CCAs and Indiana's State Nutrient Reduction Strategy: Programs, Practices, and Priorities

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Background - Gulf of America Hypoxia Task Force & State Strategies

- The Gulf of America dead zone occurs every summer due to nutrient pollution from the Mississippi River Basin.

- To help protect our local streams and the Gulf of America, Indiana and 11 other states in the Mississippi River Basin have developed state nutrient reduction strategies to reduce the nutrient loads leaving their state.
- These strategies are part of a national plan developed by the Gulf of America Hypoxia Task Force (HTF) to reduce the size of the Gulf of America hypoxia zone.

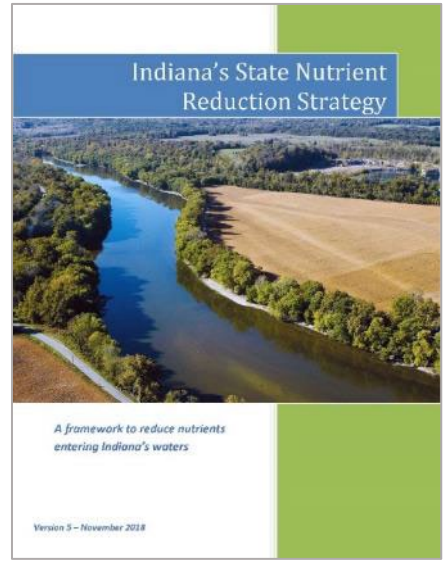
https://www.epa.gov/ms-htf

Mississippi River Gulf of Mexico Watershed Nutrient Task Force

The HTF goal is to reduce the areal extent of the Gulf of America hypoxic zone to less than 5,000 square kilometers by the year 2035, with an agreed upon interim target of a 20% nitrogen and phosphorus load reduction by the year 2025.

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".

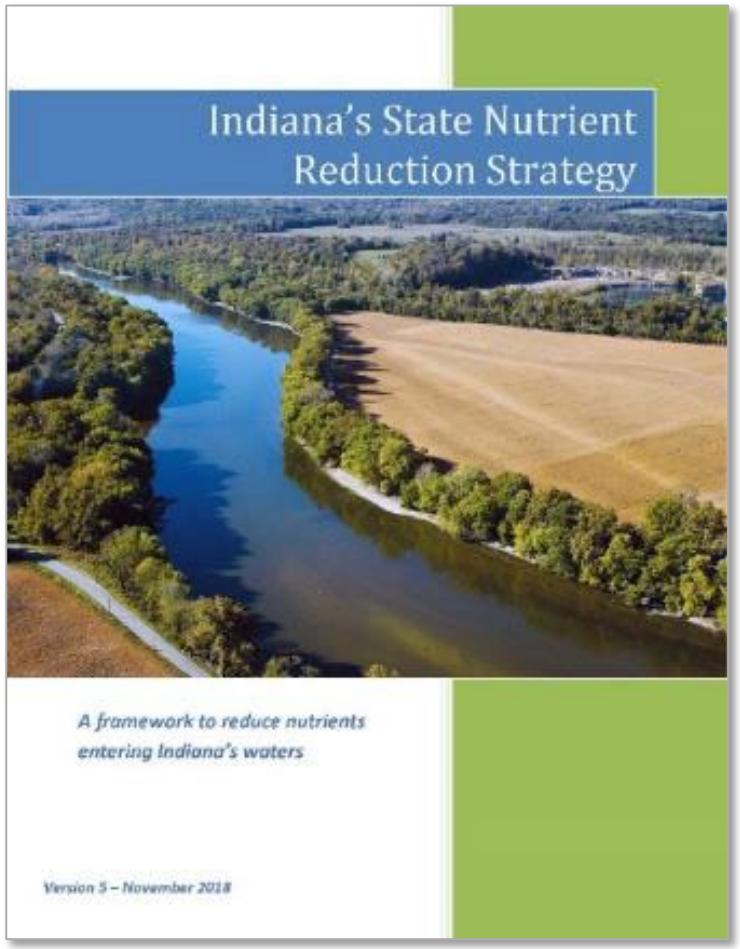


- The Indiana SNRS represents the state's commitment to reduce nutrient runoff into Indiana's waters from **point** sources and **non-point** sources.





Are you familiar with the Indiana State Nutrient Reduction Strategy?



Is Progress Being Made in the Mississippi River Basin?

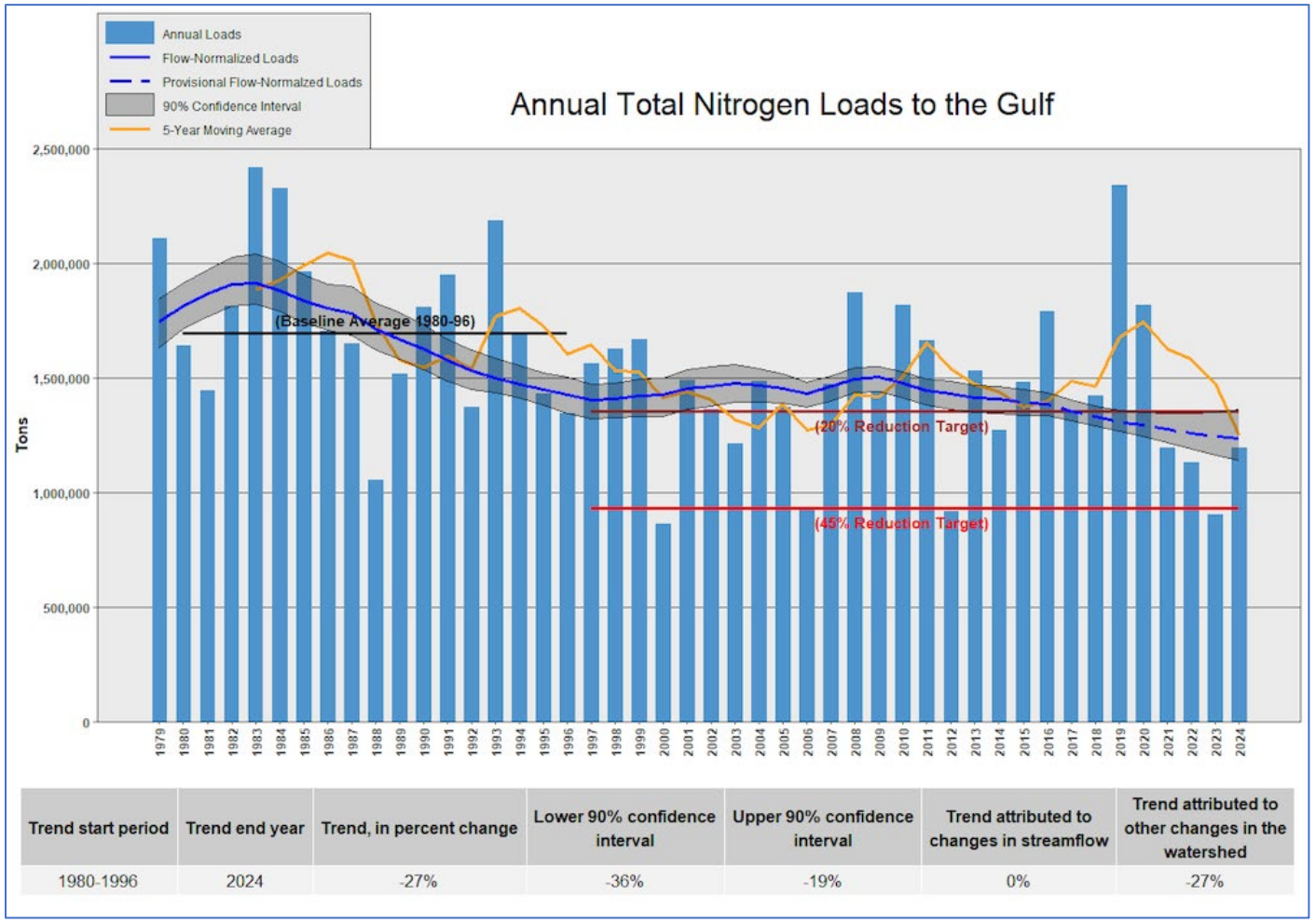
- The Gulf of America Hypoxia Task Force uses the USGS Weighted Regressions on Time, Discharge and Season (WRTDS) model to show progress toward the task force's goal.
- The WRTDS model determines loads and concentrations and shows trends in water quality.

USGS WRTDS map of the Mississippi/Atchafalaya River Basin

* WRTDS – Weighted Regression on Time, Discharge and Season

HTF Goal – Total Nitrogen

The HTF goal is to reduce the areal extent of the Gulf of Mexico hypoxic zone to less than 5,000 square kilometers by the year 2035, with an agreed upon interim target of a 20% nitrogen and phosphorus load reduction by the year 2025.



Trend start period	Trend end year	Trend, in percent change	Lower 90% confidence interval	Upper 90% confidence interval	Trend attributed to changes in streamflow	Trend attributed to other changes in the watershed
1980-1996	2024	-27%	-36%	-19%	0%	-27%

- The Hypoxia Task Force has met the 2025 Interim goal for **total nitrogen**, the 20% reduction target.

- There are many factors that contribute to this.
- There is still more work to do.

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HTF Goal – Total Phosphorus

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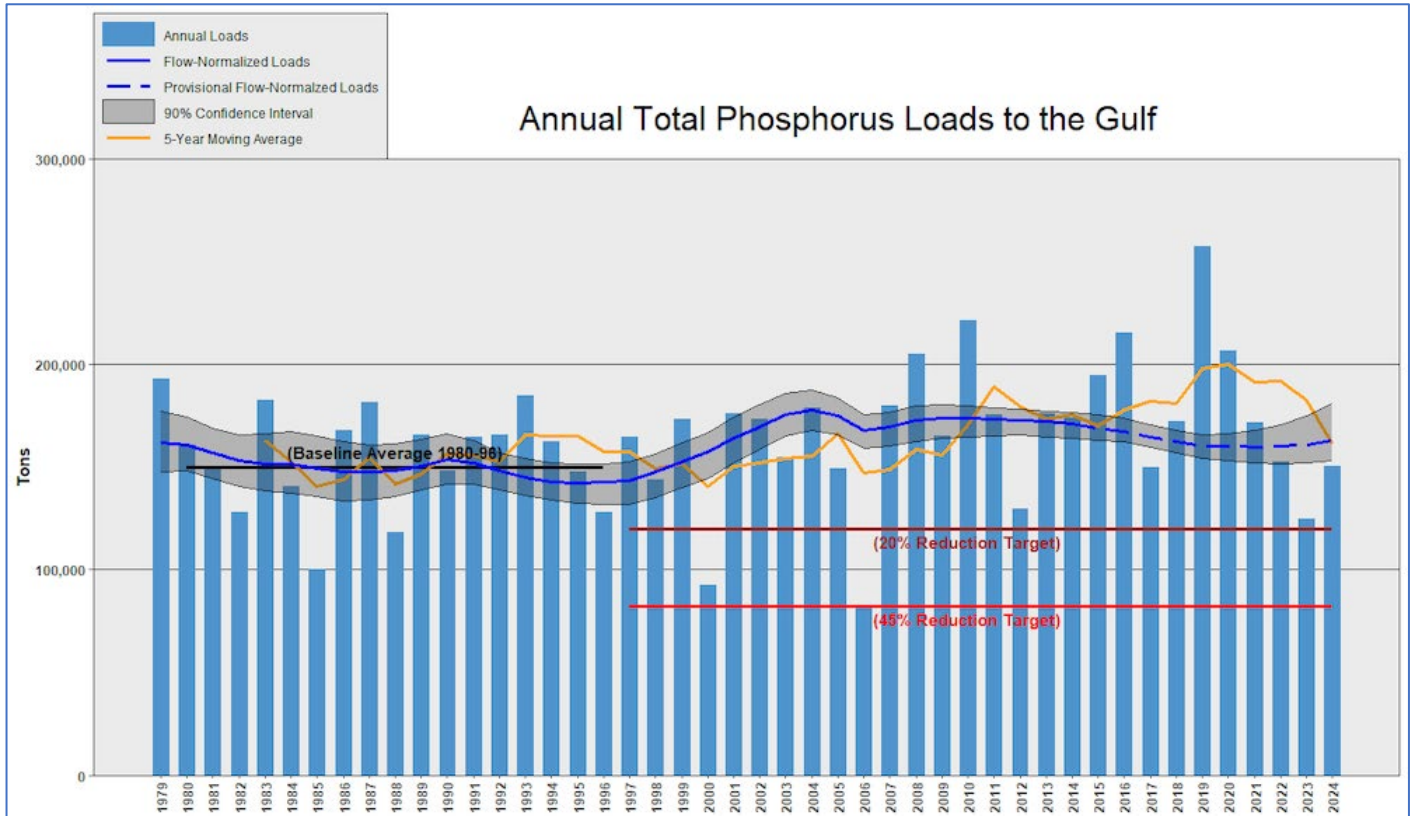


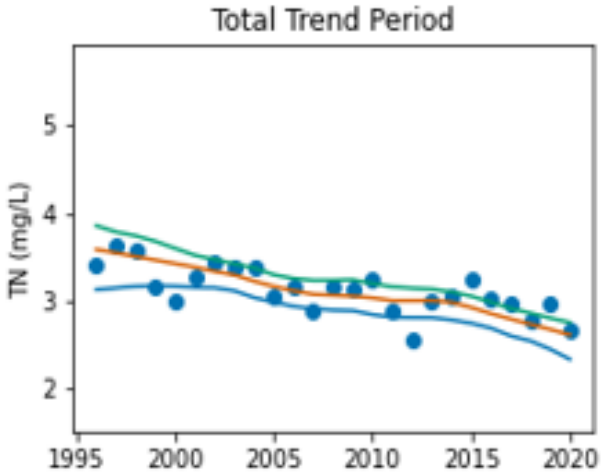
Trend start period	Trend end year	Trend, in percent change	Lower 90% confidence interval	Upper 90% confidence interval	Trend attributed to changes in streamflow	Trend attributed to other changes in the watershed
1980-1996	2024	9%	-5%	19%	-1%	10%

- TP is increasing and more work is needed.
- There are many factors that contribute to this as well.

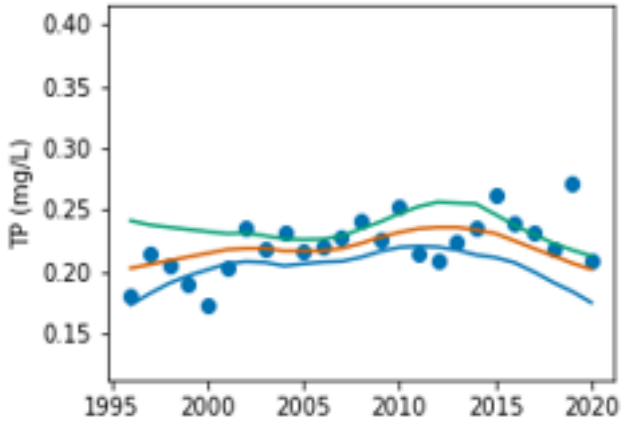
INDIANA STATE DEPARTMENT OF AGRICULTURE

What about in Indiana?

