But if these strips are potentially providing habitat (as well as resources) for bees in a landscape that is near reconstructed prairies, how well do current contour buffer and filter strips of various vegetation mixes within corn and soybean fields provide habitat for native bees?

For my thesis I am looking at bee habitat availability in current Conservation Reserve Program (CRP) contour buffer and filter strips with various vegetation mixes within rowcropped fields. I have sites that range from all grass (brome) strips to strips with more than fifteen flowering species. Based on the first year of data, the more flowering species available in the strip, the more bees I found. Not only did the number of bees present increase, the number of species present increased as well. This means that more flowers provide more available habitats for different species to utilize. In landscapes with few floral resources, these small strips are important resources for the bees.

During the summer of 2014, 2,970 bees were collected representing over 106 species across ten sites. In 2015, 2,131 bees were collected representing over 99 species. I collected bees once a month from May through August to try to capture a range of bee species that utilize the strips throughout the growing season. I also used four different methods to collect bees. Bee bowls are small bowls filled with soapy water that are fluorescent blue, yellow and white. Bees are attracted to the color of these traps, and the soapy water prevents them from escaping. Blue vane traps are inverted funnels that bees will fly down into, and not be able to find their way out. I also used a net to “sweep” or collect bees. Non-target sweeping consists of swinging the net for a few minutes around flowers to see if I catch bees. Target sweeping, on the other hand, is spotting a bee and purposefully swinging the net to capture that bee. Using different methods for collection



of us like to hear the bees are dying, so why not help them out a little and plant some pretty flowers? It would be beneficial to the bees, humans, and ecosystem. Just imagine looking out across a beautiful landscape while hearing the soft buzz of happy bees in the background. What a world that would be.

Acknowledgement of Funding:
Farm Service Agency (FSA)

Bee bowls filled with soapy water attract a wide variety of bees. Once collected, these bees are washed, dried and pinned for taxonomic identification.

is crucial to ensure as many species are collected as possible because some species are only caught using one method.

There is no historic list of the bee species once found in Iowa. Without a historic list, it is hard to know which species we have lost due to environmental changes or how many species we have lost all together. As my preliminary data shows, adding more native flowers into contour buffer and filter strips within row crops can increase the number of bees and species of bees we find in the area.

Bees are important to the plant community because they are the major pollinators. But without the plants, there may not be bees. None



Without a historic list, it is hard to know which species we have lost due to environmental changes or how many species we have lost all together.

Amy Moorhouse is working towards her MS in Ecology and Evolutionary Biology. She is co-advised by Dr. Mary Harris and Dr. Brian Wilsey. She earned her bachelor's degree in Biology with an emphasis in Ecology and Evolution from Minnesota State University Moorhead in 2013. She enjoys studying and collecting insects of all kinds, but bees and moths have a special place in her heart.

Context is everything

By Zack Ruff

When people think of Natural Resources, they think of field work. We have a reputation for getting our hands dirty, focusing on the concrete and the applied. We carry pocketknives, wear hiking boots, get sunburnt and bug-bitten in the pursuit of data.

Some of us get out more than others, though. I have no field season as such. I work in front of a computer, trying to tease meaningful relationships from strings of digits using sophisticated statistical techniques. I enjoy the work, but it's all rather abstract. Data are essentially distilled information; analytically convenient, but devoid of any context or obvious significance. So you can imagine my excitement this July, when I had the opportunity to venture into the field and finally observe my study species in situ.

I was bound for the southern end of Phillips County, Montana. My traveling companion was Kevin Murphy, a former student of my advisor, Dr. Stephen J. Dinsmore. Kevin knows the land and the people of Phillips County, having worked there during the 2013 field season. Our mission, a thousand miles from home, was to locate and observe an elusive bird: the mountain plover (*Charadrius montanus*).

The mountain plover is a cryptic, ground-nesting shorebird endemic to dry, open landscapes of western North America, visually similar to the common killdeer (*C. vociferus*). Perhaps the most distinctive thing about this species is its breeding system, in which the female lays two

clutches of eggs in rapid succession, one of which is tended independently by the male until the chicks are ready to fly. This system occurs in only a few species worldwide and offers a unique opportunity to examine how male and female birds differ in providing parental care. More generally, the species offers insights into how animals have adapted to flourish in harsh and unpredictable environments.

The mountain plover prefers disturbed habitat, and plovers in Montana are very particular, nesting almost exclusively on colonies of black-tailed prairie dog (*Cynomys ludovicianus*). The prairie dogs' grazing activity creates a unique vegetation structure that affords plovers a clear view of the surrounding country, allowing them to more easily locate prey and spot potential predators. The study area comprises a collection of such colonies scattered across 1,150 square miles of public and private land where Dr. Dinsmore has been monitoring breeding mountain plovers for the past 20 years.

