Illinois State University Paired Watershed Project

NREC Report

February 16, 2015

I. Participants:

Primary Investigator: Catherine O'Reilly, Hydrogeology Program, Department of Geography-Geology, at Illinois State University.
Co-Investigator: Shalamar Armstrong, Crops and Soil Science Program, Department of Agriculture, at Illinois State University.
Project Collaborators: Michael Plummer, Coordinator; Dan Schaefer, Director of Nutrient Stewardship, Illinois Fertilizer and Chemical Association; Kent Bohnhoff, McLean County USDA; Caroline Wade, Nutrient Watershed Manager, Illinois Council on Best Management Practices (CBMP).

II. Background:
Within the Mississippi River watershed, nitrogen loss from agricultural land use is a major contributor to reduced water quality and the hypoxic zone in the Gulf of Mexico. Locally, high nitrate loading to Lake Bloomington has consequences for the drinking water of Bloomington, IL. The contributing drainage area of Lake Bloomington is greater than 90% agricultural land use and seasonal nitrate concentrations of this drinking water reservoir have exceeded EPA nitrate standards of 10 mg/l at least 16 years between 1990 and 2008. There is a critical need to more effectively control nitrogen losses from these agriculture fields to increase the sustainability of row crop agriculture, decrease the degradation of local drinking sources, and reduce the loading of nitrate from the Upper Mississippi River Basin to the Gulf of Mexico. Our project focuses on the potential role of cover crops to improve nitrogen retention in the fields and reduce nitrogen loading to surface water systems.

III. Project objectives:
1. Our main objective is to determine whether cover crop application will decrease nitrogen, phosphorus, and suspended sediment loads in streams.
   Specifically, our goals are to test our expectations that:
   a. The effect of cover crops on stream water quality will be greatest during fall and winter.
   b. The effect of cover crops on stream water quality will be greatest during storm events.
2. An additional objective is to provide information and outreach for local farmers on the use and effectiveness of cover crops.
3. A final objective is to include a final report at the conclusion of this project to address each of the objectives stated above.

IV. Outcomes and activities to date:

Study locations: We have identified the two watersheds, each approximately 1000 acres. The map below shows the sampling locations associated with these watersheds (Figure 1). Each watershed has sites will allow us to measure both tile water outflow as well as surface water, allowing us to determine the relative contribution of each of these sources to nutrient and sediment loading. The southern treatment watershed has a single 24-inch diameter tile main draining it. The northern control watershed has two 12-inch diameter tiles and one 8-inch diameter tile. We had a map of the tile drain drawn for this watershed by one of the farmers, and thus we know that the 8-inch tile only drains a small field and the majority of the watershed is drained by the two 12-inch tiles.