- Began the process of showing Indiana trends using WRTDS also, to help determine loads and trends



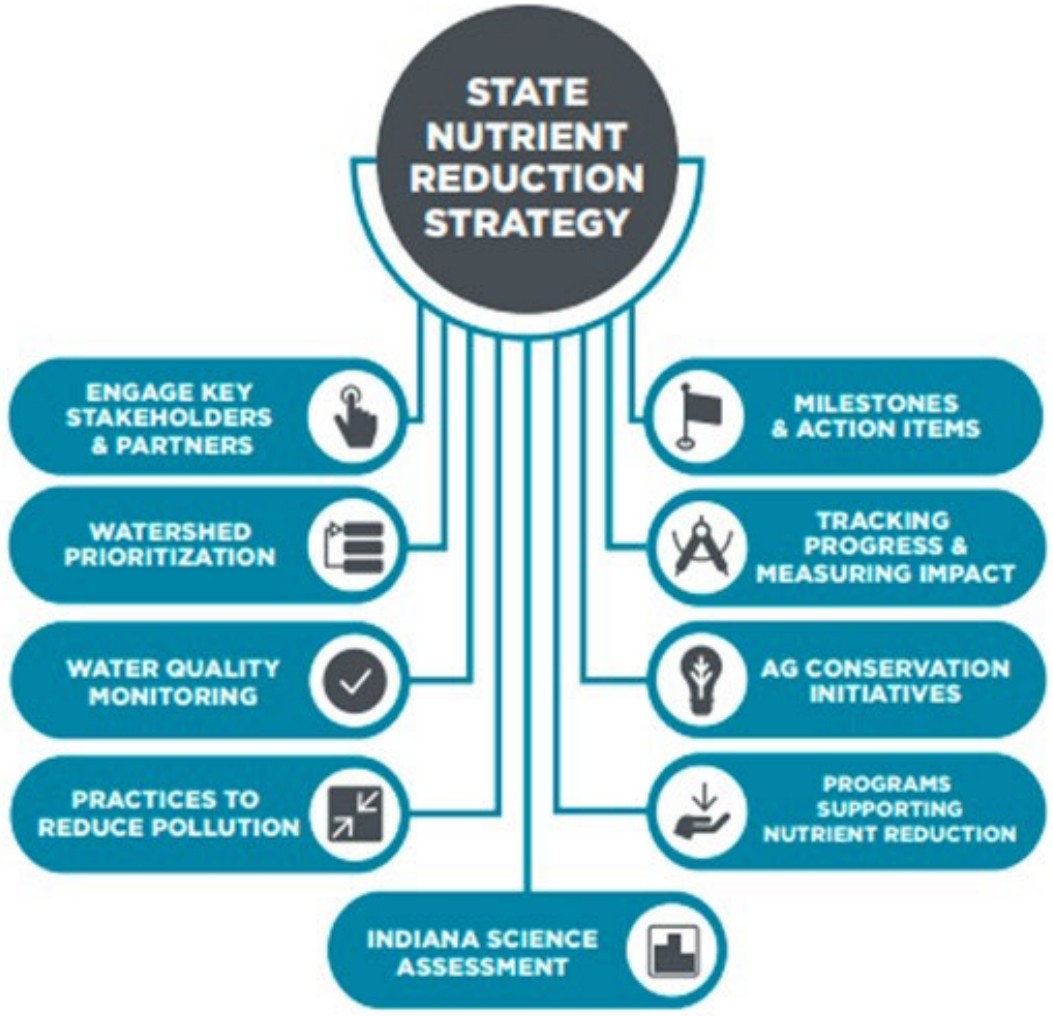
Annual Total Nitrogen Loads at the New Harmony, IN USGS Station from 1995 – 2020.



Annual Total Phosphorus Loads at the New Harmony, IN USGS Station from 1995 – 2020.

- There is a delay or lag-time, which can be decades, between installation of conservation practices and positive, statistically significant changes in water quality.
- Legacy of nutrients
- This exercise of determining water quality trends in Indiana was expanded under the Indiana Science Assessment.

IN State Nutrient Reduction Strategy Sections/Components



- Engage Stakeholders and Partners
- Watershed Prioritization
- IDEM Water Quality Monitoring Programs
- Point Source Pollution Strategies & Practices
- Non-Point Source Pollution Strategies & Practices
- Indiana Science Assessment
- Programs, Projects and Initiatives Supporting Nutrient Reduction
- Agricultural Initiatives
- Sediment and Nutrient Load Reduction Tracking and Measuring Impact
- Milestones and Actions Items

Partnerships

- The Indiana SNRS highlights the importance of partnerships.

Indiana Conservation Partnership (ICP)

http://icp.iaswcd.org/

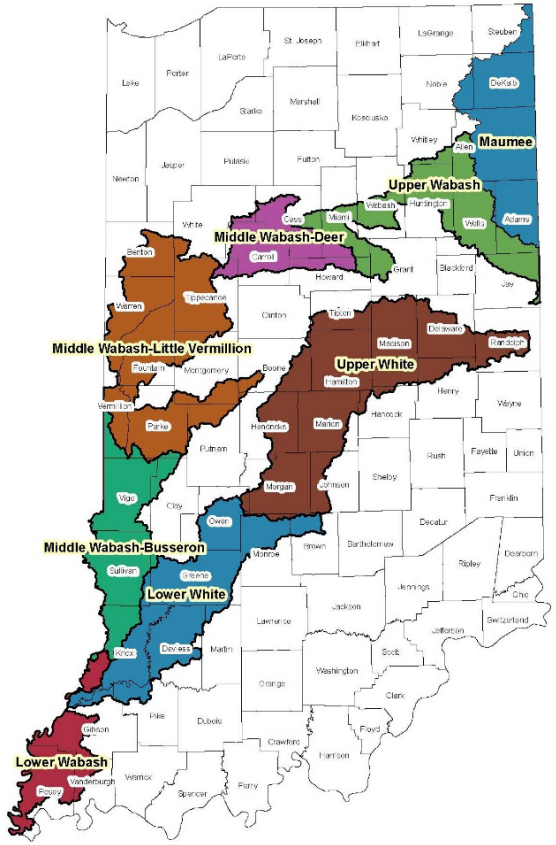
A truly unique Indiana approach

Other important partners

Indiana Agriculture Nutrient Alliance (IANA)

- Agribusiness Council of Indiana
- Indiana Farm Bureau
- USDA-NRCS
- 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 Poultry Association
- Purdue University College of Agriculture
- The Nature Conservancy of Indiana

Watershed Prioritization



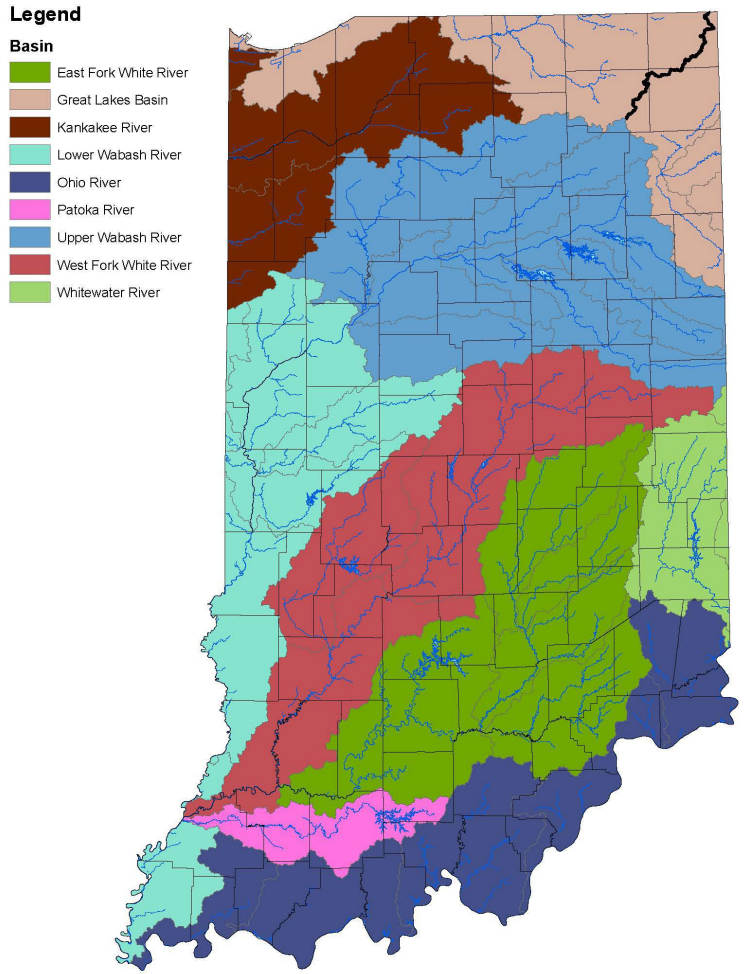
* Eight HUC 8 watersheds, situated along the Wabash and White Rivers, and the Maumee River watershed in NE Indiana.

- Important for achieving the greatest impact toward sediment and nutrient load reductions.
- Current Priority Watersheds in Indiana's strategy
- Was originally done in 2011

Re-Assessing Priority Watersheds

- Re-prioritize the HUC8 watersheds
- All the 38 HUC8 watersheds in the state will be prioritized in tiers.
- Factors being used re-access the priority watersheds include:

1. Source Water Protections watersheds
2. Water Quality Monitoring Data/Trend results of Component 1 of Indiana Science Assessment
3. Impairments/Impaired Streams
4. Loading Data from SPARROW model
5. Conservation Practice Implementation Data
6. Groundwater Vulnerability (using Aquifer Sensitivity)

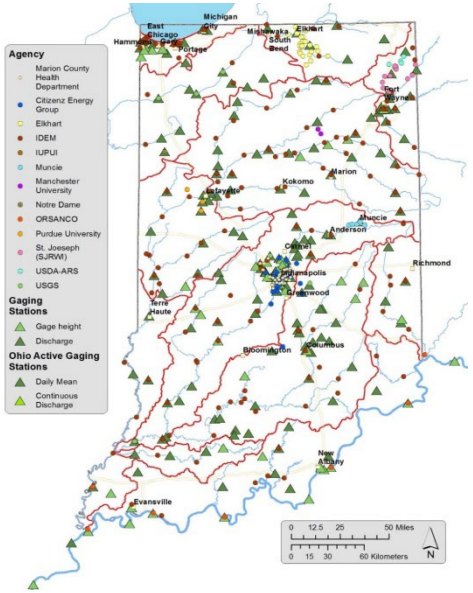


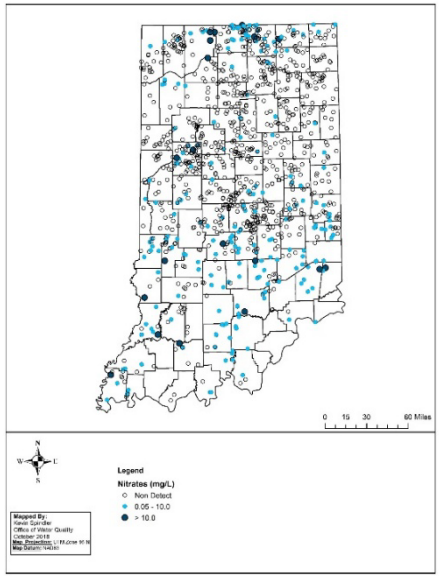
Ten Major River and Lake Basins in Indiana

Water Quality Monitoring in Indiana's Waters

IDEM Water Monitoring programs

- Surface Water Monitoring programs
- Ground Water Monitoring Network (GWMN)
- Data Sharing and Inventory
- Lake Monitoring Data
- Harmful Algal Bloom Monitoring Data
- TMDLs





Strategies to Reduce PS and NPS Pollution

Reducing Point Source Pollution

- **Point Source Pollution strategies:**

  Urban/Suburban and Rural

  - NPDES nutrient standards will be employed at wastewater treatment plants (WWTPs).
  - Combined Sewer Overflow (CSO) communities will implement their long-term control plans (LTCPs) and associated schedules and will track progress.
  - Stormwater Management:
    - Municipal Separate Storm Sewer System (MS4) communities will implement their stormwater quality management plans and track progress.
    - Construction site sediment runoff controls will be implemented according to the Notice of Intent (NOI) and living stabilization covers will be used that minimize nutrient inputs.
    - Industrial site runoff controls will be implemented according to the Notice of Intent.
  - Local Health Departments and communities will continue to identify failing residential septic systems and seek to put infrastructure in place to replace them or connect them to WWTPs.

Reducing Non-Point Source Pollution

- **Non-Point Source Pollution strategies:**

  Urban landscapes:

  - Support practices that promote infiltration, bio-retention, and slow natural water release.
  - Seek installation of larger, regional or multipurpose green infrastructure practices.
  - Provide technical and financial support to install rain gardens, green roofs, rain barrels, and porous pavement in industrial, commercial and residential settings.

  Rural landscapes:

  - Restore stream sinuosity and riparian buffers.
  - Restore and reconnect riparian wetlands and floodplains.
  - Employ practices for the maintenance of legal drains such as retaining native vegetation on one streambank while staging maintenance equipment on the side with easier drain access.
  - Install 2-stage ditches where feasible.
  - Install drainage water management BMPs and saturated buffers on working lands.
  - Restore natural wetland areas with hydric soils.

