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

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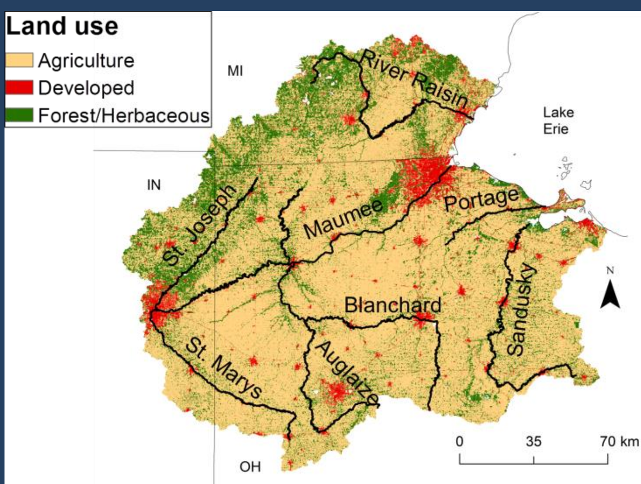
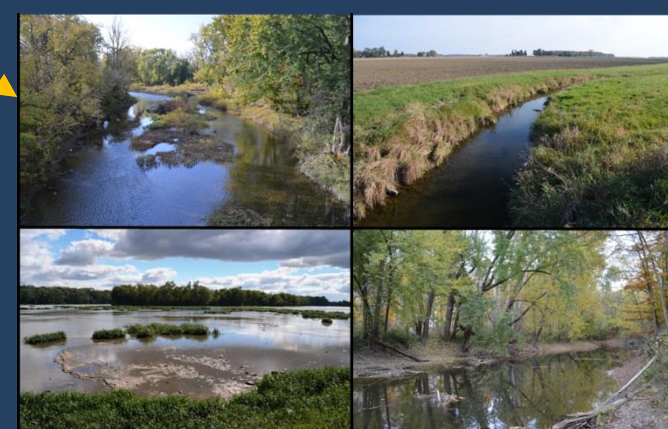
Scott Sowa, Conor Keitzer, Stu Ludsin, Anthony Sasson, Maura O'Brien, Carrie Volmer-Sanders, Matt Herbert, Gust Annis, August Froelich, Jeff Arnold, Mike White, Haw Yen, Prasad Daggaputi, Chris Winslow, Jay Atwood, Mari Vaughn-Johnson, Charlie Rewa, and Dale Robertson



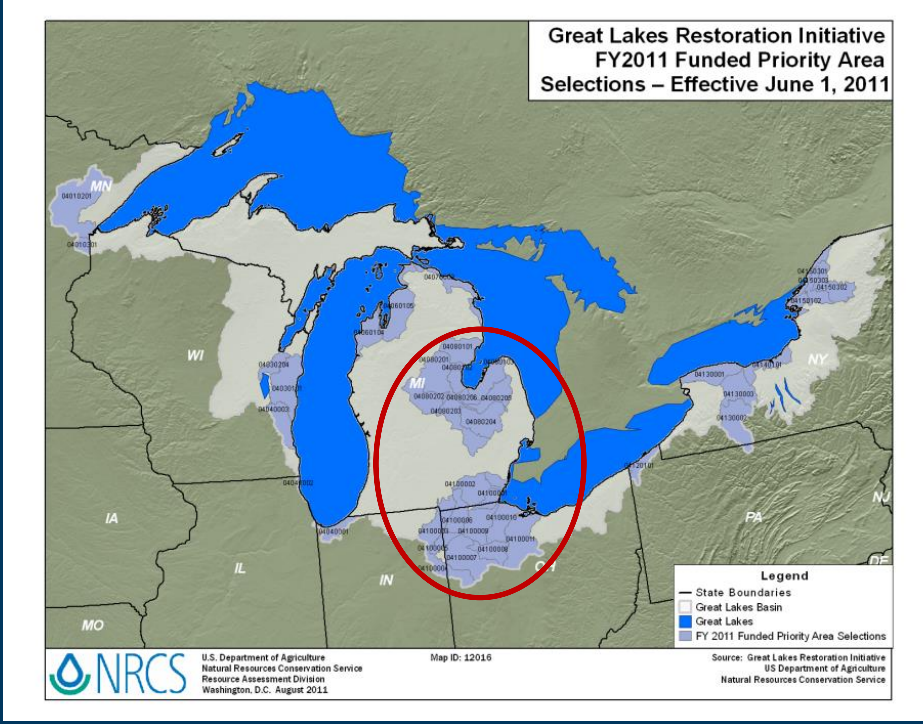


March 3rd
MI SWCS Seminar, East Lansing, MI

Overview

- Focus on Western Lake Erie (WLE) Wildlife CEAP
- Begin with some context
- End with some examples of potential applications from Saginaw Bay

Saginaw Bay and WLE Wildlife CEAP Projects

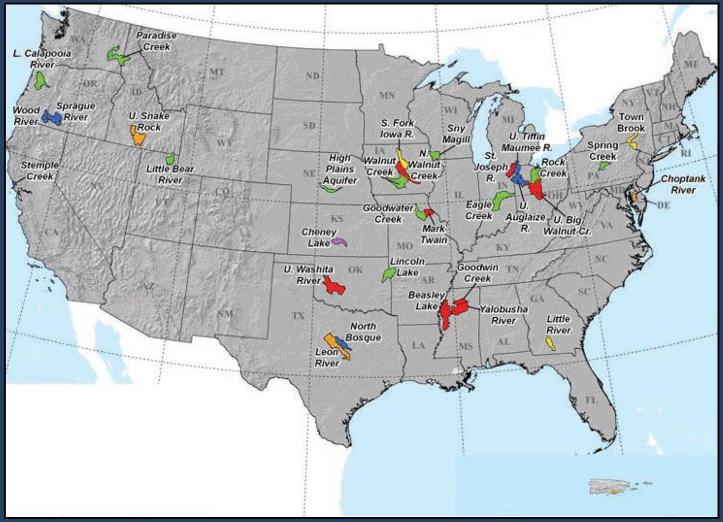


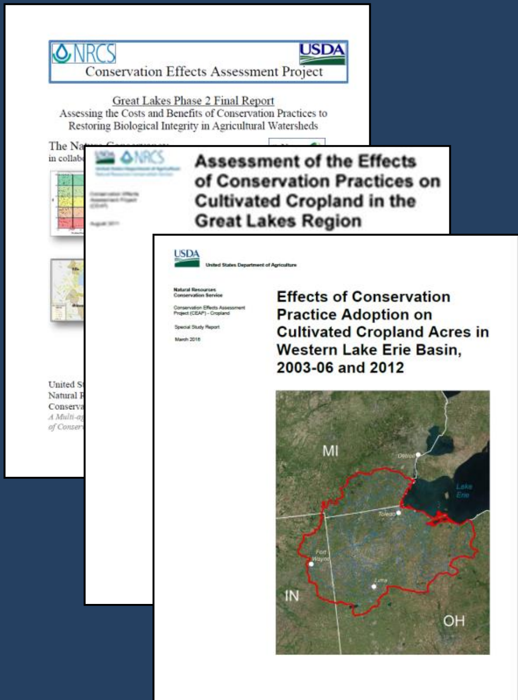
Overview of USDA NRCS CEAP

- **Goal**: improve efficacy of conservation practices and programs by providing the science and education needed to enrich conservation planning, implementation, management decisions, and policy

- Providing valuable information to managers and policy makers through multiple complementary components

- Components
  - Watershed
  - Cropland
  - Wildlife
  - Wetland
  - Grazing Lands





