Indiana Science Assessment: Determining Practice Effectiveness at Reducing Nutrient Loss

IN CCA Conference

December 20, 2023

Additional contributors: Julie Harrold, ISDA; Kristen Arnold, IDEM; Mike Dunn, The Nature Conservancy; Kris Vance & Jill Reinhart, USDA NRCS; Katy Mazer, Purdue

INDIANA SCIENCE ASSESSMENT for the State Nutrient Reduction Strategy

Presenters

INDIANA AGRICULTURE NUTRIENT ALLIANCE

Ben Wicker – Executive Director, Indiana Agricultural Nutrient Alliance

PURDUE UNIVERSITY

Jane Frankenberger - Professor, Agricultural & Biological Engineering, Purdue University

Why a Science Assessment?

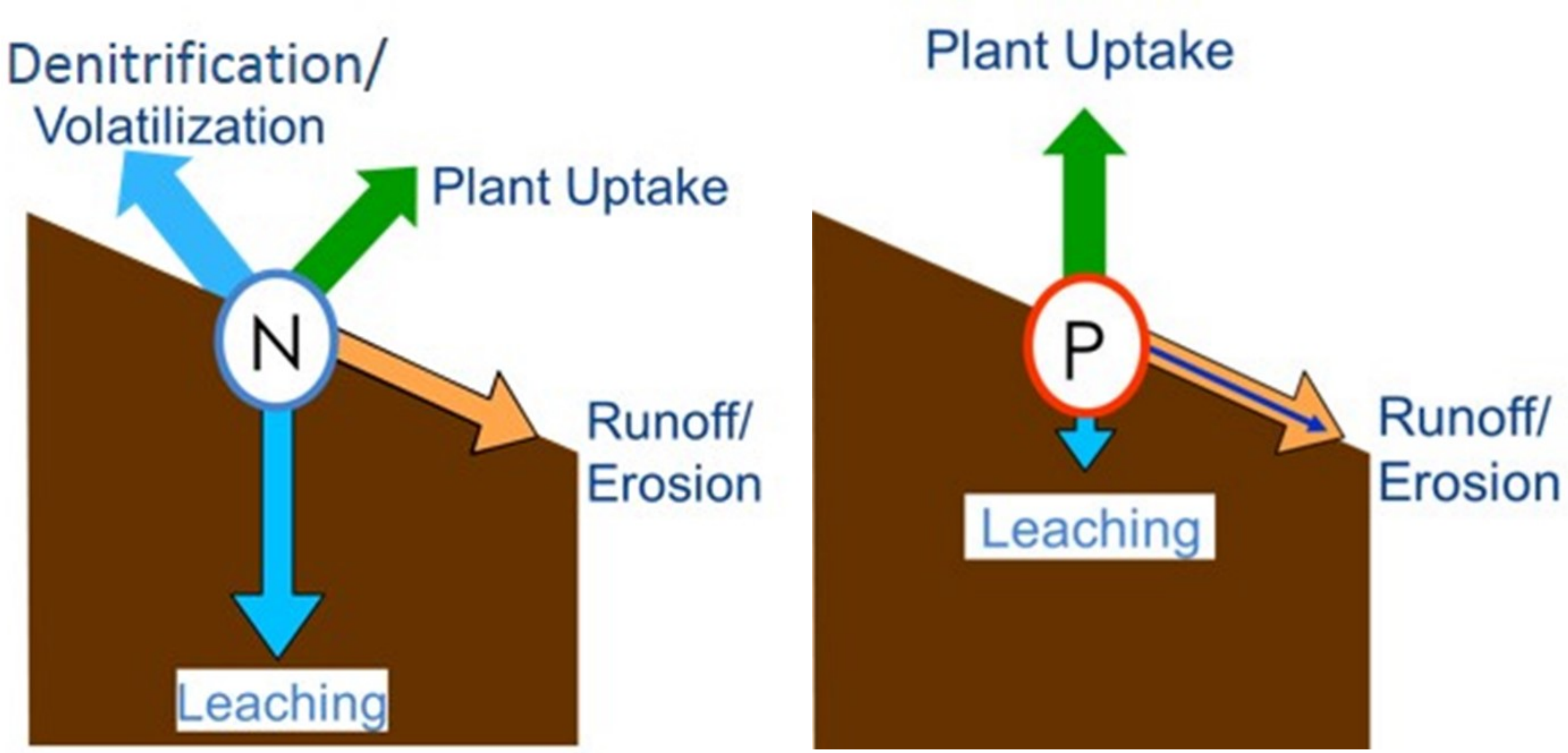
- **2 Main Questions Around Water Quality and Nutrients**

1) How much nitrogen, phosphorus, and sediment are leaving/entering the state in our rivers (and what direction are we trending)?
2) How effective are the conservation practices we recommend and implement in Indiana at reducing nutrients?

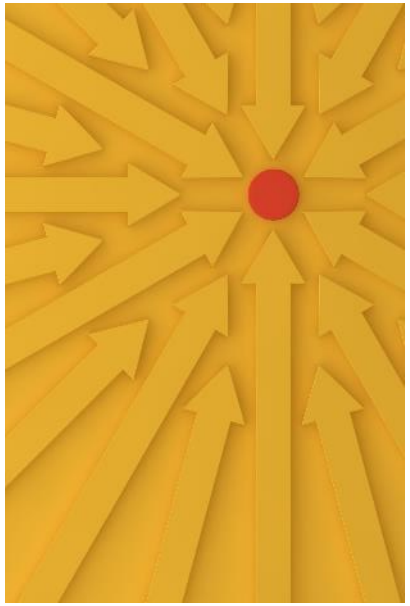
Why a Science Assessment?

- Establish consensus with researchers of relative nutrient loss reduction effect of practices in Indiana
- Build confidence in farmers, advisors, policymakers and others of the effectiveness of practices
- Improve tracking and measuring of nutrient loss reductions of implemented practices
- Better illustrate scale of practice needed to reach larger nutrient loss reduction goals