Reducing Non-Point Source Pollution

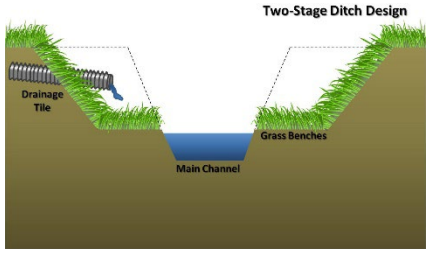
- **Non-Point Source Pollution strategies:**

  Agriculture:

  - Ensure compliance with Confined Feeding Operations (CFO) and Fertilizer Certification rules via routine inspections.
  - Timely investigate reports of nutrient mismanagement or runoff from regulated farms and spills from unregulated farms.
  - Repair broken sub-surface drainage tile that create blow-holes that allow surface water to enter sub-surface drainage systems. Add blind-inlets in place of tile risers.
  - Promote nutrient management:
    - Employ the 4Rs – **right source** at the **right rate** at the **right time** in the **right place**.
    - Increase outreach on manure management to livestock farms.
    - Increase outreach to farmers on adoption of performing regular soil sampling to determine nutrient management efficiency on ag land.
  - Emphasize soil health

4 nutrient stewardship

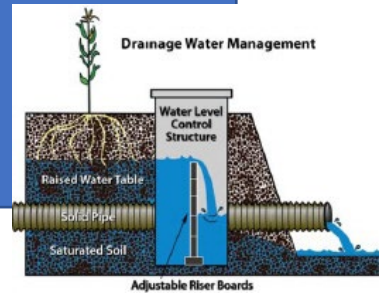
Reducing Non-Point Source Pollution



- **Non-Point Source Pollution practices:**

Urban/Suburban practices:
- Curb cuts
- Green roof
- Porous pavement
- Rain barrel
- Rain garden
- Vegetated Swale

Agriculture Nitrogen Reduction Practices:
- Improved nitrogen management
- Winter cover crops
- Increasing perennials in the cropping system
- Controlled Drainage Water Management
- Reduced Drainage Intensity
- Drainage Water Recycling
- Bioreactors
- Constructed Wetlands
- Two-Stage Ditches
- Saturated Buffers



Agriculture Phosphorus Reduction Practices:
- Conservation Tillage Practices
- Cover Crops
- Conservation Buffers
- Perennial crops
- Grade Stabilization Structures
- Blind inlets
- Soil Testing
- Nutrient Management

- *A system of conservation practices is important and is what is needed. Each practice treats nutrients differently, so a system or combination of practices treats nutrient runoff more effectively.*

Programs Supporting Nutrient Reduction

- The SNRS lists multiple programs that support nutrient reduction.
  - Point Source/Regulatory Programs
    - National Pollutant Discharge Elimination System (NPDES) (has Phosphorus limits and Nitrogen monitoring)
  - Non-Point Source/Regulated Programs
    - IDEM Wellhead Protection Program
    - Confined Feeding Operations (CFOs)
    - Concentrated Animal Feeding Operations (CAFOs)
    - Fertilizer and Detergent Regulations
    - Stormwater Runoff Programs
  - Non-Point Source/Non-Regulated (Voluntary Programs)

    <u>STATE and FEDERAL PROGRAMS</u>
    - Indiana State Department of Agriculture (ISDA)
    - Indiana Department of Natural Resources (IDNR)
    - Indiana Department of Environmental Management (IDEM)
    - USDA, Natural Resources Conservation Service (NRCS)
    - USDA, Farm Service Agency (FSA)

Non-Point Source/Regulated Programs

➢ IDEM Wellhead Protection Program

- Educational Awareness program focusing on source water protection and promoting the value of ground water.
- Wellhead Protection Plans

➢ Confined Feeding Operations (CFOs)

- All regulated animal feeding operations in Indiana are considered confined feeding operations.

➢ Concentrated Animal Feeding Operations (CAFOs)

- CAFOs are based on a size designation.

➢ Fertilizer and Detergent Regulations

- Detergents: Indiana prohibits the use of laundry detergents containing phosphorus; in 2012, this was extended to include detergents in residential automatic dishwashers.
- Fertilizers: *Certification for Distributors and Users of Fertilizer Materials*

➢ Storm Water Runoff Programs

- MS4s
- Construction Site Runoff
- Industrial Site Runoff

Non-Point Source/Non-Regulated (Voluntary) Programs

STATE PROGRAMS

- Indiana State Department of Agriculture (ISDA)
  - Conservation Reserve Enhancement Program (CREP)
  - Clean Water Indiana (CWI)
  - Cover Crop Premium Discount Program (CCPDP)
  - Mississippi River Basin Soil Sampling Program

Clean Water Indiana

- The CWI Program is responsible for providing local matching funds to Indiana's Soil and Water Conservation Districts (SWCDs), as well as grants for sediment and nutrient reduction projects.

https://www.in.gov/isda/divisions/soil-conservation/clean-water-indiana/

Conservation Reserve Enhancement Program

- Environmental sensitive or frequently flooded agricultural land.
- Enroll 100,000 acres of buffer land on waterbodies and restore wetland and floodplain areas in Indiana.

https://www.in.gov/isda/divisions/soil-conservation/conservation-reserve-enhancement-program/

Non-Point Source/Non-Regulated (Voluntary) Programs

Mississippi River Basin Soil Sampling Program

- Project focus is on increasing the knowledge and use of soil sampling as a nutrient management practice to benefit farm operations and nutrient use efficiency.
- Supports 4R Nutrient Stewardship
- Provides free or reduced cost of soil testing to farmers in Indiana watersheds that drain to the Mississippi River
- Targets farmers/fields that have never been tested or are not regularly tested within the last 4 years

https://www.in.gov/isda/divisions/soil-conservation/indiana-soil-sampling-program/

Cover Crop Premium Discount Program

- Partnership between ISDA, TNC and the USDA Risk Management Agency (RMA).
- Eligible participants receive a $5/acre premium discount on the following year's crop insurance invoice.
- Eligible to landowners in watersheds that drain to the Mississippi River.

https://www.in.gov/isda/divisions/soil-conservation/cover-crop-premium-discount-program/

Non-Point Source/Non-Regulated (Voluntary) Programs

STATE PROGRAMS
- Indiana Department of Natural Resources (IDNR)
  - Lake and River Enhancement (LARE)

Lake and River Enhancement Program

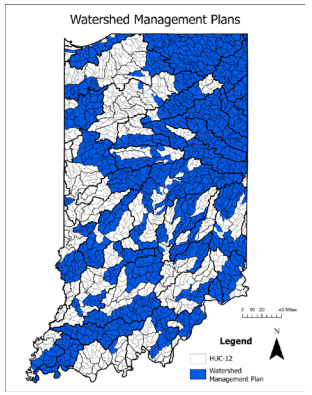
- A portion of all **boat registration fees** is used for grant projects that reduce non-point source sediment and nutrient pollution of surface waters on publicly accessible lakes and rivers, to protect and enhance aquatic habitats for fish and wildlife.

  https://www.in.gov/dnr/fish-and-wildlife/wildlife-resources/lake-and-river-enhancement/

STATE PROGRAMS
- Indiana Department of Environmental Management (IDEM)
  - Section 319 Grant Funding
  - Section 205j Grant Funding
  - Clean Water Act Section 106 Supplemental Funding

- There are no state dollars to support these programs, funding comes from EPA.
- Since 1994, Indiana has directed over $74 million of its USEPA 319 non-point source grant funding to projects related to reducing nutrient loads to surface waters.
- Section 205j Funding is approximately $350,0000 per year.

https://www.in.gov/idem/nps/funding/clean-water-act-section-205j-grants/



CWA Section 106 Supplemental Funding

- Funds gaps identified in the WQ Monitoring Strategy.
- Funds the Ground Water Monitoring Network.

Non-Point Source/Non-Regulated (Voluntary) Programs

FEDERAL PROGRAMS

- USDA, Natural Resources Conservation Service (NRCS)
  - Environmental Quality Incentive Program (EQIP)
  - Conservation Stewardship Program (CSP)
  - Regional Conservation Partnership Program (RCPP)
  - Agricultural Conservation Easement Program (ACEP)
    - Agricultural Land Easements (ALE)
    - Wetland Reserve Easements (WRE)
    - Wetland Reserve Enhancement Program (WREP)
  - Mississippi River Basin Initiative (MRBI)
  - National Water Quality Initiative (NWQI)
  - Great Lakes Restoration Initiative (GLRI)
- USDA, Farm Service Agency (FSA)
  - Conservation Reserve Program (CRP)
  - Conservation Reserve Enhancement Program (CREP)
  - State Acres for Wildlife Enhancement (SAFE)

- Each year, NRCS approves millions of dollars to landowners to install conservation practices, conserve natural resources, and improve water quality.
- Below are a few of the program dollars and acres impacted in 2024:

ACEP — 28 new WRE applications on 1,502 acres
3 new ALE easements on 704 acres

CSP — $21.5 million spent impacting 137,838 acres

EQIP — $48.6 million spent impacting 192,088 acres

RCPP — $1.3 million obligated impacting 4,063 acres in 4 watershed or regional projects

USDA
United States Department of Agriculture
Natural Resources Conservation Service

www.in.nrcs.usda.gov

USDA Farm Service Agency
U.S. DEPARTMENT OF AGRICULTURE

www.fsa.usda.gov/state-offices/Indiana/index

CCA roles related to conservation programs

1. How willing are you to engage with farmers on conservation programs?
2. Do you know where to send farmers for conservation program assistance?
3. What is a CCA's role in helping farmers access conservation programs?

Non-Point Source/Non-Regulated (Voluntary) Programs

FEDERAL PROGRAMS

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Projects/Initiatives Supporting Nutrient Reduction

Agricultural Initiatives
➢ Indiana's Conservation Partnership (ICP) Soil Health Philosophy ➢ A System's Approach of Conservation Practices ➢ Conservation Cropping Systems Initiative (CCSI) ➢ Indiana Agriculture Nutrient Alliance (IANA) ➢ 4R Nutrient Stewardship Certification Program





Agricultural Initiatives

➢ Indiana's Conservation Partnership (ICP) Soil Health Philosophy

http://www.in.gov/isda/files/ICP_Soil_Health_Philosophy_final.pdf

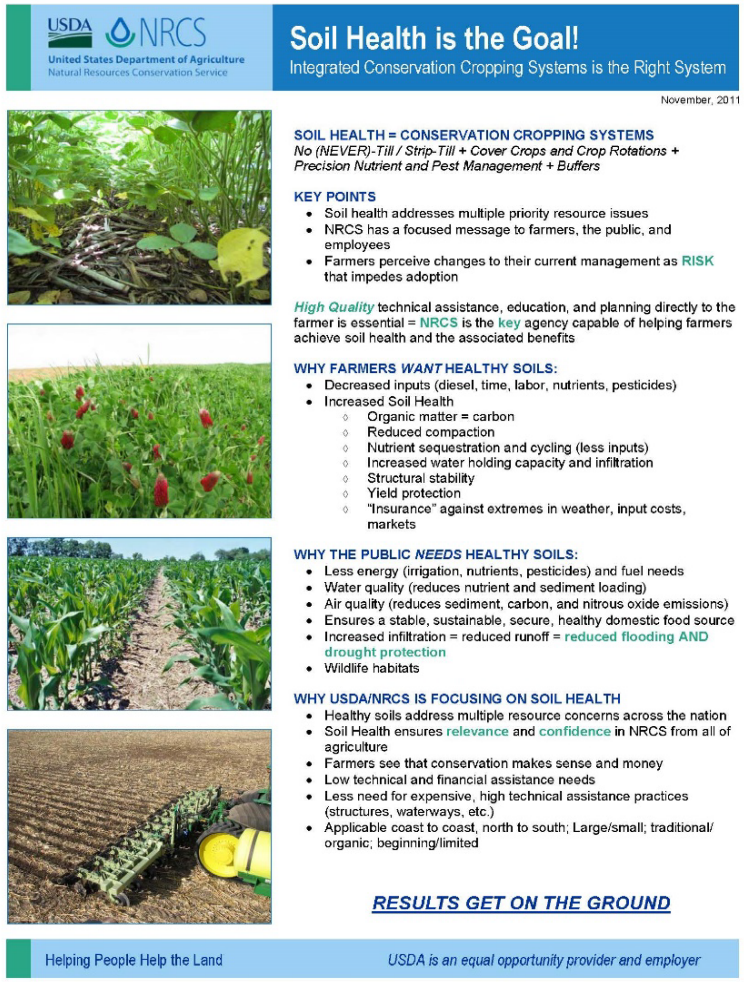
The ICP endorses these four key **Soil Health Principles** for all lands:

- Minimize Disturbance
- Optimize Soil Cover
- Optimize Biodiversity
- Provide Continuous Living Roots

Objectives of Soil Health Improvement:

- Increas**ing** organic matter
- Increas**ing** aggregate stability
- Increas**ing** water infiltration
- Increas**ing** water-holding capacity
- Improv**ing** nutrient use efficiency
- Enhanc**ing** and diversifying soil biology

➢ A System's Approach of Conservation Practices



USDA NRCS
United States Department of Agriculture
Natural Resources Conservation Service

Soil Health is the Goal!
Integrated Conservation Cropping Systems is the Right System

November, 2011

SOIL HEALTH = CONSERVATION CROPPING SYSTEMS
No (NEVER)-Till / Strip-Till + Cover Crops and Crop Rotations + Precision Nutrient and Pest Management + Buffers

KEY POINTS
- Soil health addresses multiple priority resource issues
- NRCS has a focused message to farmers, the public, and employees
- Farmers perceive changes to their current management as RISK that impedes adoption

High Quality technical assistance, education, and planning directly to the farmer is essential = NRCS is the key agency capable of helping farmers achieve soil health and the associated benefits

WHY FARMERS *WANT* HEALTHY SOILS:
- Decreased inputs (diesel, time, labor, nutrients, pesticides)
- Increased Soil Health
  - Organic matter = carbon
  - Reduced compaction
  - Nutrient sequestration and cycling (less inputs)
  - Increased water holding capacity and infiltration
  - Structural stability
  - Yield protection
  - "Insurance" against extremes in weather, input costs, markets

WHY THE PUBLIC *NEEDS* HEALTHY SOILS:
- Less energy (irrigation, nutrients, pesticides) and fuel needs
- Water quality (reduces nutrient and sediment loading)
- Air quality (reduces sediment, carbon, and nitrous oxide emissions)
- Ensures a stable, sustainable, secure, healthy domestic food source
- Increased infiltration = reduced runoff = reduced flooding AND drought protection
- Wildlife habitats

WHY USDA/NRCS IS FOCUSING ON SOIL HEALTH
- Healthy soils address multiple resource concerns across the nation
- Soil Health ensures relevance and confidence in NRCS from all of agriculture
- Farmers see that conservation makes sense and money
- Low technical and financial assistance needs
- Less need for expensive, high technical assistance practices (structures, waterways, etc.)
- Applicable coast to coast, north to south; Large/small; traditional/organic; beginning/limited

RESULTS GET ON THE GROUND

Helping People Help the Land

USDA is an equal opportunity provider and employer

Agricultural Initiatives

➢ Conservation Cropping Systems Initiative (CCSI)

- CCSI is a program of the ICP with a mission of improving soil health on Indiana cropland accomplished through education and outreach efforts that are based on farmer-proven management practices and peer-reviewed agronomic and social science.
- Since its inception in 2009, hundreds of individuals have attended at least one soil health training event.
- Through CCSI's educational events, logistical support and workshop activities, more than 38,000 attendees have been reached.

