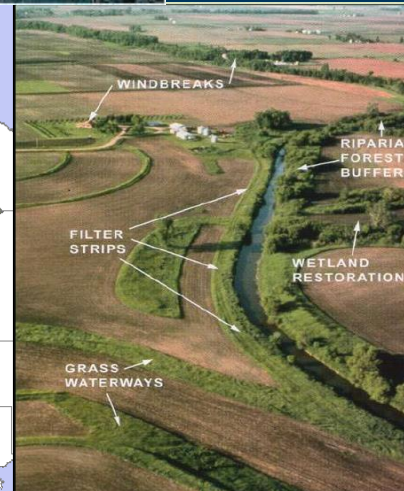
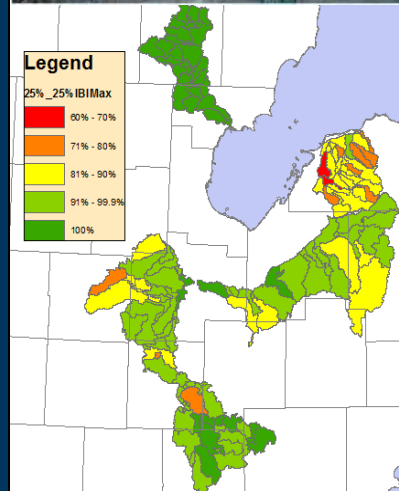
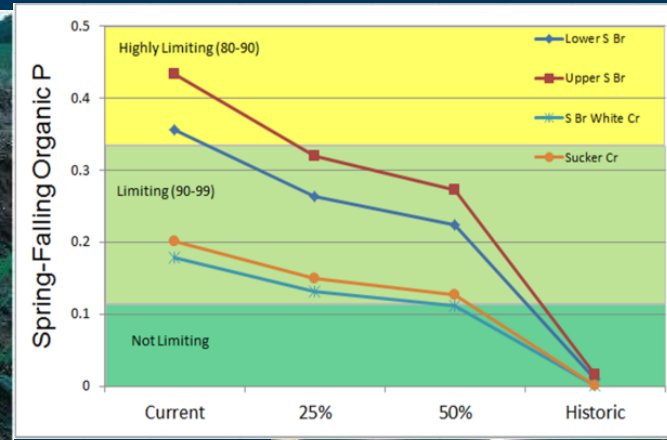