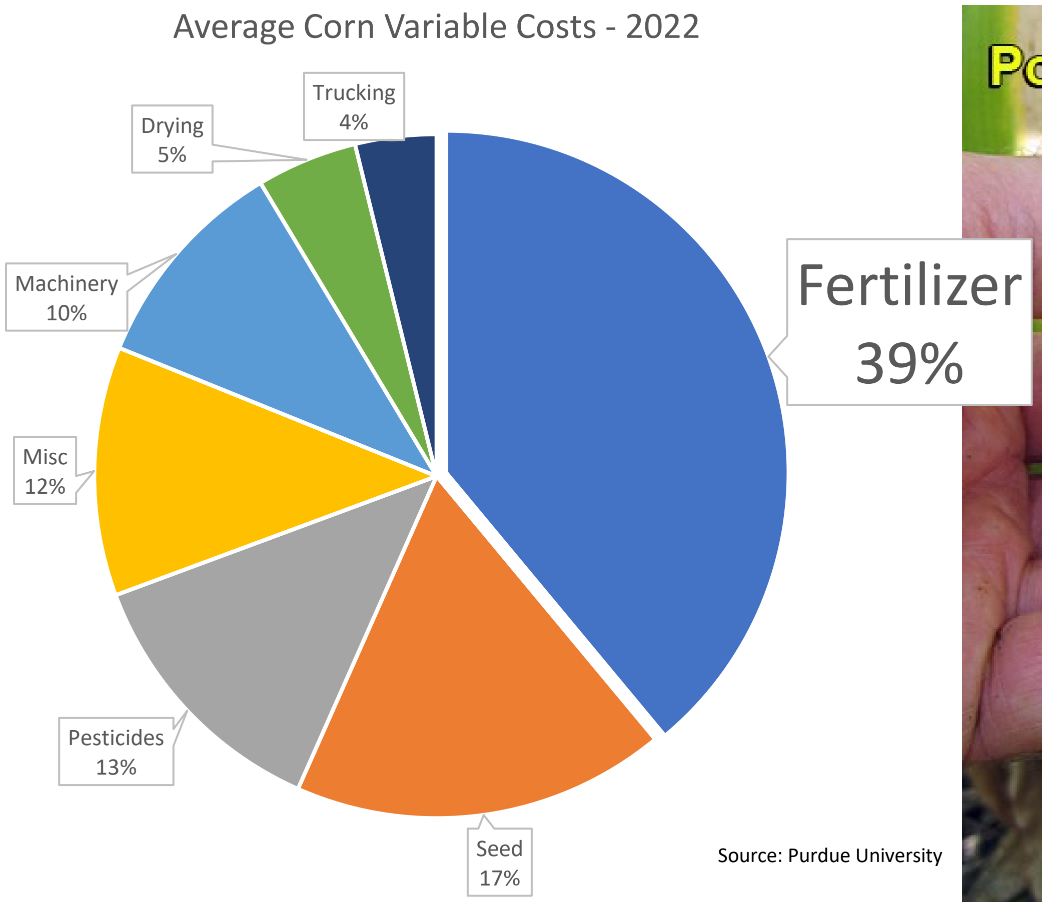
Establish Researcher Consensus



Simplified Mechanisms of N & P Loss, Credit: Amy Schober, Univ of Delaware

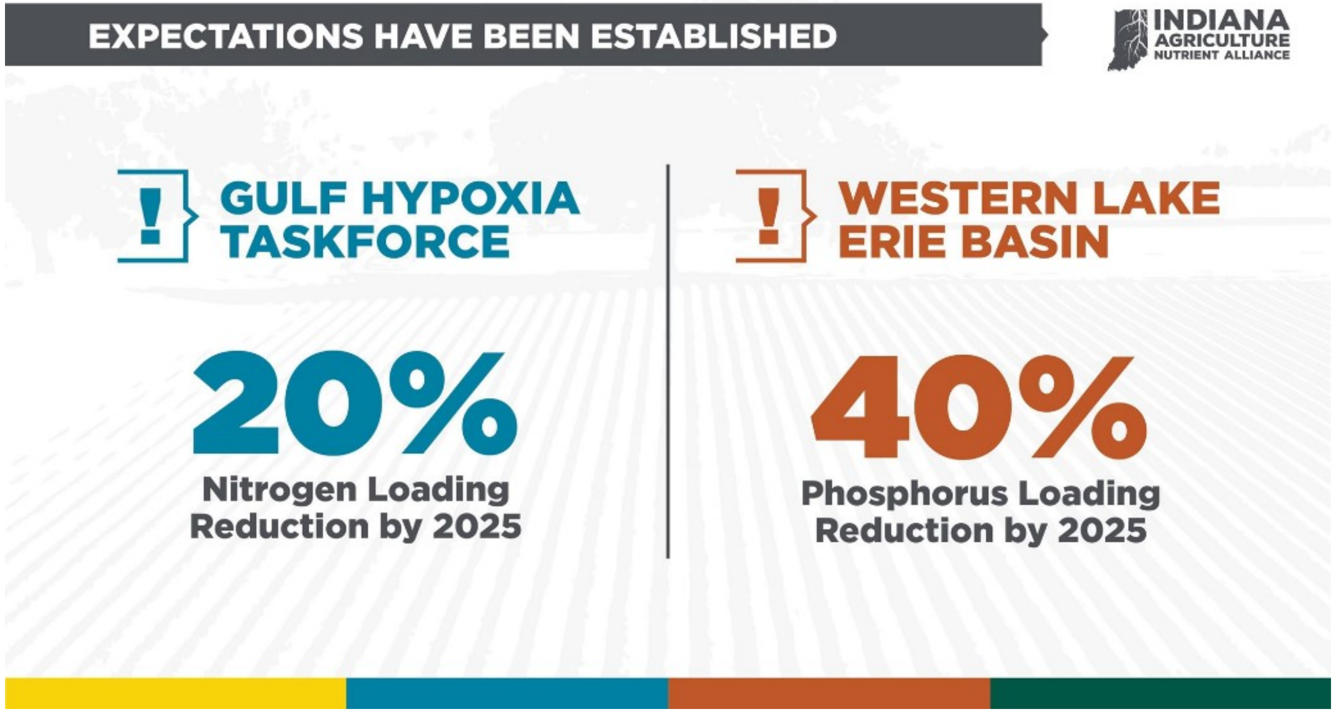


Building Farmer and Advisor Confidence

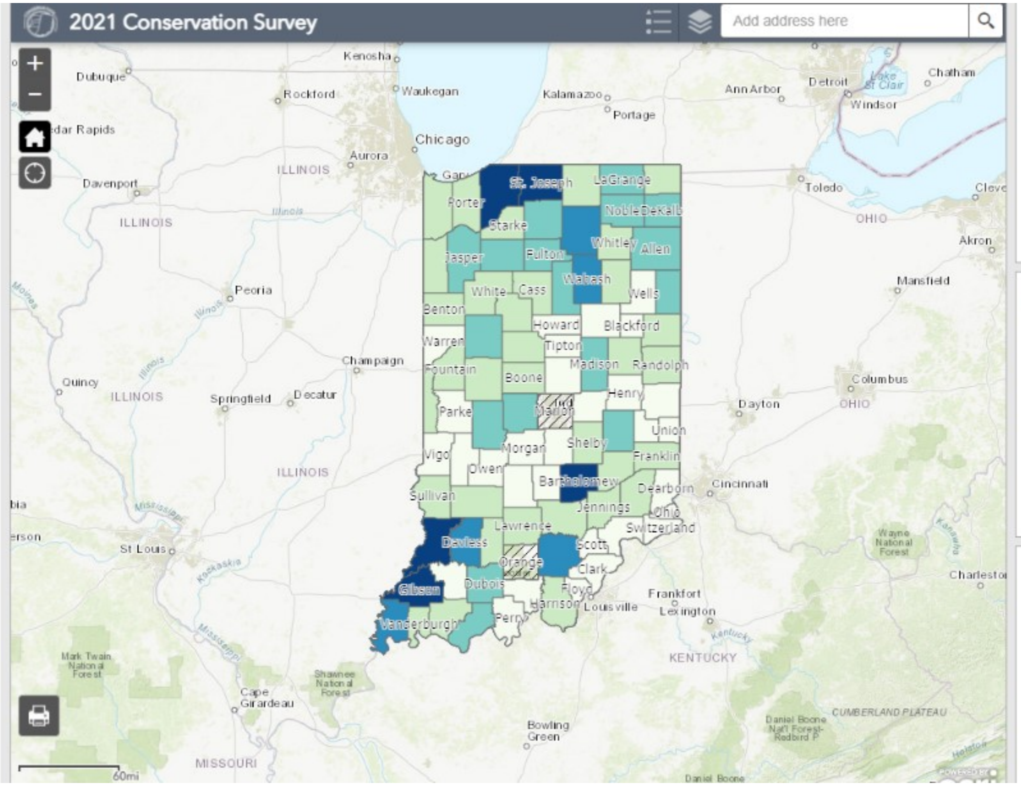


Source: Purdue University

Building Policymaker and Agency Trust



Tracking and Measuring Loss Reductions



Acres of Living Cover

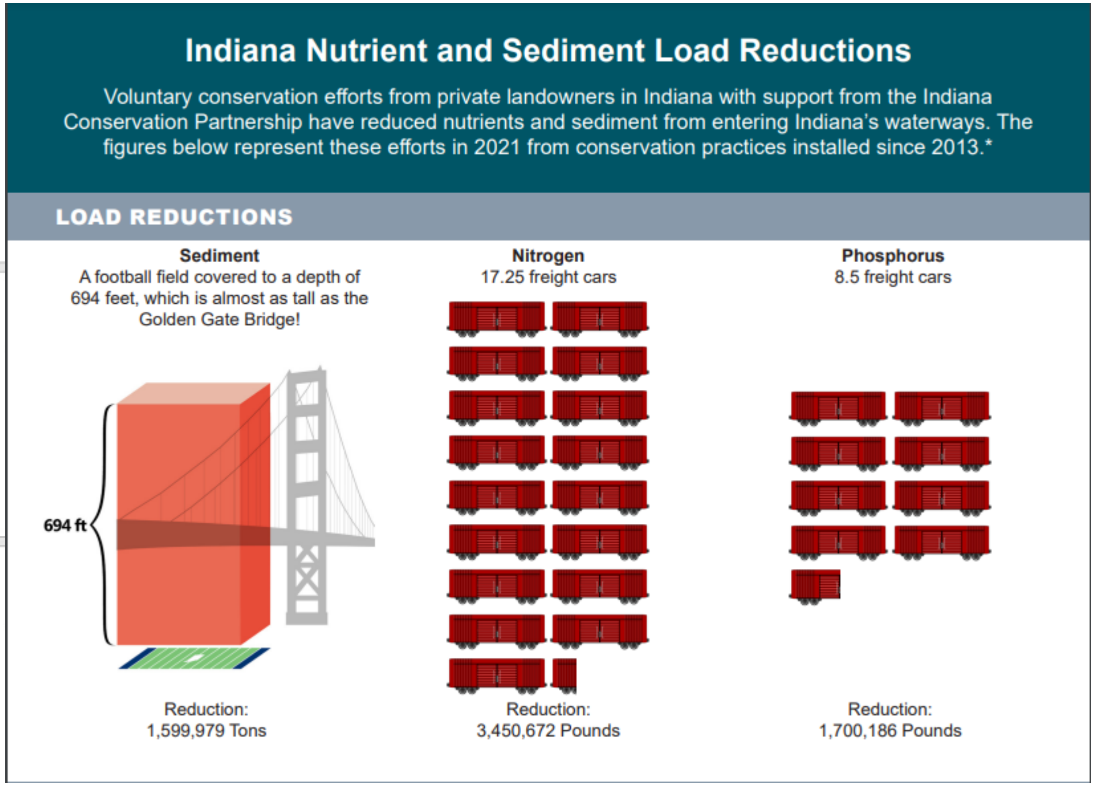
1.59M

Living Cover Acres After Corn Harvest

616k

Living Cover After Soybeans Harvest

915k



Selection of Practices and How Do We Define?

- Initial practices are a combination of nutrient management, soil health and edge of field practices
- Selected based on likelihood of adoption and potential for nutrient reductions
- Align with practice adoption goals of IANA
- Most common receiving assistance through ICP partners
- Practices are defined through established standards (NRCS) and common industry practice
  - Recognize uncertainty/ambiguity in some areas

Indiana Agriculture Support

INDIANA SCIENCE ASSESSMENT for the State Nutrient Reduction Strategy

ABOUT IANA

INDIANA AGRICULTURE NUTRIENT ALLIANCE

AGRICULTURE ORGANIZATIONS

+

INDIANA CONSERVATION PARTNERSHIP

+

CONSERVATION ORGANIZATIONS

Keeping Indiana farmers at the forefront of proactive nutrient management and soil health practices that improve farm viability and, ultimately, reduce nutrient loss to water

BOARD MEMBERS

Executive Committee

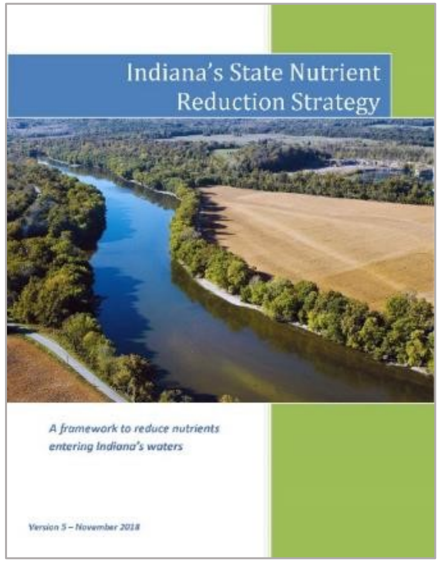
- Agribusiness Council of Indiana
- Indiana Farm Bureau
- USDA Natural Resources Conservation Services of Indiana
- Indiana Soybean Alliance

- American Dairy Association of Indiana
- Indiana Association of SWCDs
- Indiana Beef Cattle Association
- Indiana Corn Marketing Council
- Indiana Dairy Producers
- Indiana Pork
- Indiana State Department of Agriculture
- Indiana State Poultry Association
- Purdue University College of Agriculture
- The Nature Conservancy of Indiana

Supporting the State Nutrient Reduction Strategy

- Indiana's State Nutrient Reduction Strategy (SNRS) was developed to "capture statewide, present and future endeavors in Indiana which positively impact the State's waters as well as gauge the progress of conservation, water quality improvement and soil health practice adoption in Indiana".

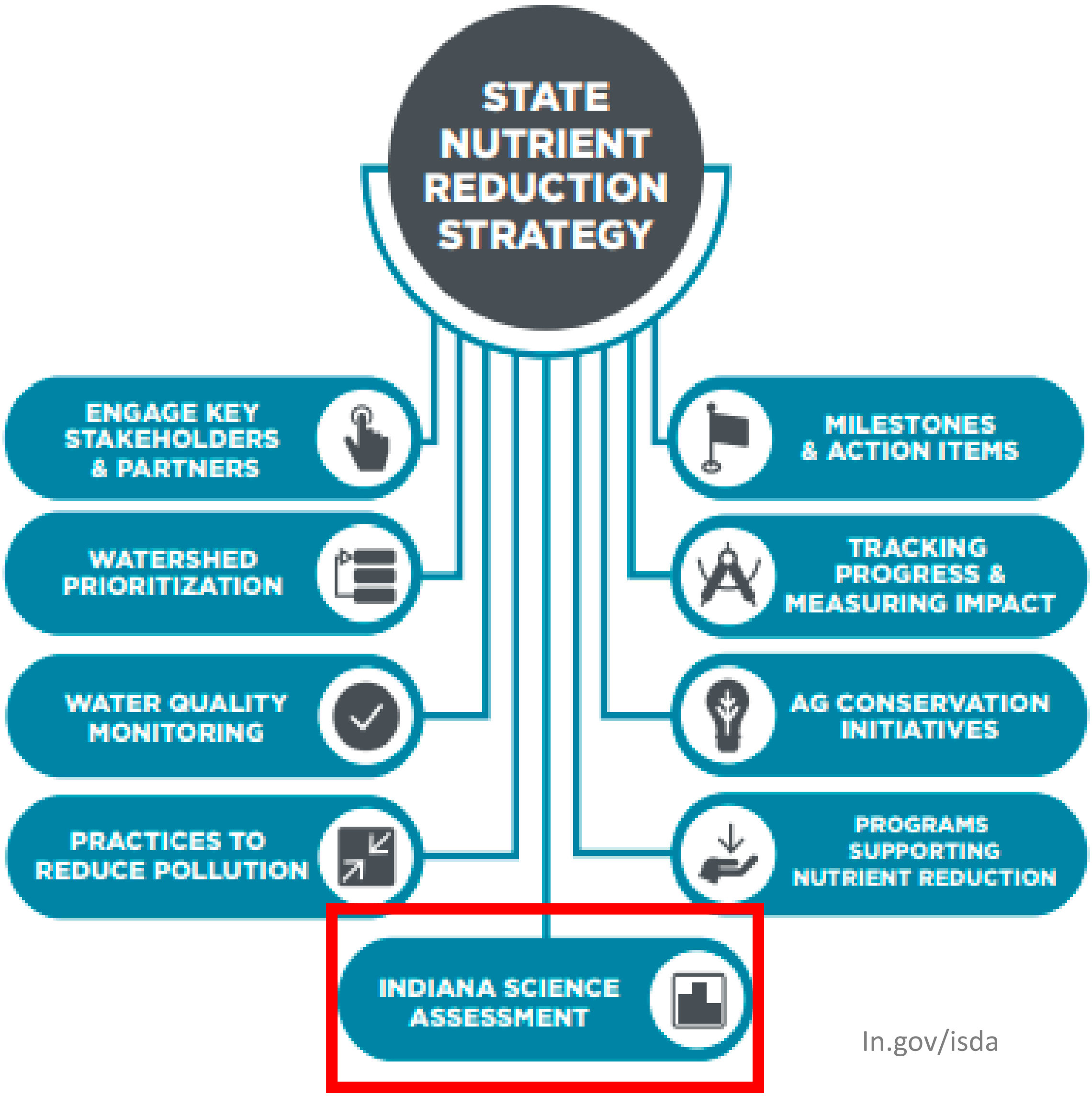
- The Indiana SNRS represents the state's commitment to reduce nutrient runoff into Indiana's waters from **point** sources and **non-point** sources.







Supporting the State Nutrient Reduction Strategy



In.gov/isda

Indiana Science Assessment

Indiana Science Assessment Core Team

- Indiana State Department of Agriculture (ISDA) — Julie Harrold
- Indiana Natural Resources Conservation Service (NRCS) — Jerod Chew
- The Nature Conservancy (TNC) — Mike Dunn
- Indiana Agriculture Nutrient Alliance (IANA) — Ben Wicker
- Indiana Department of Environmental Management (IDEM) — Kristen Arnold
- Purdue University, College of Agriculture — Jane Frankenberger

➢ Indiana Science Assessment Strategy Developed and Finalized in September 2019

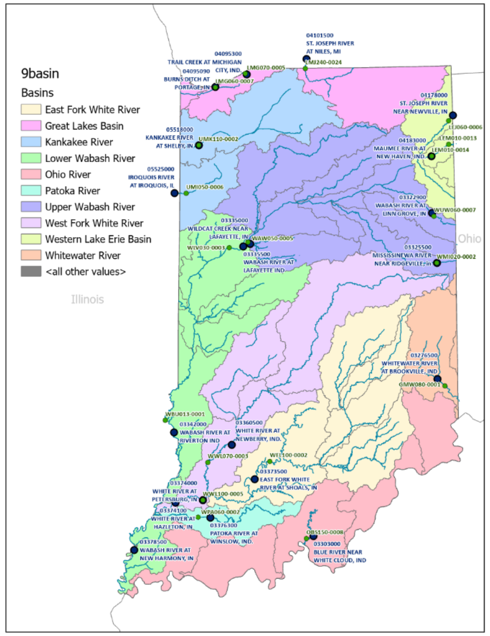
- Includes two components
- https://www.in.gov/isda/divisions/soil-conservation/indiana-state-nutrient-reduction-strategy/indiana-science-assessment/

Indiana Science Assessment

The Indiana Science Assessment was born out of the desire of the Indiana Conservation Partnership (ICP) wanting to improve the process of how nutrient load reductions are determined for best management practices.