Conservation Cropping Systems Initiative

Improving Soil Health on Indiana Crop Land

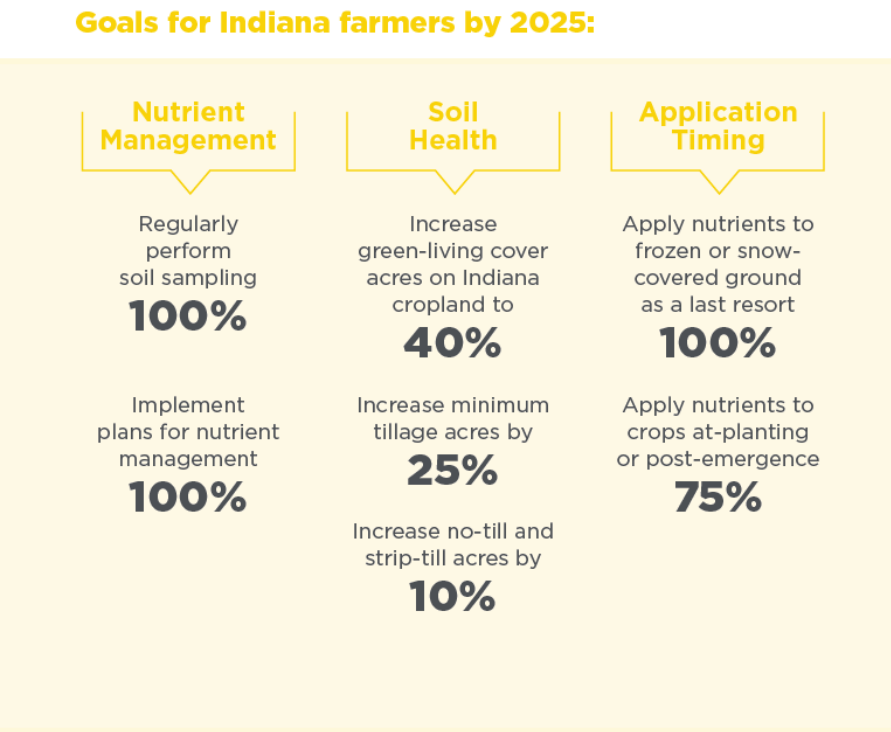
www.CCSIN.org

Agricultural Initiatives

➢ Indiana Agriculture Nutrient Alliance (IANA)

www.inagnutrients.org

- IANA is one Ag Initiative within the SNRS
  - Dedicated to 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.



Healthy Soil
Clean Water
Viable Farms

IANA Goal Metrics

Metric	Goal	2014	2024
% of Farmers Regularly Soil Sampling	100% of farmers	76%	86%
% of Farmers Planning for Nutrient Management	100% of farmers	27%	69%
% of Farmers Using In-Season Application	75% of farmers	62%	74%
% of Farmers Avoiding Frozen/Snow-Covered Application	100% of farmers		
% of Acres with Living Green Cover	40% of acres	10%	14%
Incease % of Reduced Tillage Acres	25% increase	3.06	4.284
Increase % of No-Tillage Acres	10% increase	4.95	4.726

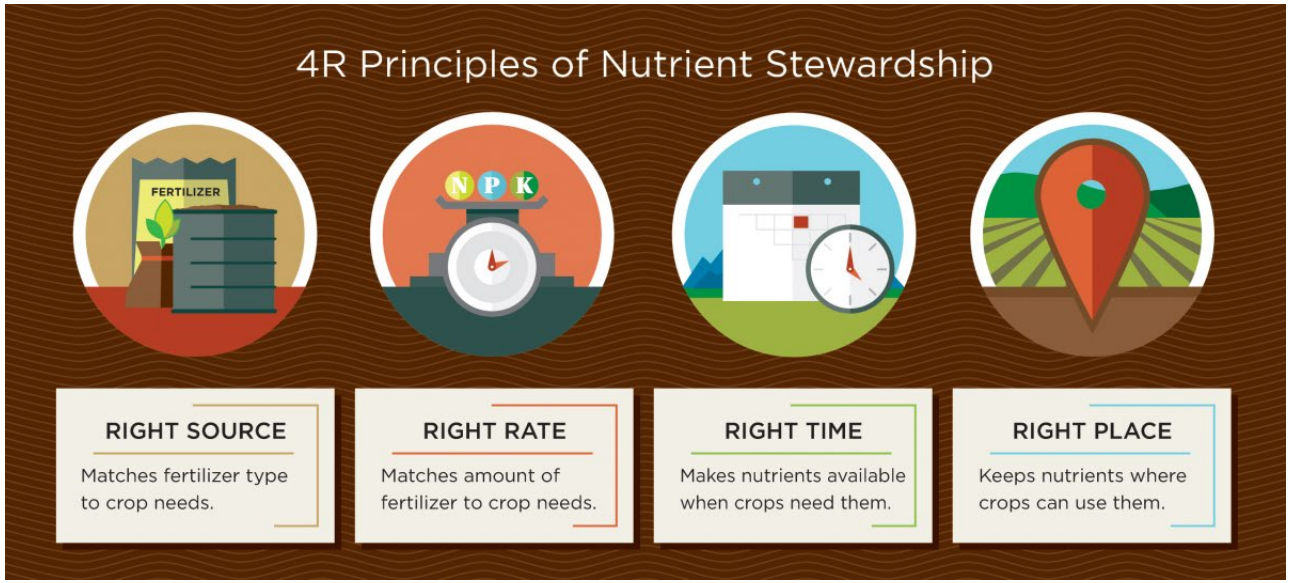
** Purdue Nutrient Mngmt Survey, ISDA Tillage Transect, 2012 NASS vs 2022 NASS*

Agricultural Initiatives

➢ 4R Nutrient Stewardship Program

- Voluntary Certification for Nutrient Service Providers
- Program of the Agribusiness Council of Indiana

https://www.inagribiz.org/Indiana4RCertification



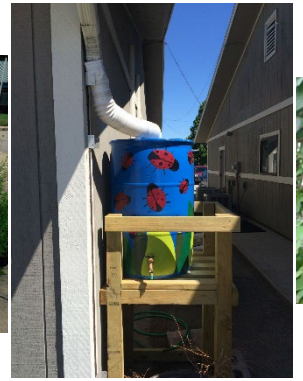
2025 Indiana 4R Certification Program

9 certified locations
932,000 acres

“What you can do to protect water quality in Indiana”

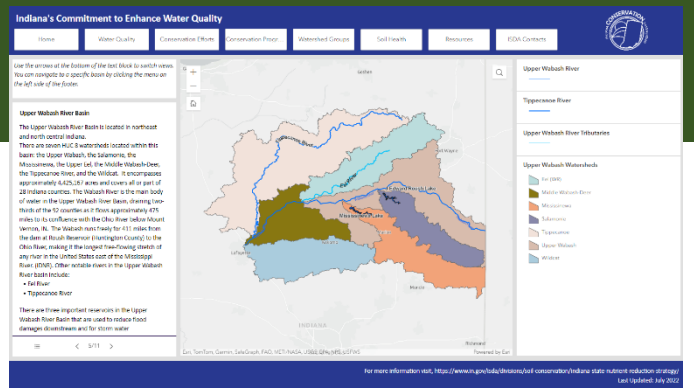
- Dispose of oil and household chemicals properly
- Maintain septic tanks
- Create and enhance riparian corridors
- Pick up pet waste
- Take care of big issues on small farms
- Read the label – use lawn and garden fertilizer wisely
- Think before you dig
- Plant a rain garden
- Connect your downspouts to rain barrels
- Use Porous pavement
- Responsible car washing

- Clear Choices, Clear Water program
  http://indiana.clearchoicescleanwater.org/



Measuring Impacts

- Tracking Progress



Tillage and Cover Crop Transects

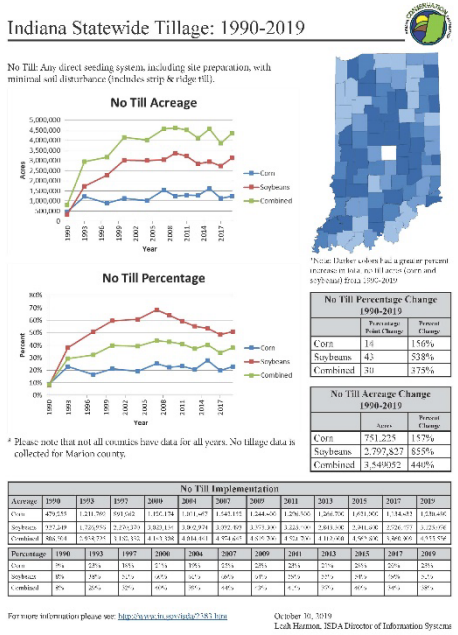
Sediment & Nutrient Load Reduction Analysis

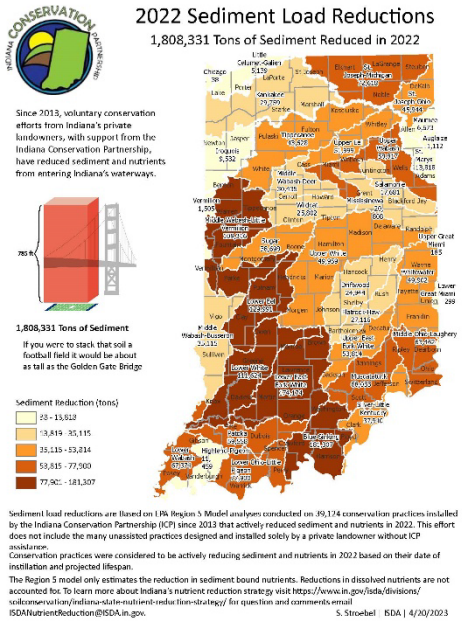
GIS Story Maps

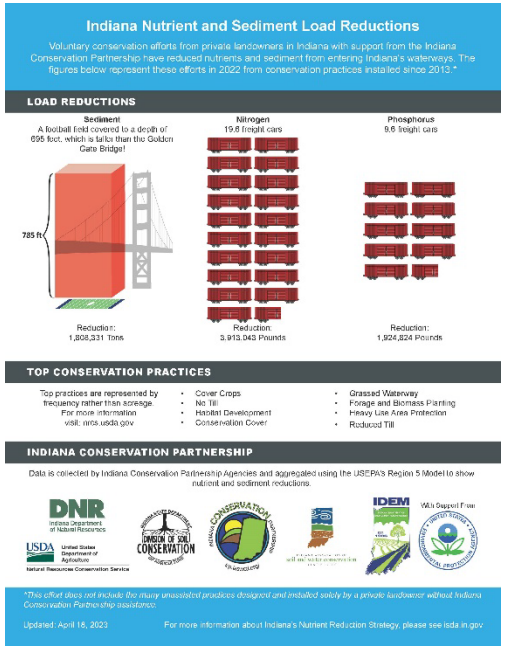
Performance Measures Monitoring

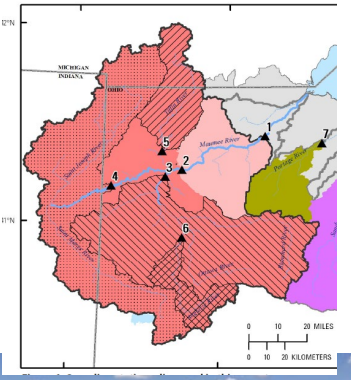
Regulatory Framework

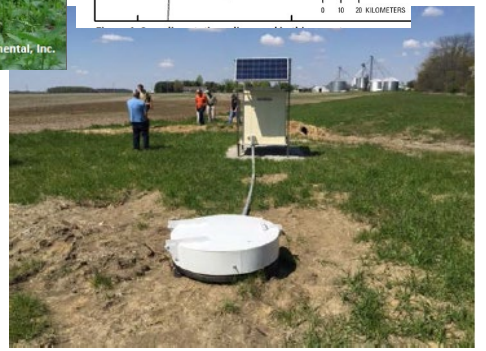
- POTW and LTCP



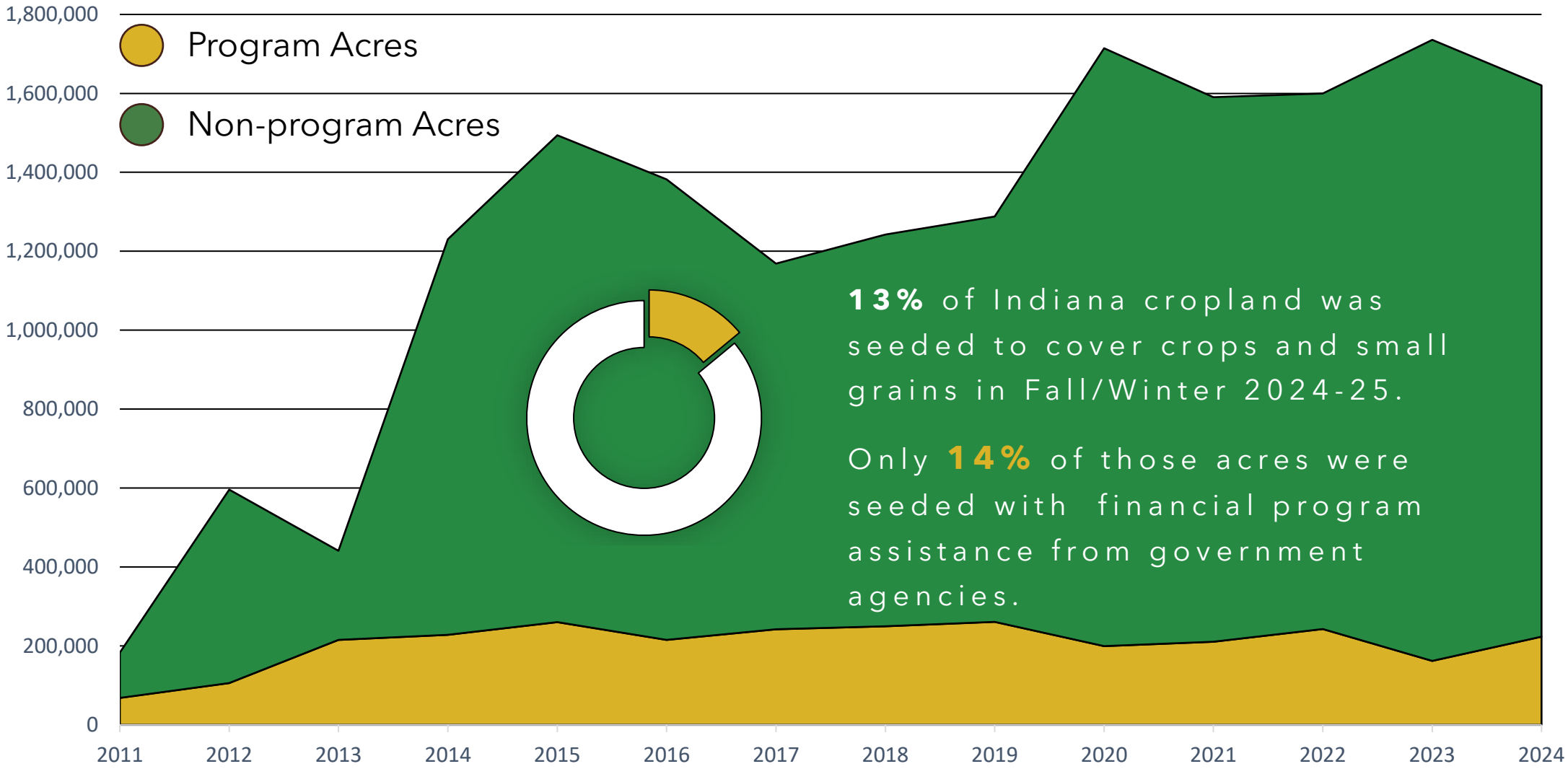








Indiana Green-Living Cover Acres



Source: Indiana Tillage and Cover Crop Transect, ISDA, Indiana USDA-NRCS, and USDA-NASS

