Science Assessment to Support the
Indiana State Nutrient Reduction Strategy

Component 2: Quantify Expected Nutrient Reductions from Conservation Practices

Progress Report for Year 2

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Background and Vision

The Indiana State Nutrient Reduction Strategy has provided a foundation for nutrient reduction efforts across Indiana Conservation Partnership (ICP) agencies and has enhanced collaboration in conservation implementation. To address scientific question needed to move the strategy forward, the Indiana Science Assessment is being implemented, comprising two components. Component 1 focuses on determining historic and ongoing nutrients loads leaving the state and its basins and is led by the Indiana State Department of Agriculture (ISDA). Component 2, which focuses on quantifying nutrient reduction from conservation practices, is described in this report.

The goal of the Science Assessment Component 2 is to **develop a method to quantify expected nutrient reductions from conservation practices in Indiana to be used statewide**. The vision is that this process will lead to (1) improved documentation of 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 assessment of Indiana's contributions to downstream water quality issues, and (4) alignment of communication by researchers, agencies, and others throughout Indiana about conservation practices effectiveness.

Participants and Roles

The Core Team, with members from major conservation organizations and agencies, provides overall guidance to the process.

Core Team Members

Name	Affiliation
Julie Harrold	Indiana State Department of Agriculture
Ben Wicker	Indiana Agriculture Nutrient Alliance
Kristen Arnold	Indiana Department of Environmental Management
Kris Vance	USDA Natural Resources Conservation Service
Mike Dunn	The Nature Conservancy
Jane Frankenberger	Agricultural & Biological Engineering, Purdue University
Katy Mazer	Agricultural & Biological Engineering, Purdue University

The assessment is guided by a Science Committee composed of experts from throughout Indiana, which provides scientific input and evaluation of the process. The members are established researchers from five academic institutions in Indiana and two federal science agencies (USDA-ARS and USGS) who conduct research related to nutrients and water quality in Indiana.

Science Committee Members

Name	Affiliation
Shalamar Armstrong	Agronomy, Purdue University
Bob Barr	Center for Earth and Environmental Science, IUPUI
Nate Bosch	Lilly Center for Lakes & Streams, Grace College
Sylvie Brouder	Agronomy, Purdue University
Jim Camberato	Agronomy, Purdue University
Bernie Engel	Agricultural & Biological Engineering, Purdue University
Dennis Flanagan	USDA-ARS National Soil Erosion Research Laboratory
Jeff Frey	U.S. Geological Survey, Ohio-Kentucky-Indiana Water Science Center
Eileen Kladivko	Agronomy, Purdue University
Sara McMillan	Agricultural & Biological Engineering, Iowa State University
Chad Penn	USDA-ARS National Soil Erosion Research Laboratory
Linda Prokopy	Horticulture and Landscape Architecture, Purdue University
Dan Quinn	Agronomy, Purdue University
Carson Reeling	Agricultural Economics, Purdue University
Todd Royer	O'Neill School of Public and Environmental Affairs, Indiana University
Jennifer Tank	Biology, University of Notre Dame
Mark Williams	USDA-ARS National Soil Erosion Research Laboratory

For some practices, the Science Assessment will estimate load reductions using a percentage reduction and modeled runoff and drainage from agricultural fields throughout Indiana. The modeling framework, called Indiana Runoff and Drainage (INRAD) is being developed and run by the following leading experts on hydrologic modeling in Indiana.

Indiana Runoff and Drainage (INRAD) Modeling Group

Name	Affiliation
Laura Bowling	Agronomy, Purdue University
Keith Cherkauer	Agricultural & Biological Engineering, Purdue University
Charlotte Lee	Agronomy, Purdue University

Project implementation is led by Jane Frankenberger, Purdue University, through a subcontract from the Indiana State Department of Agriculture managed by Julie Harrold. The Research Associate is Katy Mazer.

