Bringing SWAT to stakeholders to explore conservation scenario development in the Western Lake Erie Basin

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Approach

Aim: Develop stakeholder-driven scenarios for agricultural best management practices (BMPs) in the Maumee watershed

Outline:

1. Stakeholder workshops
2. Brainstorming scenarios
3. Running stakeholder-driven scenarios

1. Stakeholder workshops

- Three initial workshops in August, 2014
- Three follow-up workshops in June, 2015
- Participants: farmers, extension, soil and water conservationists, policymakers…


Old Woman Creek (Ohio)


Ottawa National Wildlife Refuge (Ohio)


University of Michigan

From workshops:

Input we hope to learn from you

1. Which BMP scenarios are of interest (and for which watersheds)

2. If those scenarios can be modeled, we can talk about BMP characteristics to improve our modeling

3. If those scenarios cannot be modeled in SWAT, can we provide recommendations for future model development?

We will now enter into a brainstorming session about what sorts of decisions and practices you consider to be most important for scenario testing.

From workshops:

Conservation tillage

Managing the amount, orientation and distribution of crop and other plant residue on the soil surface year round while limiting soil-disturbing activities to those necessary to place nutrients, condition residue and plant crops.

- No-tillage
- Strip tillage
- Ridge tillage

Waste utilization

Using agricultural wastes such as manure and wastewater or other organic residues in a way that protects the environment.

- Type of manure
- Manure application methods

Nutrient management

Managing the amount, source, placement, form and timing of the application of plant nutrients and soil amendments.

- 4R nutrient stewardship
- Fertilizer source
- Fertilizer rate
- Application timing
- Placement in/on soil

Winter cover crop

Planting a winter cover crop to maintain soil cover.

- Crop type (winter wheat, cereal rye, oil seed radish)
- Timing of plant and kill/harvest

Vegetated filter strip

A strip or area of herbaceous vegetation that removes contaminants from overland flow.

- Fraction of the runoff entering the most concentration 10%
- Fraction of field in filter strip

Grassed waterway

A shaped or graded channel that is established with suitable vegetation to carry surface water at a non-erosive velocity to a stable outlet.

- Roughness (Manning's "n")
- Area draining to it
- Width
- Length

Drainage issues

Issues related to keeping water on the land in heavily drained landscapes

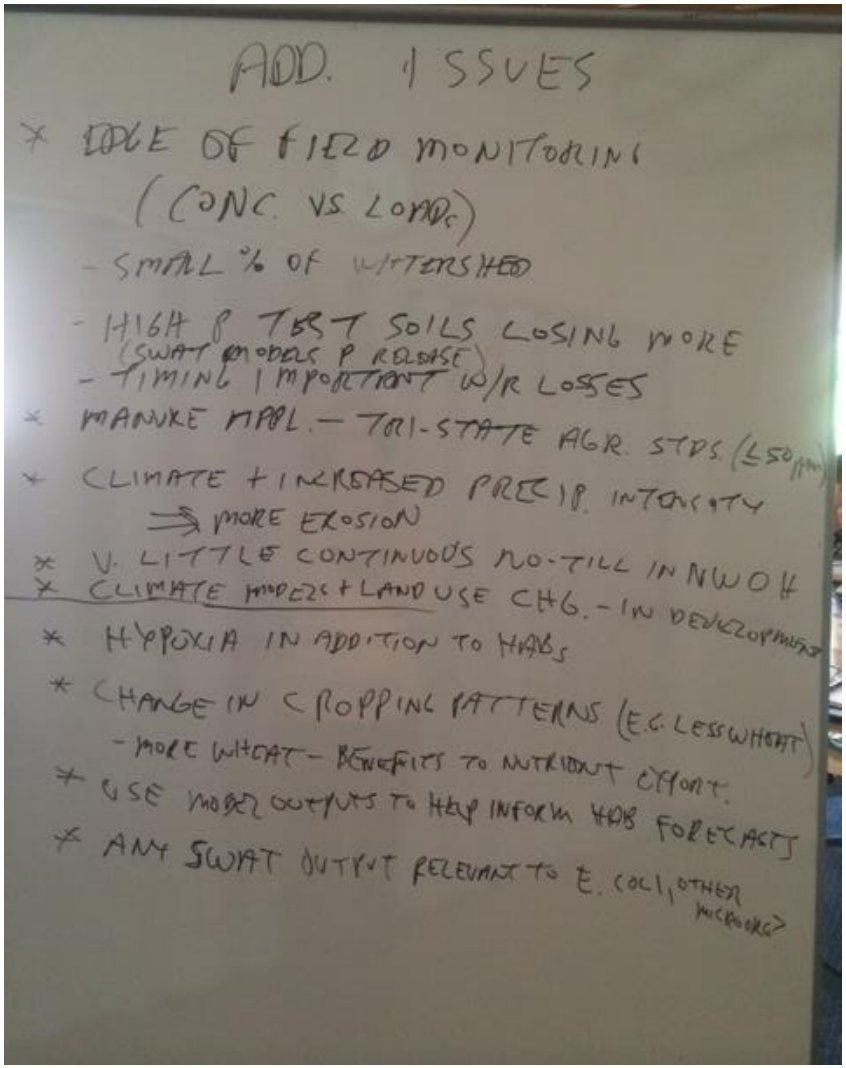
- Drainage water management/controlled drainage
- Two-stage drainage ditches

