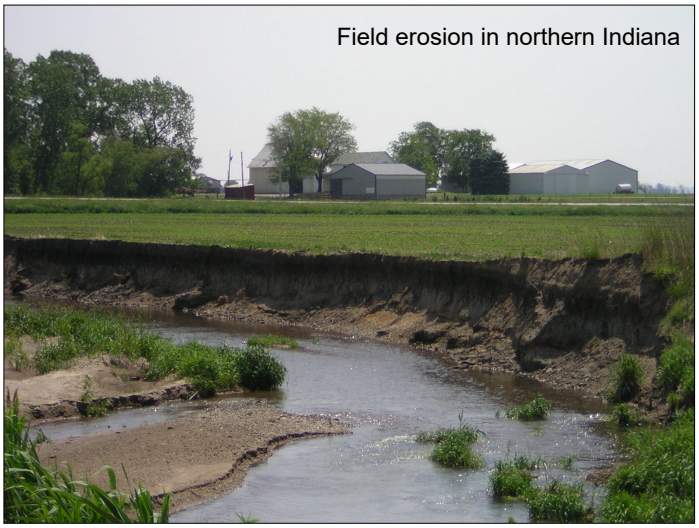
Water Quality and Agricultural Conservation Practices



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What is meant by *water quality*?

- Dissolved compounds (nutrients, toxins, metals)
- Particles (sediment)
- Temperature
- Biotic communities (both desirable and undesirable species)

Indiana Department of Natural Resources / Brant Fisher

Today I will focus mostly on *nutrients*, namely nitrogen and phosphorus

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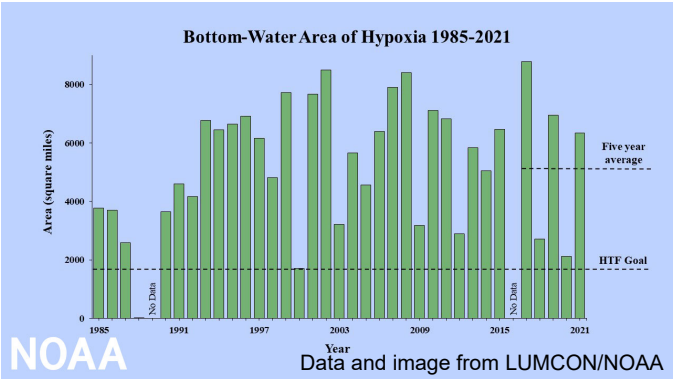
Local and Downstream Concerns

When nitrogen (N) and phosphorus (P) occur in excess, they stimulate rapid growths of algae, or blooms



For nitrate (NO_3^-) there is also a drinking water standard that must be met

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USDA United States Department of Agriculture
Natural Resources Conservation Service

Provides support for 169 approved conservation practices

- Certain of these practices are promoted to improve water quality
- Adoption of the practices is voluntary and the cost of implementing them is reimbursed if NRCS standards are met

Why rely on voluntary adoption of practices?

Agricultural runoff is explicitly exempted from regulation in the Clean Water Act, and promoting voluntary actions is the only mechanism for addressing non-point source pollution under the Clean Water Act.

The drinking water standard for nitrate applies to providers of tap water (municipalities or water companies) not to the source water.

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Questions

What is the magnitude of the effect of these practices?

Can they be implemented at a scale sufficient to solve large-scale water quality problems?

Kirkpatrick Ditch Watershed, Jasper Co., IN

Conservation is not "at scale" currently

2020 Indiana Statistics

5.7 million acres of soybeans
5.4 million acres of corn

1.5 million acres of winter cover*

= 13.5% of row-crop acres had winter cover – Indiana leads the nation

*includes winter wheat

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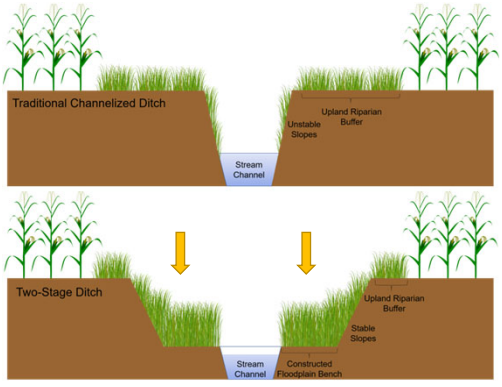
Two-stage ditch