Year 2 Accomplishments

The Science Assessment continues to advance towards the goal of an agreed-on method to quantify expected nutrient reductions from conservation practices in Indiana to be used statewide, with the following accomplishments.

1. Selection of Phase 2 practices

Phase 1 analyzed 10 practices that were selected at the beginning of the project. In Year 2, a structured process was implemented to select 15 practices to be added in Phase 2, bringing the total to 25 practices. The selection criteria agreed on were the following:

- The practice is promoted by agencies in Indiana,

- There is potential for widespread use of the practice in Indiana,
- Sufficient data exists in the literature to assess the practice effectiveness,
- Indiana scientists have expertise and willingness to assess the practice.

Science Committee members rated each potential practice individually, and the final rankings were agreed on by consensus. Practices to be assessed in Phase 2 are listed in Box 1.

2. Practice analysis and decisions

Preliminary practice effectiveness has been determined for 12 practices, and we will share these results with the Science Committee for final consensus and approval on load reduction and percent reduction values. All practices and progress made on them can be seen in Box 1.

Box 1. Progress of practice analysis in the Science Assessment

Completed steps	**1**	**2**	**3**	**4**	**5**
Phase 1 practices					
Cover crops					
Reduced tillage					
No till					
Filter strips					
Grassed waterways					
Drainage water management					
N rate					
N timing					
P rate					
P placement					
Phase 2 practices					
Gypsum					
Nitrification inhibitor					
WASCOB					
Bioreactor					
Blind inlet					
P removal structure					
Wetland					
Add grain into rotation					
Add hay into rotation					
Working perennials					
Non-working perennials					
River-floodplain reconnection					
Two-stage ditch					
Reduced drainage intensity					
Saturated buffer					

Steps for practice analysis

1. **Definition and assessment criteria**
2. **Systematic review and analysis of available literature**
3. **Small group meeting with experts**
4. **Full Science Committee meeting and decisions**
5. **Fact sheet created**

Completed

Partially complete

Not needed

3. Tool development

Results of the practice effectiveness analysis will be applied in a GIS-based calculator tool that ISDA can use to estimate load reductions for practices implemented across the state. This tool will apply the load reduction found for each practice to an estimate of runoff and drainage nutrient loads that occur without the practice. The loads are estimated from runoff and drainage annual volumes simulated by the Indiana Runoff and Drainage (INRAD) framework based on the VIC model and gridded climate, soil, and land use data for the state, combined with concentrations based on monitoring of corn and soybean agricultural areas.

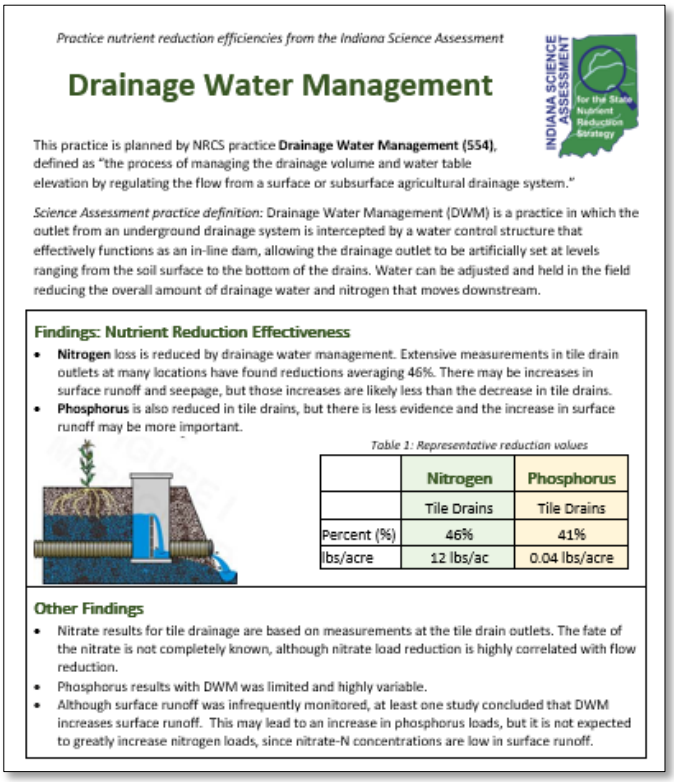
The Region 5 model, which is the current method used to calculate practice effectiveness, can be an effective tool for estimating sediment loss reductions, but it is limited in part because inputs are based by county rather than by local soil and climate characteristics. ISDA is developing updates to the Region 5 model that will include more site-specific parameters to estimate sediment load changes as a result of practice installation. These updates will provide the sediment and sediment-related effectiveness of practices for the Science Assessment.