The Indiana State Nutrient Reduction Strategy (SNRS) has provided a foundation for nutrient reduction efforts across the Indiana Conservation Partnership (ICP) agencies and others, and has enhanced collaboration in conservation implementation. This collaboration is demonstrated by Indiana's leadership in sharing conservation practice information among agencies within the ICP, which has allowed results of the SNRS and efforts across agencies to showcase the impacts of

Overview of Science Assessment Components

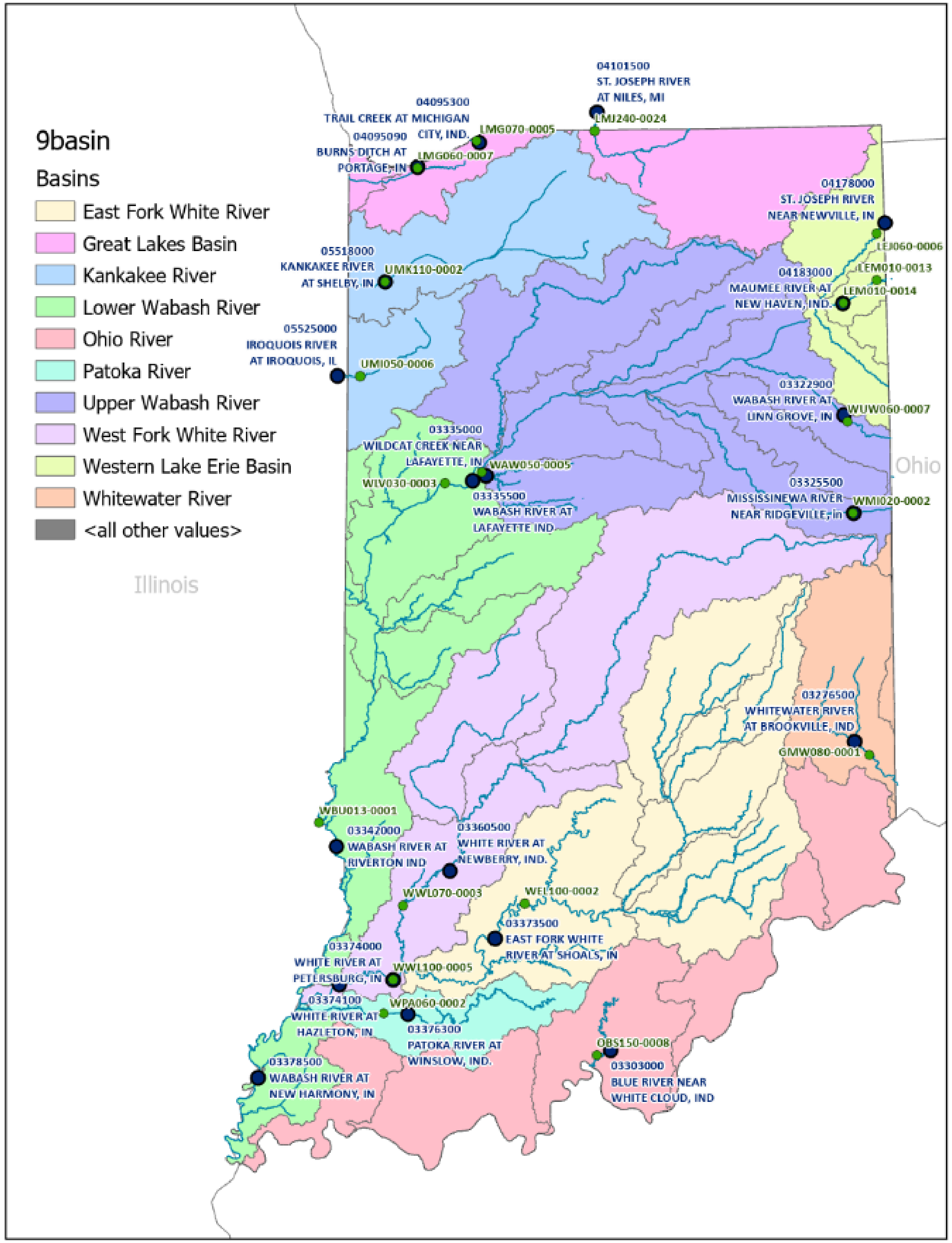


- **Component 1**: Determine historic and ongoing nutrient loads in rivers, especially those leaving the state.
  - **Roles**: Led by Indiana State Department of Agriculture (ISDA) with support from IDEM, USGS and The Nature Conservancy

- **Component 2**: Improve method to quantify nutrient reductions from conservation practices, including dissolved nutrients, and determine efficiency of practices in reducing loads.
  - **Roles:** An EPA grant is used to hire a Research Associate who works at Purdue University.
  - Researchers from 5 universities, USDA-ARS, and USGS are participating on the Science Committee.

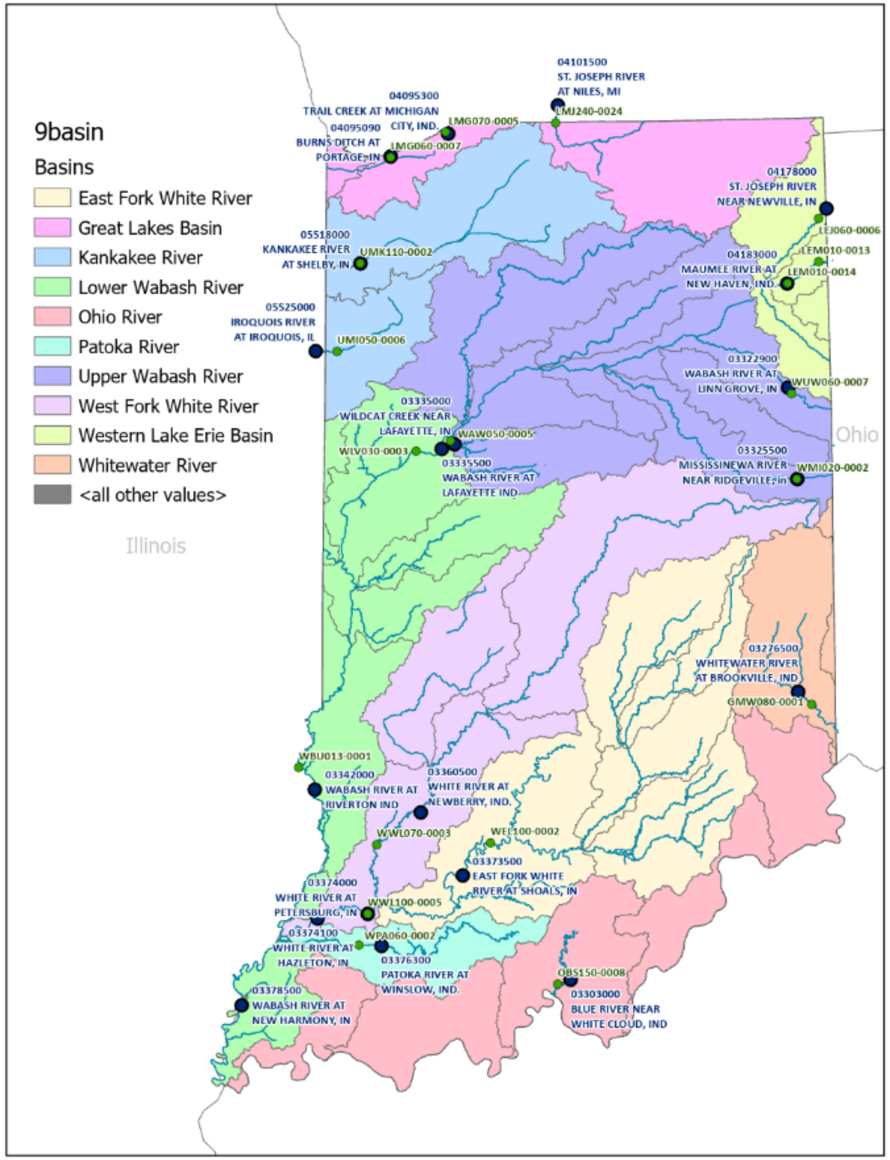
Component 1:

Determine historic and ongoing nutrient loads leaving the state

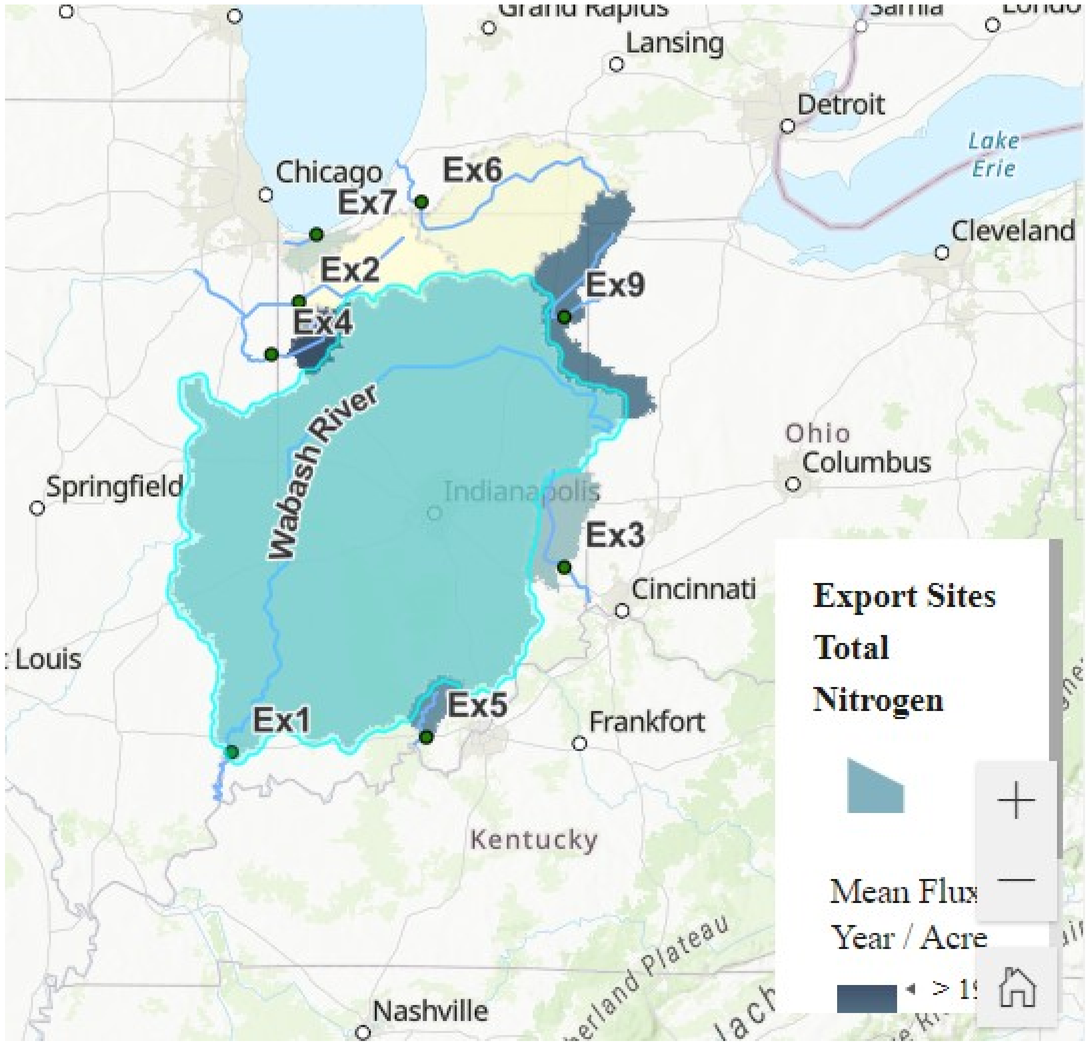


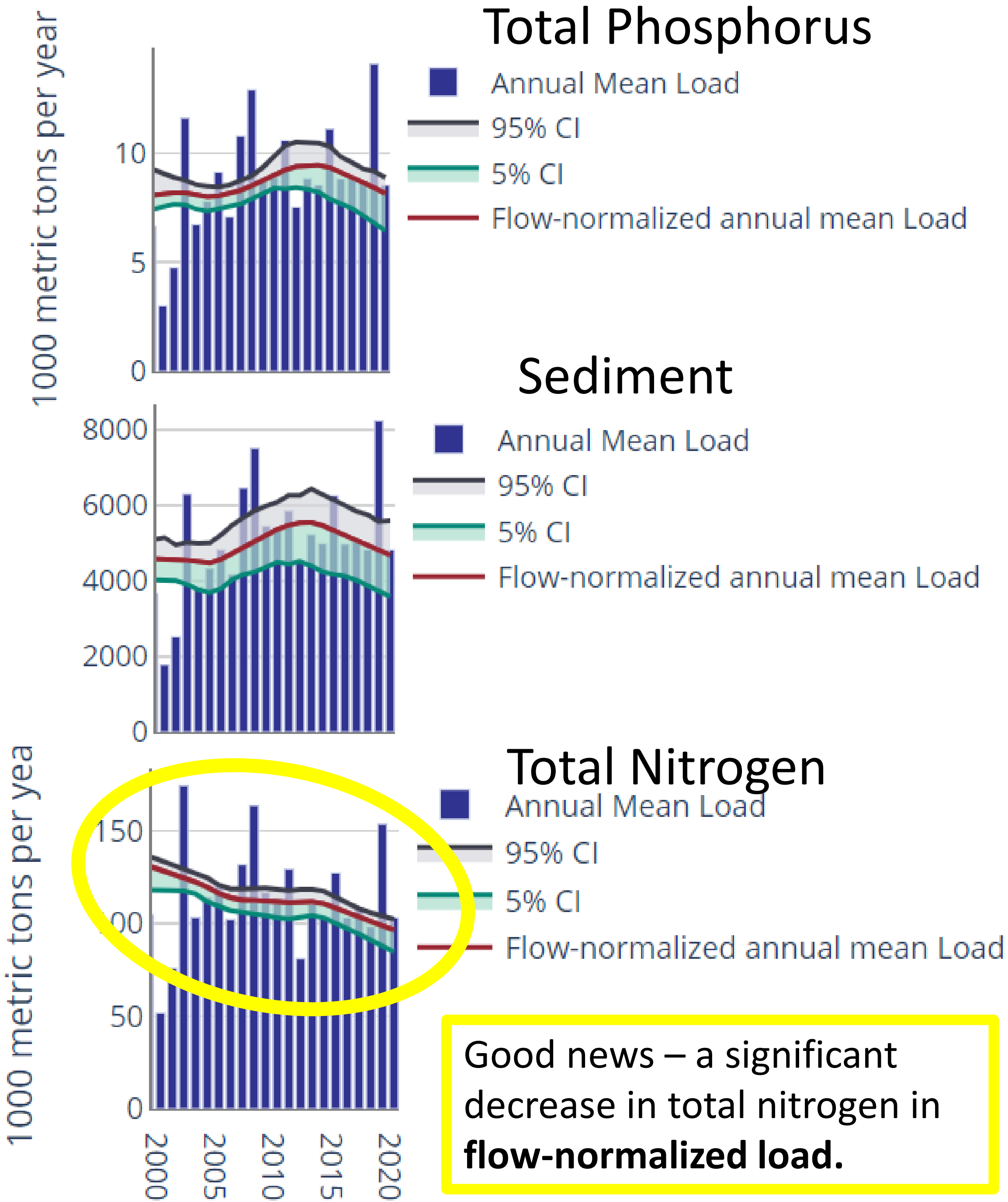
Component 1 Process

- Uses historical data from
  - IDEM Fixed Station Network Monitoring Sites (N, P, Sediment concentration) and
  - USGS Stream Gages Network (flow)
  - from 1980s to 2020.
- Load calculation using the USGS Weighted Regressions on Time, Discharge and Season (WRTDS) model
  - Calculates total annual load **flow-normalized** annual load
- Loads calculated for:
  - Total Nitrogen,
  - Total Phosphorus,
  - Total Suspended Solids