The landscape these birds call home is vast and, to the untrained eye, desolate. A sun-drenched expanse of gravel and scrub rolls away in all directions; the air smells of dust and sagebrush, often with a hint of smoke from distant wildfires. Everything out here happens on an epic scale, against which the casual visitor feels tiny and isolated. Montana's nickname of Big Sky Country takes on a mighty resonance: without any trees or tall buildings to break up the horizon, it's just you, the parched earth, and the unblinking void of space. Cormac McCarthy would love it out here.

For the mountain plover, learning to separate signal from noise in this environment is the difference between life and death.

continued...



An adult Mountain Plover sporting a unique combination of colored leg bands for identification. (Photo by Kevin Murphy)

Of course, this impression of emptiness is misleading. Sagebrush steppe is an ecosystem as dynamic as any other, and mountain plovers share their arid home with a variety of wildlife: bison, elk, pronghorn, mule deer, coyotes, jackrabbits, prairie dogs, rattlesnakes, burrowing owls, falcons, eagles... Spend enough time out here and you'll encounter most of them sooner or later. The community is surprisingly rich, but to understand it takes time and careful observation.

For visitors like myself, this observation can be quiet and contemplative. For the mountain plover – for any full-time resident – learning to separate signal from noise in this environment is the difference between life and death, for oneself and one's offspring. The shadow of a prairie falcon flickering across the brush, the rustle of a snake slithering over the rocky terrain, the angle of the sun, the air temperature, an approaching hailstorm – all of these are signals that figure vitally into a bird's ability to survive and reproduce.

Mountain plovers nest on the ground and, as with many shorebirds, the nest is little more than a shallow depression scraped into the dirt. A typical clutch includes three eggs and is

incubated for about a month. After hatching, chicks can run and forage almost immediately and will generally leave the nest within 24 hours. However, they cannot fly and must depend on their parent for guidance and safety for the first few weeks of life. There is little shelter from predators or the elements; survival is a matter of quickness, subterfuge, and luck of knowing when to run and when to hide.

Given these intense pressures, mountain plovers are not easy to find in this sage-scented moonscape. The population is sparse at the best of times and both the buff adults and mottled chicks are decidedly inconspicuous amid the dust and scraggly ground cover. The eggs, drab olive stippled with black, are practically invisible; there is a substantial risk of stepping on a nest even if



Zack banding a Mountain Plover chick. (Photo by Kevin Murphy)

continued...

I got in the habit of wishing each chick good luck as it went toddling off to rejoin its parent.

you know exactly where it is.

Thus, most of our trip was spent driving slowly from one prairie dog colony to another, constantly scanning for plovers with binoculars. On spotting one, we would look for leg bands. Unique combinations of colorful plastic bands, placed on birds' legs during the nesting season, provide a means of individual identification. This forms the basis of mark-resight analysis, which allows us to estimate a plover's chance of surviving from one year to the next, as well as overall population size. We can even use resighting of marked adults to estimate the survival of chicks, which often are not individually marked.

Seeing an adult with chicks is always exciting because it presents an opportunity to band more individuals. Unlike adults, which can simply fly away, plover chicks can be caught by hand. On catching a chick we band it, take various physical measurements to help determine its age, collect

feather samples for genetic sexing, and release it, none the worse for wear. Chasing down chicks is as fun as you'd expect, but it also hammers home just how vulnerable they are out here. I got in the habit of wishing each chick good luck as it went toddling off to rejoin its parent.

I was only able to spend a week in Montana, but in that time I gained a real appreciation for these birds and the land they inhabit. The mountain plover is not a game species. It holds no particular economic importance, and its conservation status, while not ideal, is not exactly urgent. But it is interesting. This is a bird with abundant charm and a unique ecology, a bird that makes its living in a harsh environment and has much to teach us about the study and management of species in similar climates.

More importantly, I developed an intimate, palpable understanding of what these data of mine actually represent. In tramping across the windswept Montana landscape and studying its inhabitants, I was really learning to see those strings of digits on my computer screen for what they mean, putting all those cold and intangible numbers back in a living, breathing ecological context. I was learning to be at home among the data like a plover among the sagebrush, seeing what really matters.

Zack Ruff is a second-year M.S. student in Wildlife Ecology, advised by Dr. Steve Dinsmore. His research centers on the reproductive ecology of mountain plovers. His primary interests are in wildlife conservation and population ecology.



Mountain Plover chick with brand-new leg bands.
(Photo by Keny Murphy)

Developing new tools to assess macroinvertebrate communities in prairie pothole wetlands

By Ryan Baldwin and Michael Sundberg

Driving across rural Iowa, the casual observer will see corn fields in all directions. However, this seemingly endless checkerboard of agriculture and gravel roads is dotted with small aquatic habitats known as prairie pothole wetlands. Currently few and far between, these wetlands once covered the landscape. Central Iowa marks the southern extent of a vast, formerly glaciated area known as the prairie pothole region (PPR).