Sediment Load Reductions

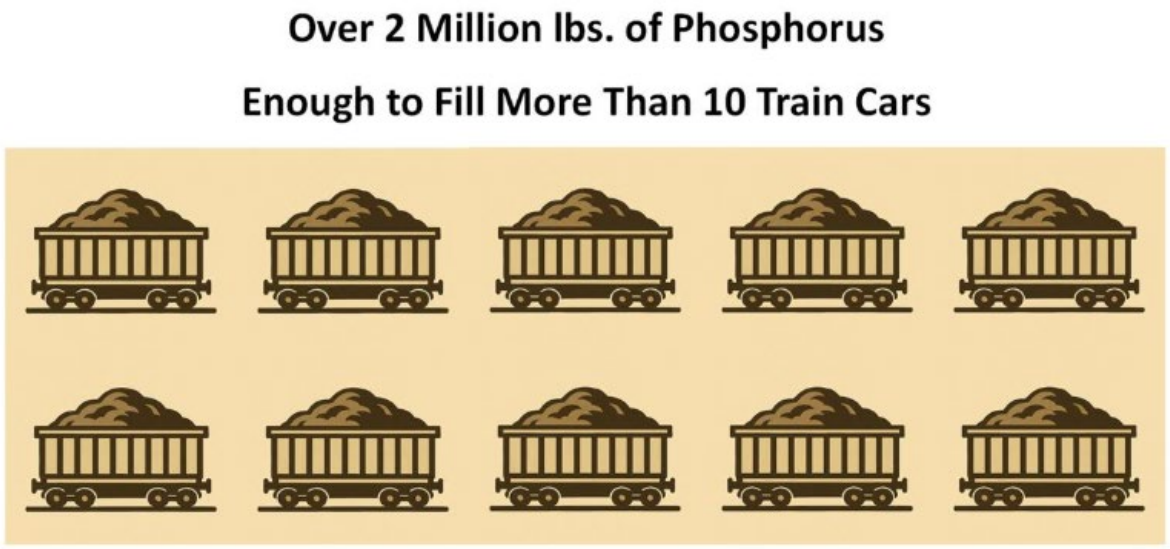
- In 2024 over **46,000** conservation and farm best management practices were implemented. **19,000** of these practices were modeled to quantify reductions of sediment and nutrients entering Indiana's waterways.

2,023,799 tons of sediment were estimated to be saved from entering Indiana's waterways.

Economic Impact: One ton of top soil cost approximately $44 in 2024, which would mean the value of the top soil if sold commercially would be over $88 million dollars.

Phosphorus Load Reductions

2,140,450 lbs. of phosphorus were estimated to be saved from entering Indiana's waterways.

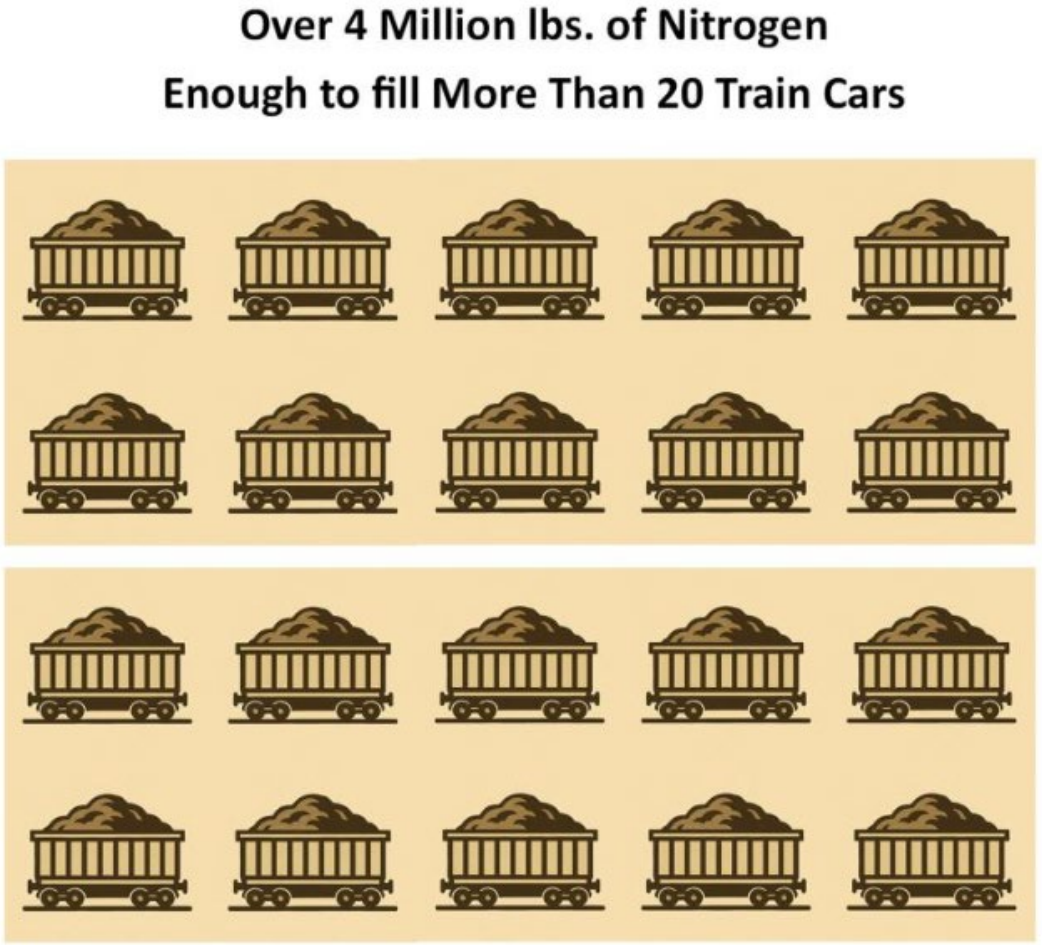


Economic Impact: amount of phosphorus contained in over 12 thousand tons of 10-20-10 fertilizer, which is over $7 million dollars worth of fertilizer.

Nitrogen Load Reductions

4,354,749 lbs. of nitrogen were estimated to be saved from entering Indiana's waterways.

Economic Impact: Equivalent to the amount of nitrogen in over 4,700 tons of urea fertilizer, which is over $2.8 million dollars worth of fertilizer.

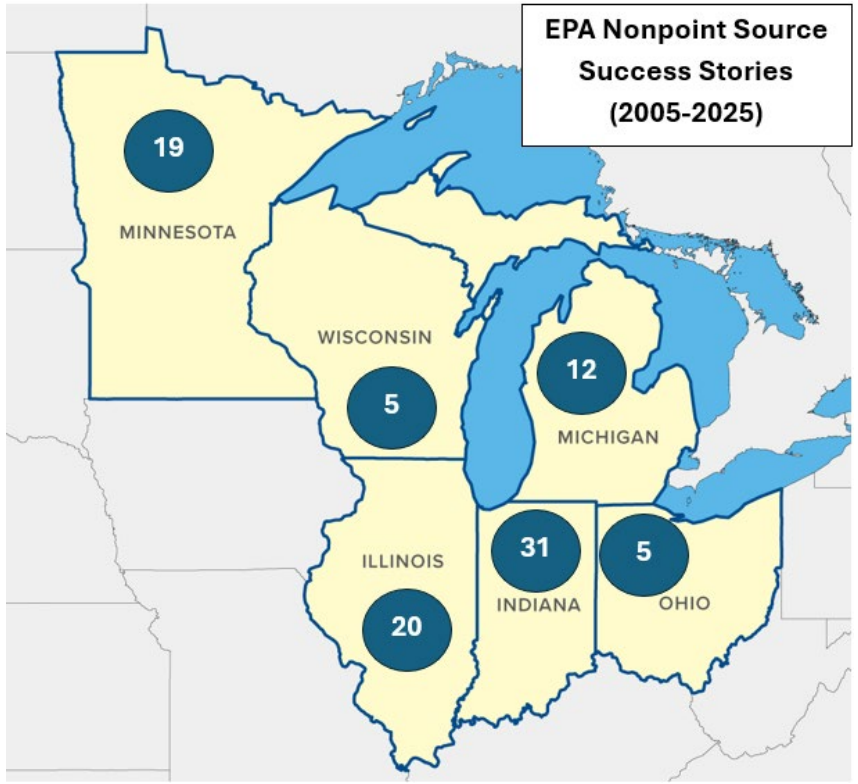


Documenting our impacts through Nonpoint Source Success Stories

- EPA-recognized case studies documenting waterbodies restored from nonpoint source pollution
- **Purpose**: Stories address efforts where water quality was improved through nonpoint source reduction efforts
- **Examples**: Projects addressed agricultural runoff, nutrient reduction, and stream restoration across diverse watersheds
- **Process**: States submit stories to EPA; published nationally as evidence of program impact.
- Stories published online by U.S. EPA https://www.epa.gov/nps/success-stories-about-restoring-and-protecting-water-bodies-impaired-nonpoint-source-pollution

Indiana's 2025 Accomplishments

- Indiana ranked #1 nationally for new stories in 2025
  - 13 stories submitted to EPA
- Indiana leads EPA Region 5 states and ranks #5 nationally with 31 published stories
  - Represents 60 waterbodies
- Published first "Type 5" stories for major accomplishments
  - 20 Years of Indiana Watershed Leadership Academy
  - Watershed plan coverage for IN portions of WLEB



Indiana Science Assessment

- **Why a Science Assessment?**
  - **Two 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)?

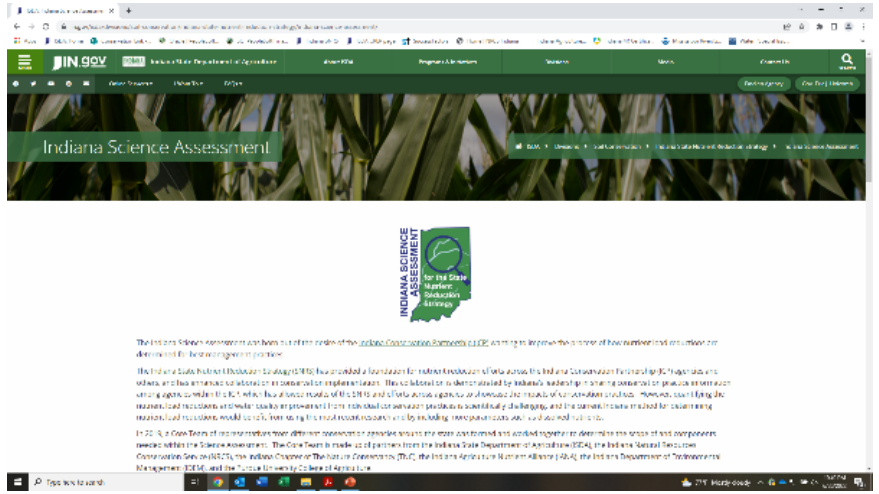
2) How effective are the conservation practices we recommend and implement in Indiana at reducing nutrients?

Indiana Science Assessment - Overview

Indiana Science Assessment Core Team

- Indiana State Department of Agriculture (ISDA)
- Indiana Natural Resources Conservation Service (NRCS)
- The Nature Conservancy (TNC)
- Indiana Agriculture Nutrient Alliance (IANA)
- Indiana Department of Environmental Management (IDEM)
- Purdue University, College of Agriculture

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



Indiana Science Assessment Components

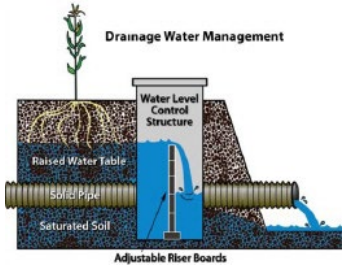
INDIANA SCIENCE ASSESSMENT for the State Nutrient Reduction Strategy

➢ Includes two components:

- **Component 1**: Determine historic and ongoing nutrient load trends leaving the state, and also by watershed basins used in the SNRS.
  - Led by ISDA personnel with support from IDEM, USGS and TNC
  - A written report as well as an online tool are available showing trend results for loads and concentrations at 20 different locations in Indiana, including pour points and within the basins.

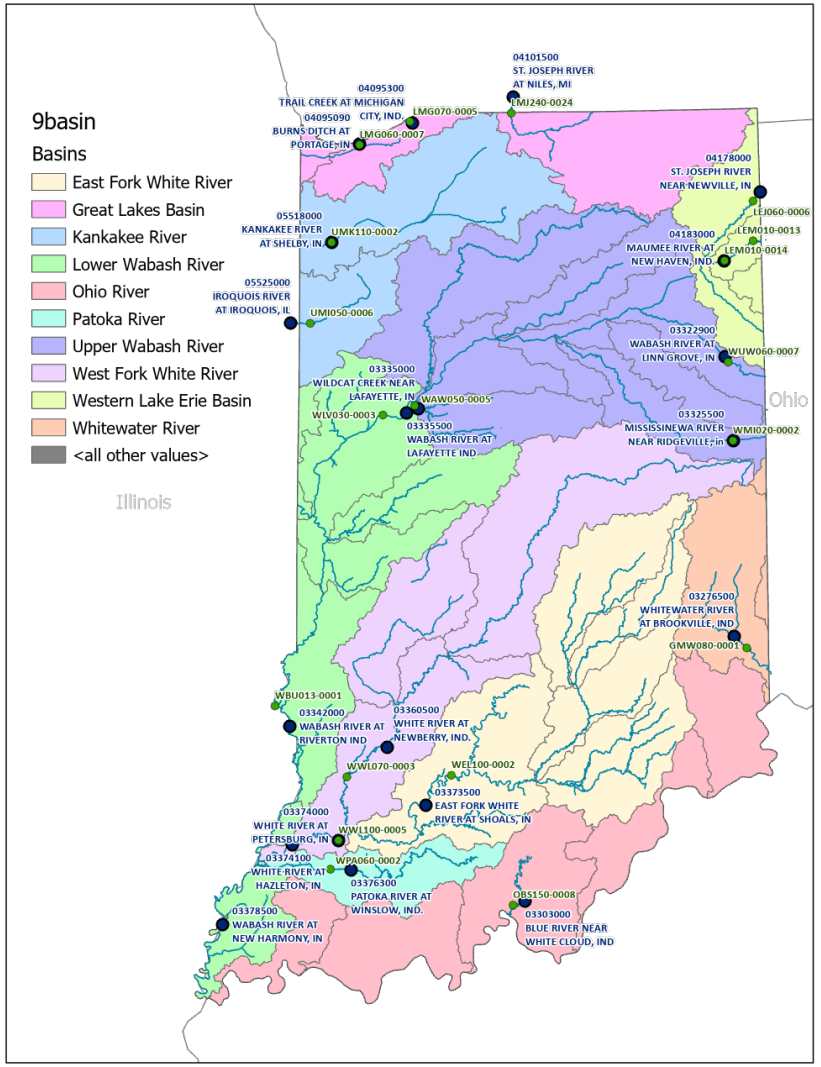
Trends of Sediment and Nutrients Loads in Indiana Watersheds

- **Component 2**: Improve current method for determining sediment and nutrient load reductions from conservation practices, including dissolved nutrients, and determine efficiency of conservation practices in reducing nutrient loads.