Wetlands

The return of a wetland and its functions to a close approximation of its original condition as it existed prior to disturbance on a former wetland site.

- Size, and fraction of subwatershed it drains
- Nutrient and sediment removal parameters
- Type and scale

1. Stakeholder workshops: Concerns



- ***Phosphorus delivery*** from the Maumee watershed.
- ***Cost*** of BMPs to farmers; quantify benefits to the farmer.
- Importance of a ***systems approach*** to BMP implementation.

1. Stakeholder workshops: feedback

Stakeholders encouraged us to make a model they could “trust”, including:

- Simulating manure in the SWAT model
- Better data on assumptions of nutrient application rates, crop rotations, and tillage

Even so, some decisions we made were sub-optimal:

- Fertilizers and manures applied evenly over watershed
- One tillage strategy across the watershed
- We did not feel comfortable assuming particular fields to have higher P tests than others, and left SWAT defaults
- We did not have data for existing BMPs

2. Brainstorming scenarios: *In-field*

Brainstorming

- Tillage: does no-tillage help or hurt P losses?
- Waste utilization: concern about elevated manure use near confined animal feeding operations (CAFOs) and general over-application as evidenced by high soil P tests
- Nutrient management: placement in the soil or on the soil—which is better for preventing P losses?
- Cover crops: capable of improving soil quality. Do models (e.g. SWAT) consider this? Cereal rye and tillage radish becoming more common.


Conservation tillage

Nutrient management


Waste utilization


Winter cover crop

2. Scenarios: *In-field*

Scenarios

- **Nutrient placement:** Broadcast fertilizers on no-tillage v. incorporated into the soil with tillage
- **Nutrient timing:** Fall, winter, spring P fertilizer applications
- **Tillage:** Compare more intensive tillage to no-tillage
- **Cover crops:** Rotations of cereal rye cover crop after soybeans, tillage radish cover crop after wheat


Conservation tillage

Nutrient management

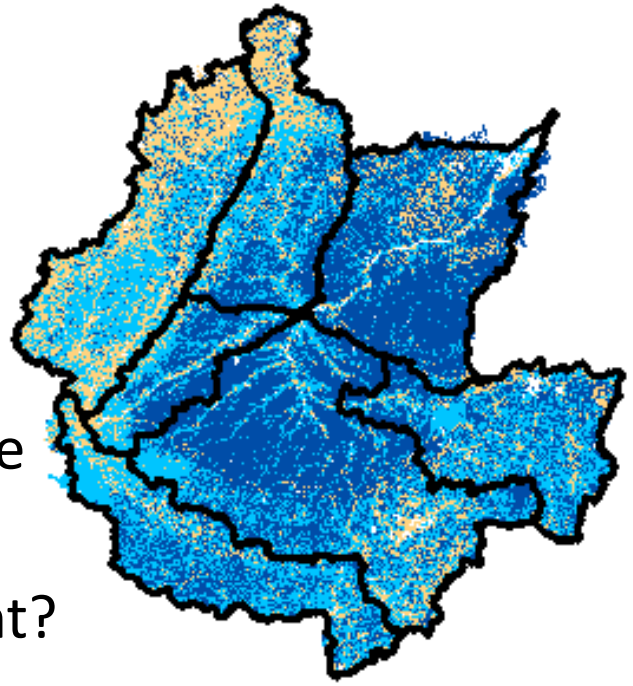

Waste utilization


Winter cover crop

2. Scenarios: *Edge-of-field*

Brainstorming

- Subsurface tile drainage: interest in controlled drainage
- Tile drainage: new installations lead to greater DRP loading?
- Tile drainage: tiles directly draining surface potholes
- Vegetated filter strips: targeting placement?