The PPR extends through much of North America, covering an area of over 270,000 mi² (Dahl 2006). These wetlands provide important ecosystem functions that benefit both people and wildlife. For example, they intercept large amounts of surface water runoff, which reduces flood damage. Additionally, nutrients found in surface water runoff become trapped by wetlands, where they are processed by plants and microorganisms rather than polluting streams. PPR wetlands also provide critical waterfowl breeding habitat. Although the region only encompasses 10% of North America's waterfowl breeding area, more than half of the continent's ducks are hatched there annually (Kantrud et al. 1989)!

Despite their importance, destruction of PPR wetlands is widespread. As agriculture expanded across the landscape, wetlands rapidly disappeared. Within the past 200 years, over 50% of wetlands in the region have been drained

or filled (Euliss et al. 2006). This problem is especially severe in Iowa, where it is estimated that over 90% of wetlands that existed at the time of European settlement have been destroyed for agricultural development (Dahl 2006). Additionally, many remnant wetlands face a multitude of problems associated with altered land management. For example, pesticides entering wetlands from agricultural areas cause stress and, in some cases, mortality in aquatic organisms. Additionally, many wetlands have been invaded by large-bodied fishes such as black bullhead *Ameiurus melas*. Although this species is native to Iowa, early records suggest it was historically absent from PPR wetlands. Black bullhead are ecologically harmful in small habitats such as PPR wetlands because they stir up sediment while foraging. This leads to reduced water clarity, with cascading negative effects on native flora and fauna.

Due to these problems, the condition of many wetlands, which ecologists define as their ability to properly function and support a native biological community, has been impaired. In many cases restoration work may be necessary to improve wetland condition. However, effective wetland restoration first requires identifying specific causes of impairment. Thus, accurate assessments of wetland condition require measuring variables that are likely to change when wetland ecosystems are altered.

This problem is especially severe in Iowa, where it is estimated that over 90% of wetlands that existed at the time of European settlement have been destroyed for agricultural development (Dahl 2006).

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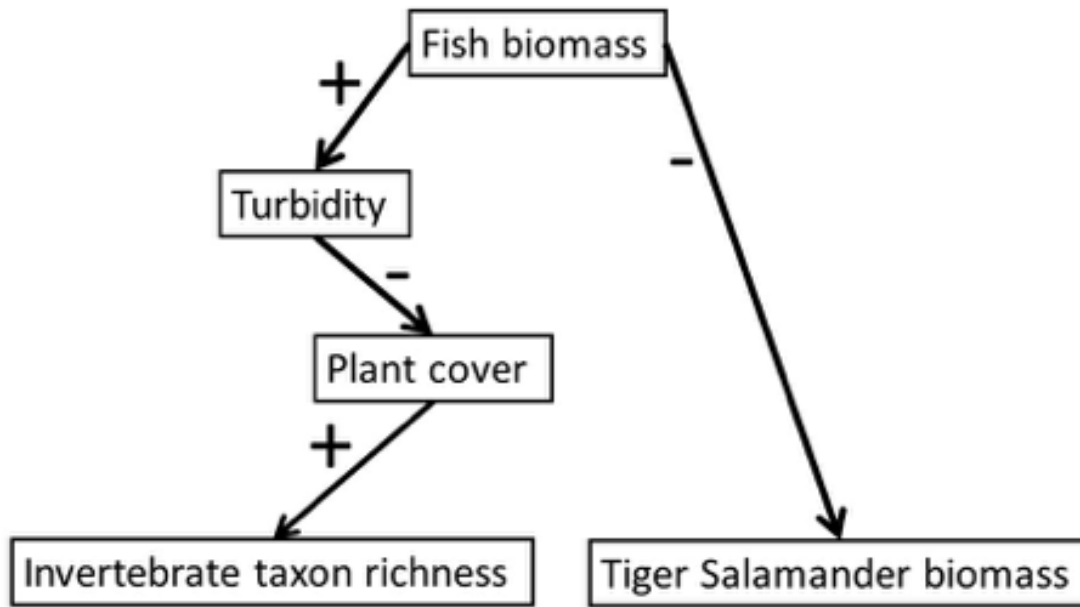


Figure 1. Relationships among variables previously identified as indicators of wetland condition (Mauer et al. 2014).

In 2011–2012, researchers at Iowa State University conducted extensive wetland surveys with the goal of finding variables indicative of wetland condition. They identified several variables that appear to be especially useful indicators. These included turbidity (a measure of water clarity), plant cover, tiger salamander *Ambystoma tigrinum* abundance, fish abundance, and macroinvertebrate taxon richness (Maurer et al. 2014; Figure 1). In this study, fish were found to indirectly reduce plant cover by increasing turbidity. They were also negatively associated with tiger salamanders and macroinvertebrates, likely due to predation and habitat destruction (Maurer et al. 2014).

Most of the variables identified by this study can be measured in the field in a matter of hours. However, measuring macroinvertebrate taxon richness poses a challenge. Despite the value of macroinvertebrates in wetland condition assessments, these organisms are often omitted from agency wetland assessment programs because samples require extensive amounts of time to process and there are no standard

sampling protocols.

