Exploring the Use of Subsurface Water Quality Data as a Feedback Mechanism for Improving Conservation: A Case Study in the River Raisin Watershed

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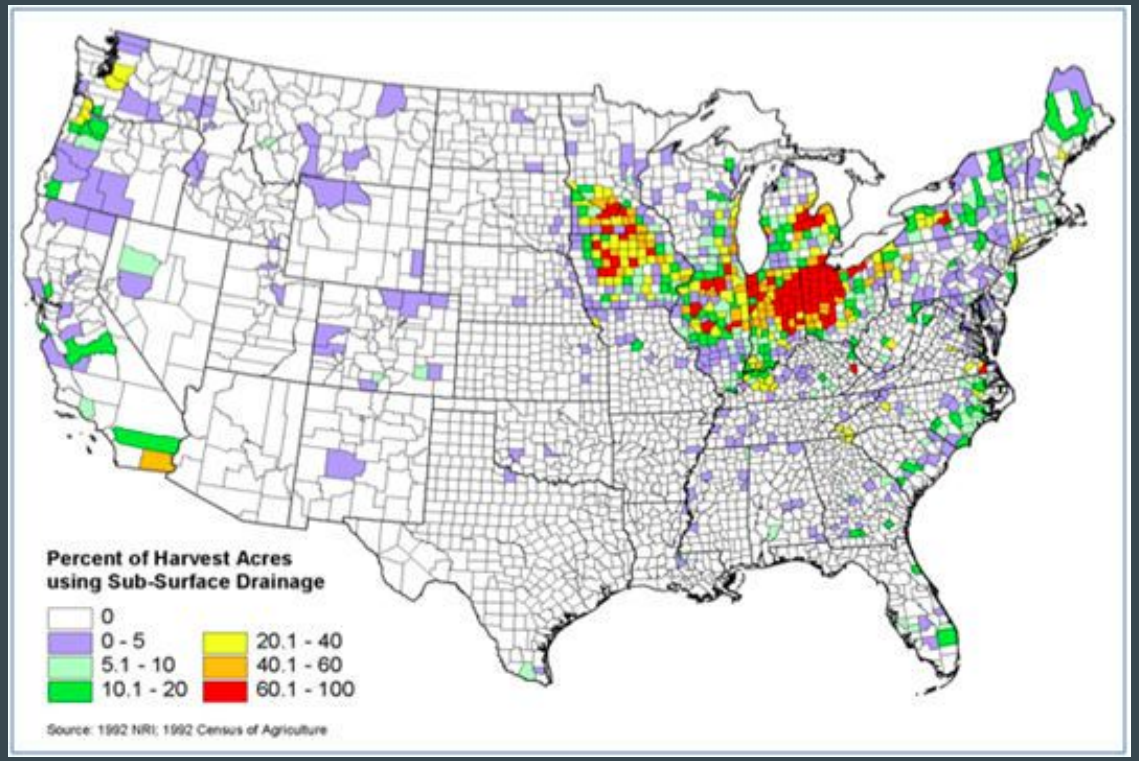
Today's Discussion

- The significance of tile drainage
- Project objectives
- Establishment of water monitoring program
- Current data collection
- Future data collection
- Thoughts from farmer participants
- Discussion