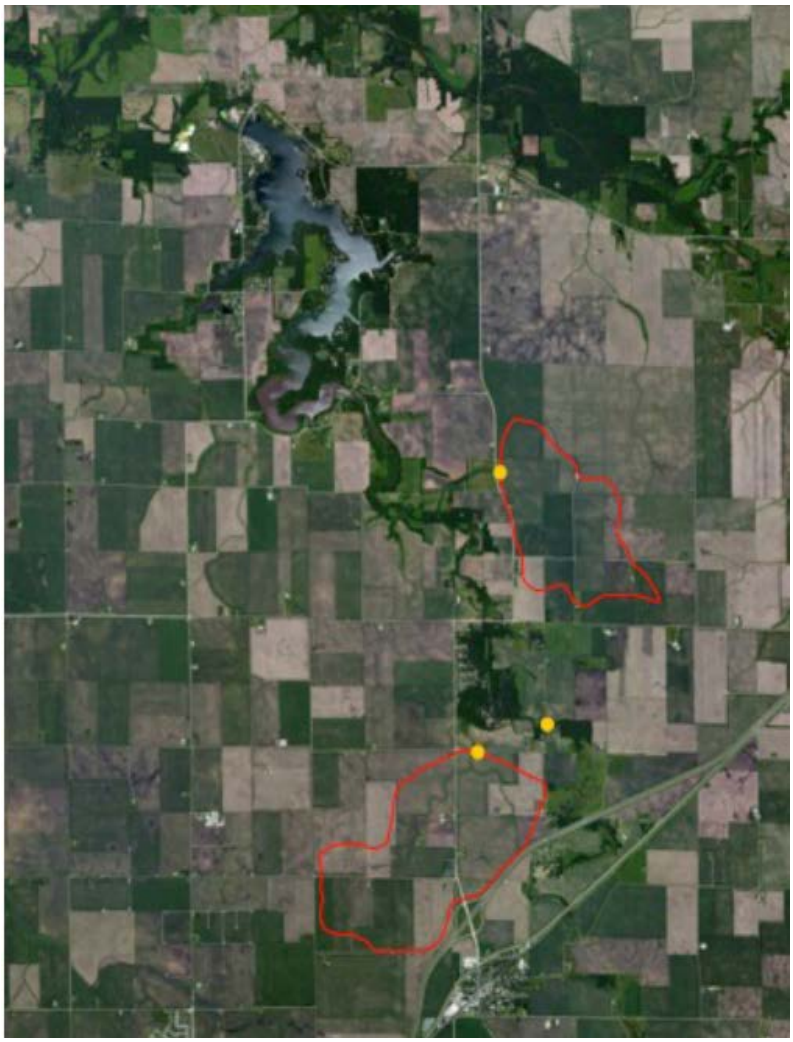

Figure 1. The two paired watersheds (outlined in red) draining into Money Creek, which flows towards the top of the figure, where Lake Bloomington is located. We are installing monitoring stations at the outflow of each study watershed (yellow circles mark the locations) as well as the stream (yellow circle). The southern watershed will be seeded with cover crop in Year 2.

Farmer participation: Agreement by the farmers in these watersheds is key to our study. Dan Schaefer, working with Bob Fish, has been instrumental in initiating contact and setting up meetings. Farmers in the control watershed have been willing to participate by providing information about their fertilizer management. Farmers in the treatment watershed have generally been willing to participate in cover cropping – there have been various concerns, primarily about the termination of cereal rye in the spring.

We are in the process of setting up contracts to work with these farmers and a form for them to complete with their crop information and fertilizer management practices. We have a draft versions of contracts prepared in a manner is similar to the one used for the Nitrogen Management Research Farm project. Different activities require different contracts - All farmers agree to provide us with information on their fertilizer and crop management, Kuntz and Reese agree to allow us to install instrumentation, and the farmers in the treatment watershed agree to cover crop.

Water quality monitoring equipment: The system we are constructing is similar to that used by Discovery Farms in Minnesota, and involves equipment was ordered from multiple companies (Table 1). The key companies are Teledyne (ISCO equipment) and Forest Technology Systems, Inc. a major provider of automated instrumentation to government agencies in North America. Forest Technology Systems currently has all the equipment and is the process of testing the configuration and customizing the code for sampling. The equipment will be sent back to us in time for an early spring deployment. There are numerous advantages to this combined instrumentation setup, which include a touch-screen data logger and USB drive, eliminating the need to bring a computer into the field.

Table 1. Major equipment items associated with the sampling system.

ISCO 6712 water samplers	Teledyne
Autosampler 1 L bottle configuration, and replacement	Teledyne
ISCO 2150 area velocity sensor	Teledyne
H2 Axiom data loggers	Forest Technology Systems
Rain gauge	Forest Technology Systems
Power – solar and battery	Forest Technology Systems
Telemetry	Forest Technology Systems and Verizon
Enclosure	Forest Technology Systems and custom

The road commissioner Scott Grunloh has given his approval for the project, and drainage structures will be installed by Woodrum Bros Excavating at the control site; the 24-inch tile main at the treatment site will probably not be appropriate for a drainage control structure. The tiles have been running all year at each location. At the treatment watershed, the instrumentation will be placed in a single enclosure (Figure 2), mounted on posts. At the control watershed, all instrumentation will be placed into a shed or customized enclosure because there will be multiple ISCO samplers, but only a single datalogger, power supply, and telemetry system.

Figure 2. The enclosure with sampling equipment and datalogger, which will be placed on posts near the tile drains.

Sampling: We have continued to sample Money Creek and have also taken water samples from the tile main at the watershed that will be used for the cover crop treatment. For example, the table below compares water from the main tile drain in the treatment watershed to water from Money Creek at our standard sampling location (Table 2). We note that creek water, which flows into Lake Bloomington, was above EPA drinking water limits early in the summer, but that the tile water remained high, above the 10 mg/l limit, for the entire summer. Internal uptake processes in the stream, along with potential dilution, may be why the stream concentrations are lower than the tile water.