4. Communications

Communicating results is important for ensuring support for the Science Assessment results and providing transparency about the process of development. Results of the Science Assessment will be shared as: 1) a tool that will calculate practice effectiveness for new practices implemented in the state, 2) a table that will report effectiveness of each practice, and 3) communication documents (i.e. factsheets) on each practice. An example of a draft factsheet is shown in Figure 1.

A strategy was developed for connecting practices from the science assessment to the practices assisted by NRCS and other ICP agencies. These relationships will allow us to apply calculated effects to practices that are installed throughout Indiana.

The project team has communicated extensively about the process and decisions made through twelve presentations to various decisions makers and stakeholders as shown in Box 2.



Practice nutrient reduction efficiencies from the Indiana Science Assessment

Drainage Water Management

INDIANA SCIENCE ASSESSMENT for the State Nutrient Reduction Strategy

This practice is planned by NRCS practice **Drainage Water Management (554)**, defined as "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 Reduction Effectiveness

- **Nitrogen** loss is reduced by drainage water management. Extensive measurements in tile drain outlets at many locations have found reductions averaging 46%. There may be increases in surface runoff and seepage, but those increases are likely 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 (%)	46%	41%
lbs/acre	12 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 nitrate load reduction is highly correlated with flow reduction.
- Phosphorus results with DWM was limited and highly variable.
- Although surface runoff was infrequently monitored, at least one study concluded that DWM increases surface runoff. This may lead to an increase in phosphorus loads, but it is not expected to greatly increase nitrogen loads, since nitrate-N concentrations are low in surface runoff.

Figure 1: Example of a factsheet (draft) to communicate the analysis process and results for each practice.

Box 2: Presentations on the Science Assessment in 2022

1. Harrold, J. *Update on the Indiana Science Assessment to support the State Nutrient Reduction Strategy*. Presented to the **Indiana Conservation Partnership** Leaders, Indianapolis, Jan. 11, 2022.
2. Harrold, J. *Update on the Indiana Science Assessment to support the State Nutrient Reduction Strategy*. Presented at the **State Soil Conservation Board meeting**, Indianapolis, Jan. 23, 2022.
3. Harrold, J. *Update on the Indiana Science Assessment to support the State Nutrient Reduction Strategy*. Presented to the **Indiana Water Monitoring Council** Board, Indianapolis, Feb. 1, 2022.
4. Harrold, J. *Indiana Nutrient Research and Education Program Proposal*. Presented at the **Indiana Conservation Partnership** Leaders meeting, Indianapolis, May 10, 2022.
5. Wicker, B. Presentation to the **Agricultural Organization Executives**. May 18, 2022.
6. Mazer, K., J. Frankenberger, J. Harrold, M. Dunn, B. Wicker, and J. Reinhart. *Quantifying Conservation Practice Effectiveness Statewide: Balancing Variability with Usability*. 2022 **Universities Council on Water Resources**/National Institute for Water Resources Annual Water Resources Conference, Greenville, SC. June 14-16, 2022.
7. Frankenberger, J. and J. Harrold, J.. *Science Assessment to Support the Indiana State Nutrient Reduction Strategy*. Presented at the 41st **Indiana Water Resources Association** Annual Symposium, Nashville, IN. June 22, 2022.
8. Laureys, T., *Indiana Science Assessment Component 1.* Presentation to the **Indiana Agricultural Nutrient Alliance Board.** Indianapolis, July 25, 2022.
9. Laureys, T. *Trends in Indiana Water Quality - Quantifying Impacts*. Presentation to the **Agribusiness Council: Farm to Faucet**. Indianapolis, August 18, 2022.
10. Harrold, J., B. Wicker, and J. Reinhart. I*ndiana State Nutrient Reduction Strategy and Indiana Science Assessment*. Presented at the **Indiana Water Summit**, Indianapolis, Sept. 8, 2022. https://thewhiteriveralliance.org/programs/water-summit/2022-indiana-water-summit/
11. Harrold, J., and T. Laureys. *Indiana State Update*. Presented to the **Gulf of Mexico Hypoxia Task Force.** U.S. Environmental Protection Agency HQ, Washington DC. Dec. 14, 2022.
12. Laureys, T. *Conserving private lands across Indiana: Indiana Conservation Partnership*. Presentation to the **Indiana Legislature Drainage Task Force**. December 21, 2022. https://iga.in.gov/legislative/2022/committees/drainage_task_force.