Vegetated filter strip

Grassed waterway

Drainage issues

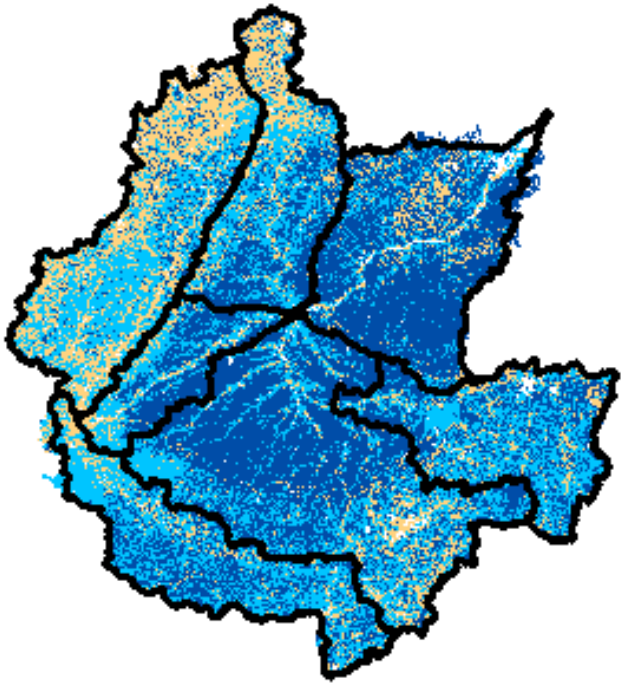
SSURGO soil drainage class

- Well drained
- Poorly drained
- Very poorly drained

2. Scenarios: *Edge-of-field*

Scenarios

- **Tile drains:** Comparison of tile drainage densities
- **Filter strips:** Vary the width of filter strips, and the portion of watershed buffered by filter strips



Vegetated filter strip

Grassed waterway

Drainage issues

SSURGO soil drainage class

- Well drained
- Poorly drained
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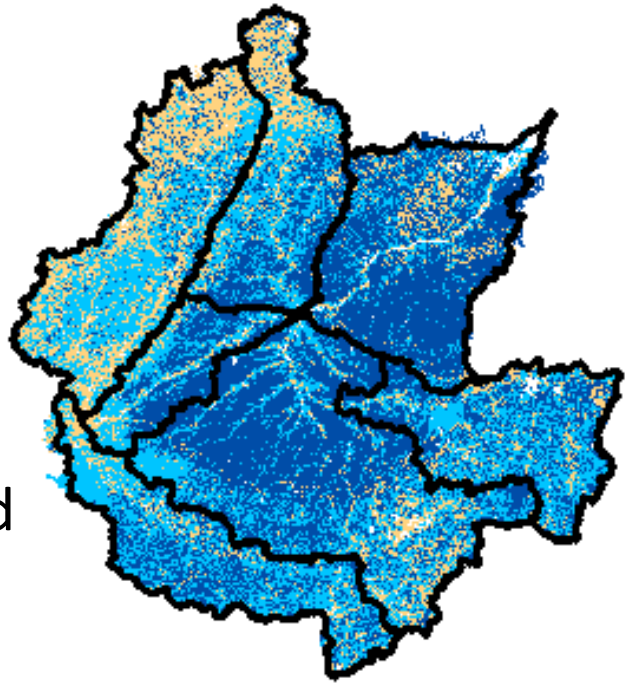
2. Scenarios: *In-stream*

Brainstorming

- Treatments wetlands: where are they suitable? Permanent sink for P? Targeting?
- Two-stage drainage ditches: divergent views from the *most effective practice* to *completely infeasible* (taking adjacent land out of production).