The significance of tile drainage



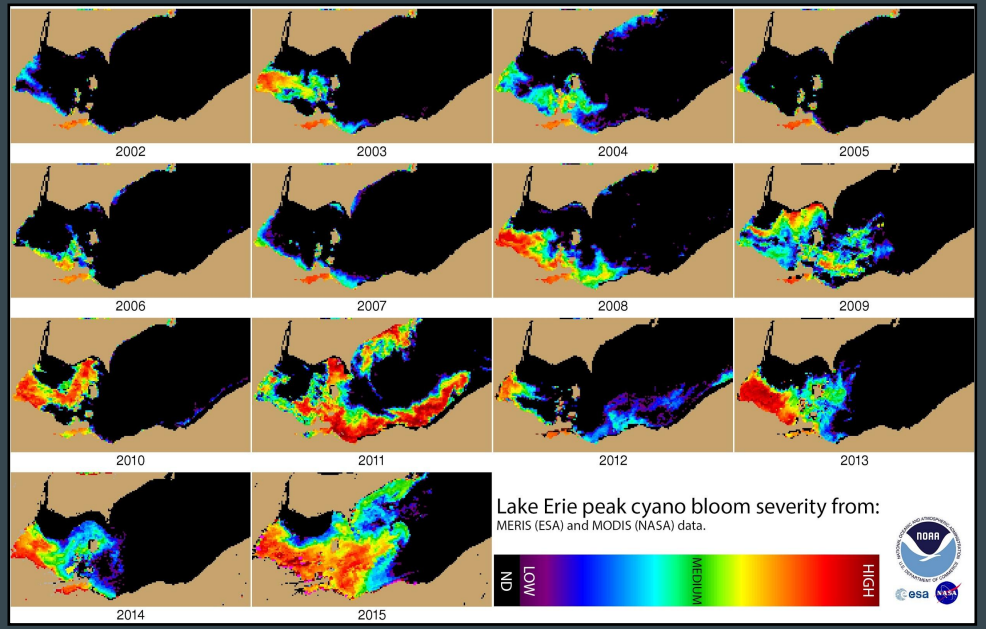
At least 40% of farmlands are tiled today across the U.S. Midwest

Numerous studies have demonstrated that periods of high flow result in increased P loss through tile drainage (Algoazany et al., 2007; Ball Coelho et al. 2012; Gentry et al., 2007; Morrison et al., 2013)

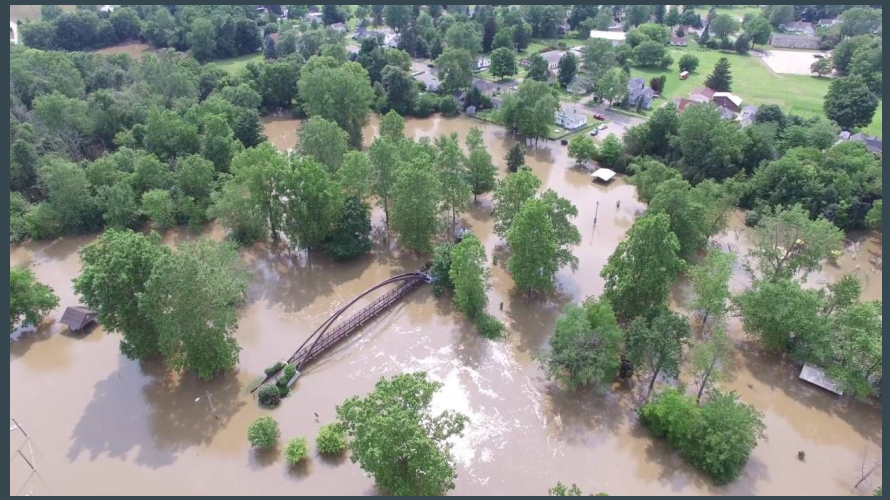
On average, 50 percent of both dissolved reactive phosphorus and total phosphorus escape fields via tile drains (King et al., 2014).

https://fmr.org/minnesota-agricultural-water-quality-certification-program

Climate projections have indicated that storms will become more intense and frequent throughout the spring and winter seasons, ultimately exacerbating phosphorus losses from farmland (Daloğlu et al., 2012; Sharpley et al., 2012)



Lake Erie peak cyano bloom severity from 2002 - 2015. National Oceanic and Atmospheric Administration.



River Raisin Flood, June 2015

Stakeholders are calling for a 40% reduction in total phosphorus loading by 2025

It is anticipated that this cannot be accomplished using traditional voluntary approaches.

"It appears that traditional voluntary, incentive-based conservation programs would have to be implemented at an unprecedented scale or are simply not sufficient to reach these environmental goals, and that new complementary policies and programs are needed."