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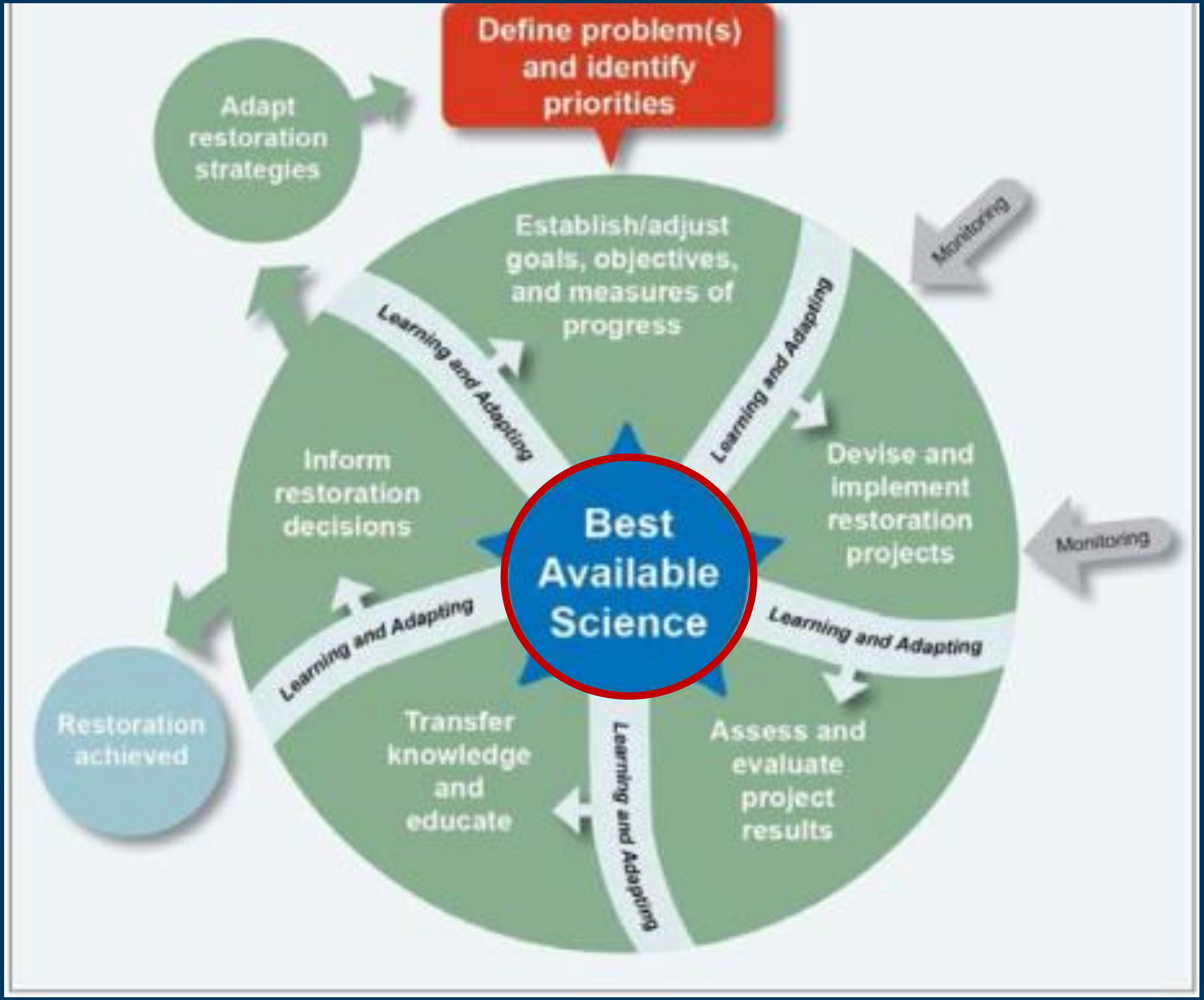
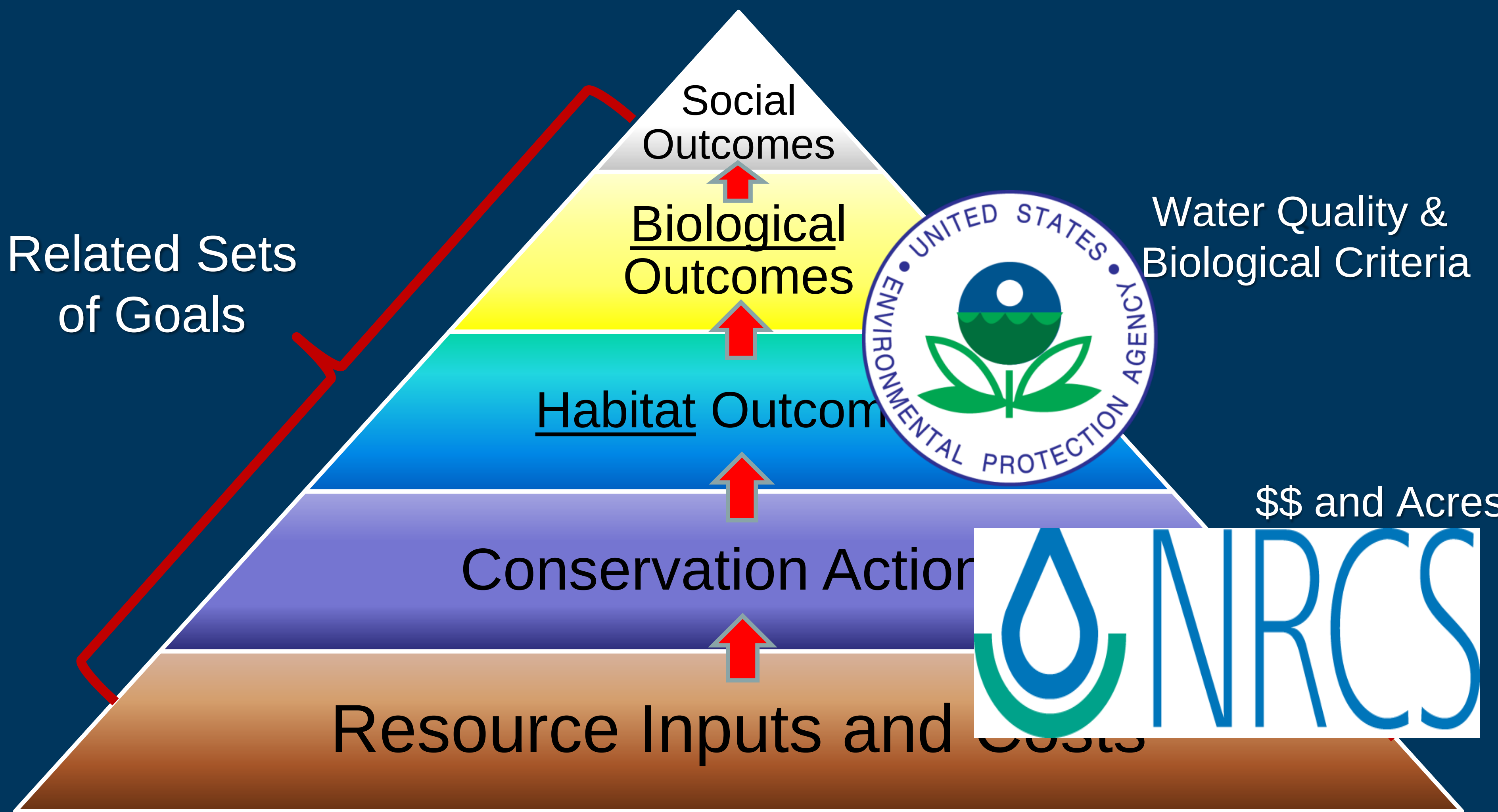
Fundamental Questions We Are Trying to Answer



Relating Conservation Actions to Desired Outcomes



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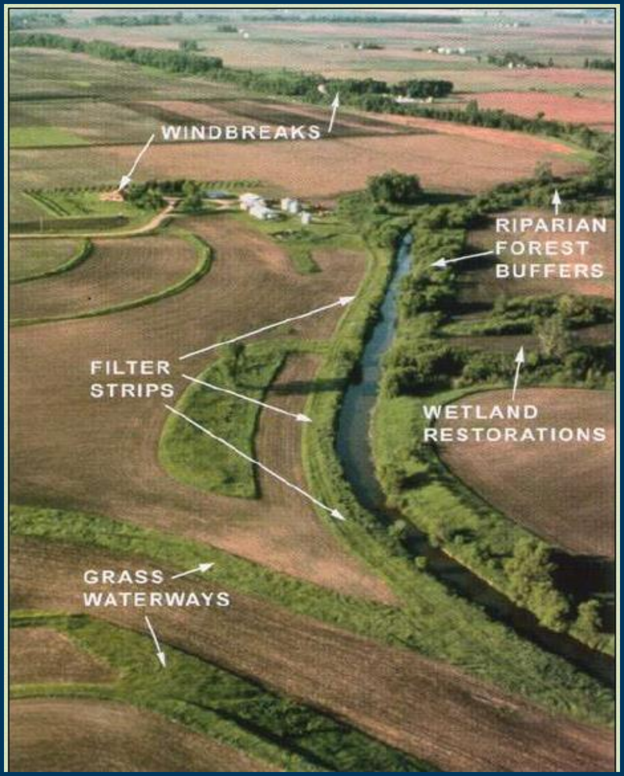
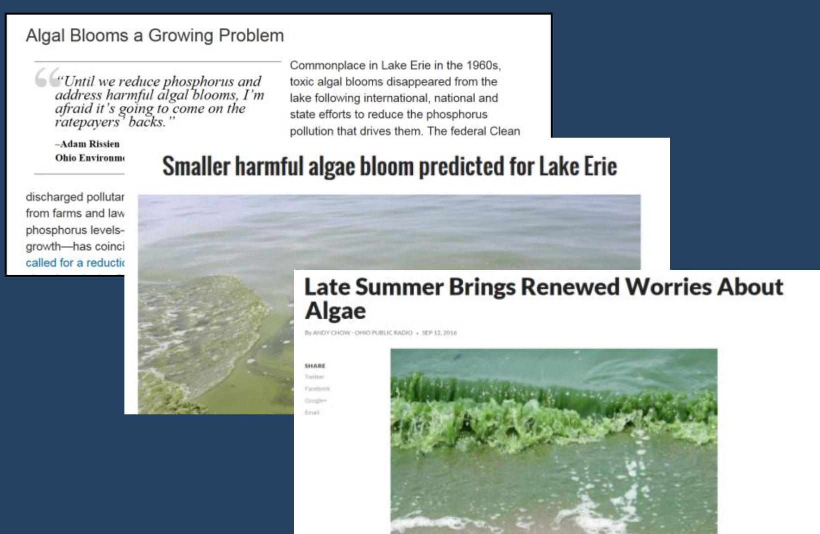
Science to Inform Strategic Conservation

Getting the right conservation practices to the right places, in the right amount, at the right time, as efficiently as possible, to achieve desired ecological & socioeconomic outcomes.



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 ratepayers' backs."