Drainage issues


Wetlands

3. Running stakeholder-driven scenarios

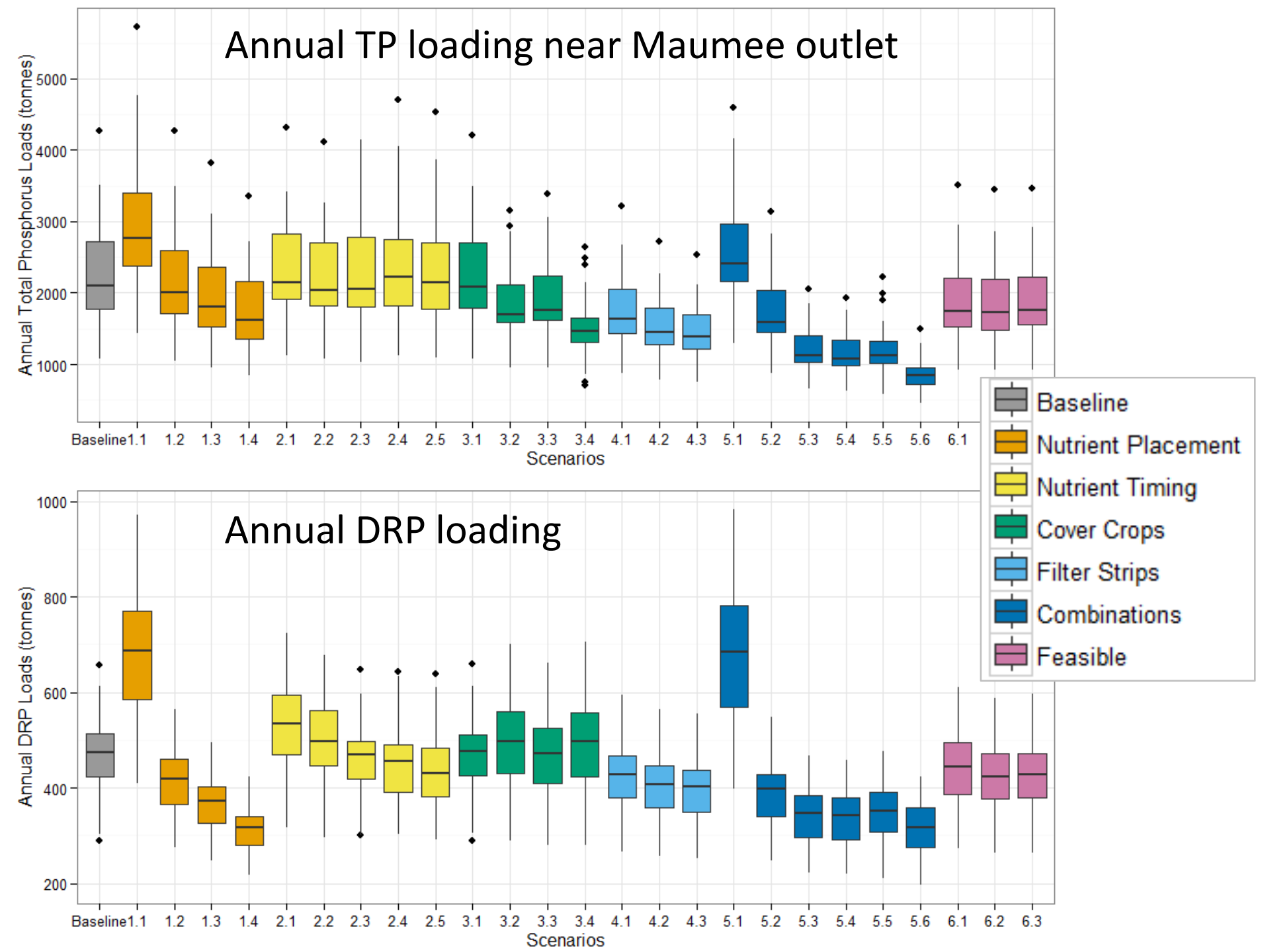
Type	Scenarios
Baseline (calibrated model)	The baseline scenario had a mixture of no-tillage and conventional tillage based on historical management information (CTIC survey). Phosphorus and manure were broadcast and incorporated, and applied at rates consistent with historical data and estimations (Ag Census). Tile drainage was simulated on crop fields with poorly, very poorly, and somewhat poorly drained soils. 2, 3, and 7-year rotations were designed from NASS estimates in recent years, and contained a mixture of corn, soybean, and winter wheat. Other cover crops, filter strips, and additional conservation practices were not included in the baseline model because we lacked access to this data. All scenarios had temperature and precipitation forcing from the 30-year historical station record (1981-2010).
1. Nutrient placement	1.1 Continuous no-tillage with broadcast fertilizer and manure 1.2 Continuous no-tillage with subsurface-applied fertilizer and broadcast manure 1.3 Continuous no-tillage with subsurface-applied fertilizer and manure 1.4 Baseline tillage with subsurface-applied fertilizer and manure
2. Nutrient timing	2.1 Spring phosphorus applications with no fall tillage 2.2 Spring phosphorus applications with baseline fall tillage 2.3 Winter application of manure 2.4 Fall phosphorus applications with no spring tillage 2.5 Fall phosphorus applications with baseline spring tillage