-- Don Scavia, U-M Water Center

Farmers need reliable data to address new challenges

"We are now asking farmers to think about managing water and nutrients in both surface water and leaching, and burdening them with difficult environmental trade offs...this means they need help based on sound science to deal with these new challenges."

-- Andrew N. Sharpley, Professor of Soils and Water Quality, University of Arkansas

How can we get farmers the data they need?

Water quality monitoring is EXPENSIVE

- Edge of field equipment will range anywhere from 10k-15k per site
- Sending water samples to a lab will cost approximately $25-$60 per sample

http://ocj.com/2016/09/demonstration-farm-research-hopes-to-benefit-farmers-statewide-in-years-ahead/

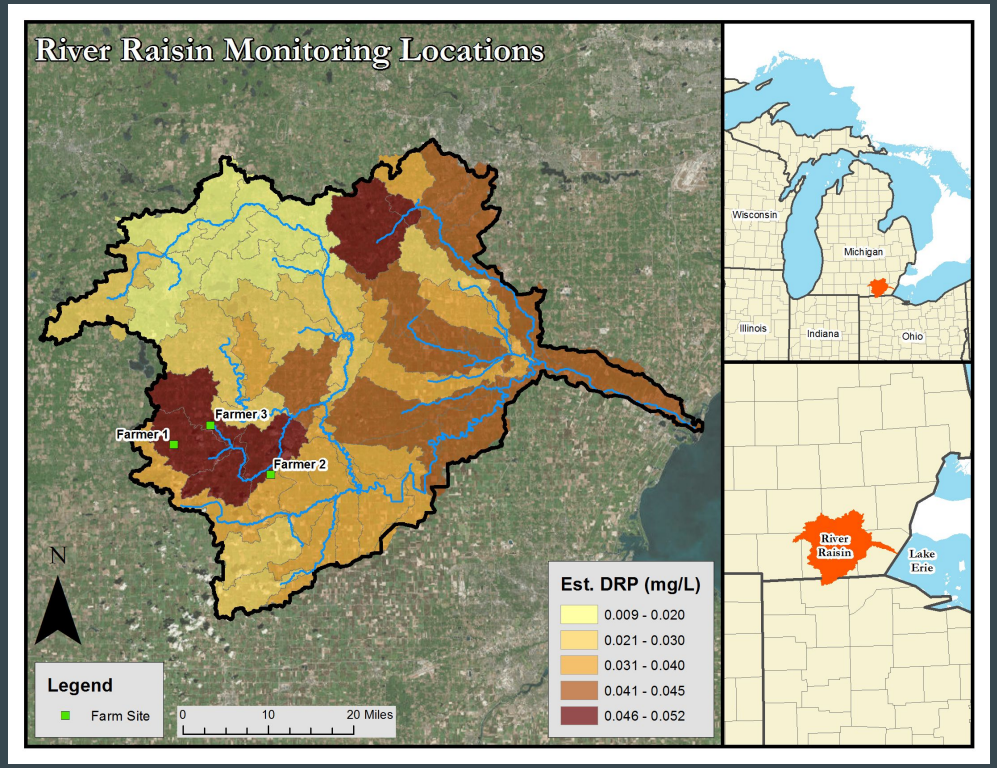
Project Objectives

1. Develop a cost-effective method for providing farmers with flow and nutrient loss data from subsurface tile drains

2. Determine how water quality data specific to participants farms impacts conservation behavior

3. Determine usefulness of information for assisting in on-farm decision making

Objective #1: develop a cost effective monitoring method



Farmer-Led Watershed Conservation

Farmer-Led Watershed Conservation
Western Lake Erie Basin (WLEB)
"Water Quality Farming"

www.waterqualityfarming.org

ADRIAN COLLEGE

Initial Investment

Hach DR 6000 Spectrophotometer

Hach Test N' Tube vials
$3.82 per sample - DRP
$1.75 per sample - Nitrate

Cost per site

Weekly sampling cost per field site
~ $15 (includes travel, DRP, and nitrate measurement)