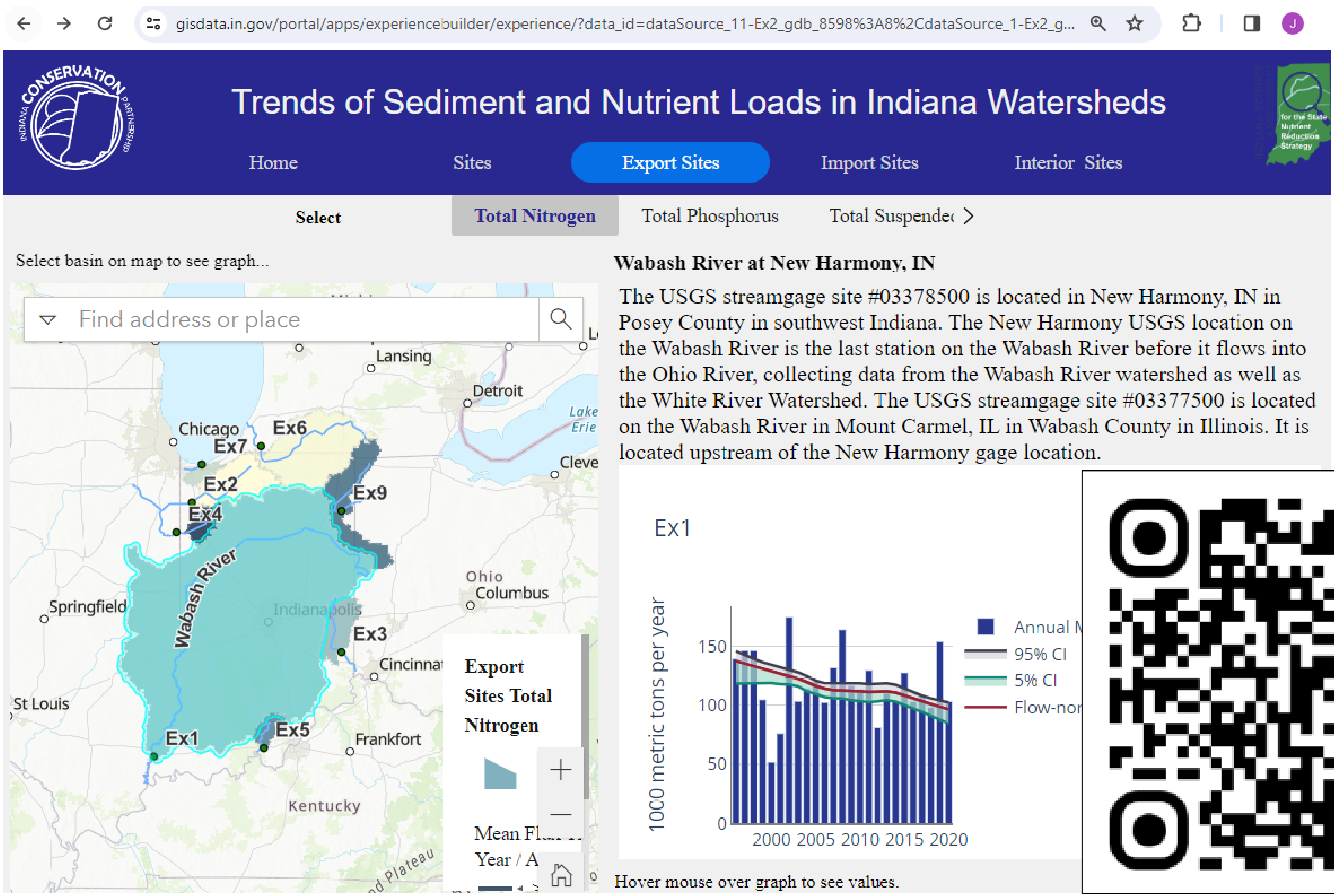


Wabash River at New Harmony





Good news – a significant decrease in total nitrogen in **flow-normalized load.**


gisdata.in.gov/portal/apps/experiencebuilder/experience/?data_id=dataSource_11-Ex2_gdb_8598%3A8%2CdataSource_1-Ex2_g...
INDIANA CONSERVATION PARTNERSHIP
Trends of Sediment and Nutrient Loads in Indiana Watersheds
Home
Sites
Export Sites
Import Sites
Interior Sites
Select
Total Nitrogen
Total Phosphorus
Total Suspended
Select basin on map to see graph...
Find address or place
Lansing
Detroit
Lake Erie
Chicago
Ex6
Ex7
Ex2
Ex9
Ex4
Wabash River
Ohio
Columbus
Springfield
Indianapolis
Ex3
Cincinnati
St Louis
Ex1
Ex5
Frankfort
Kentucky
Export Sites Total Nitrogen
Wabash River at New Harmony, IN
The USGS streamgage site #03378500 is located in New Harmony, IN in Posey County in southwest Indiana. The New Harmony USGS location on the Wabash River is the last station on the Wabash River before it flows into the Ohio River, collecting data from the Wabash River watershed as well as the White River Watershed. The USGS streamgage site #03377500 is located on the Wabash River in Mount Carmel, IL in Wabash County in Illinois. It is located upstream of the New Harmony gage location.
Ex1
1000 metric tons per year
0
50
100
150
2000 2005 2010 2015 2020
95% CI
5% CI
Hover mouse over graph to see values.

Also available as a pdf report:

[Trends of Sediment and Nutrients Loads in Indiana Watersheds]

All Sites that export from Indiana to the Mississippi River Basin

The largest period of overlapping data was used for the 5 export sites in the Mississippi River Basin, which was from 2000-2019, to show the flow normalized load/flux trend. The 5 sites are: 1) Ex1 - the Wabash River at New Harmony, IN, 2) Ex2 - the Kankakee River at Shelby, IN, 3) Ex3 - the Whitewater River at Brookville, IN, 4) Ex4 - the Iroquois River near Iroquois, IL, and 5) Ex5 - the Blue River near White Cloud, IN.

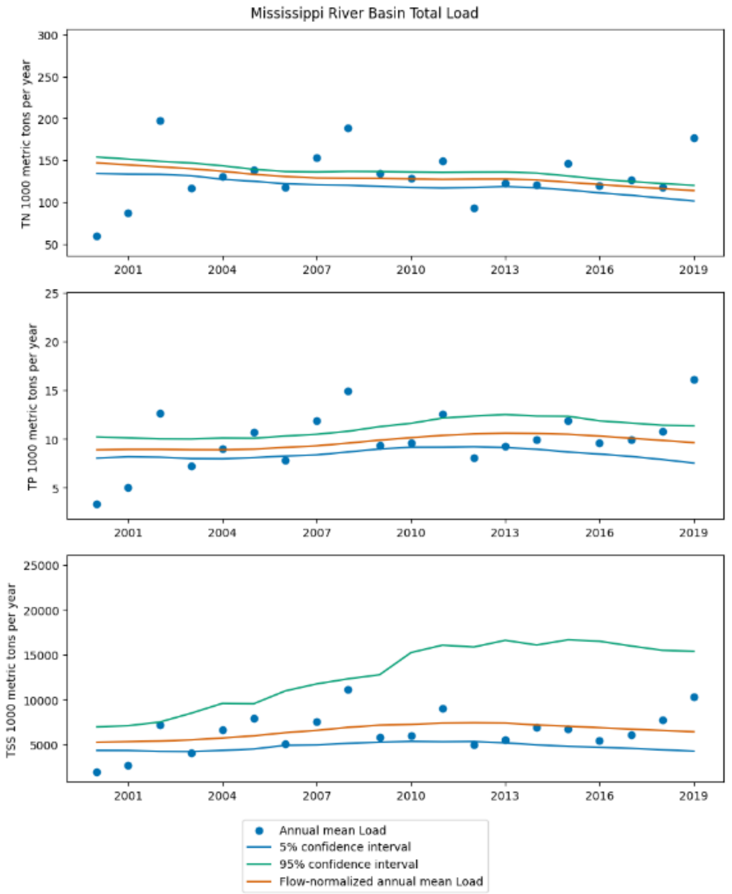


Figure 7: Figure 7 shows the trend in flow normalized load/mean flux combined for the **Mississippi River export sites**. (5 export sites)

Component 2:

Improve the method to quantify nutrient reductions from conservation practices

How do various conservation practices affect

- N loss?
- P loss?
- Sediment loss?