Building small flood plains (benches) into existing trapezoidal drainage ditches



- Slows water velocity, allowing suspended sediment to deposit on the benches
- Increases opportunity for denitrification of nitrate
- Reduce overbank flooding and provide habitat benefits

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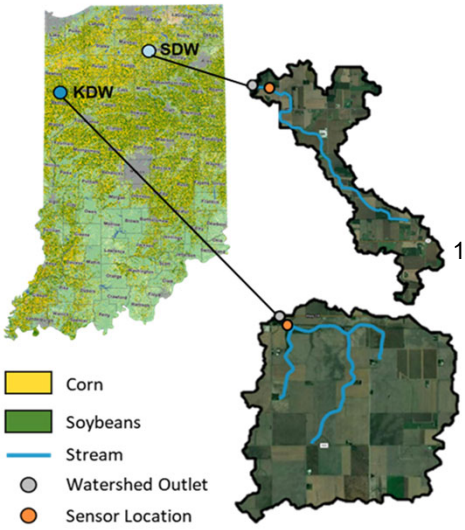

Indiana Watershed Initiative

- Kirkpatrick Ditch Watershed (KDW)
- Shatto Ditch Watershed (SDW)

1333 ha (~3300 acres)

2630 ha (~6400 acres)

Both tile-drained with about 85% of the land in corn-soybean rotation.

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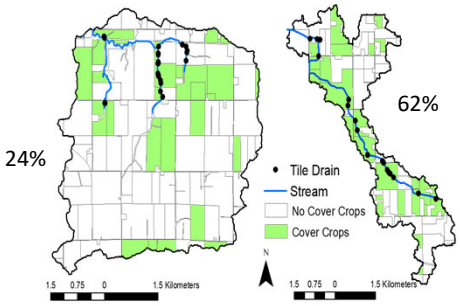
Watershed-scale experiment on working farms

- Grant from USDA-RCPP paid farmers to plant winter cover crops from 2015-2019
- Farmer participation was voluntary and varied from year to year
- All decision were left to the farmers

Cover crop maps for 2017



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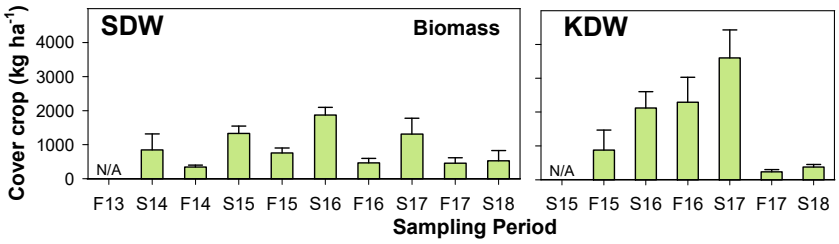
Cover crop mix in SDW

Cereal Rye in KDW
(1'x1' quadrat)

We sampled the cover crops



- Aboveground biomass: seasonally and annually variable, depends on crop type and rotation.
- Generally increased from Fall to Spring sampling.

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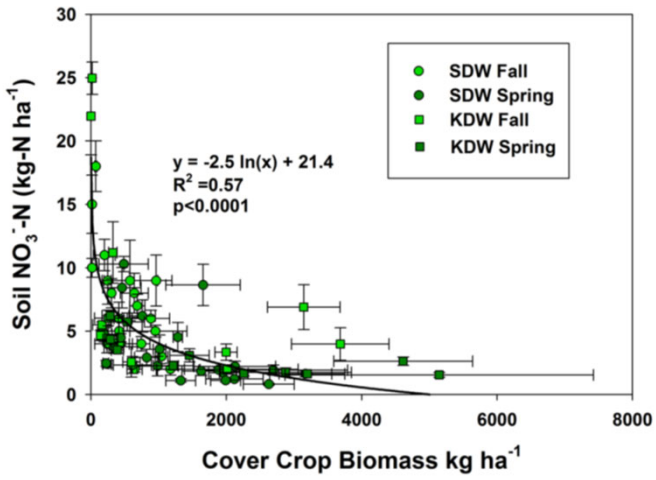

- Even a modest growth of winter cover crops and reduce soil nitrate
- The nitrogen is incorporated into the tissues of the cover crop