Yearly sampling cost per field site
~$720

Yearly sampling cost to analyze five sites weekly
~ $3,600

Cost to ship to a lab for analysis:
$25 per sample + approx. $10 to ship = $35 per sample x 5 samples = $175/week x 48 weeks = $8,400/year to analyze five sites weekly

Data Collection

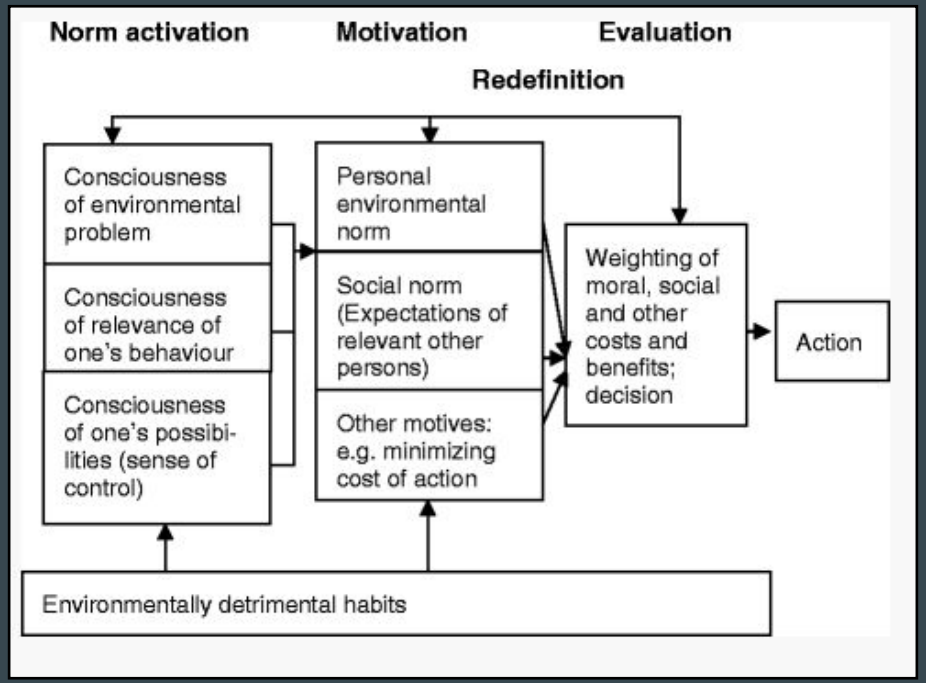
Ben Woerner collecting flow measurements and water samples

Data Collection

- Analysis performed by students at Adrian College
- Parameters measured include nitrate (NO3-N), flow, dissolved reactive phosphorus (PO4-P)
- Analysis occurs within 48 hours of collection following standard methods for the examination of water and wastewater 23rd edition

Students performing water quality analysis in Adrian College lab

Objective #2: Determine how water quality data impacts conservation behavior



The Heuristic Model of Environmentally Relevant Behavior (Matthies, 2005)

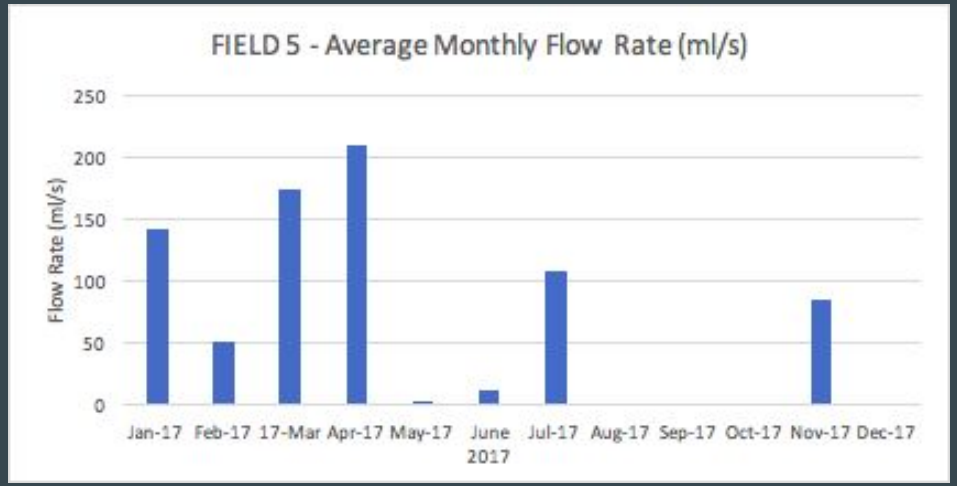
Data was collected weekly from five field sites over a 16 month period