INDIANA SCIENCE ASSESSMENT for the State Nutrient Reduction Strategy

Cover crops

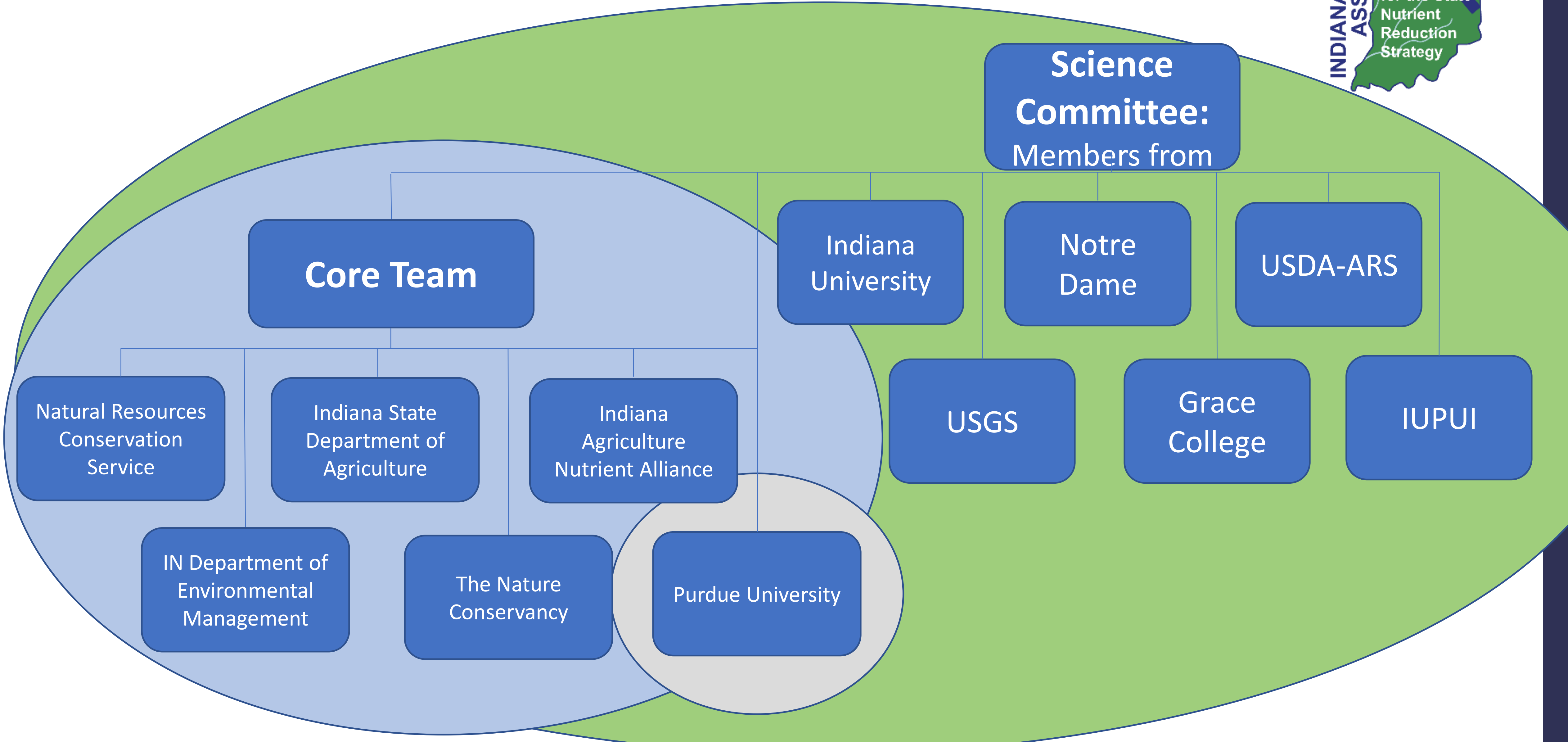
No-Till

Nitrogen Rate

Drainage Water Management

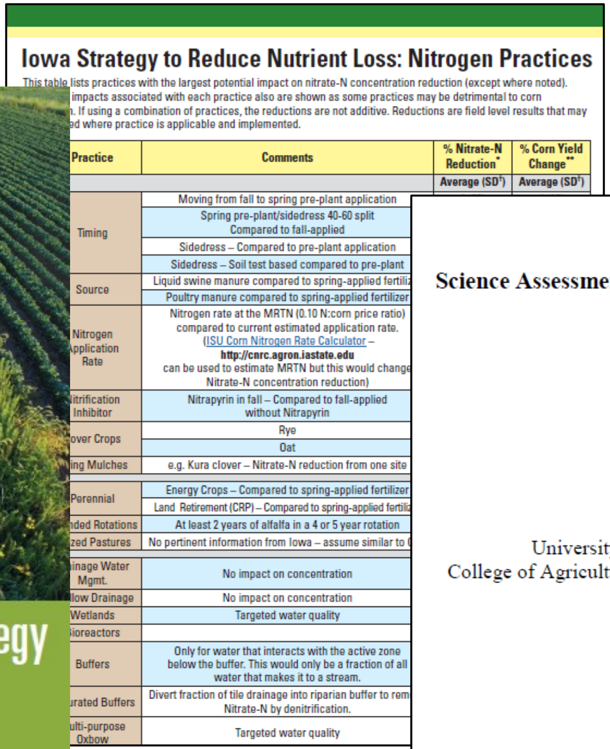
Photos from Purdue University and NRCS

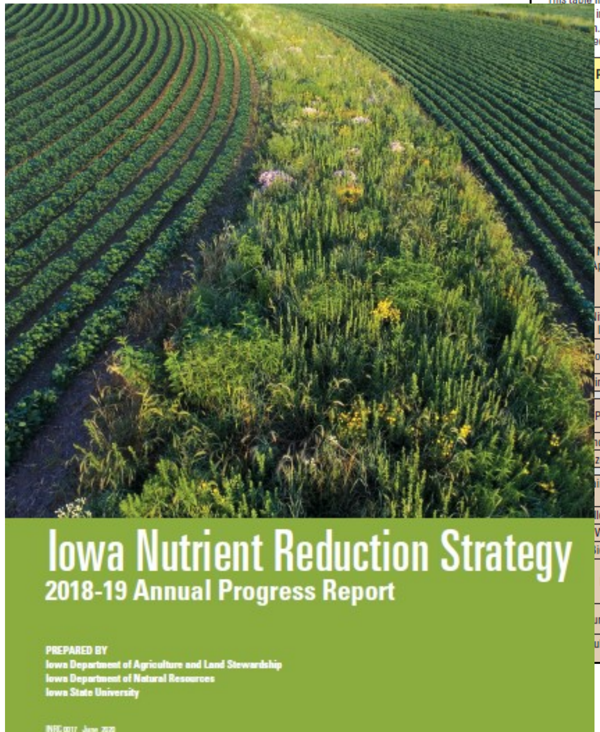
Component 2 Science Assessment Team

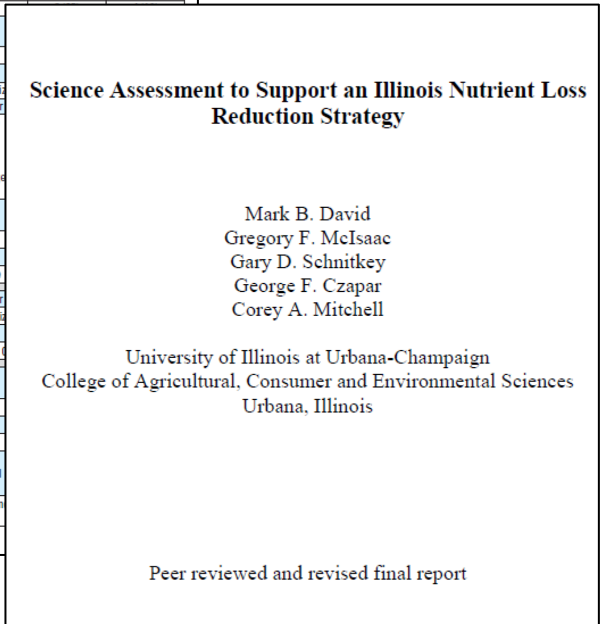


We are building on other states' analyses

- Iowa and Illinois have done Science Assessments using data from published literature
- Focused only on percent reductions
- We are improving on this method with new data and technology
  - Calculate load reductions (lb/acre or kg/ha)
  - Separate drain flow and runoff
  - Add newer data







Quantifying the effect of conservation practices

Goal is to address the effects of conservation practices on

- Nitrogen loss
- Phosphorus loss
- Sediment loss

Including reductions in both

- surface runoff

- tile drainage (where applicable)

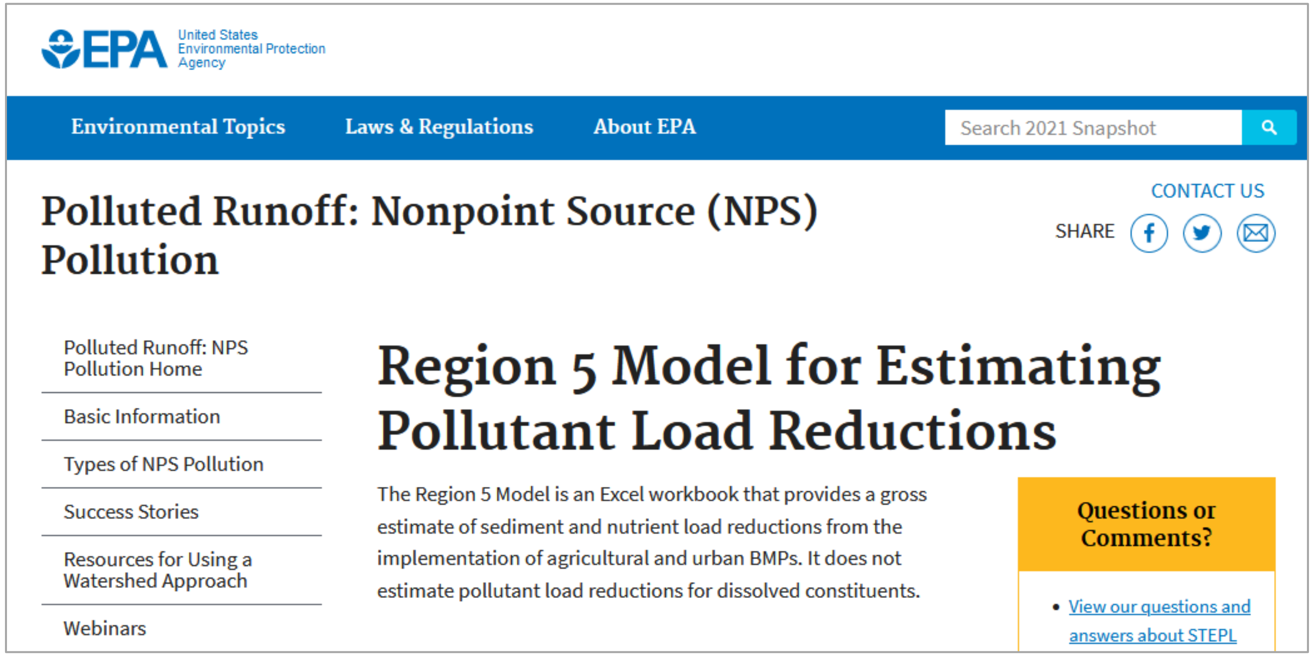
Expressing reductions in two ways

1. Percent (%) reduction
2. Pounds per acre (lbs/acre)

Photos from Purdue University and NRCS

Sediment: Use the Region 5 Model

- Sediment loss reductions are already assessed by the Indiana Conservation Partnership using the Region 5 Model, and this was determined to be sufficient for sediment.
- This analysis focuses on N and P reductions, for which dissolved reductions were not assessed using the Region 5 Model.



Practices to assess

Phase 1

1. Cover crops
2. No-Till
3. Reduced Tillage
4. Nitrogen rate
5. Nitrogen timing
6. Phosphorus rate
7. Phosphorus placement
8. Filter strips
9. Drainage water management
10. Grassed waterways

Phase 2

11. Blind inlets
12. Two-stage ditch
13. River-floodplain reconnection
14. Constructed or restored wetlands
15. Bioreactors
16. WASCOBs
17. Nitrification inhibitor
18. Gypsum
19. Saturated buffers
20. Phosphorus removal structures
21. Add small grain into rotation
22. Add hay into rotation
23. Harvested/grazed perennials
24. Non-harvested perennials
25. Reduced drainage intensity

Criteria:

- Promoted by agencies in Indiana
- Potential widespread use in Indiana
- Sufficient data in the literature
- Expertise and willingness of Indiana scientists

INDIANA SCIENCE ASSESSMENT for the State Nutrient Reduction Strategy

Strategy for assessing: Synthesize existing studies

INDIANA SCIENCE ASSESSMENT for the State Nutrient Reduction Strategy

We base the estimation method on field studies, rather than a model.

Comparing loads from two fields in Ohio

Photo: Notre Dame

Reduction assessment requires a comparison

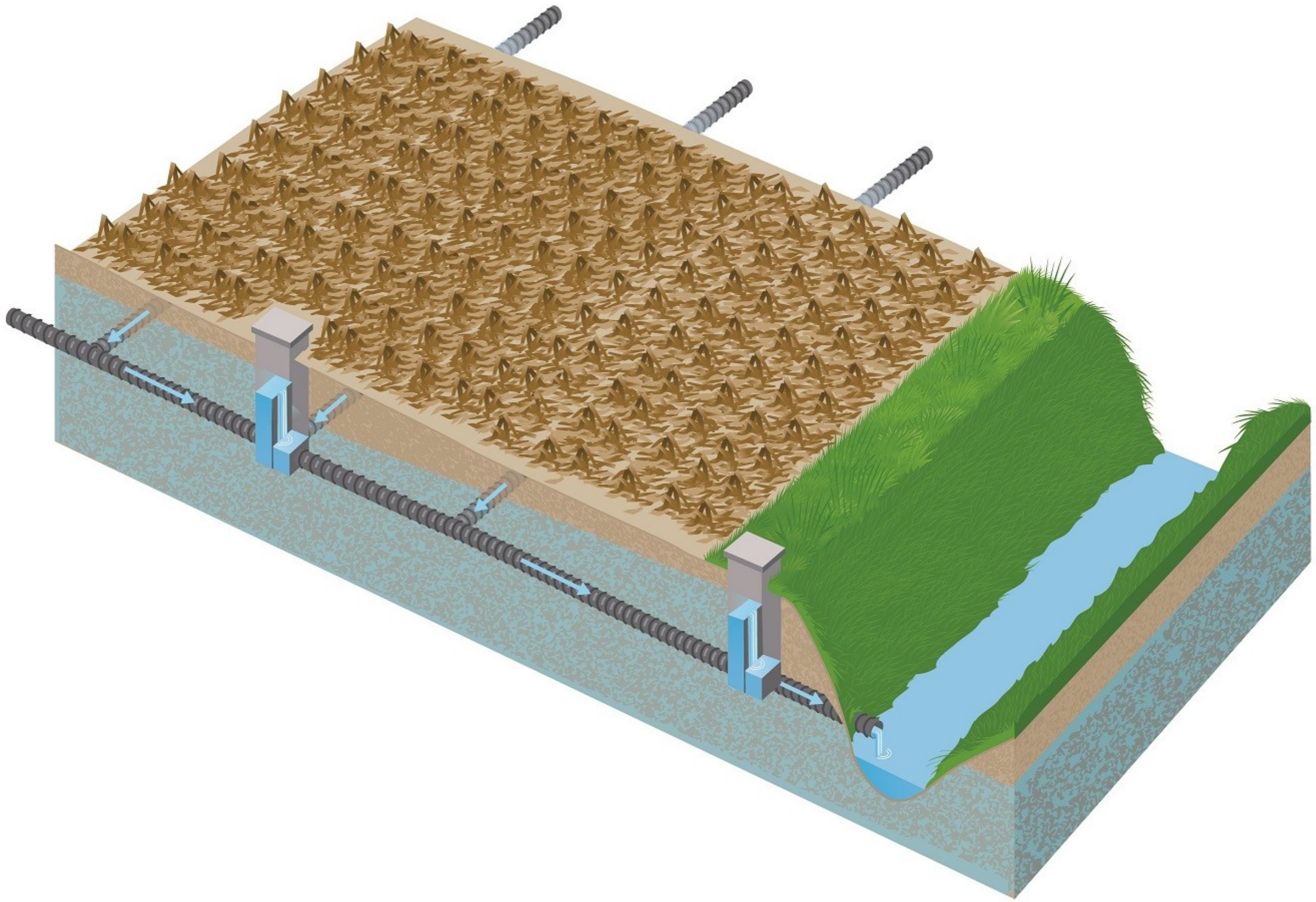
- Preferred to “not preferred”, measured at the same site.

