Thinking Outside the Lake: How can management efforts benefit Western Lake Erie and its tributaries?

Scott Sowa, Conor Keitzer, Stu Ludsin, Anthony Sasson, Maura O’Brien, Carrie Volmer-Sanders, Matt Herbert, Gust Annis, August Froelich, Jeff Arnold, Mike White, Haw Yen, Prasad Daggaputi, Chris Winslow, Jay Atwood, Mari Vaughn-Johnson, Charlie Rewa, and Dale Robertson

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HABs 2016, Toledo, OH
A True Collaborative Effort

Funding made possible through USDA NRCS CEAP-Wildlife
Western Lake Erie Gets All the Attention, but…

Western Lake Erie

Algal Blooms a Growing Problem

"Until we reduce phosphorus and address harmful algal blooms, I’m afraid it’s going to come on the taxpayers’ backs.”

- Adam Bowes
  Ohio Envrionment

Smaller harmful algae bloom predicted for Lake Erie

Late Summer Brings Renewed Worries About Algae

Commonplace in Lake Erie in the 1960s, toxic algal blooms disappeared from the lake following international, national and state efforts to reduce the phosphorus pollution that drives them. The federal Clean

Fishable?

Aquatic Life Use Index Scores Watershed Assessment Units
Ohio 2014 Integrated Report

Swimmable?

Recreation Use Index Scores Watershed Assessment Units
Ohio 2014 Integrated Report

Arteries of the Lake

Closer to Source and Solution

Wetland Restorations

FILTER STRIPS

GRASS WATERSHEDS

WATERFRONTS

HABITAT RESTORATION
Core Questions
Addressed by Our Project

1. What is the current baseline *stream health* across the WLEB?

2. What water quality parameters are likely limiting the *stream* fish community?

3. How will *stream health* improve with additional investment in AG nps conservation practices?

4. How much investment is needed to achieve the WLE 40% total phosphorus load reduction target?

5. If we meet this 40% target will we also restore *stream health*?
General Modeling Methods with Key Data Inputs and Model Outputs

Current Fish Health

Healthy fish community

Degraded fish community

Potential Future Fish Health

Current Water Quality

Empirical Model

SWAT Model

Management Scenarios

Fish Samples
Response Variables

Water quality and flow

- Total nitrogen
- Total phosphorus
- Suspended sediments
- Stream discharge

Biological measures

- Relative abundance of top predators
  - Often the first to decline
  - Important ecologically and recreationally

- Index of biotic integrity (IBI)
  - Widely adopted and accepted
  - Reflects overall fish community health
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SWAT Modeling Development

- Completed by SWAT modeling team at Grassland Soil and Water Research Lab in Temple, TX


SWAT Model Development

- Model calibrated (1990-1999) and validated (2000-2006)
- For TP, TN, Susp. Sed., and Q at five gauges
- Then we downscaled the predictions
SWAT Model Outputs

- Downscaled SWAT model to provide water quality and flow predictions at...

**HUC12 scale**
391 subwatersheds
Average size = 72 km$^2$
13,156 HRUs

**NHD+ scale**
11,335 subwatersheds
Average size = 2.61 km$^2$
34,807 HRUs
• Concentrations particularly high in southern portion of watershed
• ~53% of watershed is above WQ thresholds for all three stressors in the spring
• ~34% in the summer
Result Highlights

• Many streams in the WLEB have high pollutant concentrations that are likely degrading stream health

• Managing for multiple stressors (N, P, Sed) is vital because they often co-occur and focusing management actions on one could make things worse for another

• A suite of conservation practices including erosion control and nutrient management are needed

• These practices will need to be implemented on essentially all agricultural lands to have meaningful improvements in stream health across much of the WLEB

• Results suggest the TP 40% reduction target for Lake Erie is achievable, but at a significant cost

• Even if we meet this 40% target many WLEB streams will likely still be impaired by nonpoint source pollution
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Biological Models of Stressor-Response Relationships

- Used existing fish community data - 1990 to 2012
  - IDEM = 18
  - MIDEQ = 101
  - OEPA = 722

n = 841
Biological Models of Stressor-Response Relationships

Used quantile regression to identify ceilings in stressor-response relationships.