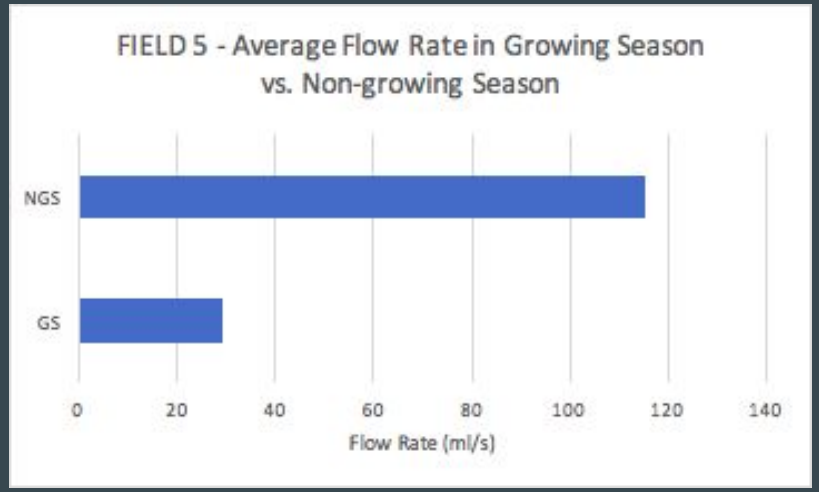
2016 - 2017

Site	Acres drained	Crops	Winter cover crops	Fertilizer	Tillage	Dominant soil type
1	35	Soybeans	Yes	Manure in fall; inorganic fertilizer at spring planting	No-tillage	Clay loam
2	50	Soybeans	Yes	Manure in fall; inorganic fertilizer at spring planting	No-tillage	Clay loam
3	40	Soybeans	Yes	Manure in fall; inorganic fertilizer at spring planting	No-tillage	Clay loam
4	15	Soybeans	Yes	Inorganic fertilizer incorporated with planter in spring	No-tillage	Clay loam
5	30	Continuous corn	Yes	Manure incorporated in fall; inorganic fertilizer at spring planting	Manure incorporated	Sandy loam

Table 3. Land and management factors per sample site

Current data collection





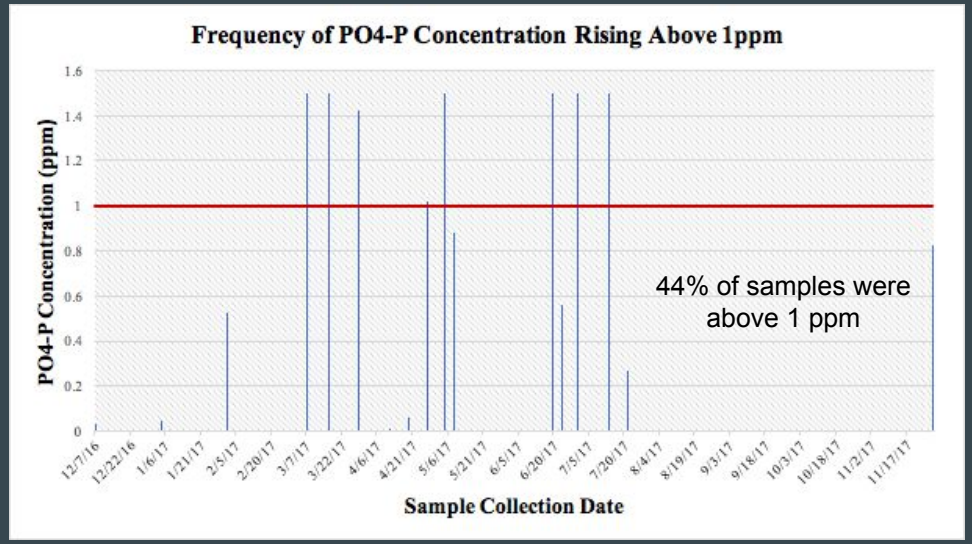
70-90 percent of phosphorus loading occurs during the highest 20 percent of flows, or during approximately 10 storm events a year (Baker et al., 2014)