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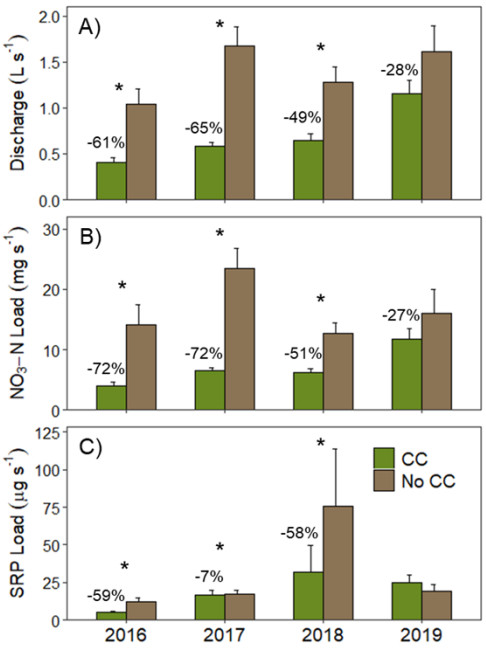
Edge of field results

- Cover crops consistently reduced flow through tile drain
- Effect of cover crops on nitrate loss was similar in magnitude to flow reductions
  - Flow drives NO_3 loss
  - Reduction ranged 27-72%
  - Statistically no difference in 2019
- Effect of cover crops on soluble phosphorus loss was variable



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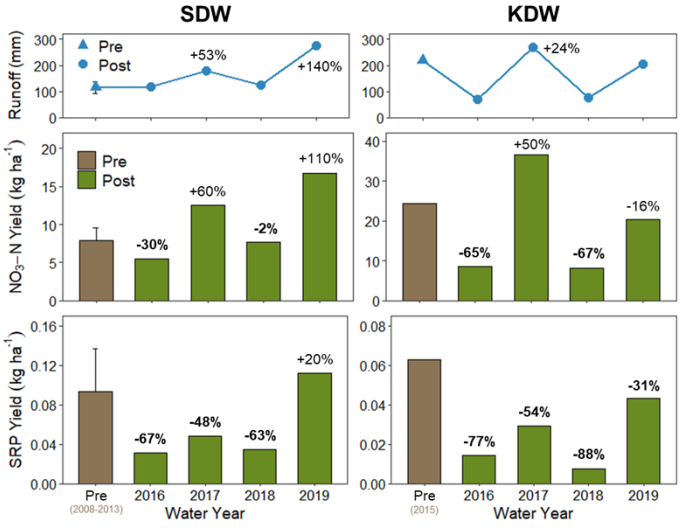
Watershed results

- Nitrate yield (kg/ha)
  - Compared to pre-treatment, the average reduction was 36%
  - Driven by interannual variability in runoff (precipitation)
- SRP yields (kg/ha)
  - 7/8 site years were lower than pre-treatment period
  - Average reduction was 51%



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What can we conclude from this?

Edge of field sampling shows a meaningful benefit of winter cover crops on nitrate loss

At the watershed scale, other factors likely mask or dilute the effect of cover crops

- Precipitation and runoff are the strongest drivers of nitrate loss (timing & intensity)
- Mobilization of in-channel sediments and desorption dynamics for phosphorus
- Contributions from groundwater and surface runoff, particularly when cash crop is growing

Accurately quantifying the effect of conservation practices is extremely challenging, particularly beyond edge of field

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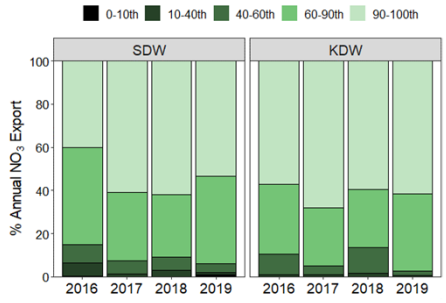

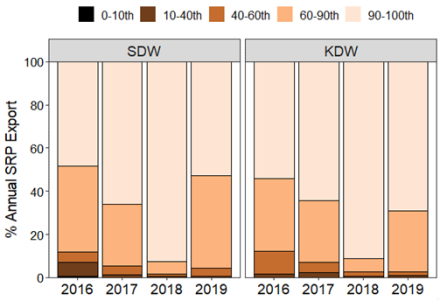

Most nutrient loss occurs during high flows

- **Top 10% of flows** drive:
  - 40-68% of annual NO_3 export
  - 48-93% of annual SRP export
- For agricultural watersheds, <u>enhanced resilience to high flows will be needed, especially for phosphorus</u>.
- Cover crops are effective during spring, and our recent modeling suggests they will become even more effective with increasingly mild winters
  - Warmer temperatures
  - Winter precip as rain rather than snow