–Adam Rissien
Ohio Environm

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

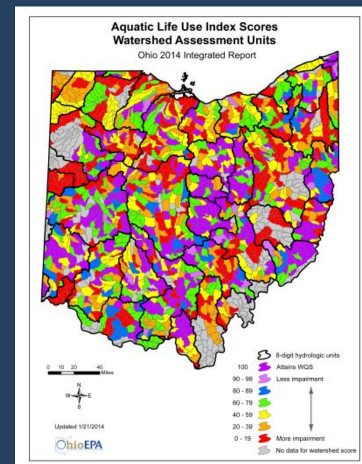
discharged pollutar
from farms and law
phosphorus levels-
growth—has coinci
called for a reductio

Smaller harmful algae bloom predicted for Lake Erie

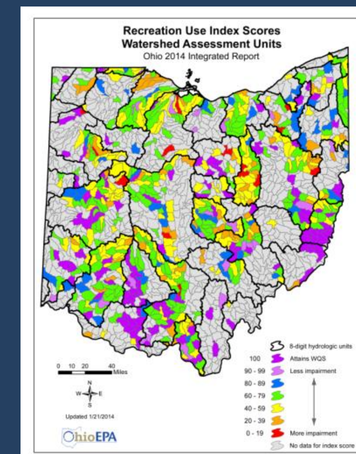
Late Summer Brings Renewed Worries About Algae

Tributaries

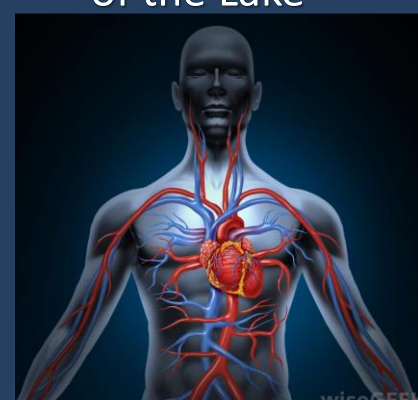
Fishable?



Swimmable?



Arteries of the Lake



Closer to Source and Solution

Specific 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?
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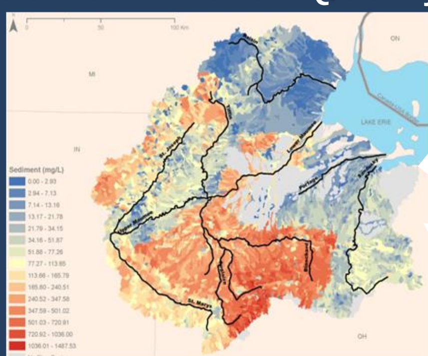
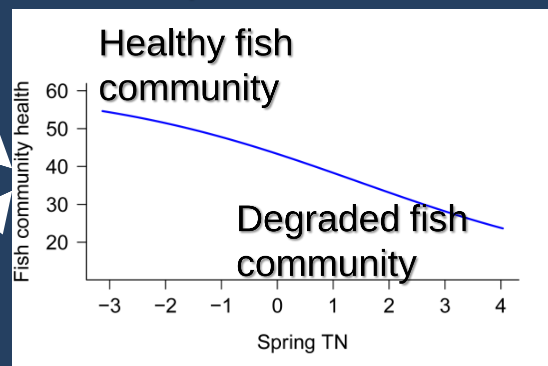
General Modeling Methods with Key Data Inputs and Model Outputs

Fish Samples

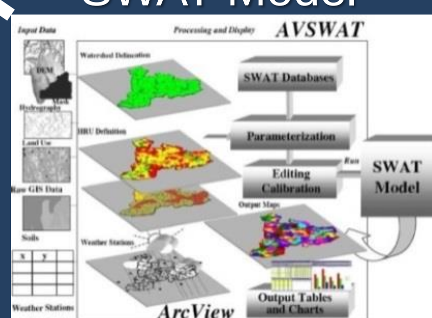
Current Water Quality



Empirical Model

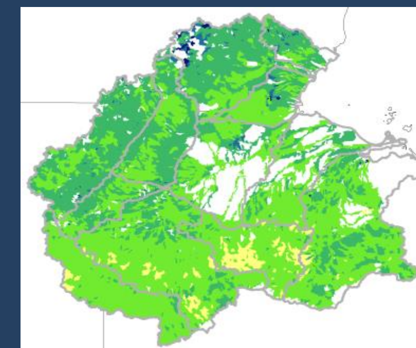


SWAT Model



Management Scenarios

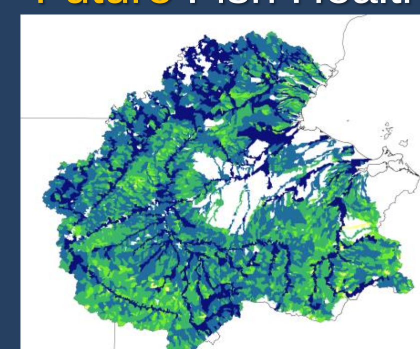
Current Fish Health



Degraded fish community

Healthy fish community

Potential Future Fish Health

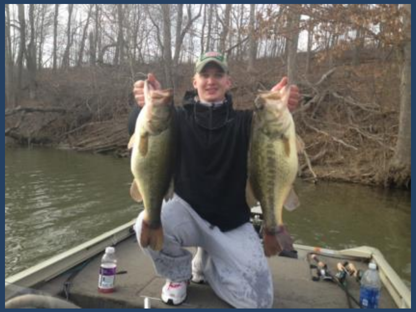


Response Variables

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

Specific Questions Addressed by Our Project

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SWAT Modeling Development

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

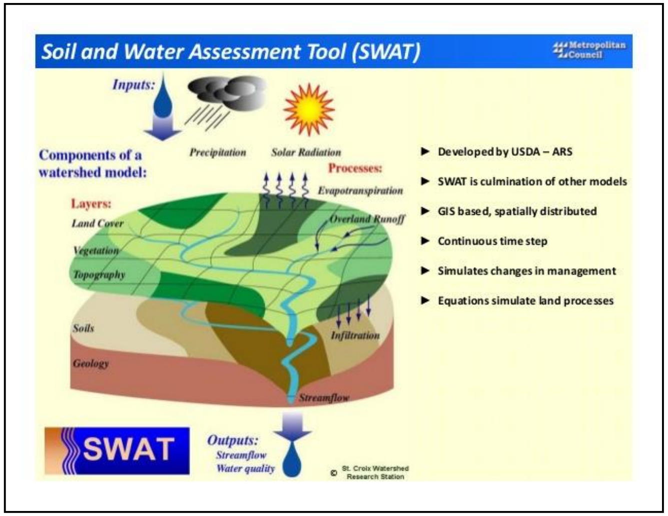
Yen, H., R. T. Bailey, M. Arabi, M. Ahmadi, M. J. White, and J. G. Arnold. **2014**. The Role of Interior Watershed Processes in Improving Parameter Estimation and Performance of Watershed Models. Journal of Environmental Quality, published online. doi:10.2134/jeq2013.03.0110

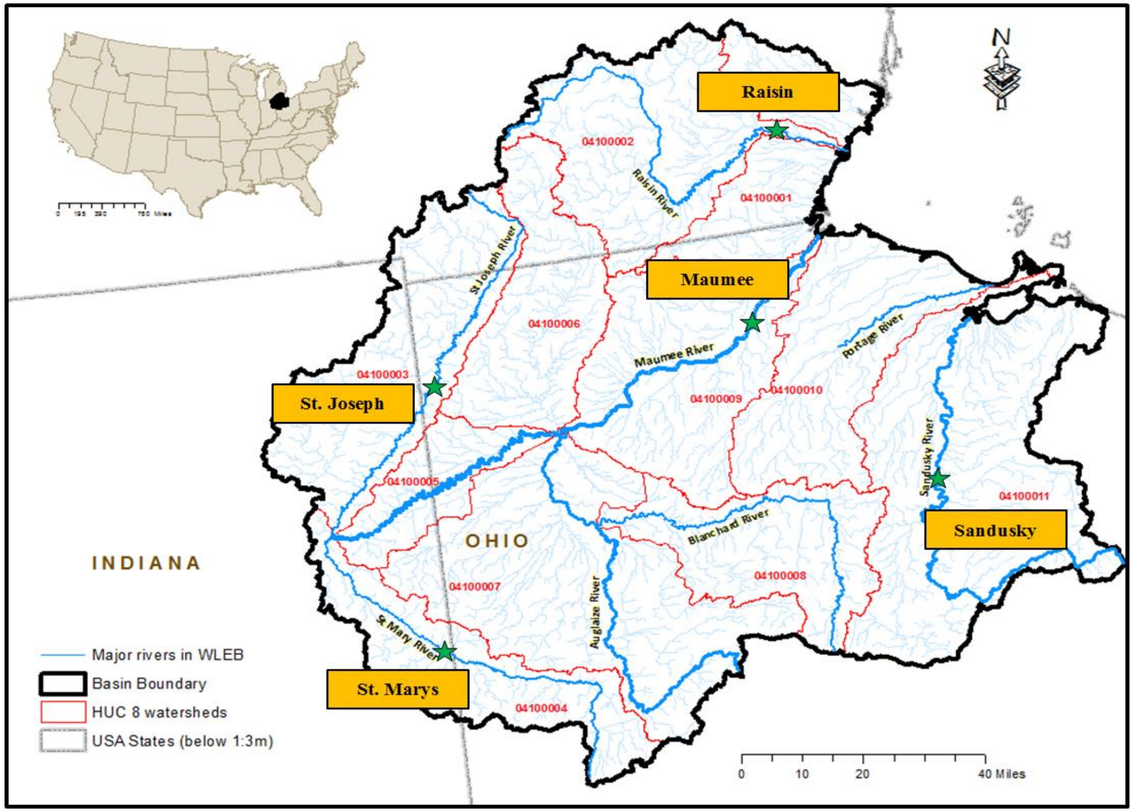
Daggupati, P., H. Yen, M. White, R. Srinivasan, J. Arnold, S. C. Keitzer, and S. Sowa. **2015.** Impact of model development, calibration and validation decisions on hydrological simulations in West Lake Erie basin. Hydrological Processes 29: 5307-5320.

Yen, H., M. J. White, S. C. Keitzer, P. Daggupati, J. G. Arnold, J. D. Atwood, M. E. Herbert, M. Johnson, S. A. Ludsin, R. Srinivasan, S. P. Sowa, and D. M. Robertson. **2016.** Soft-Data-Constrained, NHDPlus Resolution Watershed Modeling and exploration of applicable conservation scenarios. Sci. Total Env. 569-570: 1265-1281.