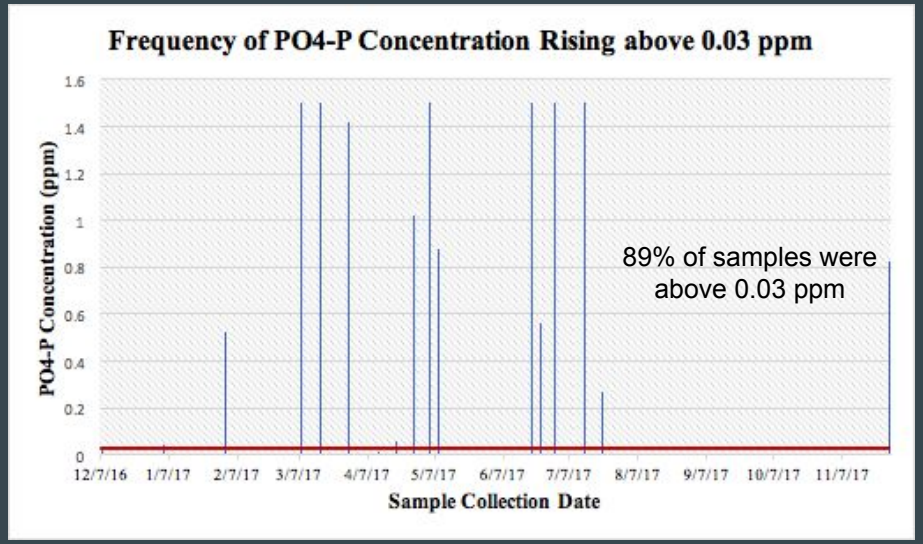
Current Data Collection

Percentage of time that the flow rate was above 100 ml/s with a concentration greater than or equal to:

1 ppm - 57% of the time

0.03 ppm - 71% of the time

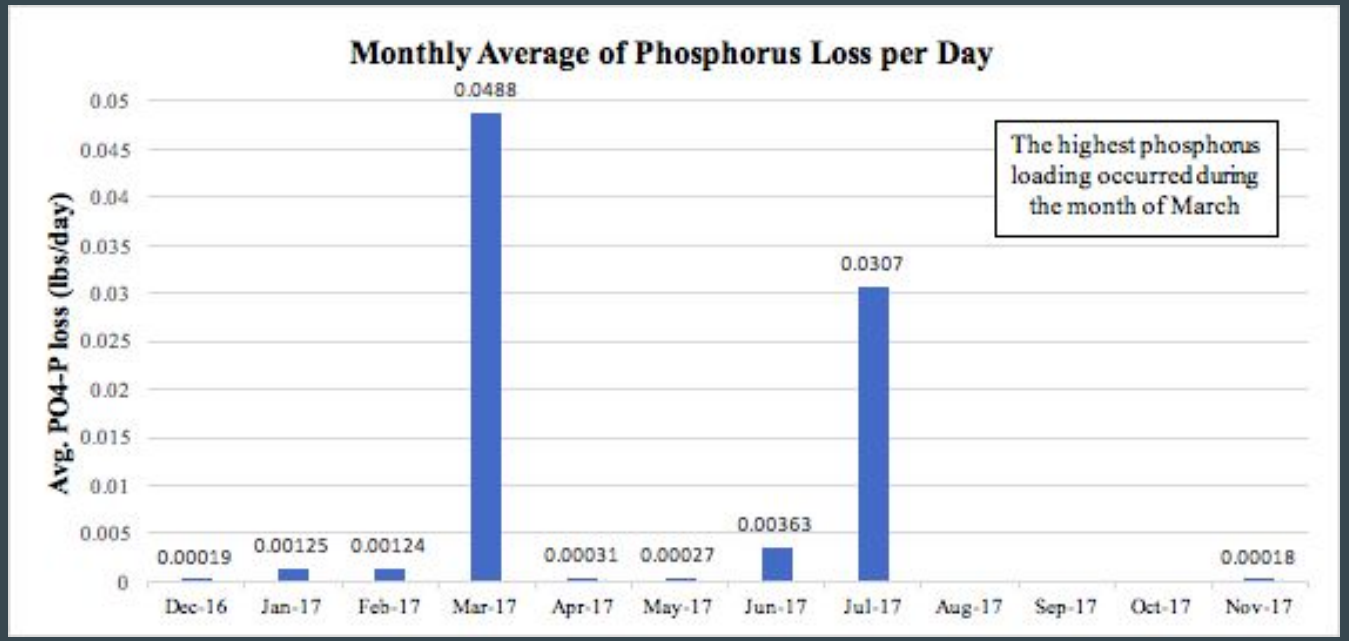




1 ppm is the highest concentration that most point sources can discharge

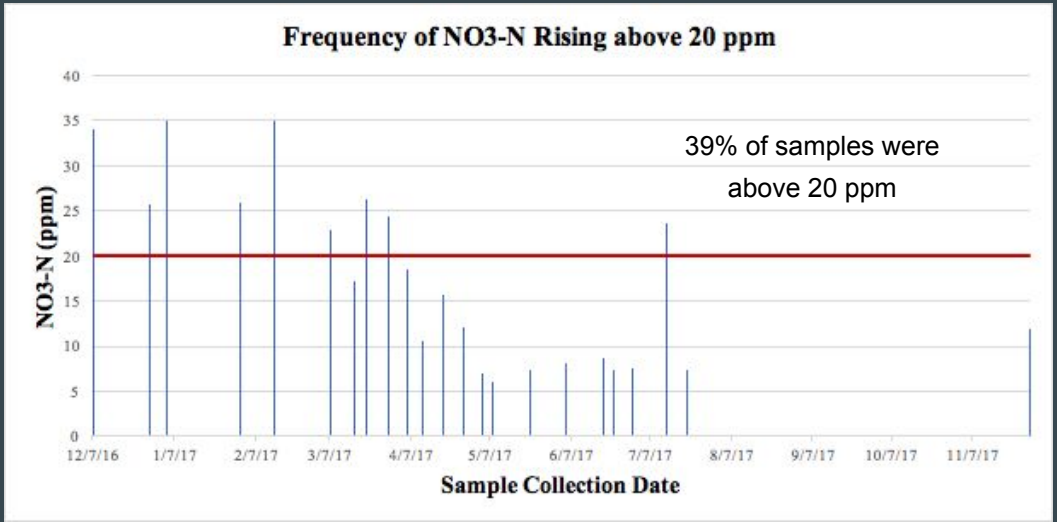
0.03 ppm is the recommended limit for curtailing blooms of toxic and nuisance algae

Current Data Collection



Phosphorus concentrations in tile drains were less than 2% of the amount typically applied by farmers on fields. In monetary terms, that's roughly $1 to $2 per acre.

