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Reconnecting riparian buffers with tile drainage (2)

Dan B. Jaynes
Iowa State University, dan.jaynes@ars.usda.gov

Thomas M. Isenhart
Iowa State University, isenhart@iastate.edu

Timothy B. Parkin
United States Department of Agriculture

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Natural Resource Ecology and Management, Water quality quantity and management

Disciplines
Natural Resources and Conservation | Natural Resources Management and Policy | Water Resource Management

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Re-connecting Iowa riparian buffers with tile drainage (2)

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Principal Investigator:

Dan Jaynes
National Laboratory for Agriculture and the Environment
USDA-ARS
Ames

Co-investigators:
Tom Isenhart
Natural Resource Ecology and Management
Iowa State University

Tim Parkin
National Laboratory for Agriculture and the Environment
USDA-ARS
Ames

Budget:
$36,647 for year one

ECOLOGY

Q The first two years of observing a saturated buffer showed that about half of the tile flow from a 10 ha field could be diverted through 1000 m of a riparian buffer with all nitrate in the diverted water removed before reaching the stream as shallow groundwater. Could this kind of removal be sustained for an additional year and, if so, would there be the same order of removal at a saturated buffer installed at a new site? Could geophysical methods (ground resistivity survey) be used to characterize the variability of soils within riparian buffers?

A Saturated buffer performance was measured for a third year at the original site and a riparian buffer was installed and monitored at a second site. Ground resistivity surveys were conducted at both sites and compared to soil core data.

Background

Riparian buffers are a proven conservation technology for reducing the movement of sediment, phosphorus and nitrogen into surface waters. These buffers reduce nutrients not only from surface runoff but also from shallow groundwater and interflow. Unfortunately, in the tile-drained areas of Iowa and the Midwest, buffers are not particularly effective in removing nitrate from shallow groundwater because most of the drainage is routed through the buffers in tile pipe. Thus, while effective for removal of sediment and phosphorus, most riparian buffers in the Midwest do little for removing nitrate.

To address this issue, the Leopold Center provided initial funding to test the potential of reconnecting tile drainage to flow through buffers for removing nitrate. This first project (E2010-01) established a pilot demonstration where a fraction of the discharge from a tile was rerouted through a distributary tile installed along the top of a riparian buffer, diverting a fraction of the tile water into shallow groundwater flow through the buffer. This site has been located as part of the suite of riparian practices established within the Bear Creek Watershed.

The goal of this project was to advance understanding of nitrate loss within re-saturated buffers and use this knowledge to inform the development of standards under which the practice would be more widely implemented on agricultural lands within the Midwestern United States.

Specific objectives were to:
1) Quantify nitrate loss within saturated buffers at two locations, and
2) Inform the development of criteria under which the practice would be established.

Approach and methods

Monitoring continued at the Bear Creek saturated buffer throughout 2013. A second saturated buffer was established at the Maass farm – a 48-ha privately owned field located in Hamilton County. The Maass farm is used for the production of corn and soybean.

A riparian buffer was established by the owners on both sides of a first order, unnamed stream sometime in the 1990s. The buffer was 43 m wide and consisted of switchgrass. A single 8" tile outlet was intercepted just inside the buffer as it left the row-crop portion of the field. The 8" diameter tile was excavated and reconnected to an in-line water-level control box. The control box consisted of three chambers separated by two sets of stoplogs that could be used to set the water level independently within the upstream and middle chamber of the box.

The water level within the middle chamber of the control box determined the head within the distribution pipe. Water level within the control box was controlled with the two sets of stoplogs separating the three chambers. Water levels within the two upstream chambers were measured with dedicated pressure transducers and recorded every hour with a datalogger.

In June 2013 the transducers were installed and the water level was set at 29 cm below the soil surface at the control box. Soils cores taken from the east, middle and west ends of the grassed portion of the buffer were used to measure soil texture and soil organic carbon content on 30 cm sections down to 240 cm depth.

Monitoring wells were installed within the buffer along three transects. Each transect consisted of three or four wells equally spaced between the distribution pipe used to convey water along the top of the buffer and the stream. Water samples were collected from each well starting in April 2013 on a weekly schedule when the field tile was flowing. and were returned to the laboratory for the determination of NO_3 concentration. At the same time, water samples from the stream and tile water flowing within the control box were collected for measurement of NO_3 concentrations. Annual mass load of NO_3 was calculated by multiplying the NO_3 concentration times the volume of water that infiltrated the buffer between water sampling dates, and summing all samples in a calendar year.