# How Much is Enough?

## Lessons from the Saginaw Bay Watershed

Mary Fales

March 7, 2014



Copyright Eric Engbretson

# Presentation Outline

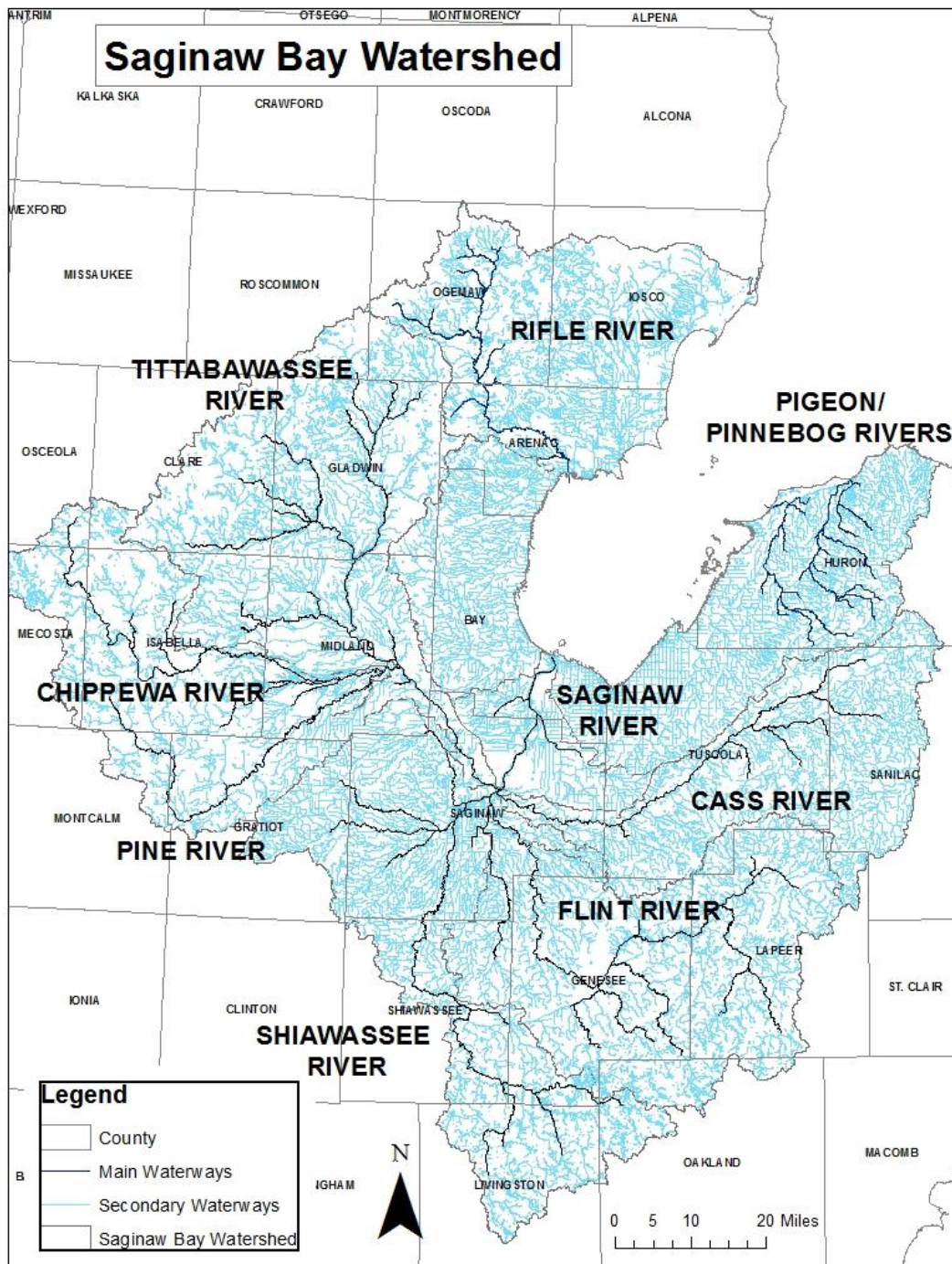
- Model and data analysis we developed to answer the question “How Much is Enough?”
- Online tools to help track ecological benefits of conservation
- Implementation Projects
- New funding models