SWAT Model Development

- Model calibrated (1990-1999) and validated (2000-2006)
- For TP, TN, Susp. Sed., and Q at five gauges
- Models were then downscaled





SWAT Model Outputs

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

HUC12 scale

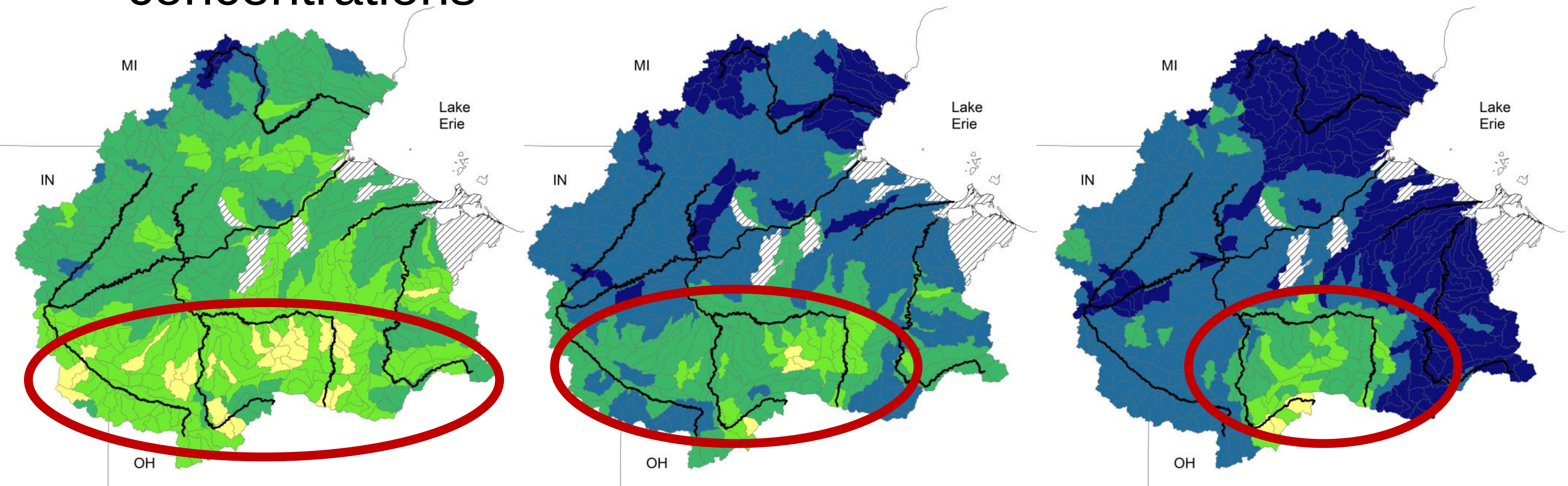
391 subwatersheds
Average size = 72 km^2
13,156 HRUs

NHD+ scale

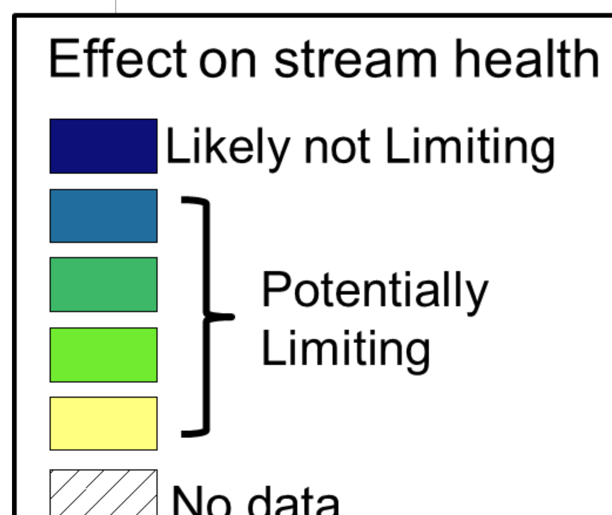
11,335 subwatersheds
Average size = 2.61 km^2
34,807 HRUs

Estimated Baseline Conditions

TN concentrations | TP concentrations | Sus.sediment concentrations



- 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
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- Results suggest the TP 40% reduction target for Lake Erie is achievable, but at a significant cost
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Specific Questions Addressed by Our Project

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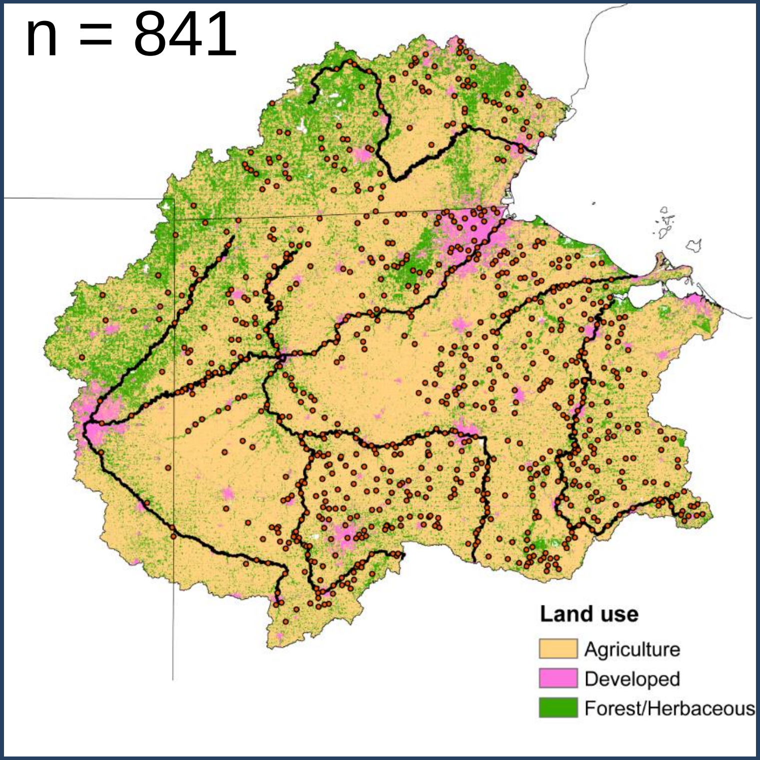
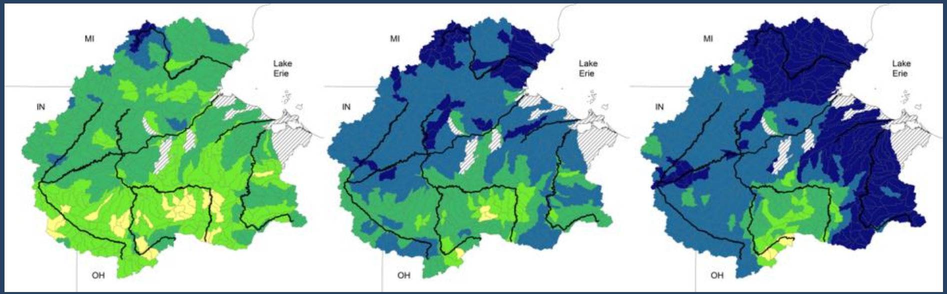
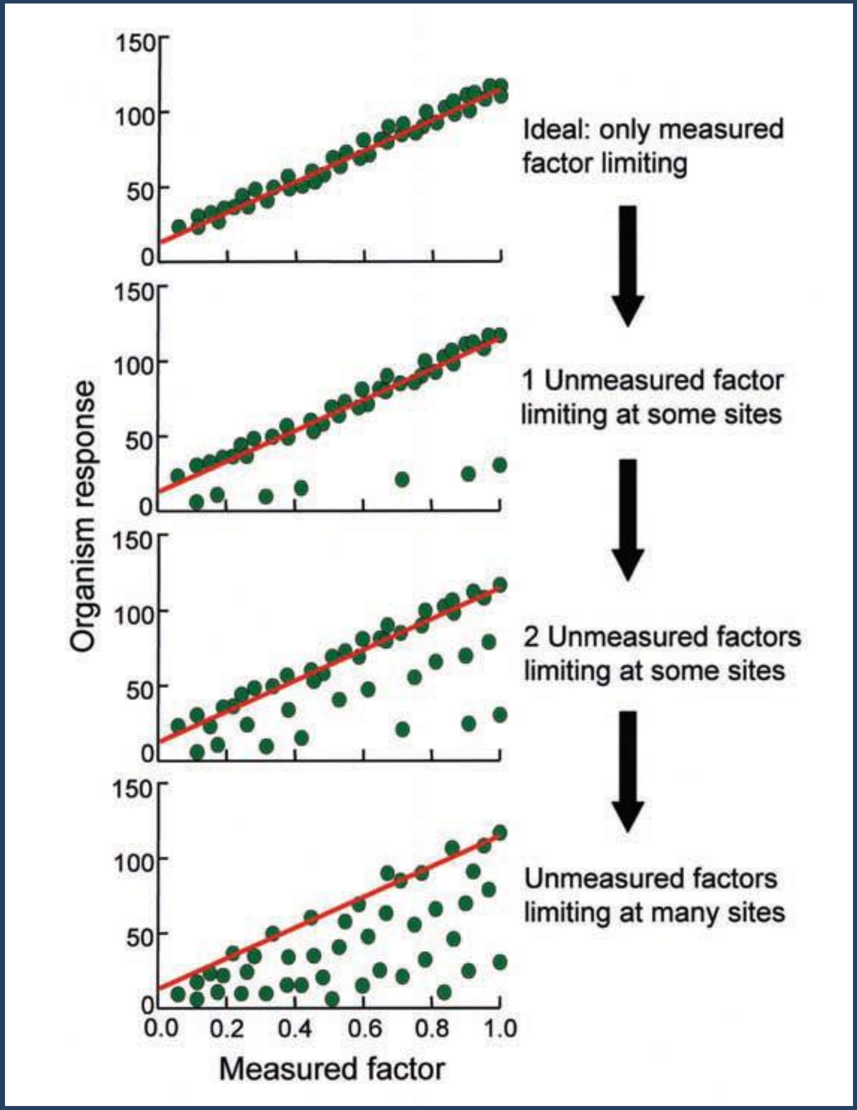
Biological Models of Stressor-Response Relationships