As a result of there being no widely agreed upon sampling method, various agencies have adopted their own methods. This poses a problem because different devices are meant to sample different parts of the macroinvertebrate community. For example, some devices are designed to

sample the sediment, while others are designed to sample the water column. Additionally, some devices, such as sweep nets, are good at sampling multiple microhabitats but are not designed to cover a standardized area. This makes it difficult to compare macroinvertebrate communities between sites and between studies. An alternative device is the stovepipe sampler, a cylinder which covers a standardized area and collects invertebrates from both the sediment and the water column. Unfortunately, samples collected using the stovepipe sampler usually take more time to process due to having to pick through large amounts of sediment. Thus, refinements to processing stovepipe samples are needed to make

Despite the value of macroinvertebrates in wetland condition assessments, these organisms are often omitted from agency wetland assessment programs...

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MS student Ryan Baldwin collects macroinvertebrates from a stovepipe sampler (photo Michael Sundberg).

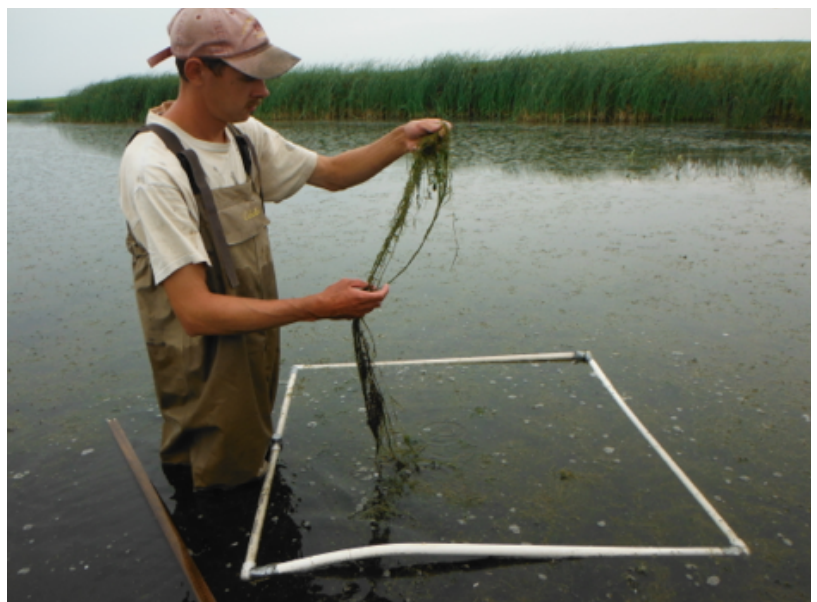
this method practical for wetland assessments.

In the previous study, it was observed that densities of large-bodied taxa such as dragonfly nymphs (order Odonata) and diving beetles (order Coleoptera) were more strongly related to changes in wetland environmental variables than small-bodied taxa such as aquatic earthworms (class Oligochaeta) and midge larvae (family Chironomidae; Maurer et al. 2014). This is likely because these small-bodied taxa are generally numerically dominate in wetlands regardless of their condition (Hentges and Stewart 2010; Maurer et al. 2014). Because of this, we are testing the hypothesis that the diversity of larger macroinvertebrates will be more strongly correlated with other wetland condition variables than diversity of the entire macroinvertebrate community.

In 2014 and 2015, we used a stovepipe sampler to collect macroinvertebrate samples from 45 wetlands in North-Central Iowa. These wetlands were selected based off previous data, satellite images, and personal observations from site visits in order to represent a strong gradient in wetland condition. Collecting each field sample

could be done in a matter of hours. However, the real time investment began in the laboratory. Macroinvertebrate samples were washed through a series of four different sieve mesh sizes to separate large-bodied taxa from small-bodied taxa. On average, it took one person working 40 hours to pick all macroinvertebrates out of a single sample. However, some samples took over 100 hours to process! Fortunately, removing the smallest sieve mesh size would save approximately 14 hours per sample.

Results from the samples processed so far indicate that taxonomic richness of macroinvertebrates retained by the smallest and second-smallest sieve mesh sizes are both strongly negatively correlated with turbidity and large-bodied fish biomass. When other variables are used, such as Simpson's diversity index, the diversity of macroinvertebrates retained by the largest sieve mesh size is most strongly negatively correlated with turbidity and large-bodied fish biomass, and positively correlated with plant cover. Both of these results suggest that if macroinvertebrates retained by the smallest sieve mesh size are ignored, saving time, macroinvertebrates could still be used as



MS student Michael Sundberg identifies aquatic plant species in a sampling quadrat (photo Ryan Baldwin).



Invertebrates were washed through a series of four sieves to separate out different size classes (photo Ryan Baldwin).

meaningful indicators of wetland condition. Our hope is that after all samples are processed, we will be able to recommend a method of quantifying macroinvertebrate taxon richness that is both time-efficient while still providing valuable insights into the condition of inland freshwater wetlands in the PPR and beyond.