# Saginaw Bay Watershed

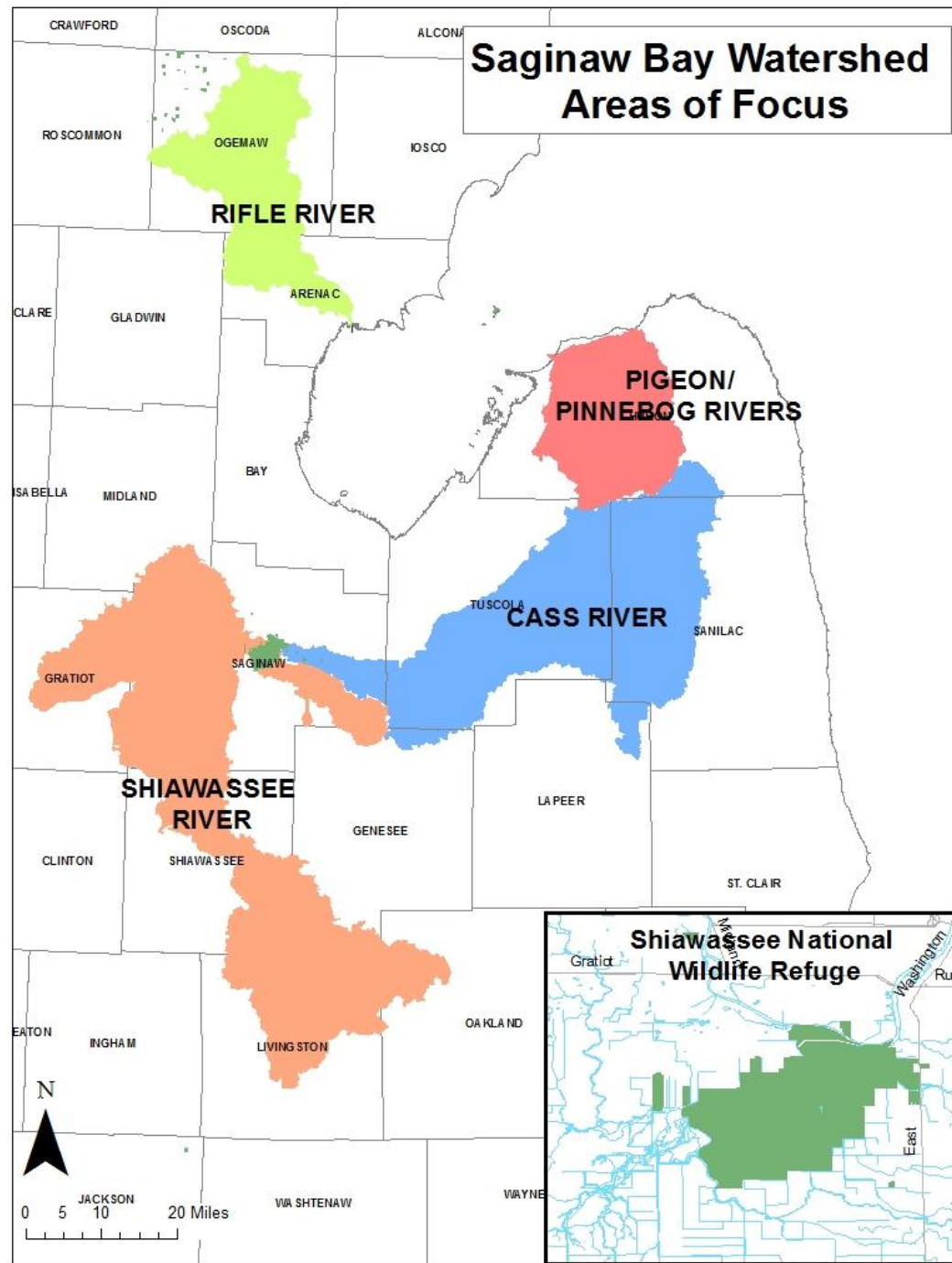
## Michigan's Largest Watershed

- Drains 8,709 mi<sup>2</sup>
- Covers 22 counties
- 15% of MI's total land area
- 7,000 miles of rivers!

45% agricultural land use







# The Focal Problem

- Agriculture has significantly altered freshwater ecosystems in the US
- We spend \$4.5 Billion on conservation provision of Farm Bill...\$50 million per year in MI
- Perception is this should be enough, but is it?
- Not an easy question to answer