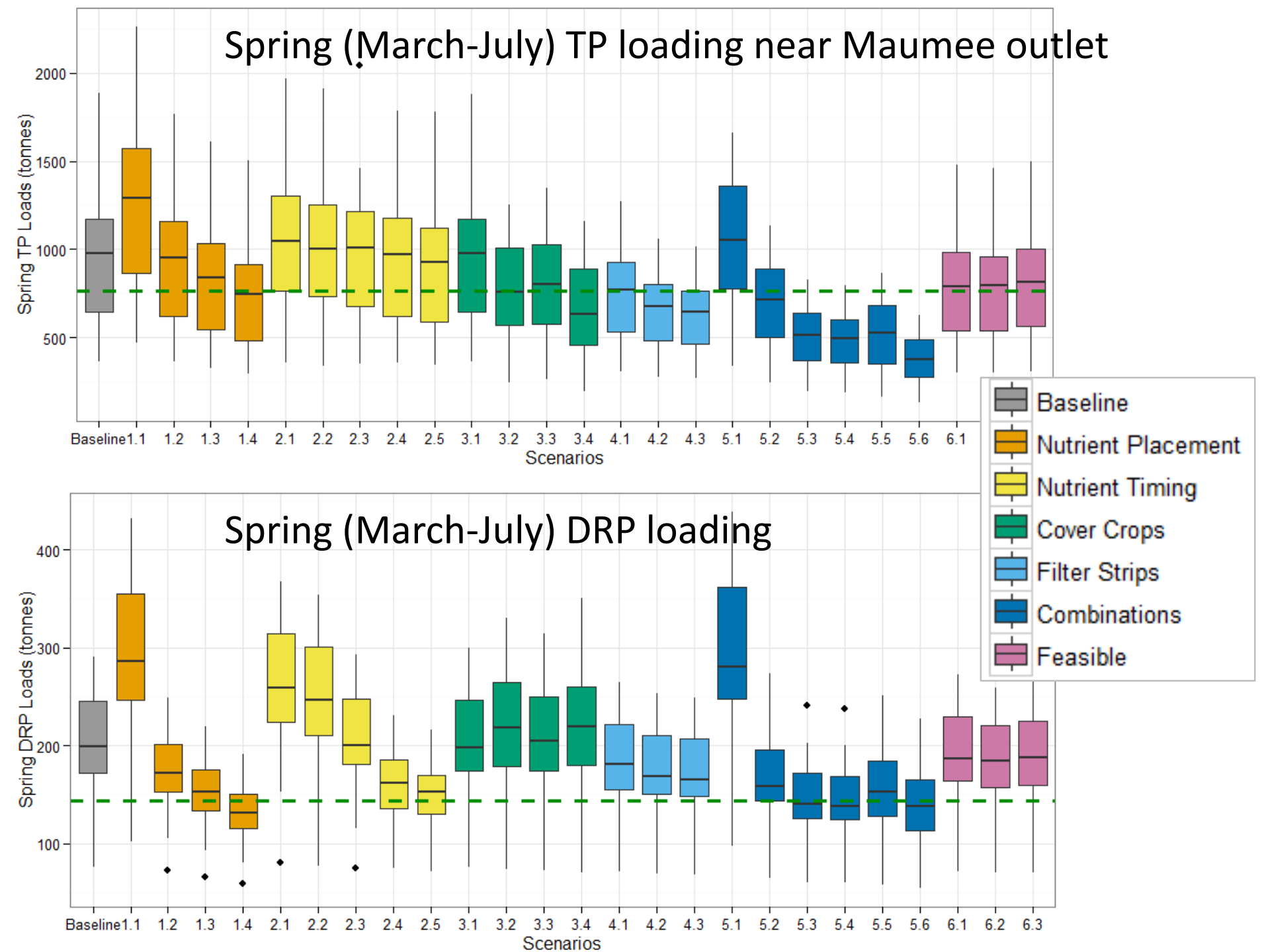
3. Running stakeholder-driven scenarios

Type	Scenarios
3. Cover crops	3.1 Tillage radish after wheat in rotations 3.2 Cereal rye after soybeans and wheat in rotations 3.3 Cereal rye after soybeans and tillage radish after wheat in rotations 3.4 Cereal rye after corn, soybeans, and wheat in rotations
4. Vegetated filter strips	4.1 Application of poor-quality filter strips throughout agricultural lands 4.2 Application of medium-quality filter strips 4.3 Application of high-quality filter strips
5. Systems approach/ Combinations	5.1 Continuous no-tillage with broadcast fertilizer and manure and cereal rye after soybeans and tillage radish after wheat (1.1 + 3.3) 5.2 Continuous no-tillage with subsurface-applied fertilizer and manure and cereal rye after soybeans and tillage radish after wheat (1.3 + 3.3) 5.3 Continuous no-tillage with subsurface-applied fertilizer and manure, cereal rye after soybeans and tillage radish after wheat, and medium-quality filter strips (1.3 + 3.3 + 4.2) 5.4 Continuous no-tillage with subsurface-applied fertilizer and manure, cereal rye after soybeans and tillage radish after wheat, and high-quality filter strips (1.3 + 3.3 + 4.3) 5.5 Baseline tillage with subsurface-applied fertilizer and manure and cereal rye after corn, soybeans, and wheat (1.4 + 3.4) 5.6 Baseline tillage with subsurface-applied fertilizer and manure, cereal rye after corn, soybeans, and wheat, and high-quality filter strips (1.4 + 3.4 + 4.3)

3. Running stakeholder-driven scenarios

Type	Scenarios
6. “Feasible” scenarios	6.1 25% adoption* of continuous no-tillage with subsurface-applied fertilizer and broadcast manure, cereal rye after corn, soybeans, and wheat, and medium-quality filter strips (1.3 + 3.4 + 4.2) 6.2 25% adoption* of subsurface-applied fertilizer and broadcast manure, cereal rye after corn, soybeans, and wheat, and medium-quality filter strips (1.4 + 3.4 + 4.2) 6.3 33% adoption* of subsurface-applied fertilizer and broadcast manure, cereal rye after corn, soybeans, and wheat, and high-quality filter strips (1.4 + 3.4 + 4.3) ** All practices were adopted on the same, randomly-selected farm fields*