Table 2: Preliminary data comparing pre-treatment water quality for nitrate concentrations in the tile drain water to Money Creek.

Date	**Tile drain** (mg/l)	**Money Creek** (mg/l)
6/5	12.1	12.2
7/12	11.55	6.55
8/13	10.04	2.76
8/29	4.34	1.04
9/11	5.50	3.81
9/25	9.94	7.74
10/8	9.85	8.34
11/6	9.37	8.18

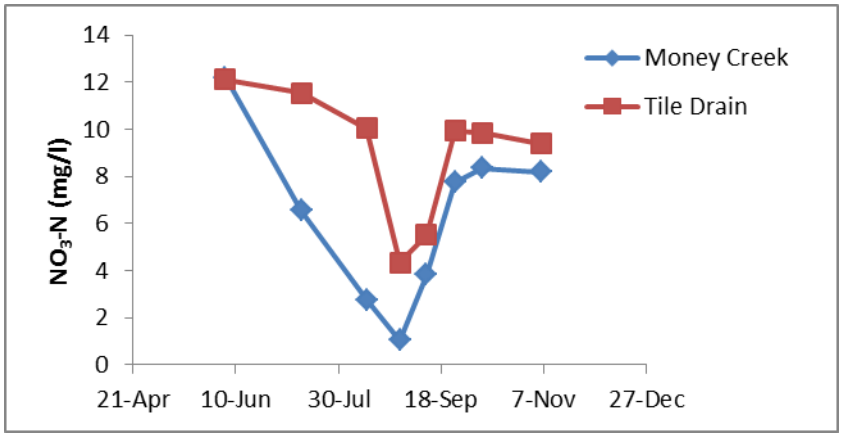

Figure 3. Nitrate concentrations in tile and creek water during summer 2014.

Nitrate concentrations in the tile and in the stream water had similar seasonal patterns (Figure 3) and are similar to what we are seeing at the Nitrogen Management Research Farm with Dr. Armstrong. The decrease in nitrate in late summer is probably due to plant uptake, and nitrate levels increase again when plant growth stops in early autumn. These results highlight the current similarity between nutrient concentrations (especially nitrogen) in the tile drain outflow and in the creek, supporting our ideas that if we reduce concentrations in tile drain outflow through the use of cover crops, concentrations in the stream will be reduced.

We hired a research technician, Victoria Bertolami. The new configuration of the combined NREC and Illinois EPA funds allows us to support a research technician to work with us on both the NREC projects at ISU. Dr. O'Reilly has been working with Victoria to ensure that our lab protocols are in accordance with EPA standards.

Outreach and Exposure: There have been several outreach events associated with this project, and outreach for this project is being done in conjunction with Nitrogen Management Research Farm project. First, Illinois Field and Bean featured Dr. O'Reilly and the project in November, 2014 (see last page). Secondly, we participated in the NREC site tour in August, 2014. Since our project was in the early phases of getting farmer participation last fall, we participated by providing handouts and a short briefing on our watershed cover crop project at the ISU Nitrogen Management Research Farm, along with Dr. Armstrong and Mike Kelley, one of the participating farmers. Finally, we helped coordinate the ISU Winter Outreach Meeting "Integration of Cover Crops within Nitrogen Management to Improve Aspects of Soil Health and Water Quality" held on January 28, 2015 in Lexington, IL. The goals of the winter outreach meeting were to 1) inform regional farmers and agricultural industry leaders of the rationale, objectives, and results of the study and other related studies of within our research program, 2) educate farmers on the influence of cover crops on soil health and water quality, 3) expose farmers to cost-share conservation programs and results from other regional watershed water quality projects. The agenda for the meeting consisted of seminar on soil health and nitrogen management programs (N-Watch, Keep it for the Crop), cover cropping, and cost-share programs. In addition, there was a farmer panel question-and-answer session regarding cover

crops, nitrogen, and other best management practices. Total attendance was 33 people and the representation of the agricultural industry in the audience were 12 farmers from the region, 6 agribusiness reps, 3 agriculture federal and state conservation agency staff, 4 graduate students, and 2 professors. The exit survey indicated that 4 of the 12 farmers decided to try cover crops in 2016 and that all participants found the program highly informative and looked forward to next year.