This project is funded by the United States Environmental Protection Agency and could not be completed without assistance from numerous individuals from Iowa State University and the Iowa Department of Natural Resources.



References:

Dahl TE (2006) Status and trends of wetlands in the conterminous United States 1998 to 2004. U.S. Department of the Interior, U.S. Fish and Wildlife Service, Washington, DC

Euliss NH, Gleason RA, Olness A, McDougal RL, Murkin HR,

Robarts RD, Bourbonniere RA, Warner BG (2006) North American prairie wetlands are important nonforested land-based carbon storage sites. *Science of the Total*

Environment 361:179-188

Ryan Baldwin is a second year MS student in environmental science advised by Dr. Timothy Stewart and Dr. Michael Weber. He received his BS in fisheries and wildlife management from Lake Superior State University in 2014.

Michael Sundberg is a second year MS student in fisheries biology advised by Dr. Timothy Stewart and Dr. Michael Weber. He received his BS in animal ecology from Iowa State University in 2012.

Learning how to have our cake and eat it, too:

Identifying opportunities for co-production of commodities and ecosystem services in Iowa

By Emily Zimmerman

One of the most striking features of Iowa's remarkable landscape is the degree to which it has been designed, constructed, and intricately managed by humans. According to the United States Department of Agriculture National Agricultural Statistics Service (USDA NASS), in 2014, 85% of land in Iowa was in agricultural production. Iowa is the nation's leading producer of corn, soybeans, eggs, and hogs, collectively generating annual revenues of over \$20 billion and supporting tens of thousands of jobs.

Environmental benefits, often referred to as ecosystem goods and services, are the benefits that humans receive from natural and managed ecosystems. Agricultural products, such as the corn and soybeans produced here in Iowa, are classic ecosystem goods. They are goods that help fulfill global needs for affordable food, feed, fiber, and fuel, all the while contributing to important economic and cultural values more regionally and locally. Nonetheless, the production of Iowa's agricultural products often comes at a tradeoff in the context of ecosystem-derived services such as water quality for drinking and recreating, flood mitigation, habitat and food resources for game and non-game wildlife, and habitat and food resources for pollinators and beneficial insects.

Recent research out of Iowa State University's Departments of Natural Resource Ecology and Management and Sociology has demonstrated that Iowans would like a more multifunctional agricultural landscape that delivers not only corn

and soybeans, but a broader suite of ecosystem services as well. The top priorities for Iowa's agricultural landscapes identified by a statewide survey of urban and rural Iowans related to maintaining and enhancing water quality for drinking water and aquatic life, expanding recreational opportunities, and improving game wildlife habitat – all the while maintaining Iowa's high yielding agricultural production (Arbuckle et al. 2015).

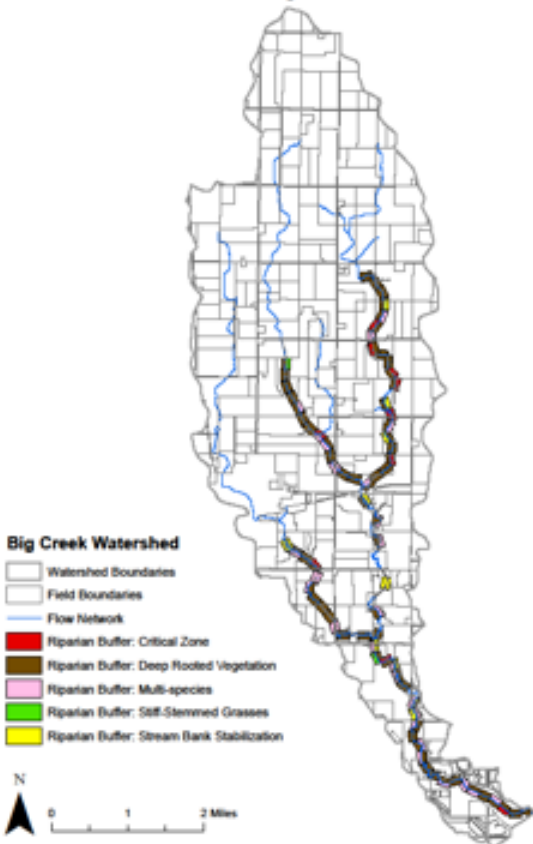
As such, agricultural stakeholders are at a crossroads of sorts in Iowa. Recent water quality litigation in Iowa involving municipal water utilities and rural farming districts clearly indicates that win-win solutions to this dilemma would be a most welcome situation. My research lies at this complex socio-ecological intersection: how can tweaks in agricultural land management jointly expand economic and environmental opportunities for farmers to co-produce agricultural products and desired ecosystem services? To get at this question, my research project is examining a two-step process: 1) a linked spatially targeted conservation approach with 2) a payment for ecosystem service system. Such an approach is designed to identify conservation opportunities for farmers that will improve conditions for water quality and biodiversity at watershed scales, potentially increase average yields and lead to expanded market opportunities and stewardship acclaim.