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

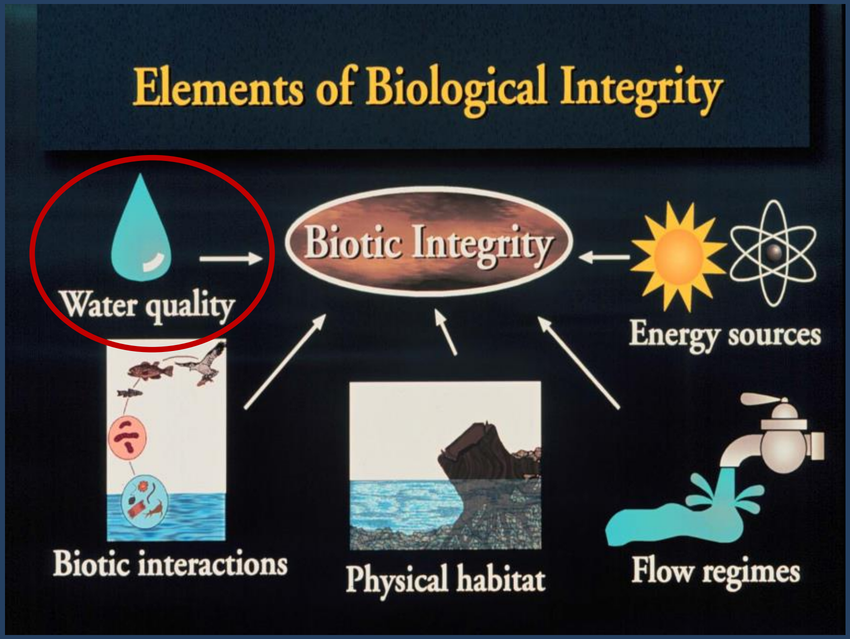




Biological Models of Stressor-Response Relationships



Used quantile regression to identify ceilings in stressor-response relationships



Cade and Noon, 2003, Frontiers in Ecology and the Environment 1:412-420

General procedure for developing robust predictive biological models

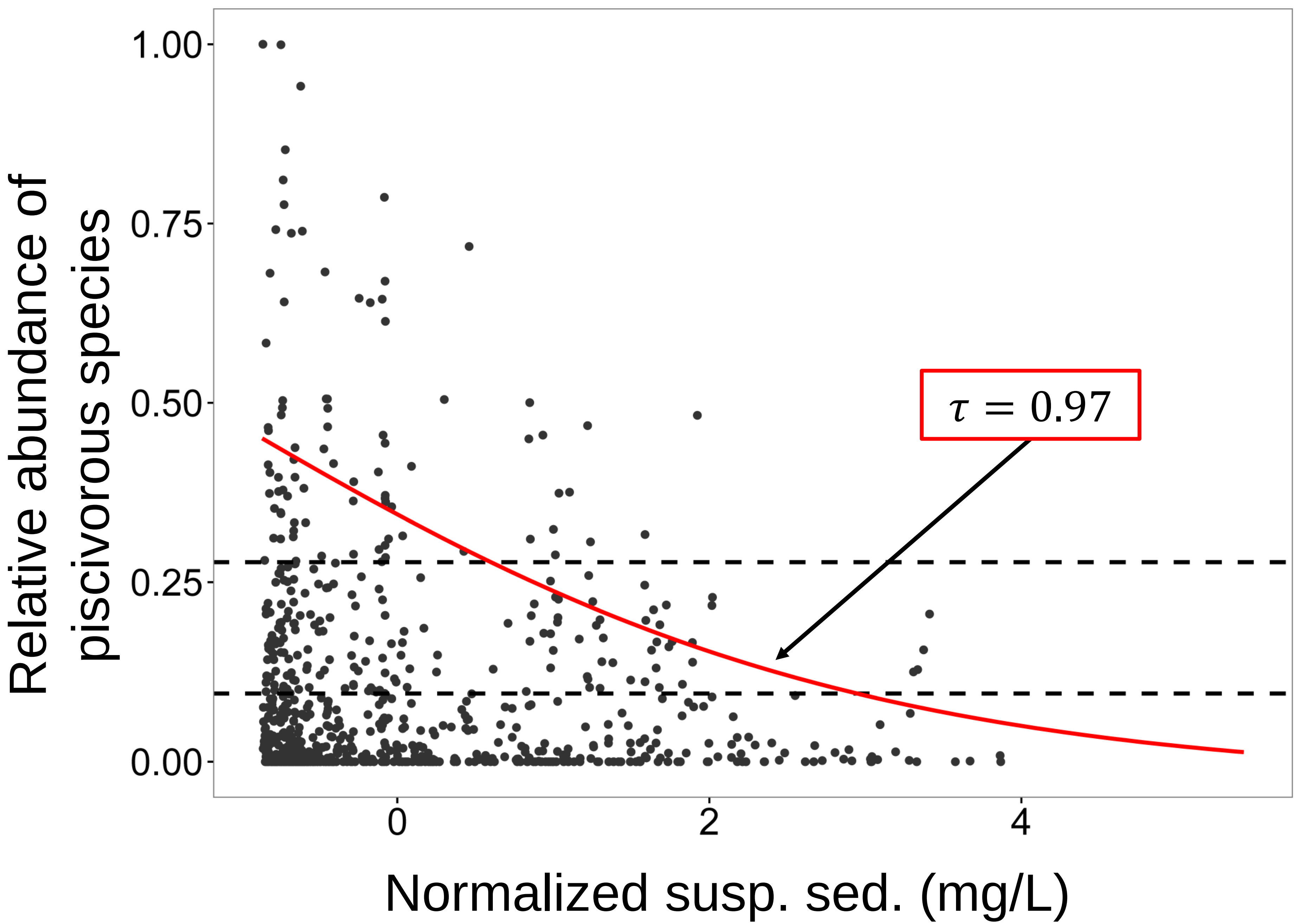
- Developed candidate set of quantile regression models

$$y = Discharge + TP + Susp.Sed. + TP\ x\ Susp.Sed.$$

$$y = Discharge + TN + Susp.Sed. + TNx\ Susp.Sed.$$

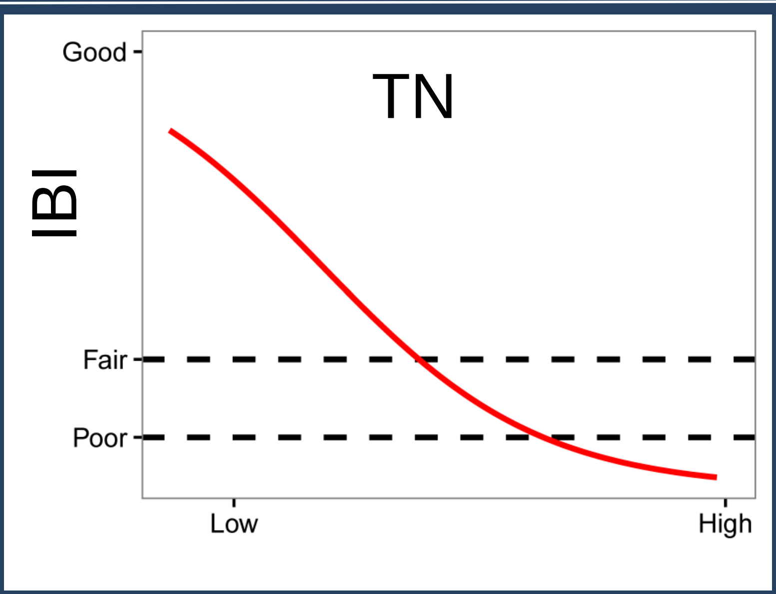
$$\tau = 0.97$$

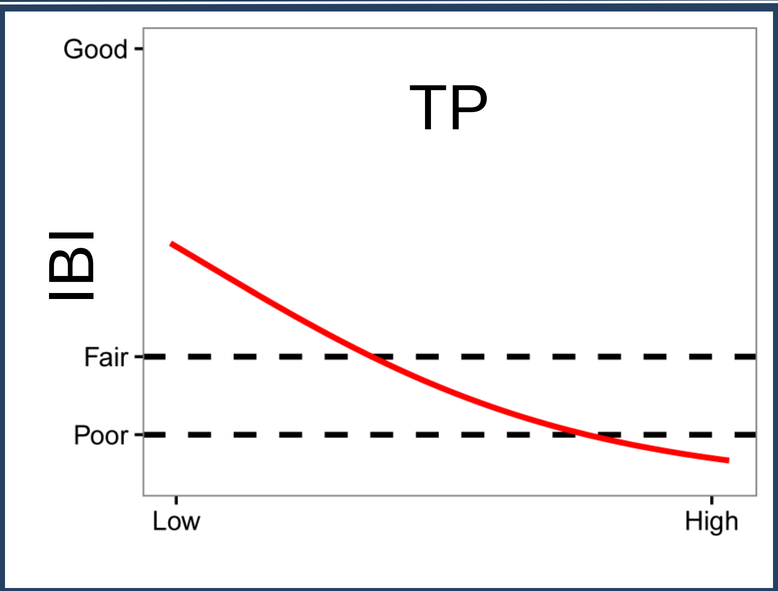
- Used model selection to identify best model
- k-fold cross validation (k = 10) to assess model accuracy
- Used validated models to then forecast potential biological conditions