General procedure for developing robust predictive biological models

• Developed candidate set of quantile regression models

\[ y = \text{Discharge} + TP + \text{Suspect Sediment} + TP \times \text{Suspect Sediment} \]

\[ y = \text{Discharge} + TN + \text{Suspect Sediment} + TN \times \text{Suspect Sediment} \]

\[ \tau = 0.97 \]

• Used model selection to identify best model

• k-fold cross validation (k = 10) to assess model accuracy

• Used validated models to then forecast potential biological conditions
Relative abundance of piscivorous species

\[ \tau = 0.97 \]
Multiple stressors are affecting stream biological conditions.
Baseline stream health

IBI

Top predators

- Poor
- Fair
- Good
- No data
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Conservation Practices

Agricultural Conservation Practices

- Residue mgmt. tillage (329)
- Cover crop (340),
- Wind break (380)
- Field border (386)
- Riparian herbaceous buffer (391)
- Riparian forest buffer (392)
- Filter strip (393)
- Surface roughening (609)
- Nutrient management (590)

Covers all desired practices, except wetlands and drainage water management
### WLE Management Scenarios

**Annual incentive payment and program cost estimates**

**In Millions**

<table>
<thead>
<tr>
<th></th>
<th>Critical (~5%)</th>
<th>Critical &amp; Mod (~50%)</th>
<th>All (100%)</th>
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</thead>
<tbody>
<tr>
<td>Erosion Control</td>
<td>$5</td>
<td>$56</td>
<td>$128</td>
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<tr>
<td>Erosion Control &amp; Nutrient Mgmt.</td>
<td>$8</td>
<td>$150</td>
<td>$263</td>
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</tbody>
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**Map and Diagram**

- **Map**: Shows the geographical distribution of management scenarios.
- **Diagram**: Illustrates 4R Nutrient Stewardship and its benefits.

**4R Nutrient Stewardship**

- **Source**: The 4Rs work to increase production/profitability for farmers while ensuring the future of the agricultural industry.

**4Rs**

- **Right Source**: Optimal nutrient source.
- **Right Rate**: Appropriate nutrient application rate.
- **Right Time**: Strategic application timing.
- **Right Place**: Targeted nutrient placement.

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*Images and diagrams are not described in detail, focusing on the textual content.*
WLE Improvements in Stream Health (IBI)

Percentage of the watershed

Baseline | Critical | Crit. & Mod. | All

Poor

- EC

Fair

- Baseline
- Critical
- Crit. & Mod.
- All

Good

- Baseline
- Critical
- Crit. & Mod.
- All
WLE Improvements in Stream Health (Top Predators)

<table>
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<td><strong>EC</strong></td>
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**Farm acre types treated**

- Baseline
- Critical
- Crit. & Mod.
- All
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Estimating Costs to Achieve 40% TP Reduction Goal for WLE and What it Means for Streams

Spring/early summer TP loading (metric tons)

- Baseline
  - ($8)
- Critical
  - ($149)
- Crit. & Mod.
  - ($263)
- All

40% TP Reduction Goal

Erosion Control & Nutrient Mgmt.

- 5,912 km
- 4,130 km
- 3,263 km

Total stream miles in Poor Condition
Result Highlights

- Many streams in the WLEB have high pollutant concentrations that are likely degrading stream health.
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- A suite of conservation practices including erosion control and nutrient management are needed.
- These practices will need to be implemented on essentially all agricultural lands to have meaningful improvements in stream health across much of the WLEB.
- Results suggest the TP 40% reduction target for Lake Erie is achievable, but at a significant cost.
- Even if we meet this 40% target many WLEB streams will likely still be impaired by nonpoint source pollution.
Summary

- Must address multiple water quality factors for streams
- Must use a combination of erosion control and nutrient management practices
- 40% reduction goal for TP appears achievable
- Reaching this 40% goal for WLE will not address all issues for streams
- Can’t forget about the streams, must find win-wins

Outputs from our Project Can Help Identify Win-Wins
Report and Publications

• Final Report and project summary are available
  – http://lakeerieceap.com/

• Special issue of JGLR focused on science and strategies to address agricultural non-point source pollution

• Should be issued in December: Keitzer et al in press