<u>Examples:</u>

1. Cover crops vs no cover crops
2. Drainage water management vs free drainage
3. Applying N above recommended rate vs. at or below recommendations
4. Subsurface P placement vs. broadcast
5. Riparian buffers vs. no riparian buffers

Example: Drainage water management

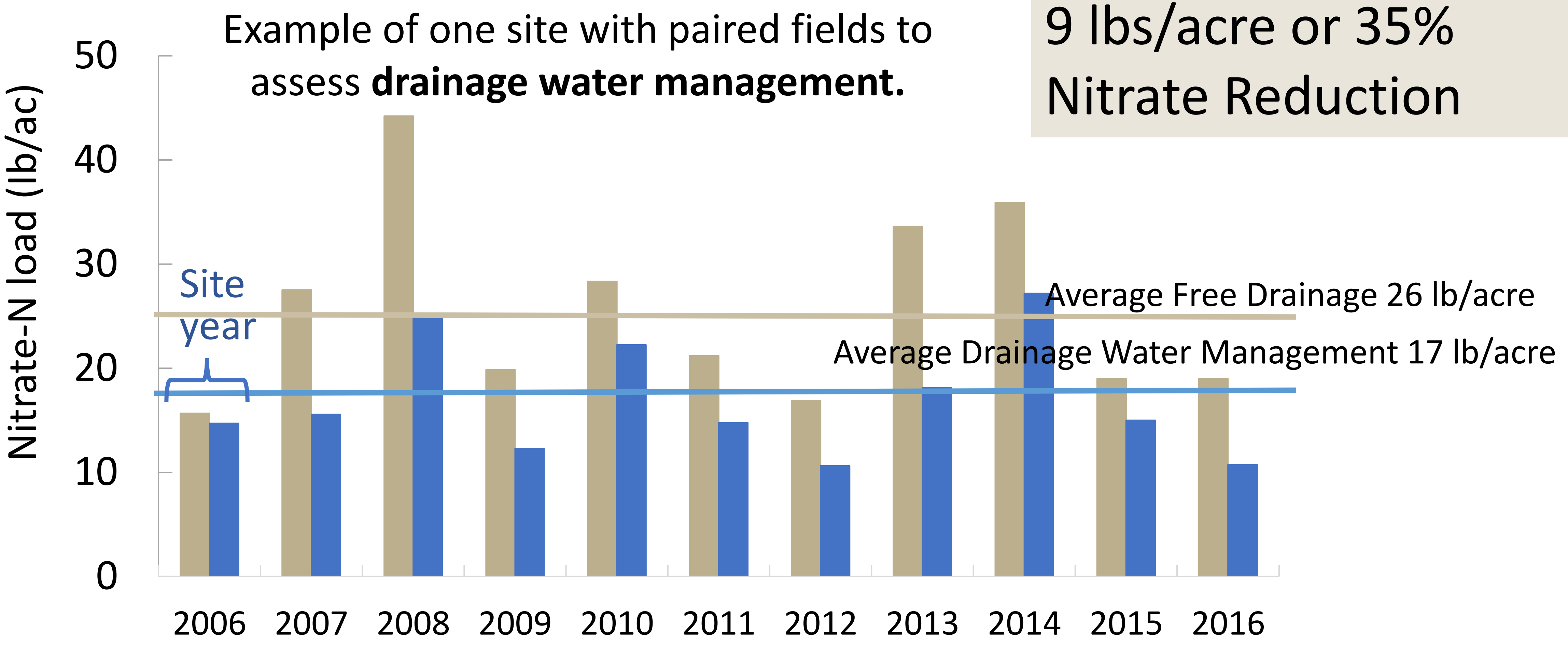
- Also known as Controlled Drainage
- Water control structure raises the outlet during the winter when drainage is not needed.



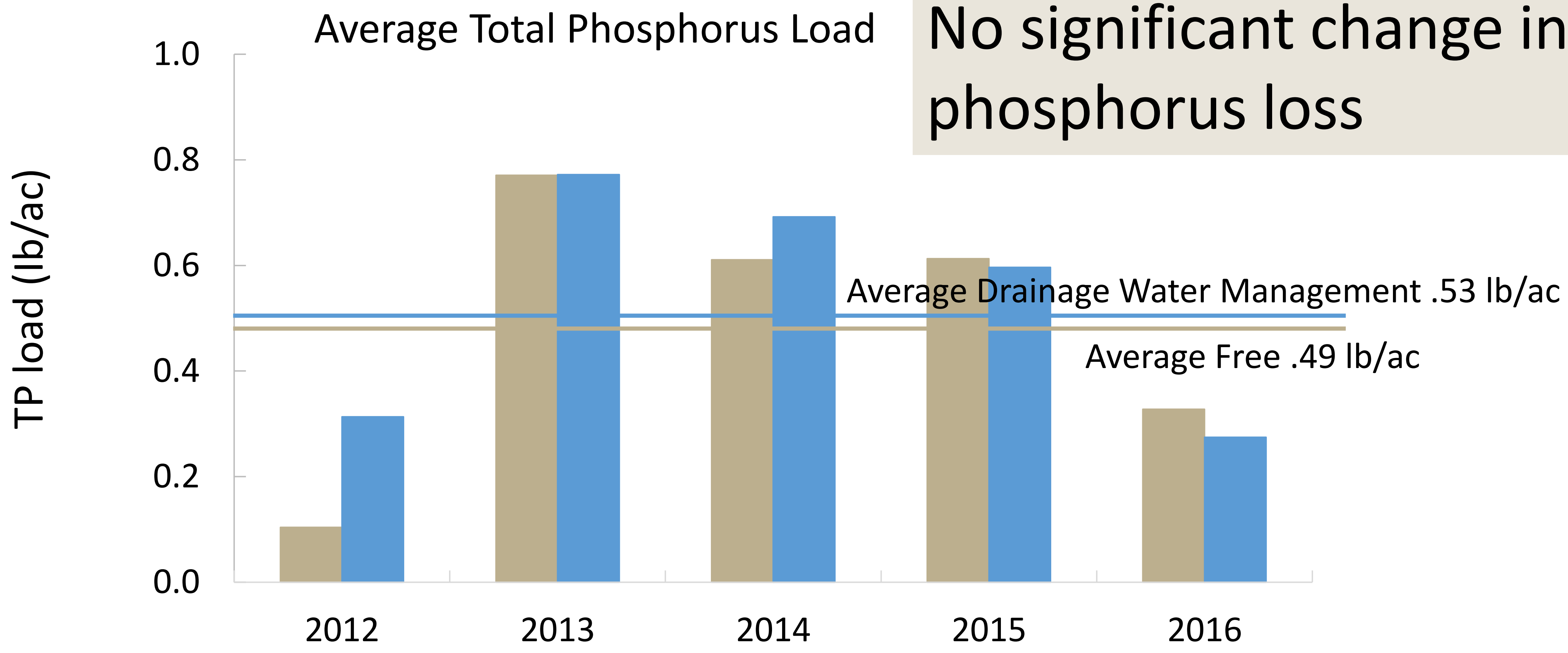
Long-term study at Davis Purdue Agricultural Center

One 40 acre field is split into four quadrants

9 lbs/acre or 35% Nitrate Reduction



No significant change in phosphorus loss



Systematic Review:

Steps for each practice

1. Agree on definition	Develop definitions that all stakeholders can accept and use
2. Identify	Identify all studies that may provide data
3. Select	Select studies that meet criteria
4. Extract	Extract data into database
5. Analyze	Analyze data to quantify effectiveness
6. Report	Report and share findings; Document processes, data, analysis, and synthesis

INDIANA SCIENCE ASSESSMENT for the State Nutrient Reduction Strategy

1. Agree on Practice Definitions

Guide to Conservation Practice Definitions for Indiana Science Assessment – Version 1

Table of Contents

The **General information/General Practice Definition & Benefits** is intended to provide a broad overview of the practice, and to provide a basis for the definition used in this project.

The **Criteria for Inclusion into the Science Assessment** is to provide a basis for deciding which studies to include in the systematic review. For this purpose, the definition should focus on the required characteristics of implementation or management, not the purpose or goal.

Note: Definitions of other conservation practices will be available in future editions of this guide as practices are added to the Indiana Science Assessment process.

No-Till

General information/General Practice Definition & Benefits

No-till farming is an agricultural technique for growing crops or pasture without disturbing the soil through tillage. It limits soil disturbance to manage the amount, orientation, and distribution of crop and plant residue on the soil surface year-round, which can reduce erosion, increase soil health, and conserve soil moisture. Strip-till, which fits the definition of no-till, is the practice of tilling the row where the seed and/or fertilizer will be placed, keeping the residue between the rows undisturbed.

ISDA photo gallery

ISDA photo gallery

This practice includes planting methods commonly referred to as no-till, quality no-till, never-till, zero-till, slot plant, zone-till, strip-till, or direct seed. Approved implements are no-till and strip-till planters; certain drills and air seeders; strip-type fertilizer and manure injectors and applicators; and similar implements that only disturb strips and slots.

Full-width disturbance of any kind is not used for any operation considered a no-till system. Full-width disturbance is any operation that disturbs more than 70% of the soil surface and residue within the implement impact area (i.e. – the soil surface and residue between the plant rows is not disturbed).
The current NRCS definition of no-till for the purpose of conservation practice standard 329 is that the soil tillage intensity rating (STIR) value, which shall include all field operations that are performed during the crop interval between harvest and termination of the previous cash crop and harvest or termination of the current cash crop (includes fallow periods), shall be no greater than 20.

A no-till operation for a single crop year is not a no-till system. See reduced tillage definition.

Criteria for Inclusion into the Science Assessment

To be included in the assessment for **no-till**, a study must meet the following criteria:

1. The study must compare the nutrient loads from the preferred (BMP) and non-preferred practices.
   - Preferred (BMP): No-till
   - Non-preferred: Conventional Tillage

Available on Indiana Science Assessment website

2. Identify all studies that might provide data

- We started with published reviews, then added all the more recent studies from Google Scholar search with relevant search terms.

3. Select Studies that Meet Criteria

Criteria for inclusion: Studies must:

- ✓ Be based on field measurements.
- ✓ Compare runoff and/or drain flow from a control to a treatment
- ✓ Allow isolation of the effects of the practice.
- ✓ Provide loads on an annual basis. (Studies with rainfall simulations included when insufficient annual load data available.)
- ✓ Have been conducted in the Midwestern US or areas with similar soils, climate, and crop types
- ✓ Follow appropriate quality assurance standards (assumed to be true for all peer-reviewed studies).

4. Extract Data. (Example for cover crop reductions for N)

Reference	State	Control Load (kg N/ha)	Treatment Load (kg N/ha)	Load reduction (kg/ha/yr)	Load Reduction (%)
Adler, R., Singh, G., Nel	Missouri	2.4	1.8	0.6	24.7%
Adler, R., Singh, G., Nel	Missouri	6.7	2.6	4.1	61.0%
Daigh, A. L., Zhou, X., H	Iowa	5.5	0.5	5.0	90.9%
Daigh, A. L., Zhou, X., H	Iowa	11.8	4.7	7.1	60.2%
Daigh, A. L., Zhou, X., H	Iowa	29.0	24.8	4.2	14.5%
Daigh, A. L., Zhou, X., H	Iowa	15.1	14.1	1.0	6.6%
Drury et al. 2014	Ontario	17.4	8.5	8.9	51.1%
Drury et al. 2014	Ontario	19.3	11.2	8.1	42.0%
Drury et al. 2014	Ontario	22.2	21.3	0.9	4.1%
Drury et al. 2014	Ontario	29.0	30.9	-1.9	-6.6%
Drury et al. 2014	Ontario	14.1	16.2	-2.1	-14.9%
Kaspar, T. C., Jaynes, D	Iowa	40.4	11.2	29.2	72.3%
Kaspar, T. C., Jaynes, D	Iowa	34.4	11.1	23.3	67.7%

Each row is one "site-year"