Indiana Science Assessment - Component 1 Process

- Determine nutrient loads and water quality trends at pour points at the state border and within the state in the major river basins using the USGS Weighted Regressions on Time, Discharge and Season (WRTDS) model
  - IDEM Fixed Station Network Monitoring Sites and USGS Discharge and Stream Gages Network
- Parameters in the analysis include:
  - Total Nitrogen,
  - Total Phosphorus,
  - Total Suspended Solids
- There are 20 total sites selected:
  - 9 export sites
  - 3 import sites
  - 8 interior sites



Trend Analysis Results - Mississippi River Basin

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.

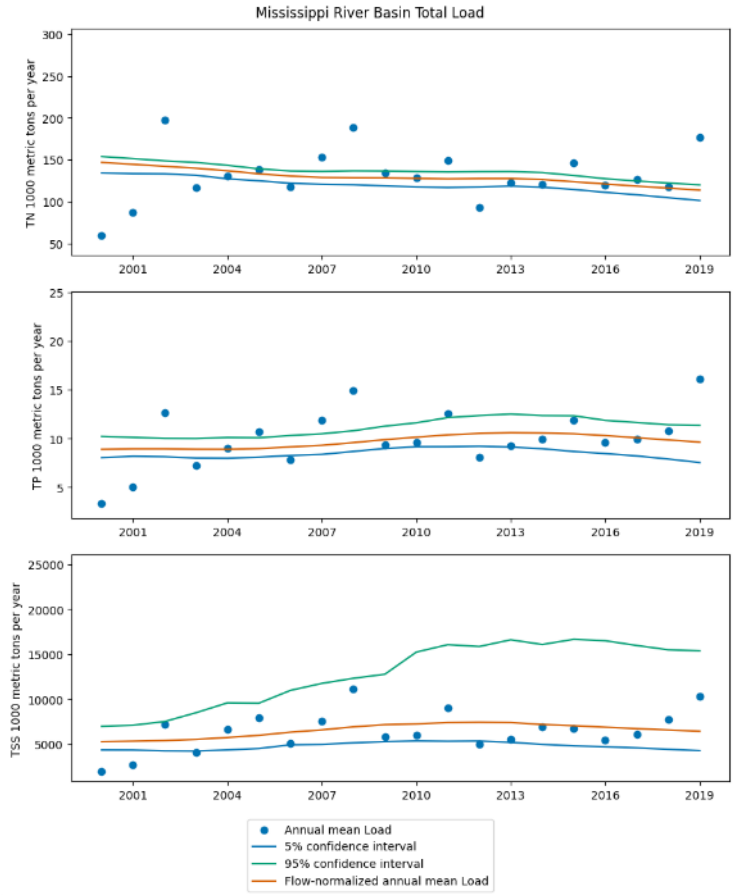
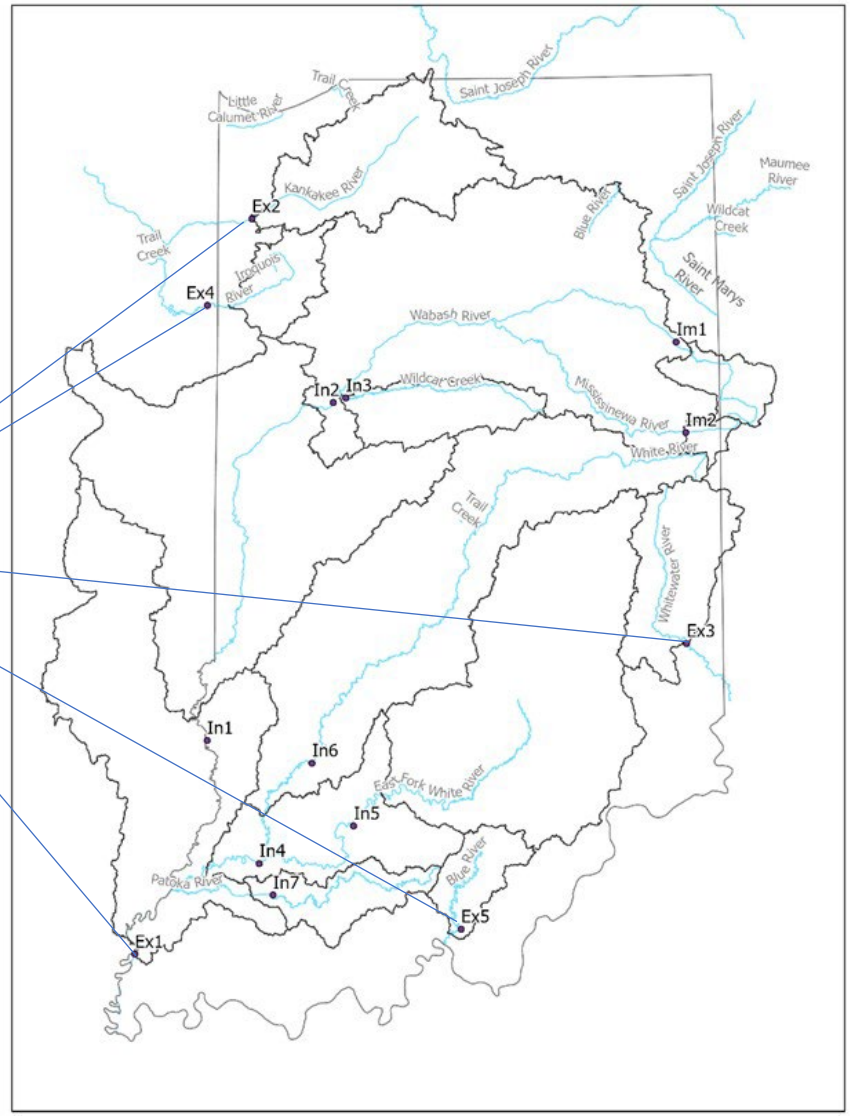


Figure 7: Figure 7 shows the trend in flow normalized load/mean flux combined for the **Mississippi River export sites**. (5 export sites)

*5 Mississippi River Basin Export Sites



Individual Site Trend Analysis Results

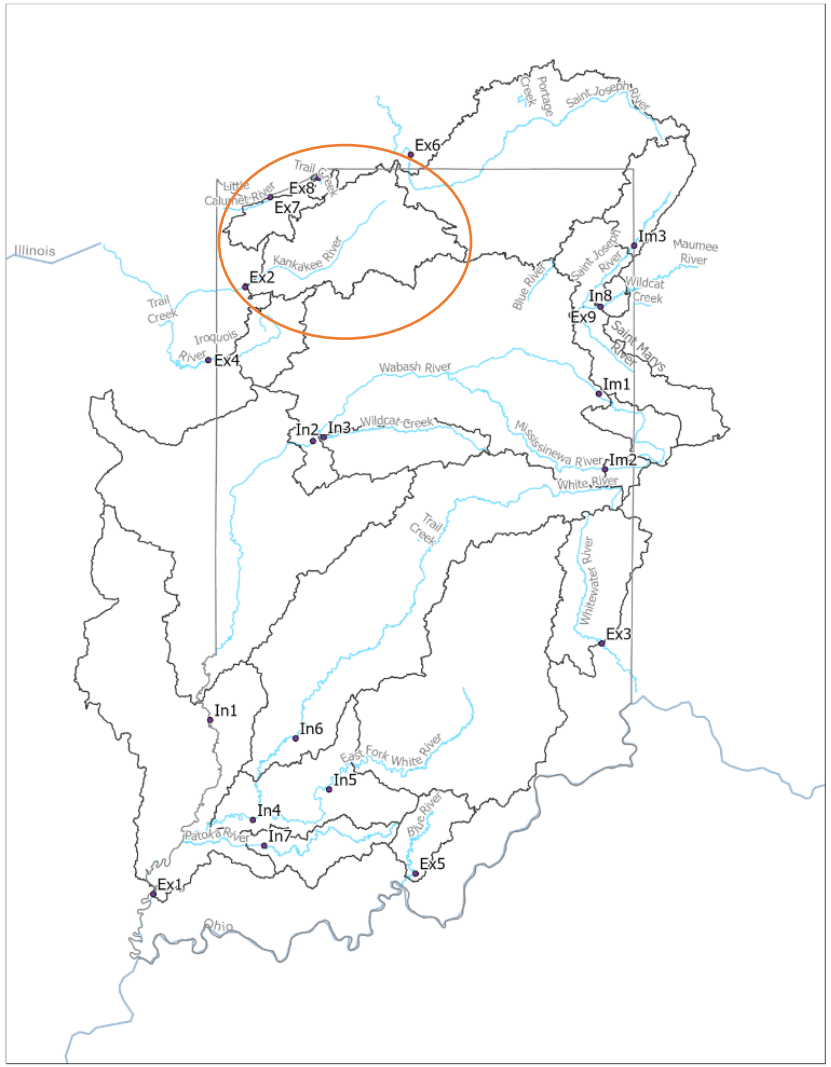


Figure 3 – USGS streamflow gages and associated drainage areas for all sites.
Figure 3 shows the drainage areas for the USGS gages associated with each sampling site, and the drainage area for each watershed.

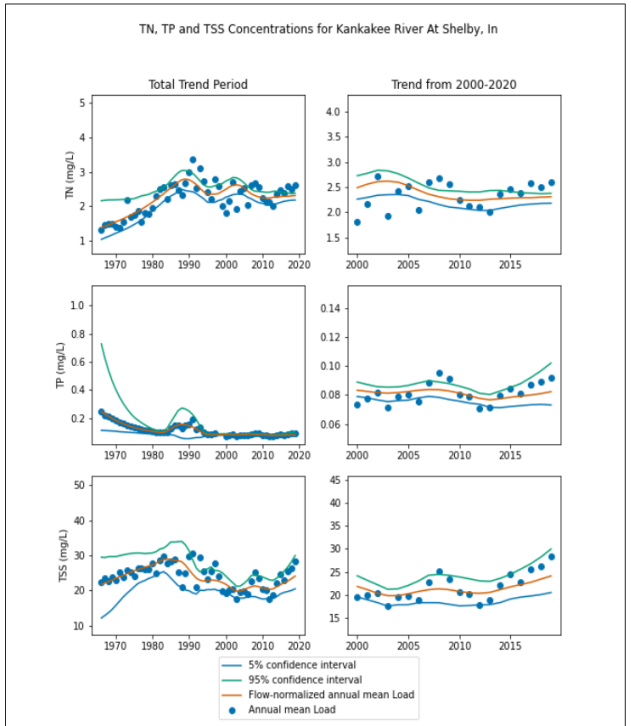


Figure 2A: Figure 2A shows the trend in flow normalized mean concentration, and annual mean concentration over time for the total trend period of available data for this site, and the trend period from 2000 to 2020, so that a more recent trend is shown.

Trend	Total Nitrogen	Total Phosphorus	Total Suspended Solids
Upward Trend in Concentration	highly unlikely	unlikely	likely
Downward Trend in Concentration	highly likely	likely	unlikely

Table 2A: WBT descriptive results for concentrations from **2005-2015** for Kankakee River at Shelby, IN (Ex2)

Flow normalized concentrations

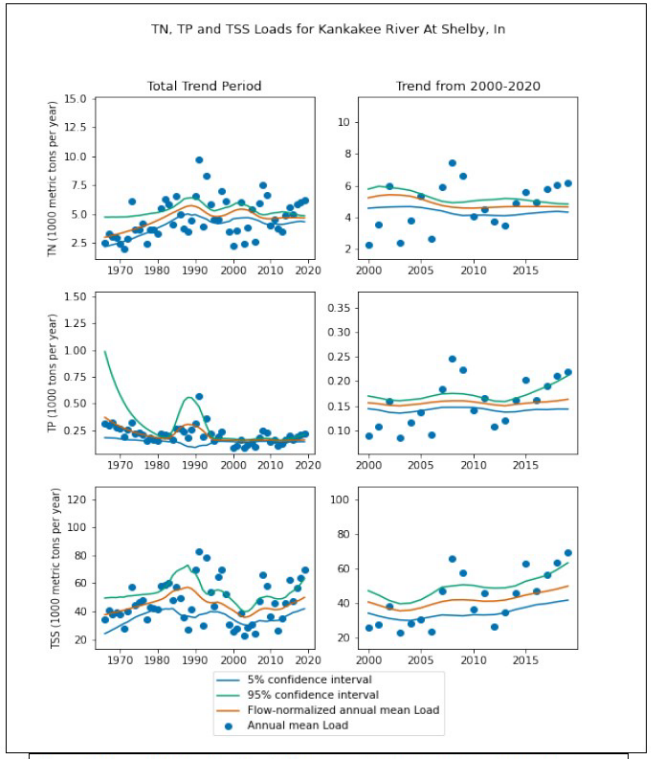


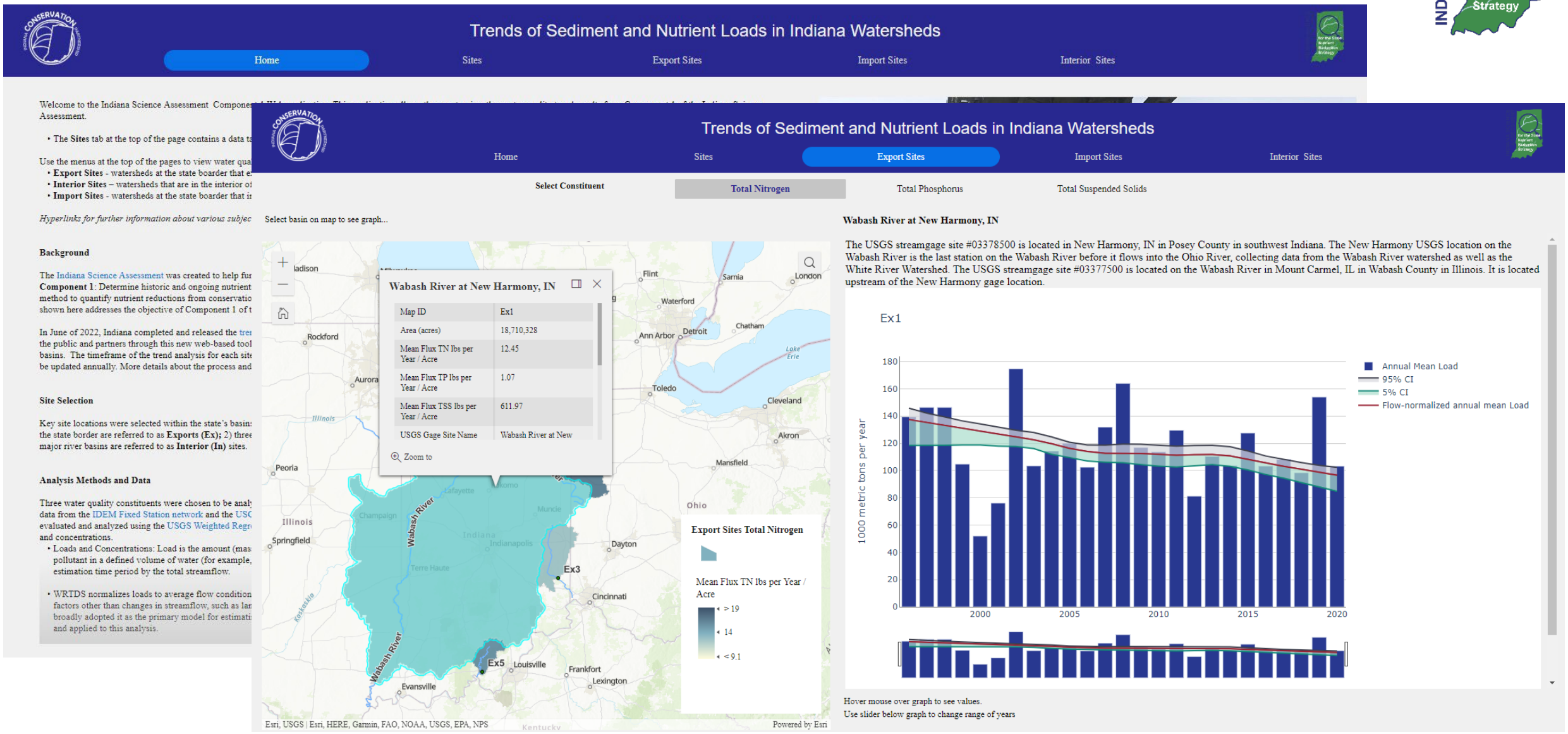
Figure 2B: Figure 2B shows the trend in flow normalized mean loads, and annual mean loads over time for the total trend period of available data for this site, and the trend period from 2000 to 2020, so that a more recent trend is shown.