Targeted conservation is a method used to identify areas of the landscape that are significant contributors to declining ecosystem services, and

The production of Iowa's agricultural products often comes at a tradeoff in the context of ecosystem-derived services...

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Conservation Scenario, Big Creek Watershed



Conservation Scenario, Big Creek Watershed

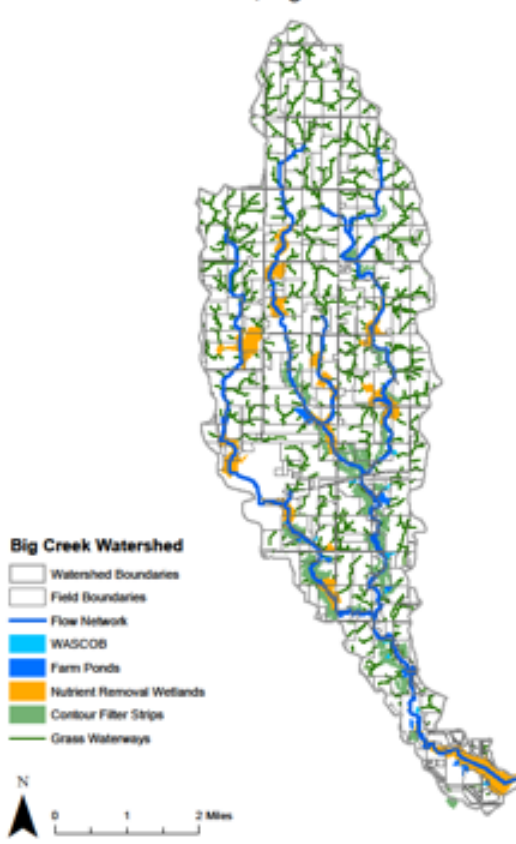


Figure 1. Two conservation scenarios for Big Creek watershed. Each conservation scenario demonstrates a different selection of conservation practices which can be implemented in the watershed, including grass waterways, riparian structure, contour filter strips, WASCOBs (Water and Sediment Control Basins), farm ponds, and nutrient removal wetlands. Placement of conservation practices is determined by several geospatial data layers (e.g., soils, topography, etc.). Different scenarios can be explored with stakeholders to find common ground for conservation opportunities at the field- and watershed-level.

land cover and management, soils, stream networks, weather, and property boundaries to identify specific fields that are contributing the highest levels of nitrate, phosphorus, and sediment to streams. Once these fields have been identified, I can use a newly-developed tool called the Agricultural Conservation Planning Framework (ACPF) toolbox to strategically place conservation practices such as

to strategically place agricultural conservation practices, such as cover crops, prairie/forest buffers or conservation tillage on those areas (Berry et al. 2005). In research contexts, targeted conservation approaches have demonstrably reduced nutrient loss and improved broader ecosystem services (e.g., enhanced water quality) while minimizing land use tradeoffs for agricultural products (Walter et al. 2007). Recent studies (e.g., Tomer et al., 2015) have demonstrated that in most cases as little as 1% of a basin requires any significant land-use change to achieve overwhelmingly positive benefit to cost ratios.

To target conservation opportunities, I am using a series of geospatial models that use topography,

grass waterways, nutrient removal wetlands, and others on those fields, producing a watershed-level map of plausible conservation practices (Fig. 1). Given these conservation practices, I can quantitatively and qualitatively assess changes in ecosystem service provisioning delivery. In a nutshell, will these conservation practices improve ecosystem service production, and if so, which ecosystem services and at what magnitude?

Secondarily, in order to foster farmer buy-in and participation in a targeted conservation approach, I am exploring the development of what is effectively a new market for environmental outcomes, a payment for ecosystem service system (Fig. 2). Such a market-based arrangement would allow traditionally nonmarket ecosystem services (e.g., enhanced clean water)