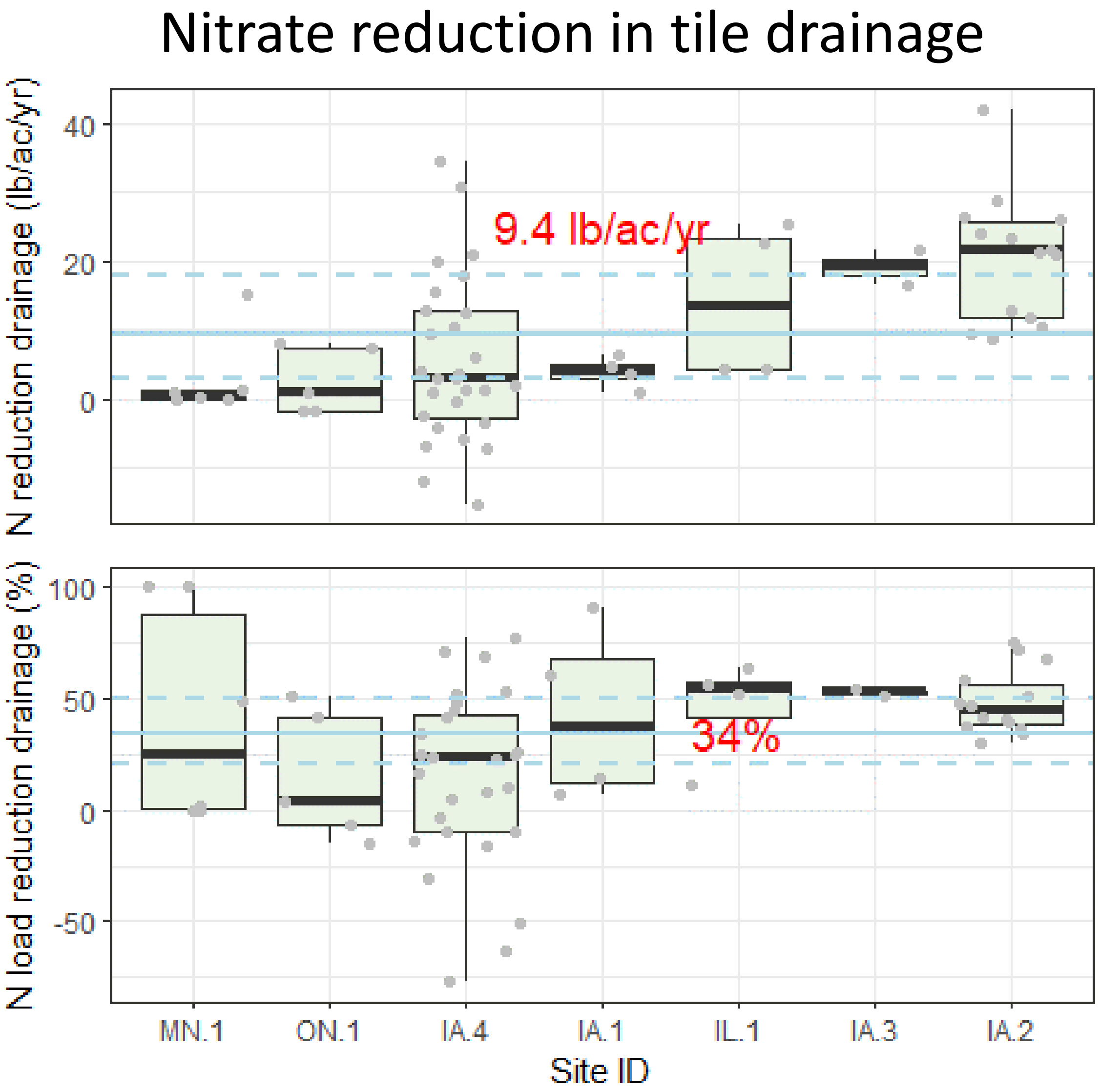
Cover crops reduced N loss

Cover crops increased N loss

…plus 53 additional site years for N; 18 site years for P

Cover Crops – Nutrient Reduction Findings

- Nitrate reduction in tile drainage: 63 site years of data, sufficient for statistical analysis.
- Few studies of Surface runoff. Effect on phosphorus mixed.



Expert sub-committee: Shalamer Armstrong, Eileen Kladivko, Todd Royer, Jen Tank

Cover Crops – Nutrient Reduction Findings

- **Nitrogen** loss in tile drainage is sharply reduced by cover crops, shown by strong evidence averaging **9.4 lbs/acre/year or 34%.** Studies are only of N in the form of nitrate. The effect of cover crops on surface runoff is neutral.

- **Phosphorus** impacts from cover crop implementation are still uncertain, with limited data showing both increases and reductions in phosphorus. It is likely that the effect depends on cover crop species, erosion potential, and other factors. There are insufficient studies to provide evidence-based determination of phosphorus effects from cover crop use at this time.

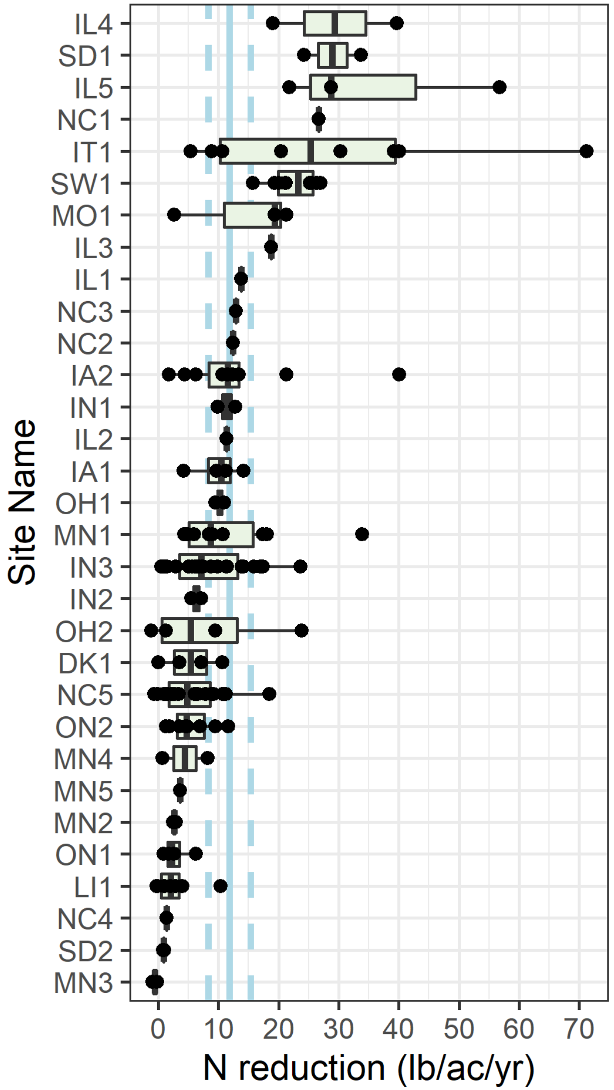
	Nitrogen		**Phosphorus**	
	Surface Runoff	Tile Drains	Surface Runoff	Tile Drains
Percent (%)	Neutral	**34%**	Insufficient data	
lbs/acre		**9.4 lbs/ac**		

Drainage Water Management - Findings

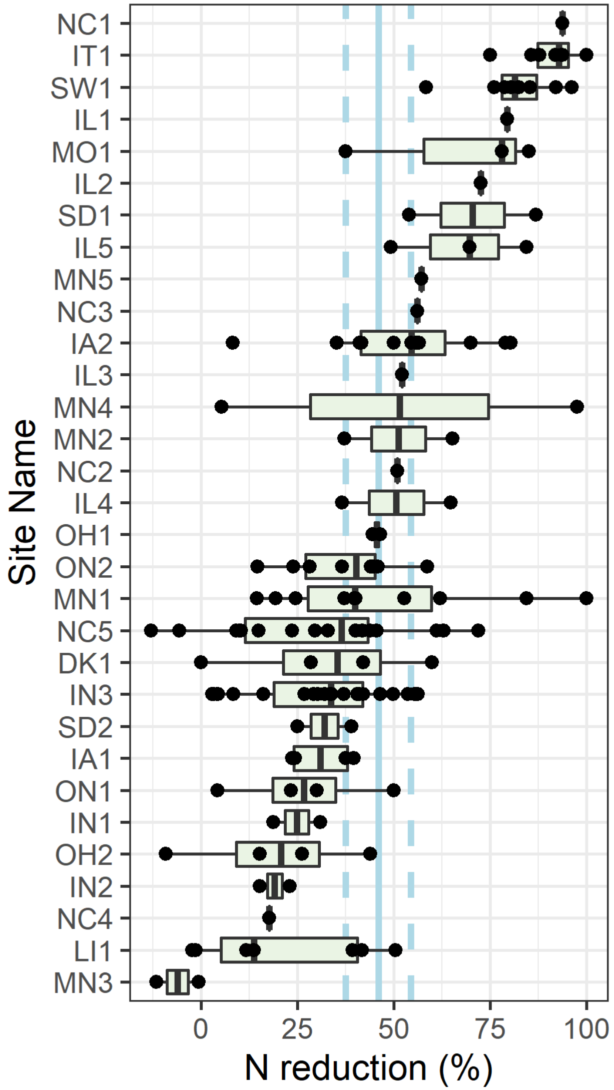
Nitrogen:

31 locations,
140 site years

Mean = 12 lbs/ac/yr

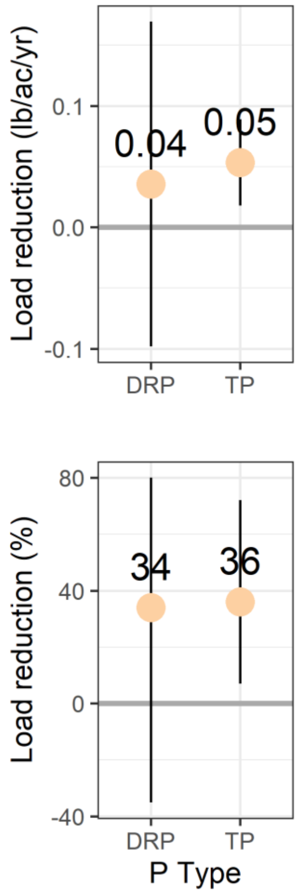


Mean = 46% reduction



Phosphorus:

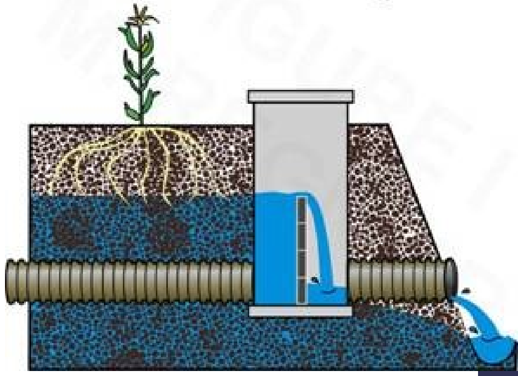
Only 7 site years for DRP and 4 for TP; questions about sampling accuracy.



Conclusion:

Insufficient data

Drainage Water Management - Findings



- **Nitrogen** loss is consistently reduced by drainage water management, shown by strong evidence from tile drain outlet measurements at dozens of locations. Reductions average **12 lbs/acre/year or 46%.** Some increase in loss through surface runoff and seepage may occur but is likely much less than the decrease in tile drain flow.
- **Phosphorus** loss is likely increased in surface runoff and reduced in tile drains, but there is insufficient data to quantify the magnitude of these effects.

	Nitrogen		Phosphorus	
	Surface Runoff	Tile Drains	Surface Runoff	Tile Drains
Percent (%)	Insufficient data	**46%**	Insufficient data ↗	Insufficient data ↘
lbs/acre		**12 lbs/ac**		

Expert sub-committee: Jane Frankenberger, Sara McMillan, Mark Williams

Phosphorus Rate - Findings

INDIANA SCIENCE ASSESSMENT for the State Nutrient Reduction Strategy

- **Definition**: In Indiana, this means using the Tri-State Fertilizer Recommendations to not apply P when soil test P is at or above the maintenance limit.

- **Nitrogen** loss is not impacted by this practice because it is targeted at changing phosphorus fertilizer application alone.
- **Phosphorus** loss is reduced by **22% or 0.8 lbs/acre/yr**, when phosphorus fertilizer is not applied when soil test P is at or above the maintenance limit.

	Nitrogen		**Phosphorus**	
	Surface Runoff	Tile Drains	Surface Runoff	Tile Drains
Percent (%)	Not applicable	Not applicable	**22%**	Insufficient data
lbs/acre/yr			**0.8 lb/acre/yr**	

Expert subcommittee: Chad Penn

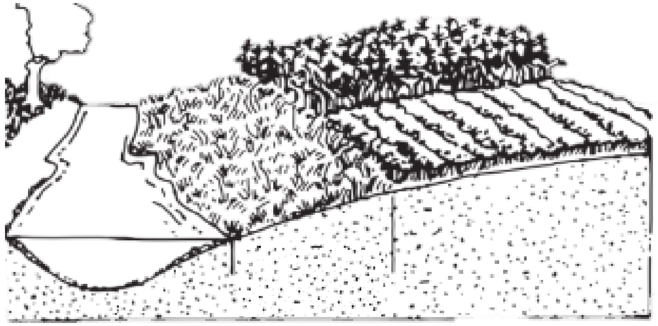
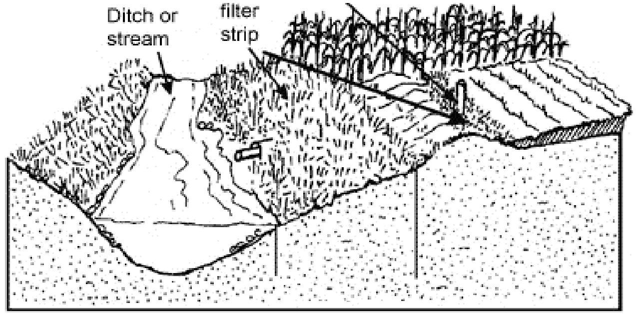
Subsurface Phosphorus Placement

- **Definition**: Subsurface phosphorus application, whether synthetic or manure, is the practice of getting nutrients placed into the soil profile versus leaving nutrients on the soil surface.
- **Nitrogen** loss is not impacted by this practice because it is targeted at changing placement of phosphorus fertilizer application alone.
- **Phosphorus** loss is reduced by **50% in surface runoff**, when phosphorus is injected or incorporated into the soil rather than surface broadcast. There is insufficient data to determine the effects of this practice on phosphorus loss in tile drainage.

