Science Assessment to Support the
Indiana State Nutrient Reduction Strategy

Component 2: Quantify Expected Nutrient Reductions from Conservation Practices

# Progress Report for Year 1

Prepared by Jane Frankenberger, Purdue University

## 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 |
| Marylou Renshaw | Indiana Department of Environmental Management |
| Jill Reinhart | USDA Natural Resources Conservation Service |
| Mike Dunn | The Nature Conservancy |
| Jane Frankenberger | Purdue University Extension; Agricultural & Biological Engineering |

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, Purdue 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 |

Project implementation is led by Jane Frankenberger, Purdue University, through a subcontract from the Indiana State Department of Agriculture managed by Julie Harrold. Research Associates were **Gilles Tagne** (January to June 2021) and **Katy Mazer** (October 2021 to the present; *kmazer@purdue.edu*).

## Decisions and Overall Strategy

The Science Committee met nine times between June and December 2021, and made the following decisions:

1. The assessment will focus on long-term effectiveness, not on the variation from year to year which cannot be predicted in advance.
2. The reductions will be provided in at least two separate formats:
    a. A table for communicating the results that is easy to read and understand.
    b. An electronic calculator tool that can be used to apply the method to thousands of practices by ISDA or others.
3. The goal is for the tool to be applicable to non-incentivized conservation as well as incentivized conservation. However, the method for tracking non-incentivized conservation is beyond our scope.
4. Reductions will be provided as both a quantity (i.e., lbs/acre) and a percent reduction, to the extent possible. For achieving this, we will use the following four-component method, based on the Iowa Nutrient Reduction Strategy with some modification and also recognizing opportunities for revisions to increase accuracy:
        1. Estimate flow (surface and subsurface) and erosion from fields across Indiana and create a map that can easily be used in calculations.

2. Estimate concentration for each of these pathways based on measurements. (Note: Many decisions remain on how to do this and how location might affect this).
3. Multiply flow at each location by the expected concentration to get estimated load, which will be publicly available as an online tool.
4. To get load reduction,
    i. For in-field practices, multiply load by a reduction percentage
    ii. For edge-of-field practices, calculate load reduction based on size/design of practice

This process is adaptable, and we will continue to modify and improve it to make it as accurate as possible. We should also keep in mind the value of enhancing future research through this process, which may include validation, varying scales, comparing load reductions from the model, and adding processes that better capture the load as a quantity.

## Conservation Practices Assessed in Year 1

The Core Team selected 10 practices to focus on in Year 1, based on those that are widely used and thought to be effective in reducing nutrient loss from Indiana agriculture. They were grouped in three categories:

**Practices that can improve soil health:** (1) No till, (2) Reduced tillage, and (3) Cover crops
**Edge of field practices**: (4) Filter strips, (5) Grassed waterways, and (6) Drainage water management
**Nutrient management practices**: (7) Nitrogen rate, (8) Nitrogen timing, (9) Phosphorus rate, and (10) Phosphorus Timing

For each practice, definitions and criteria were developed and substantial progress was made on a summary of reductions. Also, the Science Committee made decisions on key factors that will be included in the performance assessment. The definition for (3) Cover Crops, below, gives an example of definitions and criteria, which have been developed for each of the ten practices. A public version of the definitions document is at the Indiana Science Assessment website managed by the ISDA.

*Example definition and criteria for inclusion in the assessment. Similar definitions were developed for each of the ten practices listed above.*

| **Cover Crops** | |
|---|---|
| NRCS Cons. Practice Standard | Cover Crop (340)<br>Definition: Grasses, legumes, and forbs planted for seasonal vegetative cover. |
| Practice Definition(s) | 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. |

| | |
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| Criteria for inclusion in the assessment | To be included in the assessment for **cover crops**, a study must meet the following criteria:<br>1. The study must compare the nutrient loads from the preferred (BMP) and the non-preferred practices.<br>• Preferred (BMP): Cover crop<br>• Non-preferred: No cover crop<br>2. The cover crop should be established between successive productive (cash) crop harvests, which in Indiana typically means Fall/Winter.<br>3. Latitude (or regions of the state) will be included as a factor in the effectiveness of the cover crop.<br>4. The species of the cover crop (winterkill vs. winter hardy) will also be included as a factor in the effectiveness of the cover crop. |

Literature reviews are being completed of nutrient reductions monitored in agricultural systems similar to those in Indiana, following the criteria identified, to inform the expected reduction estimates.

## Next steps

Now that the overall method has been determined by consensus of the Science Committee, the analysis will move forward. Annual expected flow through surface and subsurface pathways will be estimated through modeling validated by streamflow records. These will be combined with concentrations compiled from literature values measured in similar agricultural systems to estimate loads without conservation practices. The reduction efficiencies for the initial ten practices will be made available in an accessible table for education and outreach in 2022. A tool will be developed to enable the Indiana Conservation Partnership staff to estimate load reductions for conservation practices implemented across the state. The final tool is expected to be ready in 2023.

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