Annual TP loading near Maumee outlet
Annual Total Phosphorus Loads (tonnes)
5000
4000
3000
2000
1000
Baseline 1.1 1.2 1.3 1.4 2.1 2.2 2.3 2.4 2.5 3.1 3.2 3.3 3.4 4.1 4.2 4.3 5.1 5.2 5.3 5.4 5.5 5.6 6.1
Scenarios
Annual DRP loading
Annual DRP Loads (tonnes)
1000
800
600
400
200
Baseline 1.1 1.2 1.3 1.4 2.1 2.2 2.3 2.4 2.5 3.1 3.2 3.3 3.4 4.1 4.2 4.3 5.1 5.2 5.3 5.4 5.5 5.6 6.1 6.2 6.3
Scenarios
Baseline
Nutrient Placement
Nutrient Timing
Cover Crops
Filter Strips
Combinations
Feasible


Spring (March-July) TP loading near Maumee outlet
Spring TP Loads (tonnes)
2000
1500
1000
500
Baseline 1.1 1.2 1.3 1.4 2.1 2.2 2.3 2.4 2.5 3.1 3.2 3.3 3.4 4.1 4.2 4.3 5.1 5.2 5.3 5.4 5.5 5.6 6.1
Scenarios
Spring (March-July) DRP loading
Spring DRP Loads (tonnes)
400
300
200
100
Baseline 1.1 1.2 1.3 1.4 2.1 2.2 2.3 2.4 2.5 3.1 3.2 3.3 3.4 4.1 4.2 4.3 5.1 5.2 5.3 5.4 5.5 5.6 6.1 6.2 6.3
Scenarios
Baseline
Nutrient Placement
Nutrient Timing
Cover Crops
Filter Strips
Combinations
Feasible

Main findings: Stakeholder input

Challenges:

- What if suggestions are unreasonable (unattainable)?
- What if stakeholders do not trust the model (or modelers)?
- What if they do not agree on 'the facts' or on priorities?

Benefits:

- Gain critical local knowledge. Good understanding of farming practices and farmer perceptions. When scenario development was productive, it was grounded in reality.
- Two-way learning.
- Potentially greater uptake of results.

Main findings: Modeling

- ***Many BMPs improved water quality as we expected,*** particularly subsurface placement of P.
- ***Some practices were effective that we did not expect,*** such as fall P applications.
- ***Some BMPs were less effective,*** *including no-tillage, spring P applications, and cover crops and filter strips for DRP.*
- ***Subsurface placement of P*** *could achieve as good a result as widespread application of multiple BMPs in combination.*
- ***Feasible scenarios*** *did not do enough to reach DRP target.*