Trend	Total Nitrogen	Total Phosphorus	Total Suspended Solids
Upward Trend in Load	very unlikely	about as likely as not	very likely
Downward Trend in Load	very likely	about as likely as not	very unlikely

Table 2B: WBT descriptive results for loads from **2005-2015** for Kankakee River at Shelby, IN (Ex2)

Flow normalized loads

Online Trends Tool (Component 1)



Indiana Science Assessment Component 2:

Quantifying the effect of conservation practices

Jane Frankenberger
Professor, Agricultural & Biological Engineering

PURDUE UNIVERSITY | Extension

INDIANA SCIENCE ASSESSMENT for the State Nutrient Reduction Strategy





Photos from Purdue University and NRCS

Quantifying the effect of conservation practices

A **conservation practice** is a farming or land-management action used to protect or improve soil and water quality.

Goal of the Assessment is to quantify the effects of conservation practices on nitrogen loss and phosphorus loss, in order to:

- Document statewide progress towards nutrient reduction goals
- Prioritize the most effective conservation practices
- Align communication by researchers, agencies, and others throughout Indiana

Photos from Purdue University and NRCS

We are building on other states' analyses

- Benefiting from previous Science Assessments by Iowa, Minnesota, Illinois
- We are providing separate estimate of nutrient reductions in drain flow and surface runoff
- For edge of field practices where practice size is important we are estimating load reductions (in lb/acre or kg/ha) rather than just percent

Strategy for assessing: Synthesize existing studies

We base the estimation method on field studies, not a model.

Comparing loads from two fields in Ohio

Photo: Notre Dame

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

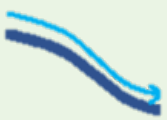
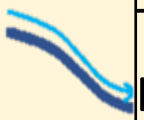
…plus 53 additional site years for N; 18 site years for P

5. Analyze Data

Findings: Nutrient Reduction Effectiveness for **Cover Crops**

- **Nitrogen** is sharply reduced by cover crops, shown by strong evidence. Reduction occurs in 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 showing both increases and reductions in phosphorus. There are insufficient studies to provide evidence-based determination of phosphorus effects from cover crop use at this time.

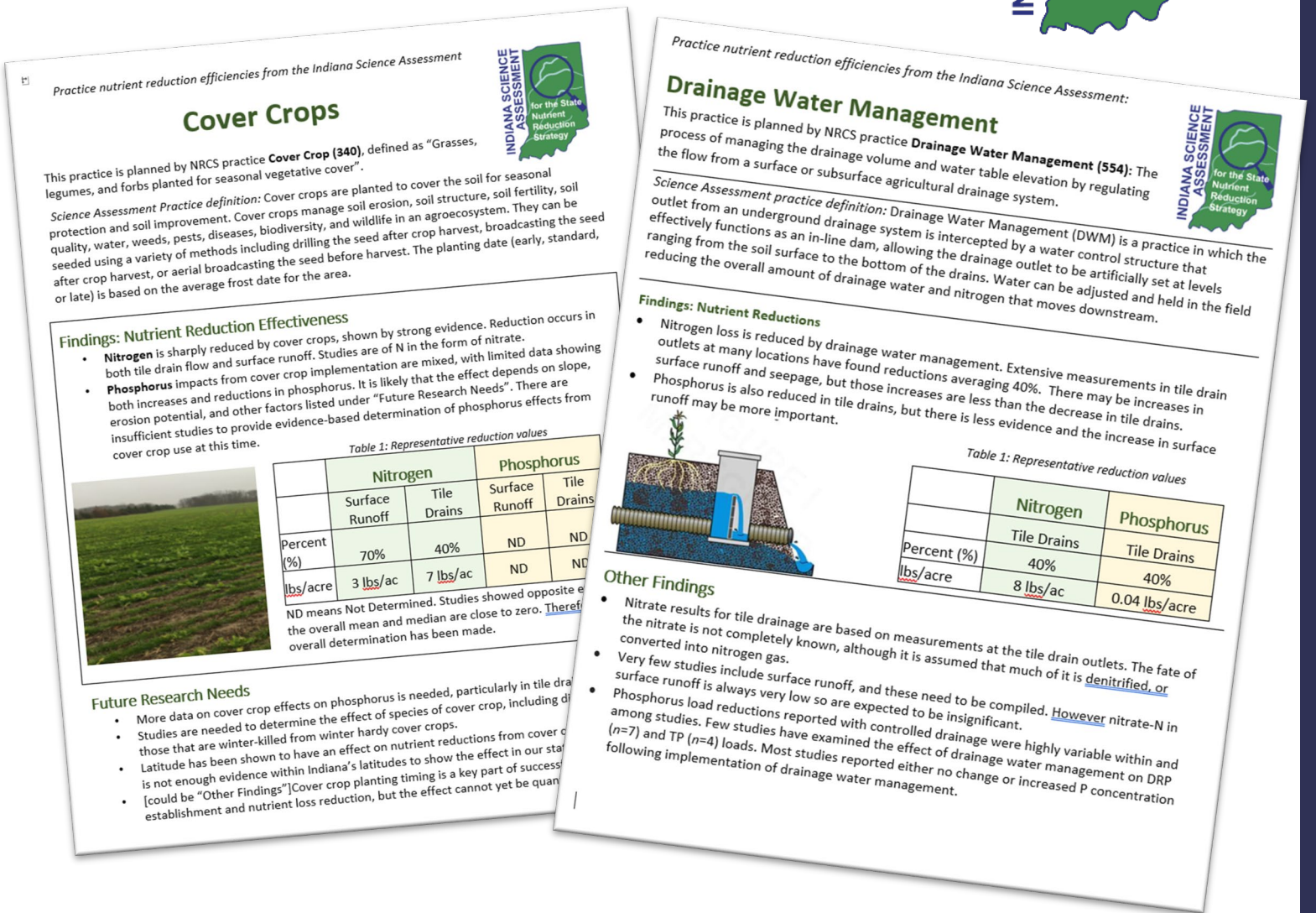
	Nitrogen		Phosphorus	
	Surface Runoff 	Tile Drains 	Surface Runoff 	Tile Drains 
Percent (%)	70%	40%	0-14%	0-30%
lbs/acre	3 lbs/ac	7 lbs/ac	0-0.06 lbs/A	0-0.01 lbs/A

Consensus by Science Team

Scientists studying these practices meet and vote on the reductions based on evidence.

Scientists are from:

- Purdue University
- Notre Dame
- Indiana University
- USDA ARS
- USGS



Practice nutrient reduction efficiencies from the Indiana Science Assessment

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 seed after crop harvest, or aerial broadcasting the seed before harvest. The planting date (early, standard, 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 in 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 showing 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 Drains
Percent (%)	70%	40%	ND	ND
lbs/acre	3 lbs/ac	7 lbs/ac	ND	ND

ND means Not Determined. Studies showed opposite e
the overall mean and median are close to zero. Therefi
overall determination has been made.

Future Research Needs

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

Practice nutrient reduction efficiencies from the Indiana Science Assessment:

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.

There are many conservation practices

Soil Health

- No-till or Reduced till
- Cover crops

ISDA photo gallery

Nutrient Management

- N rate, timing
- P rate, placement

NRCS photo gallery

Edge of field

- Filter strips
- Grassed waterways
- Blind inlets

NRCS photo gallery

Managing water and drainage

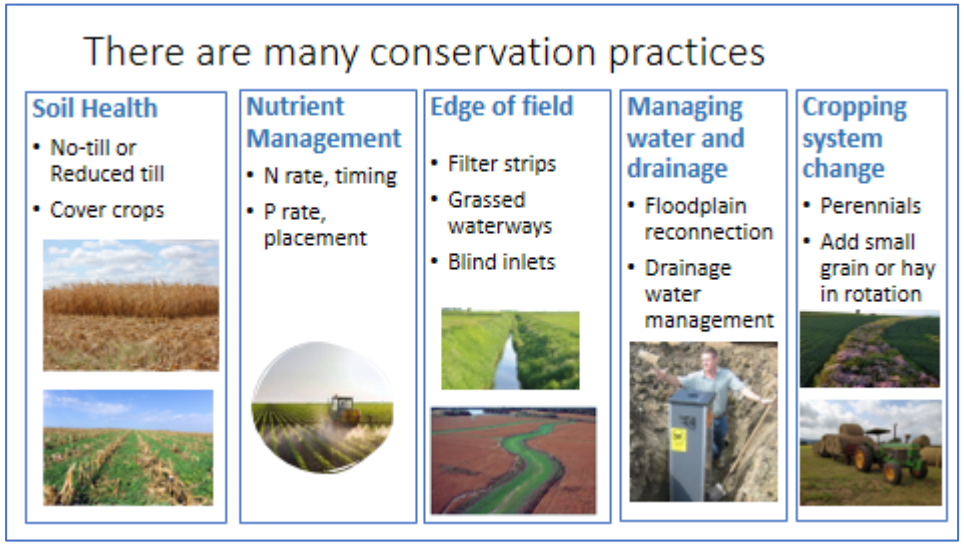
- Floodplain reconnection
- Drainage water management

Cropping system change

- Perennials
- Add small grain or hay in rotation

What is the role of the CCA?

- How comfortable are you talking with farmers about:
  - Soil Health
  - Nutrient Management
  - Edge of Field
  - Managing water and drainage
  - Cropping system change



Soil Health

Tillage | Cover Crops

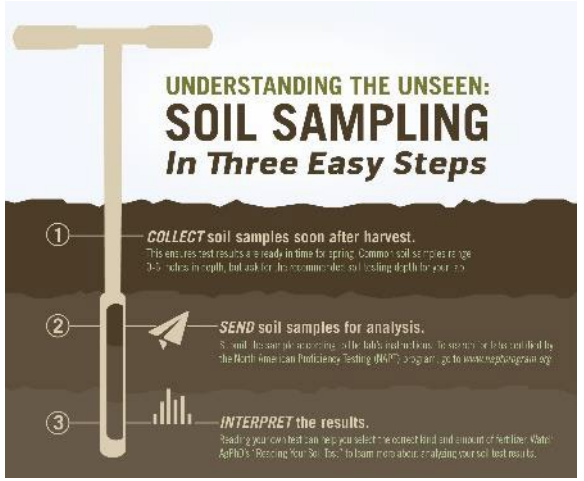
Nutrient Management practices with consensus

- **Subsurface P placement**

	Phosphorus	
	Tile Drains	Surface Runoff
Percent (%)	Insufficient data	50%
lbs/acre/yr		Insufficient data

Phosphorus Rate Based on Soil Test

	Phosphorus	
	Tile Drains	Surface Runoff
Percent (%)	Insufficient data	22%
lbs/acre/yr		0.8