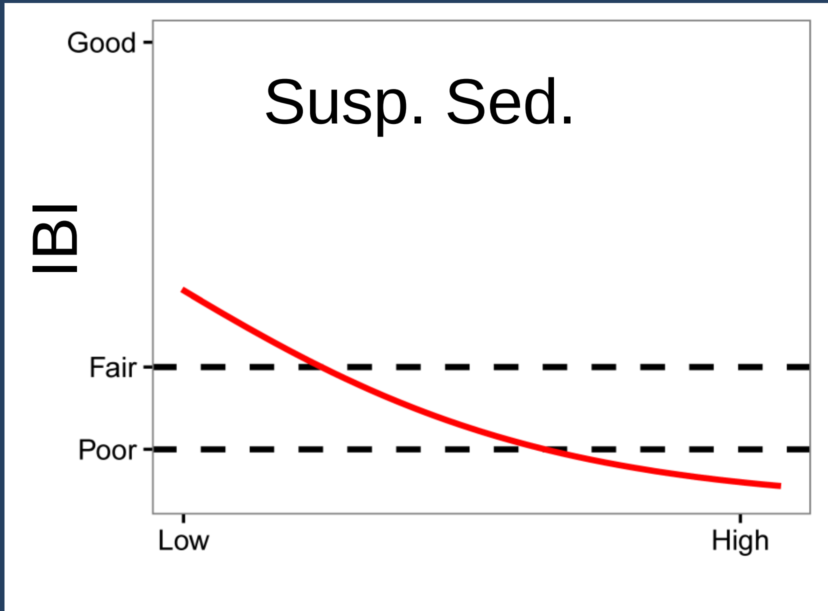


Relative abundance of piscivorous species
1.00
0.75
0.50
0.25
0.00
0
2
4
Normalized susp. sed. (mg/L)
$\tau = 0.97$

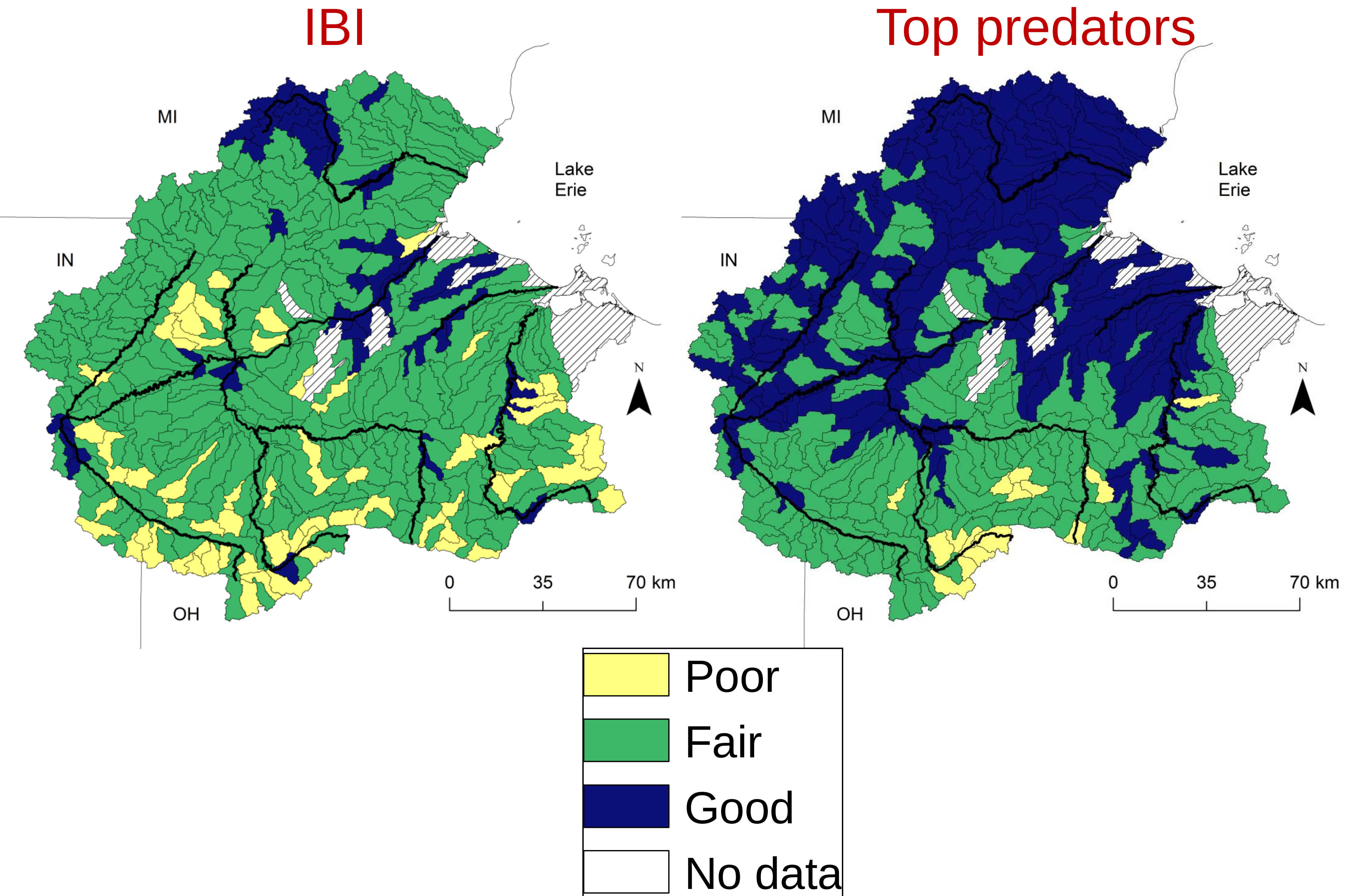
Multiple stressors are affecting stream biological conditions







Baseline stream health



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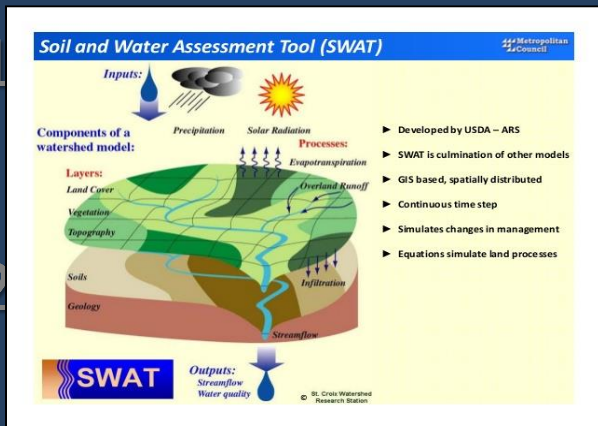

APEX
Agricultural Policy Environmental eXtender model

1. ...nt bas... ...ss

2. ...ty par... ...g ...ommu...

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

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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)

Erosion Control Practices

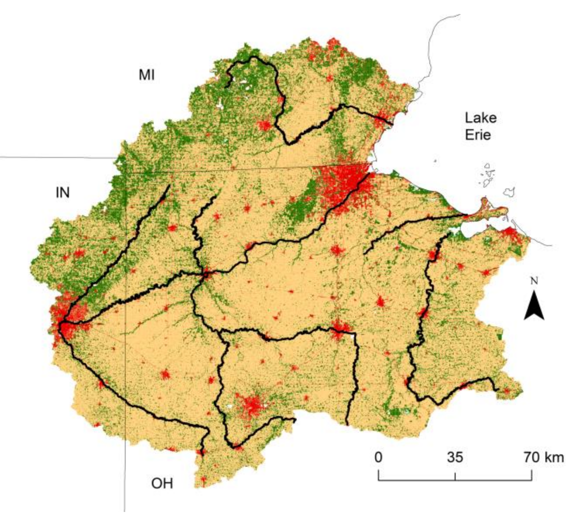
- Nutrient management (590)

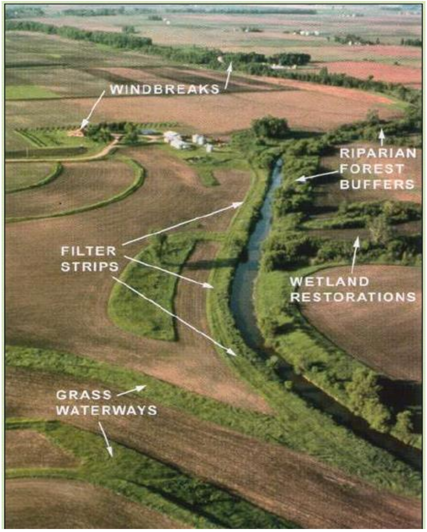
Covers all desired practices, except wetlands and drainage water management