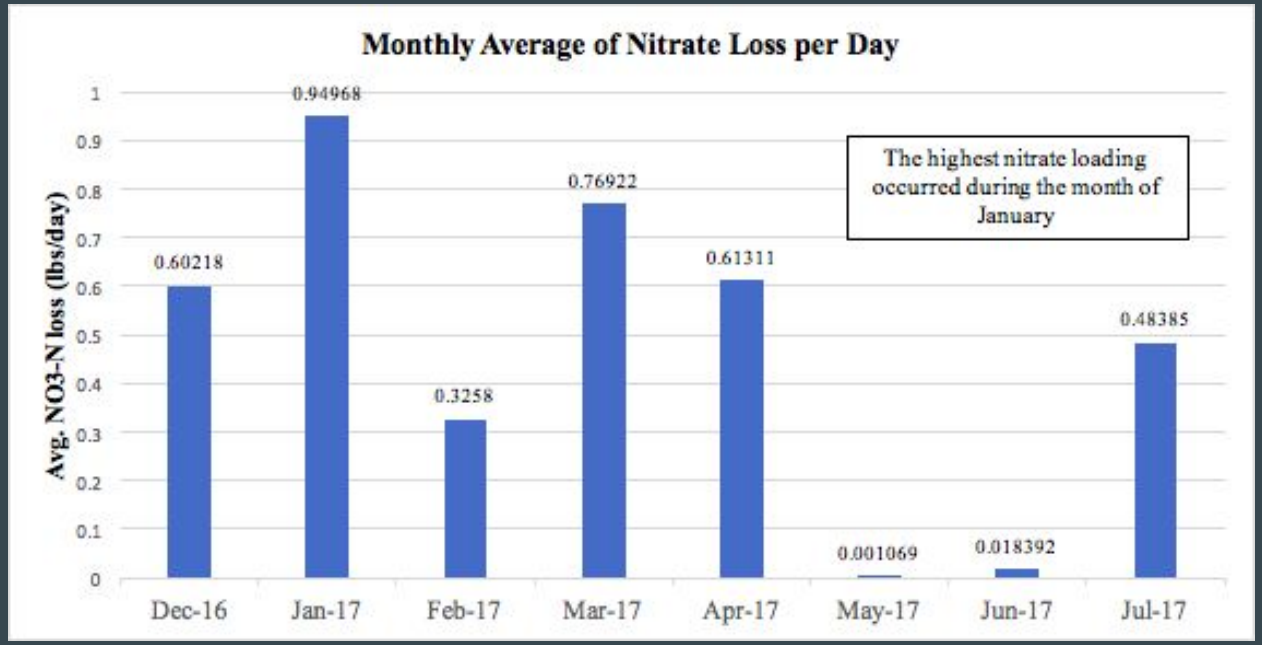
Yet, more than 90% of these same concentrations exceeded 0.03 ppm, the recommended limit for curtailing blooms of toxic and nuisance algae. "So, from an agronomic standpoint, the farmer is doing great," King says. "But from an environmental standpoint, [the loss] is very significant" (King, et al., 2015).



NO_3-N Concentration (ppm)	Interpretation
≤ 5	Native grassland, CRP land, alfalfa, managed pastures
5 – 10	Row crop production on a mineral soil without N fertilizer Row crop production with N applied at 45 lbs./acre below the economically optimum N rate† Row crop production with successful winter crop to "trap" N
10 - 20	Row crop production with N applied at optimum N rate Soybeans
≥ 20	Row crop production where: • N applied exceeds crop need • N applied not synchronized with crop need • Environmental conditions limit crop production and N fertilizer use efficiency • Environmental conditions favor greater than normal mineralization of soil organic matter

Purdue Extension publication AY-318-W

Current Data Collection



Future Data Collection (April 2018)

- One-on-one in-depth interviews with participating farmers
  - Before water quality data
  - Review water quality data
  - After water quality data

Heuristic Model of Environmentally Relevant Behavior Component	Before water quality data	After water quality data
Consciousness of environmental problem		
Consciousness of relevance to one's behavior		
Consciousness of one's possibilities (sense of control)		

Future Data Collection (April 2018)

- Presentation of findings and focus group at spring farmer-led watershed meeting

Categories	Farmer Opinions
Usefulness of Information	
Improvements	
Likelihood to Use	
Trust in Information	
Support for Continuing Data Collection	

Future Applications

Pete and Wayne Dinius (project participants)

- Short introduction
- Why did you choose to get involved in this project?
- Do farmers need this information?
- How do you see this information being used on your own farm?

If you are interested in seeing project results please email me at: alaina.nunn09@gmail.com

DISCOVERY FARMS WISCONSIN