Results and discussion

This was a continued investigation of the feasibility of re-routing a fraction of field tile drainage as subsurface flow into a riparian buffer to increase nitrate removal. At the Bear Creek site in 2013, 32 percent of the tile flow was diverted through the buffer as shallow groundwater. This compares to 55 percent of the tile flow diverted in 2011 and 2012. The infiltrated tile flow contained 152 kg (335 lbs.) of nitrate, which was completely removed within the buffer and did not enter the stream. This compares to the ~105 kg of nitrate removed each year in 2011 and 2012. A smaller fraction of the total tile flow, but a greater mass of nitrate was removed in 2013, compared to 2011 or 2012 because of the very wet conditions in the spring of 2013.

A second saturated buffer site was established on the Maass farm approximately 20 km northwest of the Bear Creek site. Performance at this site was monitored beginning June 6, 2013. During this period, all of the tile flow was diverted into the buffer and all the nitrate (totaling 61.8 kg) was removed. A geophysical survey of both sites was conducted using ground resistivity. These surveys indicated that the soil conditions within both riparian buffers are variable, but that considerable fine-grained materials exist to support denitrification.

Conclusions

In 2013, the project was able to redirect more than 21,630 m^3 (5,714,650 gal) of flow from field tile outlets as subsurface flow within existing riparian buffers at the two sites. The redirected tile flow contained a total of 352 kg (777 lbs) of NO_3-N. Based on the strong decrease in concentrations within the shallow groundwater across the buffer, the researchers conclude that all of this NO_3 was removed within the buffer and did not enter the stream. .

Impact of results

If the results found for these pilot studies are repeated at other locations, it suggests that this practice has the potential of preventing 18 million pounds of nitrate-N from entering Iowa streams each year. These results also have led to USDA-NRCS developing an interim practice standard for Saturated Buffers which they call Vegetated Subsurface Drain Outlet (# 739). While this practice was not included with other N reduction practices listed in the Science Assessment of the Iowa Nutrient Reduction Strategy, the Assessment did recommend that practice receive more study. The practice now is under consideration for inclusion in the 2014 update of the Strategy, which would make it eligible for cost-share within the Iowa Water Quality Initiative. If the practice continues to be successful and is widely adopted into USDA Natural Resources Conservation Service and Farm Service Agency buffer protocols, it could lead to a measurable decrease in nitrate delivered to surface waters across Iowa and the United States.

Education and outreach

Presentations and tours:

- "Saturated buffers for removing nitrate from water" at the Franklin-Butler Contractors Meeting, February 2013.
- "Saturated buffers for removing nitrate from water" at the 2013 Illinois Regional Tillage Seminar, January 2013.
- Field tour as part of the H.A. Wallace Endowed Chair Advisory Committee meeting, July 2014.
- Webinar presentation on "Drainage Water Management, Denitrification Bioreactors, and Saturated Buffers" for USDA-ARS webinar series for EPA, May 2013.
- Presentation and field trip of a saturated buffer to South Fork Coalition, September 2013.
- Presentation on Drainage Water Management to crop consultants, September 2013.

- "Saturating Riparian Buffers in Tile Drained Landscapes for Nitrate Removal" at the Iowa-Minnesota-South Dakota Drainage Forum November 2013, Sioux Falls, South Dakota.
- "The Impacts and Magnitude of N Loss from Midwest Cropping Systems: What Can We Do About It?" at the 43rd North Central Extension-Industry Soil Fertility Conference, November 2013, Des Moines.
- Presentation on "Field-Edge Practices to Reduce Nitrate Losses to Streams from Tile Drained Fields" at Indiana CCA Conference, December 2013, Indianapolis, Indiana.
- "Field-Edge Practices to Reduce Nitrate Losses to Streams from Tile Drained Fields" at University of Minnesota Department of Soils and Agronomy, February 2014, St. Paul, Minnesota.
- "N Loss from Midwest Cropping Systems: What Can We Do About It?" at Conservation Tillage and Technology Conference, March 2014, Ada, Ohio.

An article on this research appeared in *Corn and Soybean Digest*, January 30, 2014: "Saturated stream buffer test: Farmers divert tile water into streamside grass buffers to remove nitrates," http://cornandsoybeandigest.com/conservation/saturated-stream-buffer-test

Leveraged funds

Two additional grants were leveraged by the funding for this project:

- USDA-AFRI grant "Denitrification within Saturated Riparian Buffers Redesigned to Remove Nitrate from Artificial Subsurface Drainage" for $489,191 to T. Isenhart, K. Hofmockel, D. Jaynes, and T. Parkin, 2013.
- Iowa Nutrient Research Center grant "Establishment and Monitoring of Saturated Buffers within High-priority HUC-12 Watersheds" for $150,000 to T. Isenhart and D. Jaynes, 2013.

For more information, contact: *Dan Jaynes, National Laboratory for Agriculture and the Environment, 132 NLAE, Ames, Iowa 50011-3120; (515) 294-8243, e-mail dan.jaynes@ars.usda.gov*