WLE Management Scenarios

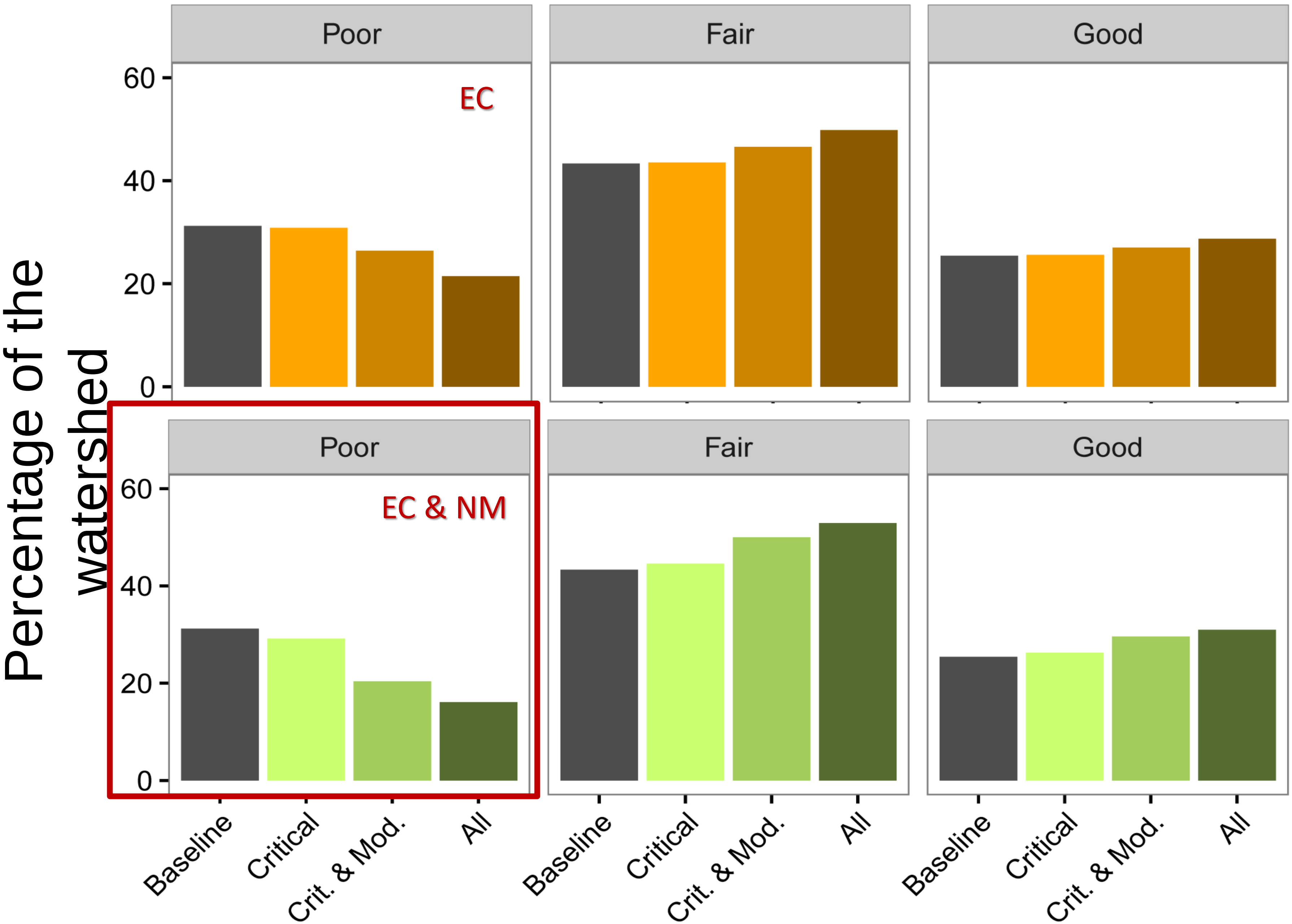
Annual incentive payment and program cost estimates
In Millions

	Critical (~5%)	Critical & Mod (~50%)	All (100%)
Erosion Control	$5	$56	$128
Erosion Control & Nutrient Mgmt.	$8	$150	$263

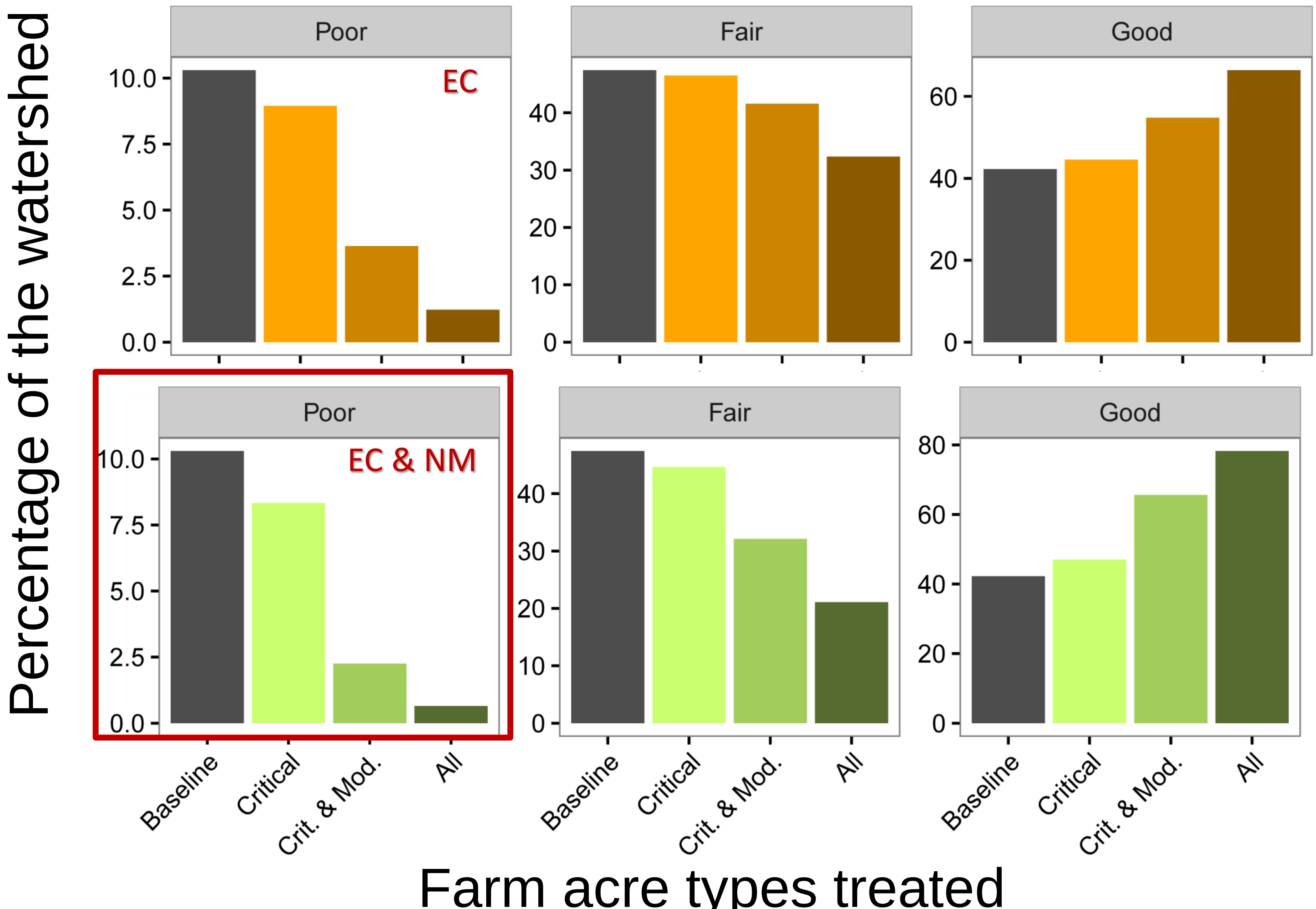




WLE Improvements in Stream Health (IBI)



WLE Improvements in Stream Health (Top Predators)



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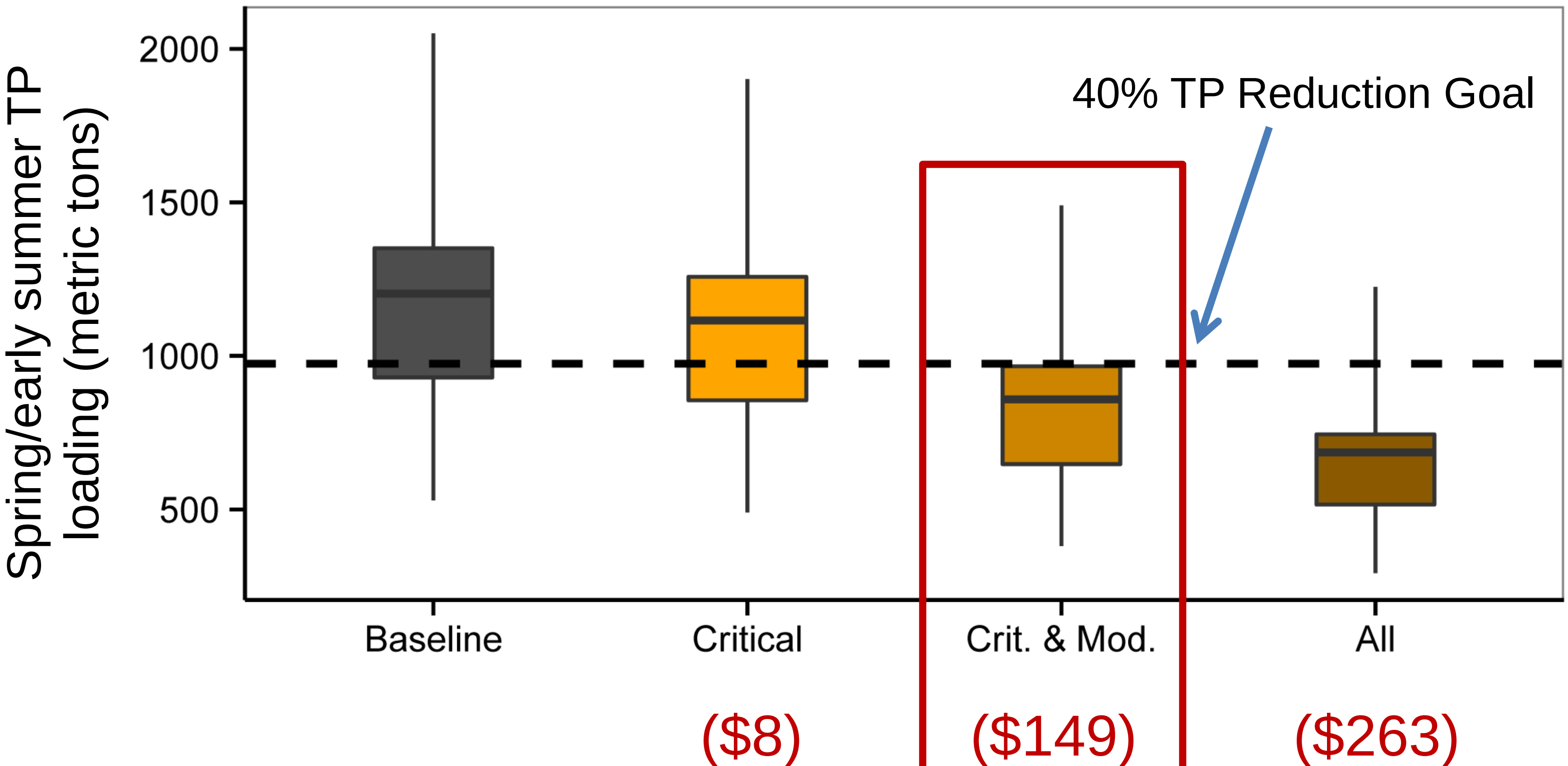
Estimating Costs to Achieve 40% TP Reduction Goal for WLE and What it Means for Streams