Introducing the Indiana Nutrient Research and Education Program (INREP)

A portion of the funds provided by USEPA through the Bipartisan Infrastructure Law to support the Indiana State Nutrient Reduction Strategy have been designated to create the Indiana Nutrient Research and Education Program (INREP). These funds will allow INREP to provide the scientific foundation for documenting nutrient reductions from conservation practice implementation, prioritizing those that are most effective, and which are critical components of the Indiana State Nutrient Reduction Strategy. INREP will develop and deliver knowledge that optimizes the management of nutrients across the Indiana landscape. Based at Purdue University, it will pursue science-based approaches by assessing the performance of current and emerging nutrient management practices, building consensus-based recommendations and analyses, and informing nutrient reduction strategies.

It will build on the Science Assessment process that has already made substantial progress, bringing together an active Science Committee that has achieved consensus on the basic process and practices to

assess. This funding will allow continued progress towards our goal of having widespread agreement on a tool and method for (1) tracking nutrient losses from decisions and practices that have already been implemented, and (2) prioritizing practices that are most cost effective for future implementation. Prioritization will need to include an economic analysis which is not funded in the current project.

The **overall goal** of INREP will be to provide a scientific foundation to inform and improve nutrient stewardship in the State. Specific objectives are to:

1. Sustain and strengthen the network of scientists and agencies collaborating to provide the scientific foundation for the Indiana State Nutrient Reduction Strategy and related efforts.
2. Lead a continual process of refining and improving 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.

Next steps

Practices and definitions: Draft definitions for the Phase 2 practices developed by the Core Team will be shared with the Science Committee for approval by consensus. The analysis of Phase 1 practices will be completed and Phase 2 practices will continue, resulting in estimates of load reductions in surface runoff and drain flow, both as percentages and in lbs/acre.

Tool development: The GIS-based calculator tool will be used to apply the reduction estimates to thousands of practices implemented annually by ISDA or others, in order to calculate load reduction for practices being installed across Indiana. The INRAD development team will fine-tune the flow simulations to provide surface runoff and subsurface drainage volumes throughout Indiana to help estimate the extent of the load reduction of practice implementation. A table of reductions for all 25 practices will provide values for load reduction in pounds per acre and percent reduction for both drainage and runoff when applicable.

Communications: Regular communication will continue to be a priority. Factsheets will be developed for each practice once the analysis is completed and approved by the Science Committee, which will be shared with practitioners, producers, and others. The datasets created through the Science Assessment will be made available online, for transparency and to encourage ongoing improvement and development of similar assessments in other states and regions. We will continue to present information about the assessment and results at conferences, meetings, and through other presentations in order to encourage input from future users to ensure that the Science Assessment is useful and accessible.

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Photos from Purdue University and USDA-NRCS