Edge-of-field Practices

Filter Strips

Source: Iowa State University

Blind inlets

Installing a blind inlet to replace the tile inlet riser

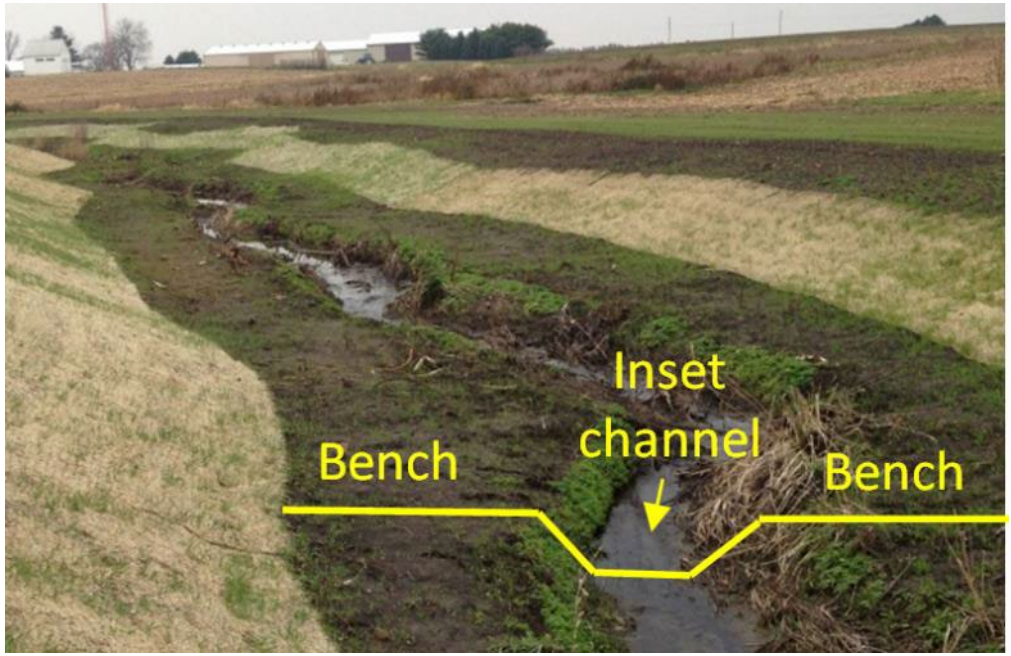
Source: USDA-ARS

Grassed waterways

Source: USDA-NRCS

Managing Water and Drainage

Two-stage Ditch

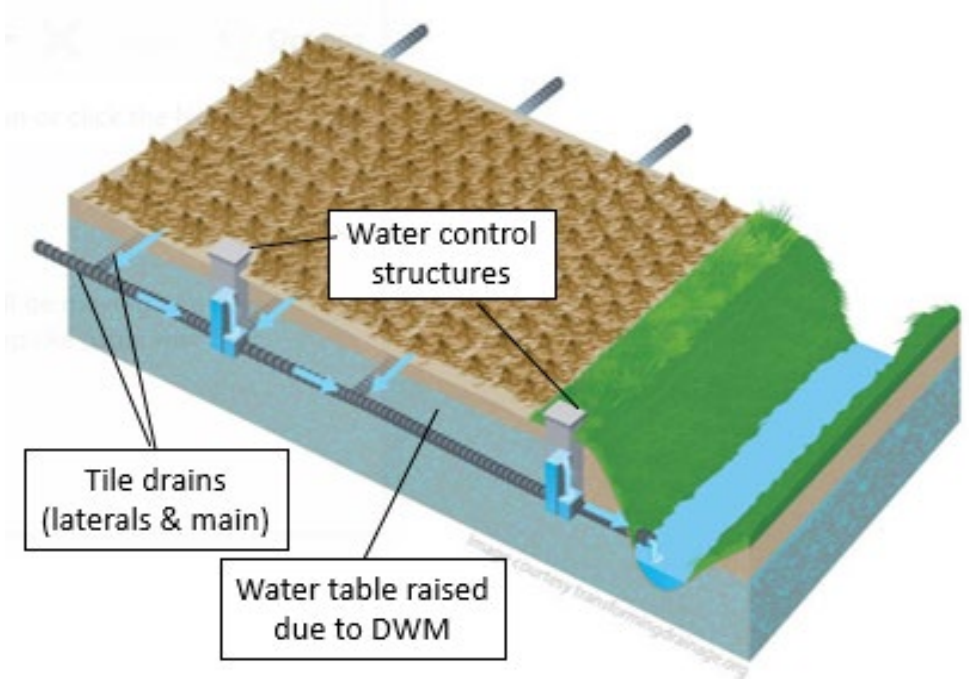


Drainage Water Management

Constructed Wetlands

Consensus: Drainage water management

- **Definition:** Drainage Water Management (DWM) is a practice in which the outlet from a drainage system is intercepted by a water control structure that effectively functions as an in-line dam, allowing the drainage outlet to be raised above the drains and reducing the overall amount of drainage water and nitrogen that moves downstream.

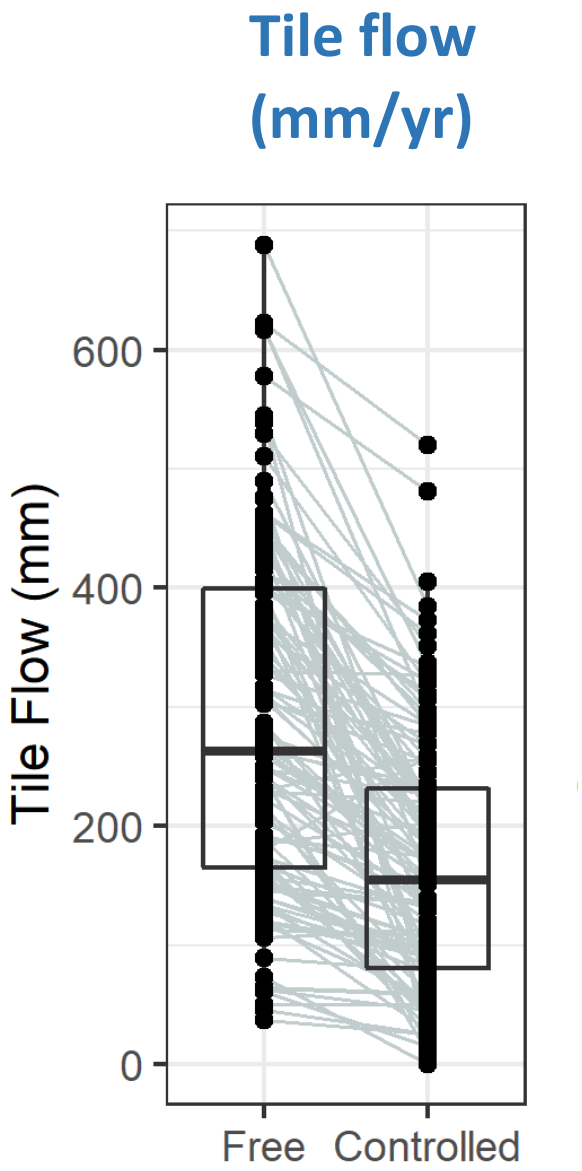


31 studies met criteria, with a total of 290 plot-years

Site	Key Reference(s)	Location name	Param.	Years	Plots reported separately*	Years reported
DEN1	Carstensen et al. 2019	Odder, Denmark	N, P	2012-2015	4	3
IA1	Jaynes et al. 2012	Story County, IA	N	2006-2009	2	4
IA2	Helmers et al. 2012, Schott et al., 2017	SERF (Crawfordsville, IA)	N	2007-2015	2	11
IL 1	Cooke and Verma 2012	Barry IL	N	2008-2009	2	2
IL 2	Cooke and Verma 2012	Enfield IL	N	2008-2009	2	2
IL 3	Cooke and Verma 2012	Hume South IL	N	2008-2009	2	2
IL 4	Cooke and Verma 2012	Hume IL	N	2008-2009	2	2
IL5	Woli et al. 2010	Deland, Piatt Cty, IL	N	2007-2009	2	3
IN1	Adeuya et al., 2012	White County IN - Site A	N	2007-2009	2	2
IN2	Adeuya et al., 2012	White County IN - Site B	N	2007-2009	2	2
IN3	Saadat et al., 2018	DPAC, Randolph Cty IN	N, P	2007-2016	4	11
IT1	Tolomio and Borin, 2018	Legnaro, NE Italy	N, P	2007-2013	4	5
LI1	Ramoska et al., 2011	Middle Lithuania	N	2001-2007	2	7
MN1	Strock et al., 2022	Redwood Cty MN	N	2006-2017	2	10
MN2	ADMC, 2012	Dundas, MN	N	2008-2009	2	2
MN3	ADMC, 2012	Hayfield, MN	N	2008-2009	2	2
MN4	ADMC, 2012	Wilmont, MN	N	2008-2009	2	2
MN5	ADMC, 2012	Windom, MN	N	2008-2009	2	1
MO1	Nash et al. 2015 (N Loss); Nash et al. 2015 (P loss)	Univ of MO Greenley Res. Center, Novelty MO	N, P	2010-2013	2	3

Free and controlled drainage were compared for each site year.

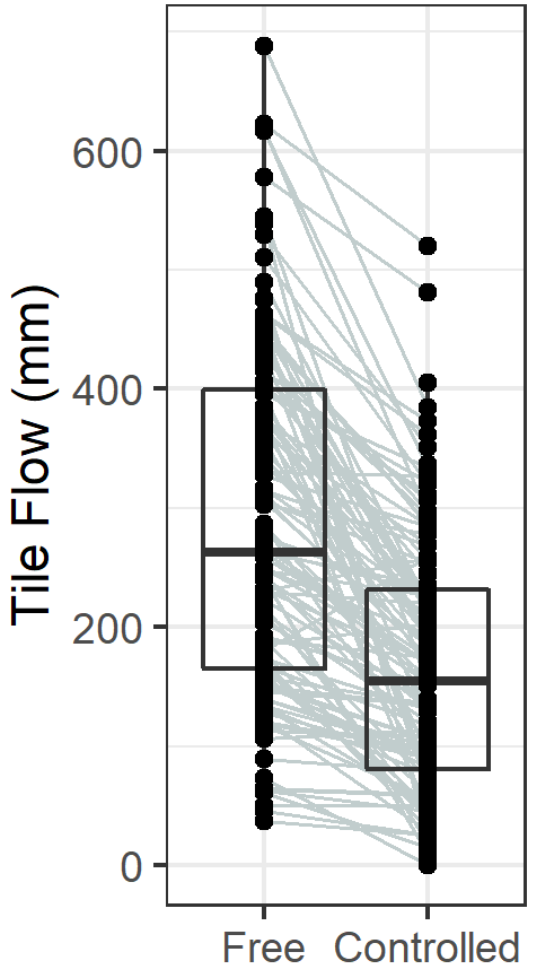
Grey lines connect free and controlled drainage for one year at one site.



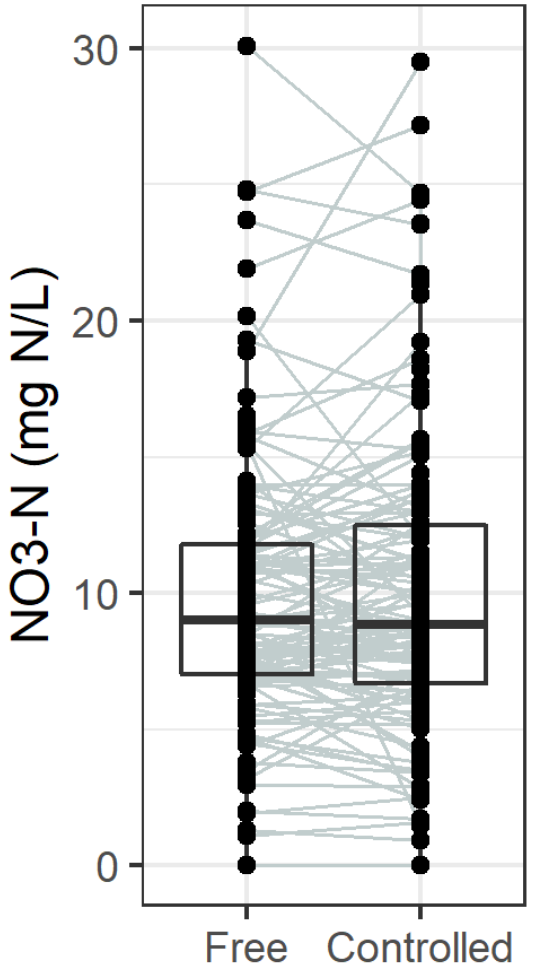
Free and controlled drainage were compared for each site year.

Grey lines connect free and controlled drainage for one year at one site.

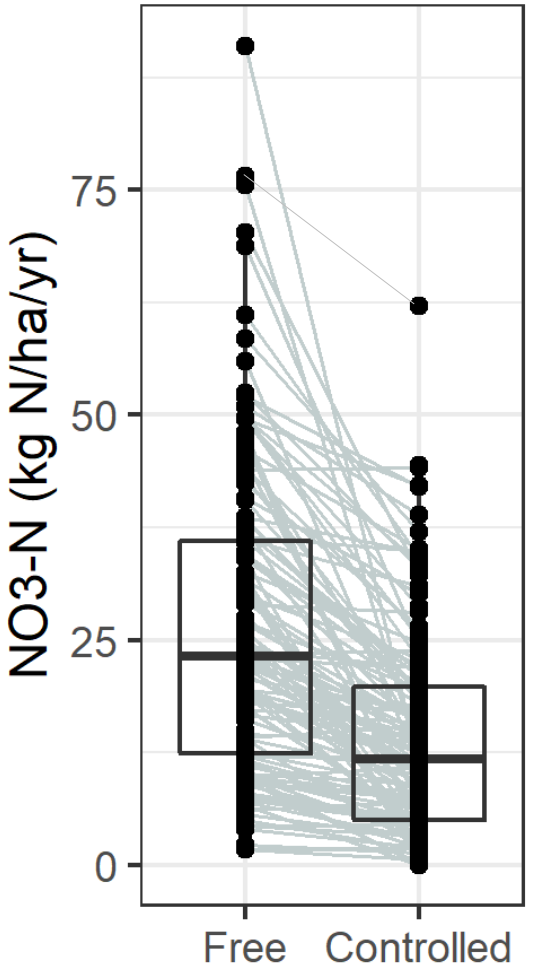
Tile flow (mm/yr)



Nitrate-N concentration (mg N/L)



Nitrate-N load (kg N/ha/yr)

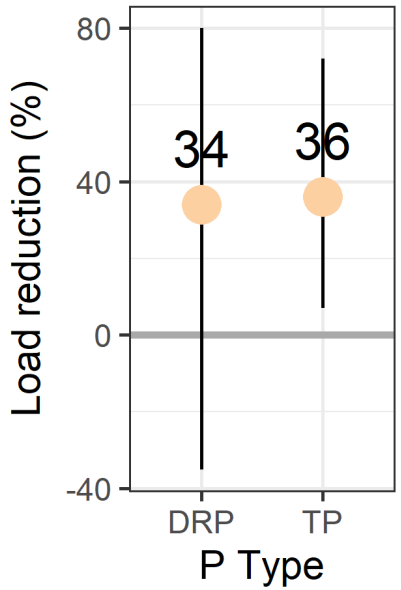


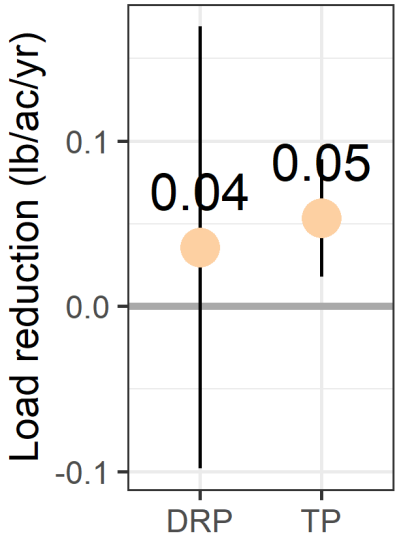
Drainage Water Management - Phosphorus

Phosphorus:

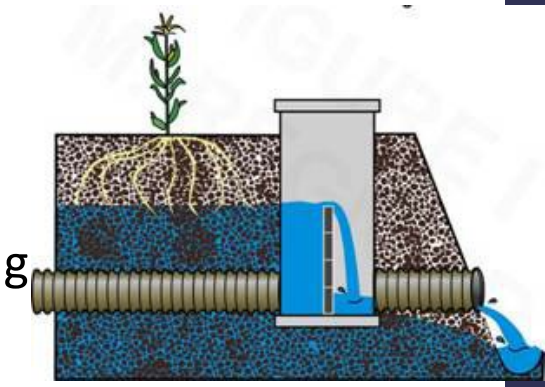
Only 7 site years for DRP and 4 for TP; questions about sampling accuracy.

Conclusion: **Insufficient data**





Drainage Water Management – Summary



- **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

A final question

- Is there is something that you are being asked in the field related to conservation programs or conservation practices that has not been addressed?

The Indiana Science Assessment will lead to:

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.**