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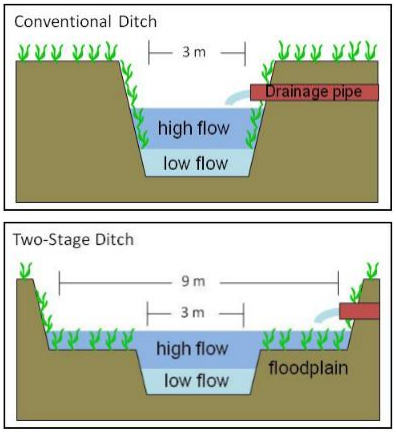
Two-stage Ditch Results

Function when benches are inundated



- Modest increase in nitrate retention
- Large improvements in water clarity

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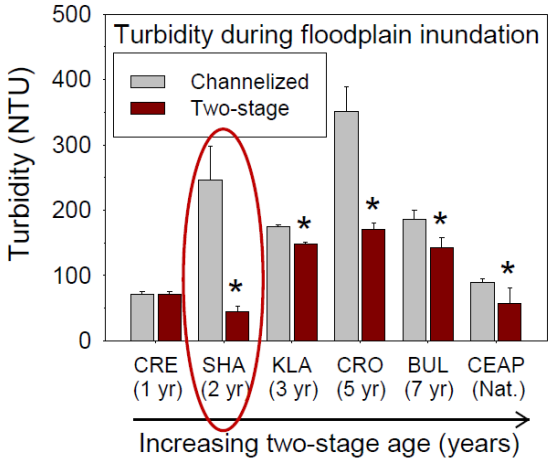

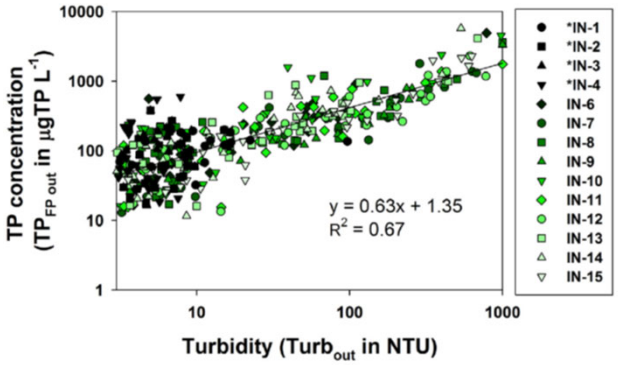

- Lower turbidity = less phosphorus
- Phosphorus adsorbed to sediment is retained on the benches

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What is the magnitude of the effect of these practices?

Can they be implemented at a scale sufficient to solve large-scale water quality problems?

With a couple million $ and 4 years of work by a lot of people, we achieved cover crop use of:

68% in SDW
32% in KDW

Both were well above the current state average of 13.5%

When incentive payments ended, use of cover crops dropped to:

22% in SDW
12% in KDW

We constructed about 3.5 miles of new two-stage ditch, which are permanent

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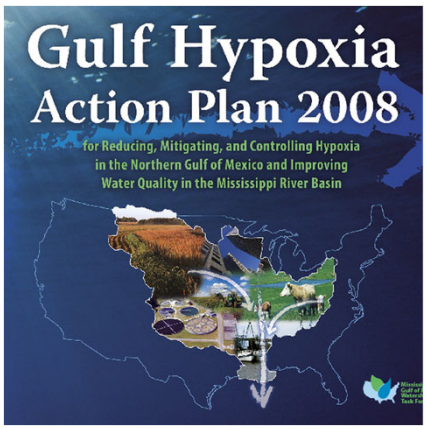
11.1 million acres of corn and soybean in Indiana

Assuming cover crops reduce nitrate loss by 30%, using cover crops 13.5% on Indiana's corn and soybean acres reduces the state's nitrate loss by 4%



Action Plan calls for 45% reduction in both N and P by 2035, and a 20% reduction by 2025

The scale of conservation needs to increase by 10-fold or more

No single conservation practice will be sufficient

Relying solely on voluntary adoption of conservation is unlikely to succeed in meeting these targets

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Acknowledgments

Dr. Jennifer Tank
Univ of Notre Dame

Numerous students and staff at Notre Dame and IU

- **Landowners and farmers who granted us access to sample**

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