V. Budget:

We also received funding from Illinois EPA for this project. This allowed us to convert the project to a 3-year project. The EPA funds will only be available for the first 2 years, while the NREC budget will be reconfigured to meet most of the needs over a 3-year period. We have a new approved budget with the Illinois EPA that is restructured to complement the NREC funds in this way.

Our budget from 2014 reflects few expenses relative to what had been originally proposed, in part due to the later contribution of the Illinois EPA grant and also because of the reconstruction of the budget to extend over 3 years rather than just two years. In addition, the primary activity during 2014 was the design and purchase of the instrumentation, and this process took much longer than expected. Other major activities included discussions with farmers and the hiring and training of the research technician. We expect that 2015 will incur additional expenses carrying over from the initial 2014 activities (such as the installation of the drainage control structure and the enclosures), and would prefer that that 2014 budget roll over if possible.

Nutrient Management Attracts New Talent to Field

> BY ALISSA KIEDROWSKI

A renewed interest in nutrient management is attracting new talent to Illinois' agricultural research community. Two new sustainability researchers are putting their scientific shoulders to the wheel to help farmers manage the environmental impacts of their farming practices while helping them to maintain the freedom to run successful businesses.

CATHERINE O'REILLY, PH.D.

Associate Professor,
Department of Geology/Geography
Illinois State University (ISU)

For Catherine O'Reilly, Ph.D., it's always been about water. Her lifelong passion for water and the critical role it plays in society has grown into a career as a freshwater biogeochemist.

Originally from South Africa, O'Reilly moved to Minnesota in her youth. She attended college in Minnesota, earned her Ph.D. in Arizona, and completed work at a college in New York before accepting her current position in 2011.

Working with Shalamar Armstrong, Ph. D., ISU Department of Agriculture, O'Reilly will help explore the impact of cover crops on water quality at both the field and watershed levels.

"Most cover crop studies have been on small plots," she says. "While those are important, fully understanding how cover crops impact water quality requires field and watershed level studies."

O'Reilly adds the watershed-scale study will involve about 700 acres that drain into Money Creek, a main tributary to Lake Bloomington and the reservoir for the Bloomington, Ill., water supply. The project is designed so results will allow farmers to understand how cover crops affect both soil health and water quality.

"We hope to see if we can improve soil quality, reduce nitrogen losses and improve water quality without having to significantly change the way people farm," she says. "Mandating land use strategies is never the best way to go, so we have provided flexibility in how cover crops can be used as a management practice."

"Water is all-encompassing. Everything relates back to it. We need to keep those resources available to us as clean as we can."

– Catherine O'Reilly

PHOTO BY AMY ROADY

"The goal is that we can be proactive and address nutrient management concerns through good science and decision-making,"

– Cameron Pittelkow

CAMERON PITTELKOW, PH.D.

Assistant Professor of Agronomy,
Department of Crop Sciences
University of Illinois

A commitment to helping growers improve farming efficiency drives the work of Cameron Pittelkow, Ph.D., who recently joined the University of Illinois Department of Crop Sciences.

Pittelkow earned his doctorate from the University of California-Davis, where he researched sustainability issues affecting the California rice industry and the impacts of no-till farming practices on crop yield. He also has partnered with the International Rice Research Institute (IRRI) in the Philippines, conducting research on improving efficiency of high-yielding rice production practices. His Illinois work will include applied research grounded in on-farm trials to help farmers discover new approaches to managing nutrients that work with high yields.

"The potential for nitrogen and phosphorous losses from our fields is getting a lot of attention, but we also need to consider that productivity levels in Illinois are extremely high," he says.

By developing approaches for optimizing fertilizer management that increase efficiency, farmers can have confidence their nutrient recovery is high, he adds. The key is to find ways to ensure that optimum yields can be achieved without adding surplus nutrients.

By working directly with farmers Pittelkow hopes his research will produce results that are useful on the farm, as well as for policymakers. "If we're going to be serious about the discussion of environmental impacts of crop production, we need to benchmark our current practices to see where we stand and what improvements can be made," he says.