Conservation Scenario, Big Creek Watershed

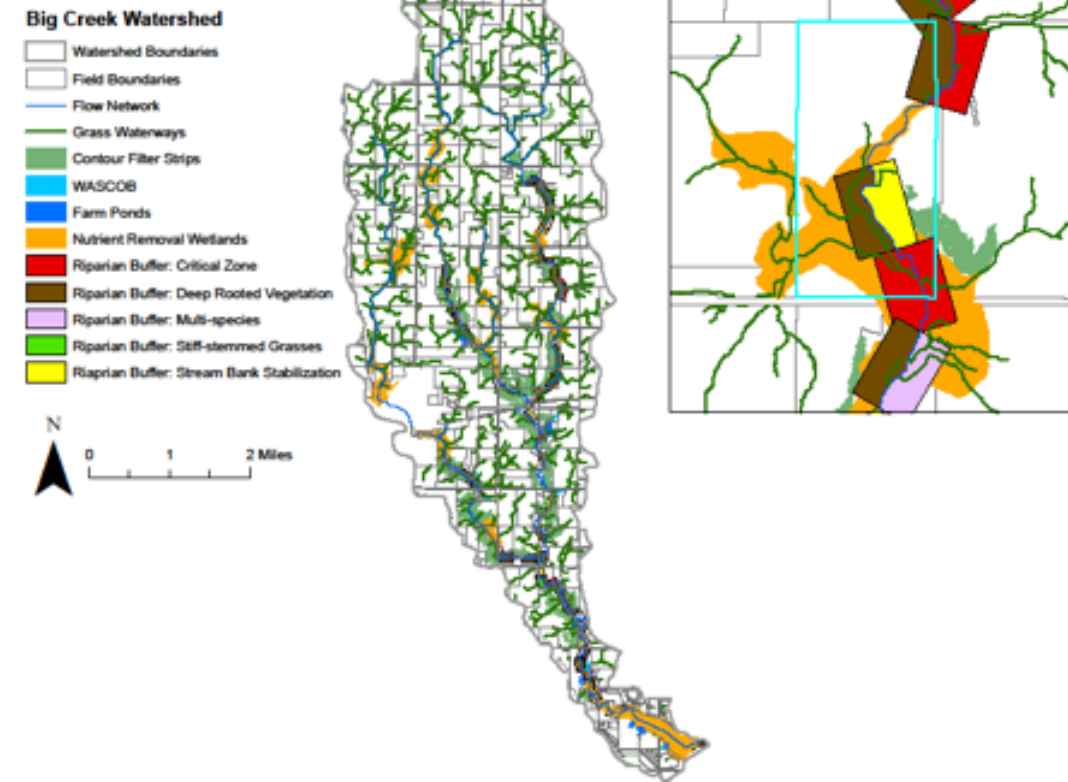


Figure 2. On the left, a watershed-level map of one plausible conservation scenario, including all of the conservation practices from the previous figure. On the right, one field has been selected and enlarged to demonstrate what the watershed-level plan could look like at the field level. In the field highlighted in aqua, there is an opportunity for placement of grass waterways, contour filter strips, a nutrient removal wetland, and riparian methods (e.g., deep rooted vegetation, stream bank stabilization, etc.) Working with the farmer, and his neighbors, conservation practices most appropriate could be selected; placement in the field would be coordinated with the farmer to select locations that are biophysically ideal and that may have the lowest crop yields, and thus lowest profitability. Installing practices in these locations may increase average yields and profitability for the farmer. In addition, if the public benefited from the ES generated by the conservation practice (e.g., downstream water users benefited from enhanced water quality), then they could participate in a PES market by compensating the farmer for that ES by paying him or her, just as one pays for corn or soybeans.

to be sold just as corn and soybeans are. As such, environmental outcomes like improved water quality are measured, recorded priced and exchanged between providers (farmers) and buyers (e.g., downstream water users and/or recreationalists). In economic terms, payment for ecosystem service systems are facilitated markets that 1) help define, measure/monitor and meter a specific ecosystem service (e.g., clean water); 2) articulate how that service should be provided

and environmental advantages and disadvantages of a targeted conservation approach and payment for ecosystem services system; the design of a hypothetical PES market arrangement; and institutional arrangements of a payment for ecosystem services market and acceptable water quality prices.

Ultimately, what would a linked targeted conservation approach and payment for

(e.g., watershed-specific targeted conservation) and weigh individual farm contributions to overall outcomes; and 3) provide a market-exchange platform (institution or market place) for willing sellers (farmers) and buyers (water utilities/water customers) to exchange ecosystem services for money. In order to assess the feasibility of a payment for ecosystem services system in Iowa, I plan to conduct focus groups with key stakeholders, including farmers, water users, and institutions (e.g., United States Department of Agriculture Natural Resource Conservation Service, Iowa Department of Agriculture and Land Stewardship, etc.) to discuss the economic

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ecosystem services system really mean for Iowans? Opportunities. There are two types of economic benefits for farmers. One is a new payment stream for contributing to desired environmental outcomes, thus expanding the scope of their farm systems. That other benefit is that identifying high impact conservation areas and removing them from cropping can reduce costs and typically boosts average crop yields. If appropriate conservation practices are installed in these areas, farmers can benefit from potential increased yields of on-farm ecosystem services produced by those conservation practices, including moisture management, nutrient cycling and soil formation. These increased service yields can boost crop yields in the long-term and minimize fertilizer and soil management costs. Meanwhile, aggregated at the watershed-level, strategically placed conservation practices can produce increased yields of off-farm, publically experienced ecosystem services (e.g., enhanced water quality, flood mitigation, recreational opportunities, etc.). For the off-farm public interested in ecosystem services and the farmer, this represents another opportunity: the public can compensate farmers for the increased yields of these ecosystem services, thus having an active economic voice (akin to voting with one's dollar) in dictating how land is managed in Iowa. As a result, the public gains ecosystem services they didn't have access to before, and the farmer is able to diversify his or her outputs and gain new customers through a payment for ecosystem services system. In all, agricultural stakeholders have the potential to experience the win-win opportunity they so greatly desire.