	Nitrogen		Phosphorus	
	Surface Runoff	Tile Drains	Surface Runoff	Tile Drains
Percent (%)	Not applicable	Not applicable	**50%**	Insufficient data
lbs/acre/yr			Insufficient data	

Expert subcommittee: Chad Penn

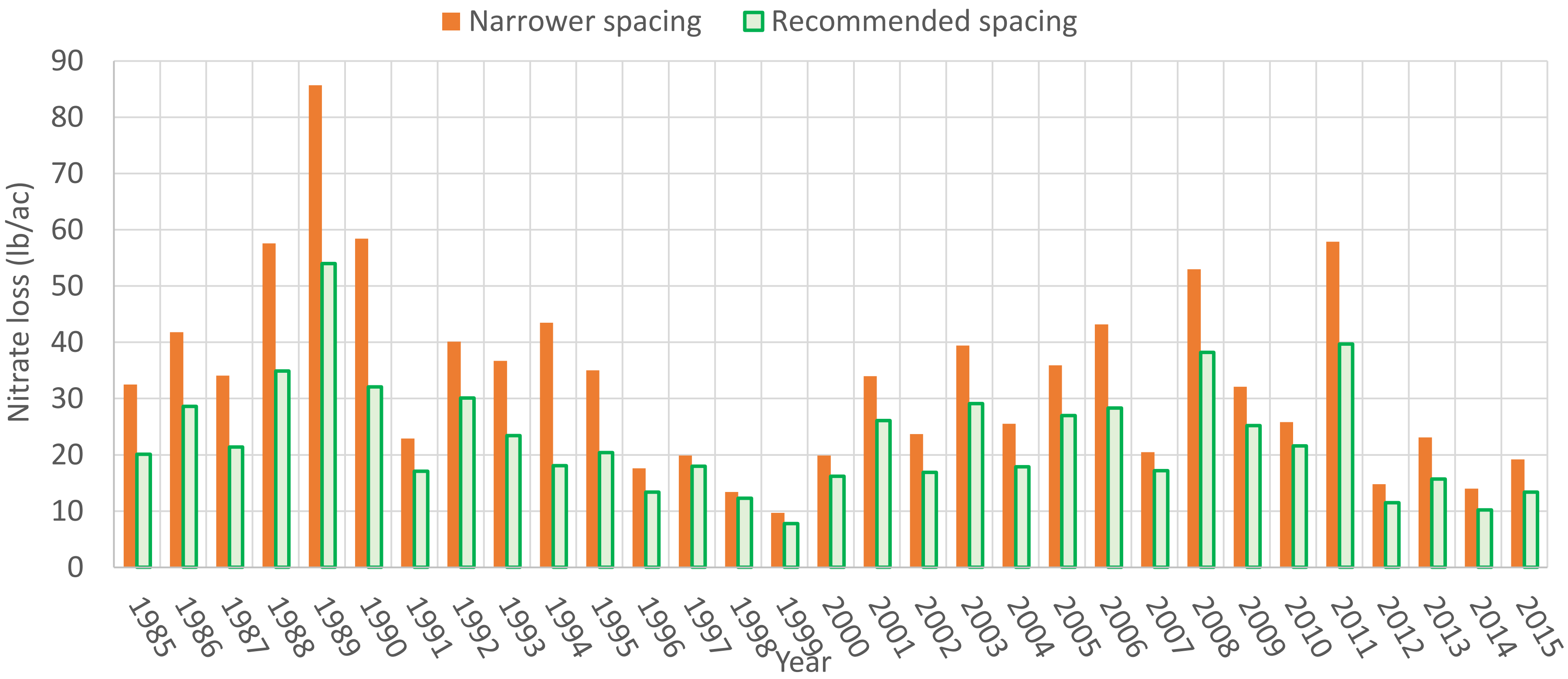
Filter Strips - Draft

Filter strips (393)	Conservation cover (327)
 Image: Purdue University Soil Judging Manual	 Image: The Ohio State University Extension Service
• Gradual vegetated slope between field and ditch allows for sheet flow • Reductions applied to surface runoff from the entire area draining to the filter strip.	• Water from field may not be able to flow through buffer without channelizing • Reductions applied only to surface runoff in the area of the buffer.

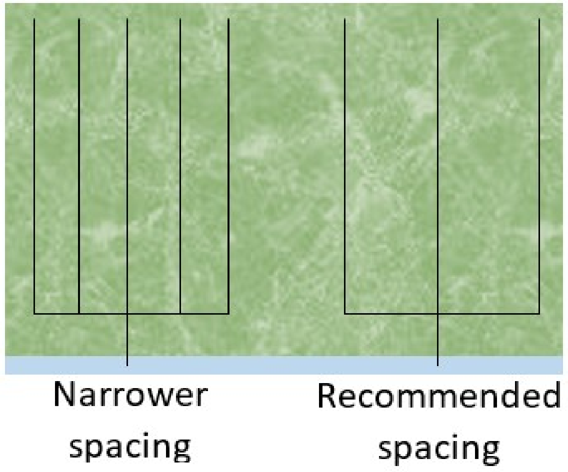
Filter Strips (393) Reductions applied to surface runoff from the entire area draining to the filter strip.		**Conservation Cover (327)** Reductions applied only to surface runoff in the area of the buffer.	
Nitrogen	Phosphorus	Nitrogen	Phosphorus
70% (of field + buffer)	80% (of field + buffer)	90% (of buffer)	90% (of buffer)
0.5 lbs/ac	0.4 lbs/ac	In process	In process

Not all practices are based on NRCS practice standards

- We have included **drain spacing** because it has been shown to have a strong impact on nitrate loss.
- Long-term study by Eileen Kladivko at SEPAC showed higher nitrate loss in narrow spacing (15 ft) than recommended spacing (30 to 60 ft)



Avoid Narrow Tile Spacing - Draft



- Recommended drain spacing for soils in Indiana is provided in the Purdue Extension publication AY-300, Drainage Recommendations for Indiana (https://www.extension.purdue.edu/extmedia/AY/AY-300.pdf). A range is given for each soil type, such as 40 to 80 feet. Installing drains at narrower spacing than this range increases the water drained and nitrate loss. No minimum/maximum slopes, soil types, or specific climates are required for this practice. This practice is not currently associated with an NRCS practice.

	Nitrogen		**Phosphorus**	
	Surface Runoff	Tile Drains	Surface Runoff	Tile Drains
Percent (%)	Little to no effect	**32%**	Some increase	Some decrease
lbs/acre		**8 lbs/ac**		

6. Report and Share Findings

Practice nutrient reduction efficiencies from the Indiana Science Assessment

INDIANA SCIENCE ASSESSMENT for the State Nutrient Reduction Strategy

Cover Crops

This practice is planned by NRCS practice **Cover Crop (340)**, defined as "Grasses, legumes, and forbs planted for seasonal vegetative cover".

Science Assessment Practice definition: Cover crops are planted to cover the soil for seasonal protection and soil improvement. Cover crops manage soil erosion, soil structure, soil fertility, soil quality, water, weeds, pests, diseases, biodiversity, and wildlife in an agroecosystem. They can be seeded using a variety of methods including drilling the seed after crop harvest, broadcasting the se[ed] after crop harvest, or aerial broadcasting the seed before harvest. The planting date (early, standar[d] or late) is based on the average frost date for the area.

Findings: Nutrient Reduction Effectiveness

- **Nitrogen** is sharply reduced by cover crops, shown by strong evidence. Reduction occurs i[n] both tile drain flow and surface runoff. Studies are of N in the form of nitrate.
- **Phosphorus** impacts from cover crop implementation are mixed, with limited data showi[ng] both increases and reductions in phosphorus. It is likely that the effect depends on slope, erosion potential, and other factors listed under "Future Research Needs". There are insufficient studies to provide evidence-based determination of phosphorus effects from cover crop use at this time.

Table 1: Representative reduction values

	Nitrogen		Phosphorus	
	Surface Runoff	Tile Drains	Surface Runoff	Tile Drain[s]
Percent (%)	70%	40%	ND	ND
lbs/acre	3 lbs/ac	7 lbs/ac	ND	ND

ND means Not Determined. Studies showed opposite ef[fects] the overall mean and median are close to zero. Therefo[re no] overall determination has been made.

Future Research Needs

- More data on cover crop effects on phosphorus is needed, particularly in tile drain f[low]
- Studies are needed to determine the effect of species of cover crop, including distin[guishing] those that are winter-killed from winter hardy cover crops.
- Latitude has been shown to have an effect on nutrient reductions from cover crops[, but there] is not enough evidence within Indiana's latitudes to show the effect in our state.
- [could be "Other Findings"]Cover crop planting timing is a key part of successful c[over crop] establishment and nutrient loss reduction, but the effect cannot yet be quantified

Practice nutrient reduction efficiencies from the Indiana Science Assessment:

Filter Strips

This practice is planned by NRCS practice **Filter strips (393)**: A strip or area of herbaceous vegetation that removes contaminants from overland flow, or **Conservation Cover (327)**: Establishing and maintaining permanent vegetative cover

Science Assessment practice definition: A filter strip is an area of grass or other perman[ent vegetation] planted between cropland and a stream or other water body, which acts as a filter to tr[ap] fertilizers, and other pollutants from surface runoff and wastewater before they reach [...] strips have habitat benefits, provide animal corridors, reduce sediment transport from [...] of no nutrient and pesticide applications near sensitive areas, and stabilize stream ban[ks].

In Indiana, two different conservation practices are used, depending on the topograp[hy]. Filter strip (393) is used for a vegetated slope between the field and ditch that allows [water to flow as a] sheet from the field through the buffer. Conservation cover (327) is used when wate[r does] not flow through the buffer, for example due to tile drains or a berm, or is channeliz[ed rather than] as a sheet. While filter strips and buffers have similar placement, their function is ve[ry different, and] reductions differ depending on which practice is implemented.

Filter strips (393)

Image: Purdue University Soil Judging Manual

- Gradual vegetated slope between field and ditch allows for water to flow in sheet
- Reduction applied to area treated by practice

Conservation [...]

Image: The Ohio State [...]

- Water from field ma[...] buffer without chan[...]
- Reduction ONLY ap[...]

Findings: Nutrient Reduction Effectiveness

- Both nitrogen and phosphorus are strongly reduced in runoff that flo[ws ...] the major factor affecting their effectiveness is the design to effectiv[ely ...]
- Filter strips (393) can reduce 70% of TN and 80% of TP for all the sur[face ...] them from the entire drainage area. Conservation cover reduces TN [...]

Table 1: Representative reduction values

	Filter Strips (393) Reductions applied to surface runoff from the entire area draining to the filter strip.		Co[...] Re[...]
	Nitrogen	Phosphorus	
Percent (%)	70% (of field + buffer)	80% (of field + buffer)	
lbs/acre	0.5 lbs/ac	0.4 lbs/ac	

Practice nutrient reduction efficiencies from the Indiana Science Assessment:

INDIANA SCIENCE ASSESSMENT for the State Nutrient Reduction Strategy

Drainage Water Management

This practice is planned by NRCS practice **Drainage Water Management (554):** The process of managing the drainage volume and water table elevation by regulating the flow from a surface or subsurface agricultural drainage system.

Science Assessment practice definition: Drainage Water Management (DWM) is a practice in which the outlet from an underground drainage system is intercepted by a water control structure that effectively functions as an in-line dam, allowing the drainage outlet to be artificially set at levels ranging from the soil surface to the bottom of the drains. Water can be adjusted and held in the field reducing the overall amount of drainage water and nitrogen that moves downstream.

Findings: Nutrient Reductions

- Nitrogen loss is reduced by drainage water management. Extensive measurements in tile drain outlets at many locations have found reductions averaging 40%. There may be increases in surface runoff and seepage, but those increases are less than the decrease in tile drains.
- Phosphorus is also reduced in tile drains, but there is less evidence and the increase in surface runoff may be more important.

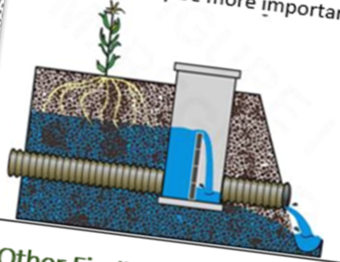


Table 1: Representative reduction values

	Nitrogen	Phosphorus
	Tile Drains	Tile Drains
Percent (%)	40%	40%
lbs/acre	8 lbs/ac	0.04 lbs/acre

Other Findings

- Nitrate results for tile drainage are based on measurements at the tile drain outlets. The fate of the nitrate is not completely known, although it is assumed that much of it is denitrified, or converted into nitrogen gas.
- Very few studies include surface runoff, and these need to be compiled. However nitrate-N in surface runoff is always very low so are expected to be insignificant.
- Phosphorus load reductions reported with controlled drainage were highly variable within and among studies. Few studies have examined the effect of drainage water management on DRP (n=7) and TP (n=4) loads. Most studies reported either no change or increased P concentration following implementation of drainage water management.

INDIANA SCIENCE ASSESSMENT for the State Nutrient

Introducing…

The Indiana Nutrient Research and Education Program (INREP)

Enhancing the scientific foundation for informing and improving nutrient stewardship in Indiana.

INREP will be based at Purdue, and include scientists and agencies from across Indiana.

Goals are to:

1. Sustain and strengthen collaboration to advance nutrient research and education.
2. Refine and improve the Science Assessment.
3. Increase the availability of data from Indiana research on nutrient loss reduction.
4. Synthesize and deliver the knowledge to conservation partners and the agricultural community.

Ways to Engage as a CCA

Help Your Clients Understand Agronomic and Conservation Intersections

How can they measure their “sustainability” today

What new practices might fit in their farming operations to improve farm outcomes

Ways to Engage as a CCA

ACI 4R Certification

Farmers for Soil Health

ISDA Soil Sampling Program

Cover Crop Premium Discount Program

The Indiana Science Assessment will lead to:

INDIANA SCIENCE ASSESSMENT
for the State Nutrient Reduction Strategy

1. **Improved documentation** showcasing statewide progress towards nutrient reduction goals
2. **Prioritization** of the most effective conservation practices based on Indiana conditions, to improve program implementation
3. More accurate and **scientifically sound assessment** of Indiana's contributions to downstream water quality issues.
4. **Enhanced transparency** and accuracy for Indiana's water quality improvement quantifications
5. **Alignment of communication** by researchers, agencies, and others throughout Indiana about conservation practices effectiveness
6. Information that provides a foundation for **increased investment in conservation and water quality monitoring.**