Erosion Control & Nutrient Mgmt.	5,912 km	4,130 km	3,263 km
Total stream miles in Poor Condition			

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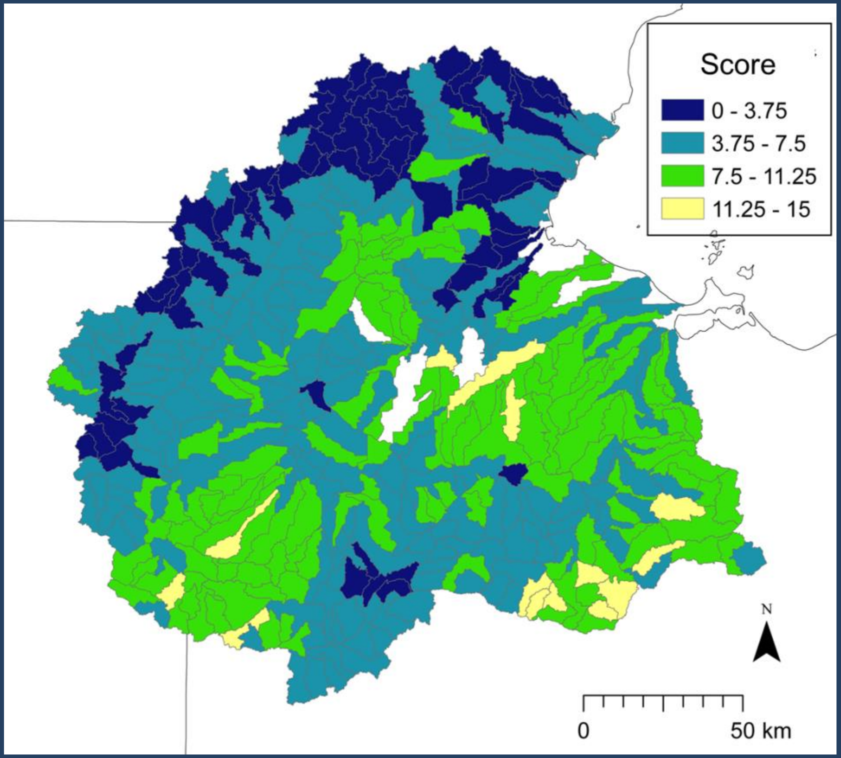
Summary

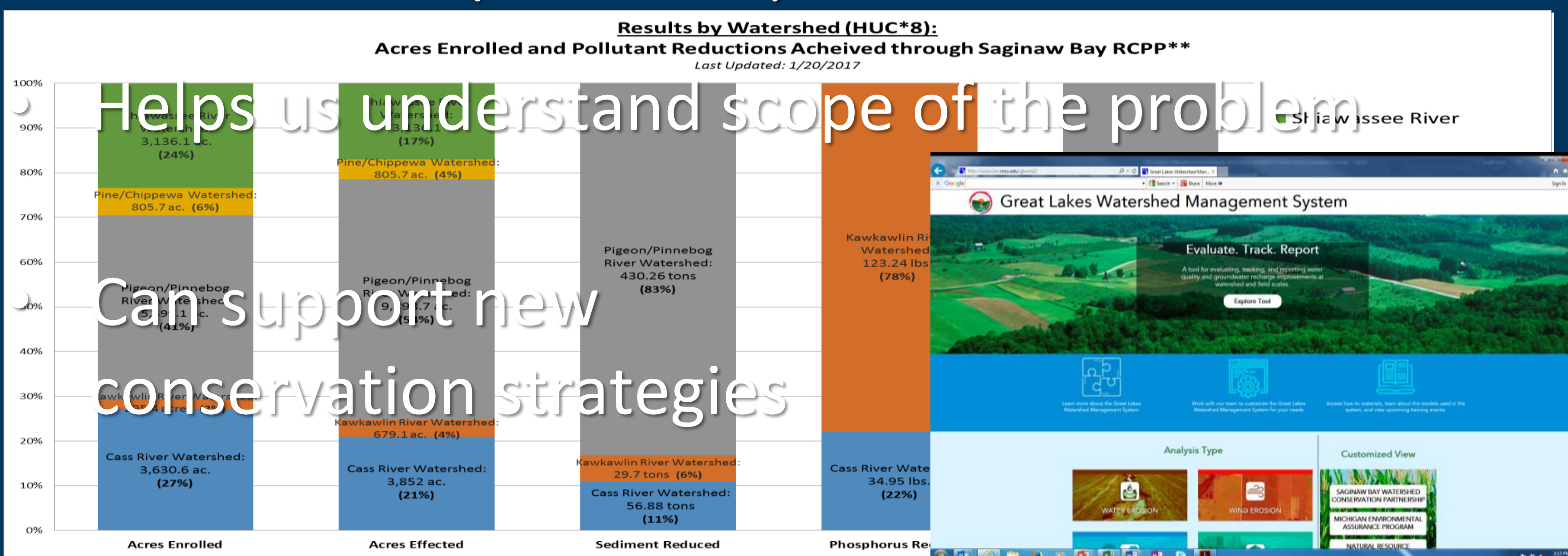
- Must address multiple water quality factors for streams
- Must use a combination of erosion control and nutrient management practices
- 40% reduction goal for TP appears achievable
- Reaching this 40% goal for WLE will not address all issues for streams
- Can't forget about the streams, must find win-wins

Outputs from our Project Can Help Identify Win-Wins



Some Benefits of This Approach

- Can speak in multiple currencies
  - $$, Acres, Water Quality, Fish Health
- Can set and track realistic related sets of goals
  - long-term
  - short-term (milestones)
- Helps us understand scope of the problem
- Can support new conservation strategies



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Can Support New Conservation Strategies

Cass River Watershed Pilot (Sanilac CD)

- Test if information and decision tools can foster changes via traditional Farm Bill to meet conservation action goals

SANILAC CONSERVATION DISTRICT

Saginaw Bay Regional Conservation Partnership Program (RCPP)

- Set watershed scale sustainability goals and related conservation action goals to drive changes in behavior through supply chain demand

MABA

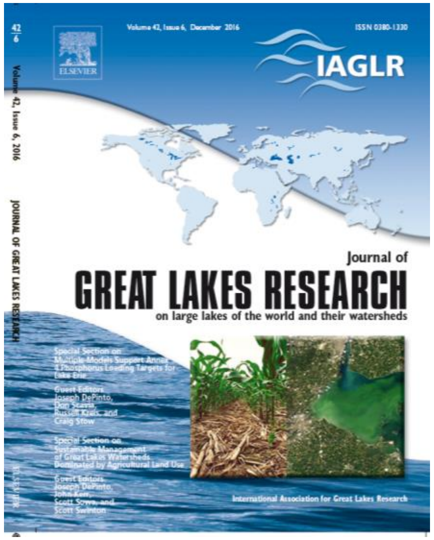
Pay for Performance

- Set ecologically meaningful sediment reduction goals and use online tools to pay farmers per ton of sediment reduced

HURON CONSERVATION DISTRICT

Great Lakes RESTORATION

Relevant Publications



- **Special issue of JGLR**

- **Kerr, J.,** DePinto, J. A., McGrath, D., Sowa, S.P., Swinton, S. M. **2016**. Sustainable management of Great Lakes watersheds dominated by agricultural land use. J. Great Lakes Res. 42(6): 1252-1259.
- **Sowa, S.P.,** Herbert, M.E., Mysorekar, S.S., Annis, G., Hall, K., Nejadhashemi, A.P., Woznicki, S.A., Wang, L., and Doran, P. **2016**. How much conservation is enough? Defining implementation goals for healthy fish communities. J. Great Lakes Res. 42(6): 1302-1321.
- **Fales, M.K.,** R. Dell, M.E. Herbert, S.P. Sowa, J. Asher, G. O'Neil, P.J. Doran, B. Wickerham. **2016.** Making the leap from science to implementation: Strategic agricultural conservation in Michigan's Saginaw Bay watershed. J. Great Lakes Res. 42(6): 1372-1375.
- **Keitzer, S. C.,** Ludsin, S. A., Sowa, S.P., Annis, G., Daggupati, P., Froelich, A., Herbert, M. Johnson, M. V., Yen, H., White, M., Arnold, J. G., Sasson, A. and Rewa, C. **2016**. Thinking outside the lake: How might Lake Erie nutrient management benefit stream conservation in the watershed? J. Great Lakes Res. 42(6): 1322-1331.

- **Other relevant upcoming publications**

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Acknowledgements

Wildlife component of the USDA NRCS Conservation Effects Assessment Project

Charles Stewart Mott Foundation

Herbert H. and Grace A. Dow Foundation

The Nature Conservancy's Great Lakes Fund for Partnership in Conservation Science and Economics.

Thank You
Questions?