This research is ongoing; our findings about the feasibility of a linked targeted conservation approach and PES system are largely preliminary.

Yet, prior research and our preliminary findings provide reasons to be optimistic – the cake is coming, and it looks like we can eat it, too.

References:

- Arbuckle, J., et al. 2015. Iowans' perspectives on targeted approaches for multiple-benefit agriculture. Sociology Technical Report 1038. Iowa State University.
- Berry, J.K., et al. 2005. Applying spatial analysis for precision conservation across the landscape. *Journal of Soil and Water Conservation*. 60.6: 363-371.
- Tomer, M.D., et al. 2015. Agricultural Conservation Planning Framework: 1. Developing Multipractice Watershed Planning Scenarios and Assessing Nutrient Reduction Potential. *Journal of Environmental Quality*. 44: 754-767.

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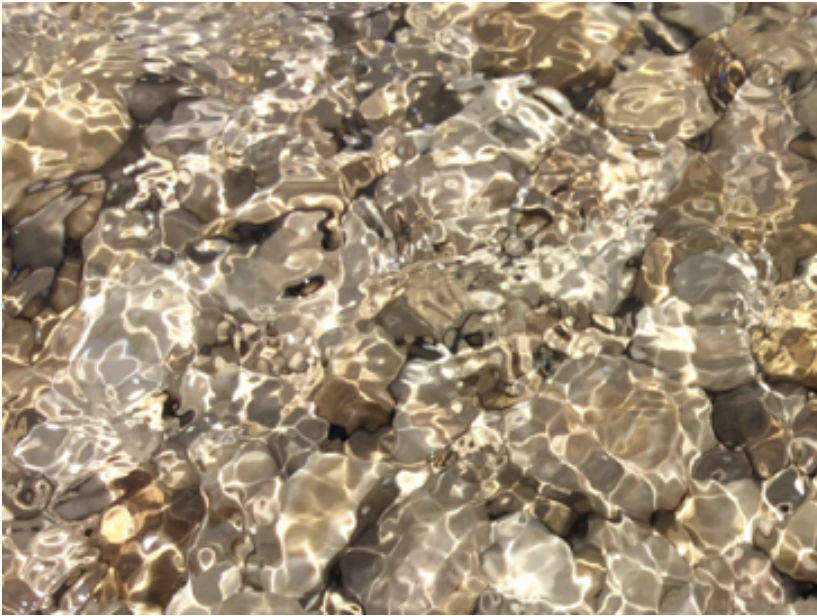
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Cassandra Nuñez



Second place TIE
Category: People in Nature
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First Place

Category: Animals

A Great Basin rattlesnake, Crotalus oreganus lutosus, warming up in the morning sun of Nevada
Cole Bleke

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Category: Animals

Newborn foal on Shackleford Banks, North Carolina
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Second place TIE

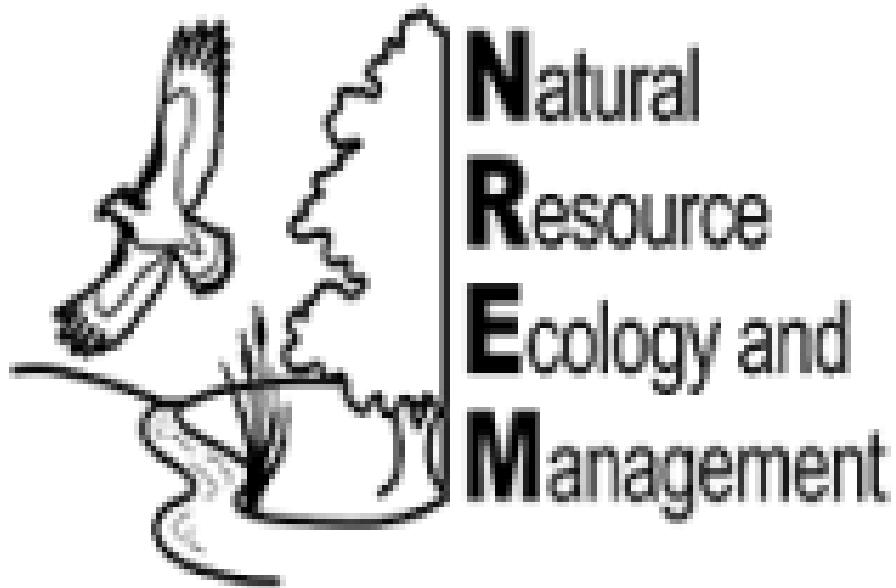
Category: Animals

The American pika, Ochotona princeps, photographed in the East Humboldt Wilderness, Nevada
Christopher Anderson

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Loving life at the top of Flattop Mountain in Chugach State Park, Alaska. (photo by Dr. Cassandra Nuñez)

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