# Traditional Approach in Agricultural Watersheds

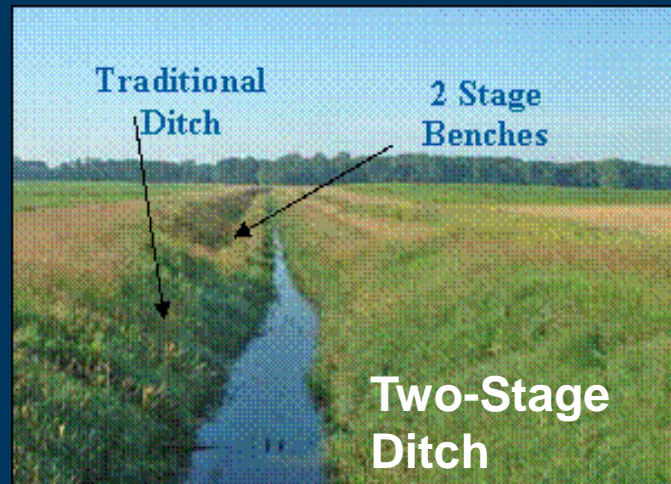
**Conservation Tillage**



**Buffer Strips**



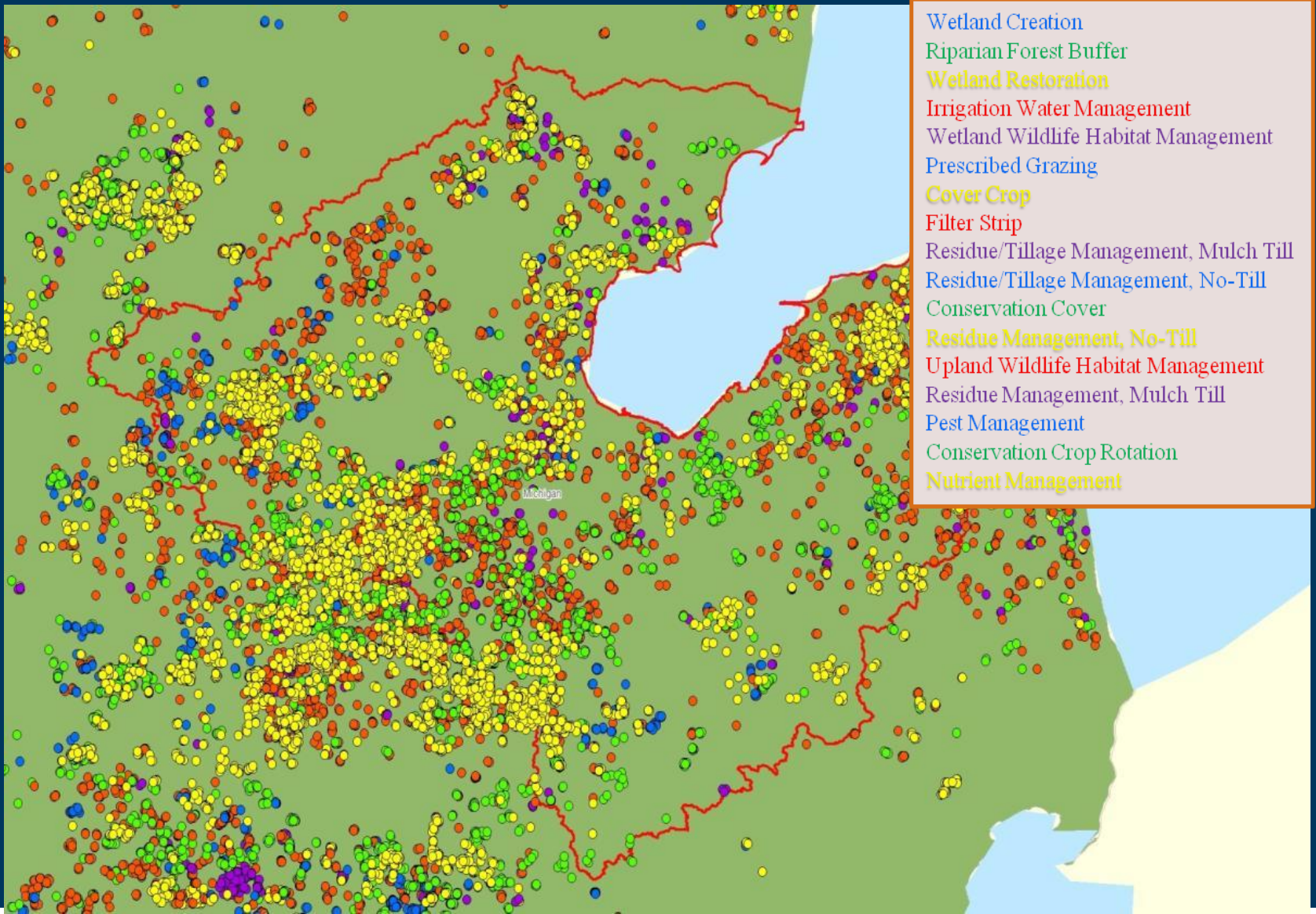
*Where will they have the most impact?*



*How much is enough?*



# How Much is Enough?

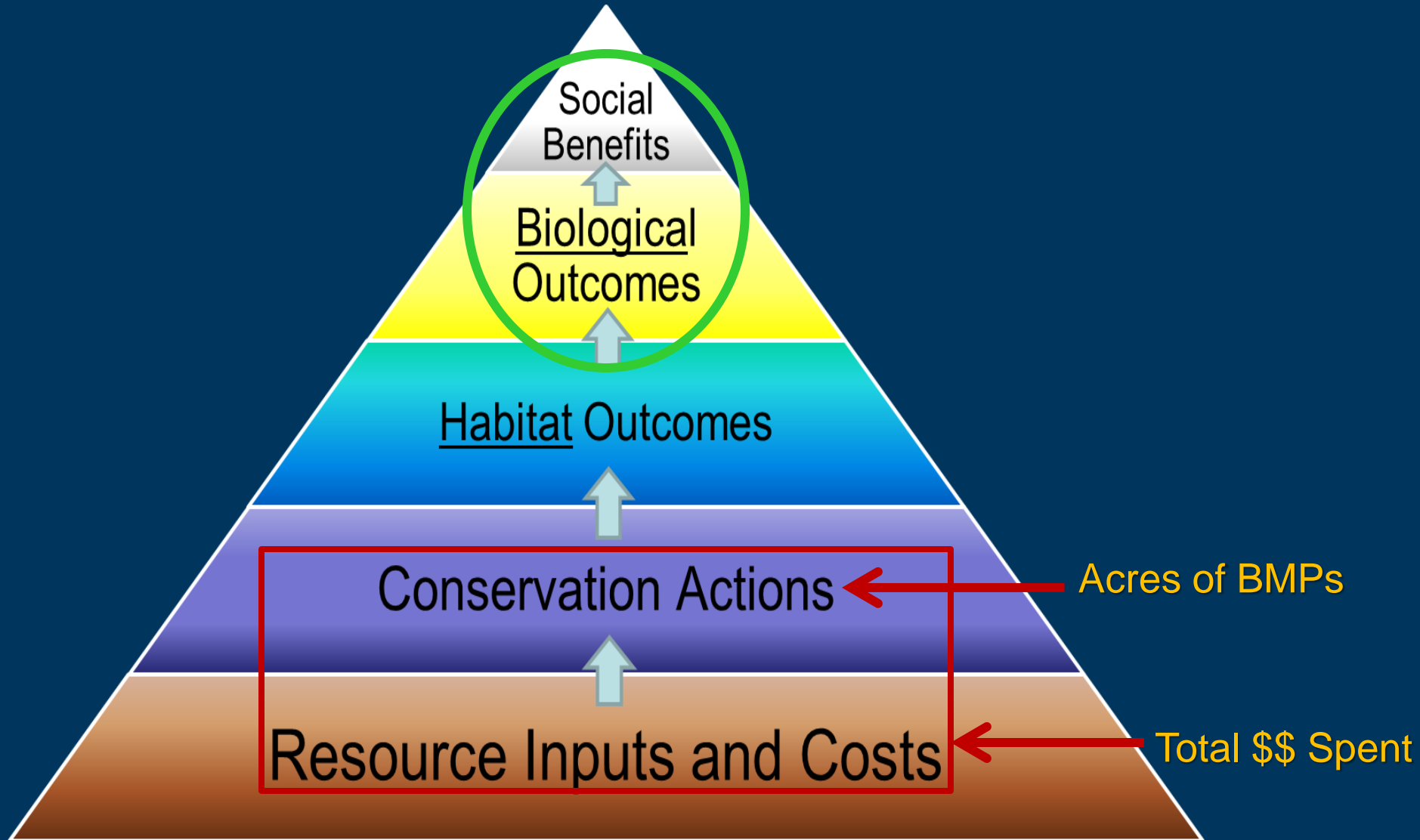


# Algae Blooms



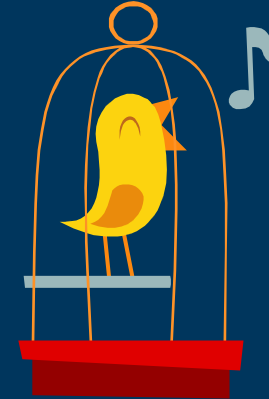


# It Depends on Your Goal



# Importance of Being Outcome-Based

- Get Healthier?
  - Outcome: Certain Goal Weight or Cholesterol Level
- Get Financially Stable?
  - Outcome: 6 months of savings
- Improve Water Quality
  - Measure: Healthy Fish Community  
(Index of Biotic Integrity of 90 or higher)



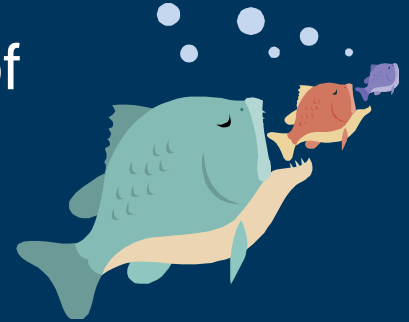
# Outcome-Based: Identifying Action Steps

- Get Healthier?
  - Outcome: Certain Goal Weight or Cholesterol Level
  - Tasks: Limit fat and calories to X per day
- Get Financially Stable?
  - Outcome: 6 months of savings
  - Task: Save \$\$ per month, reduce expenses by X%



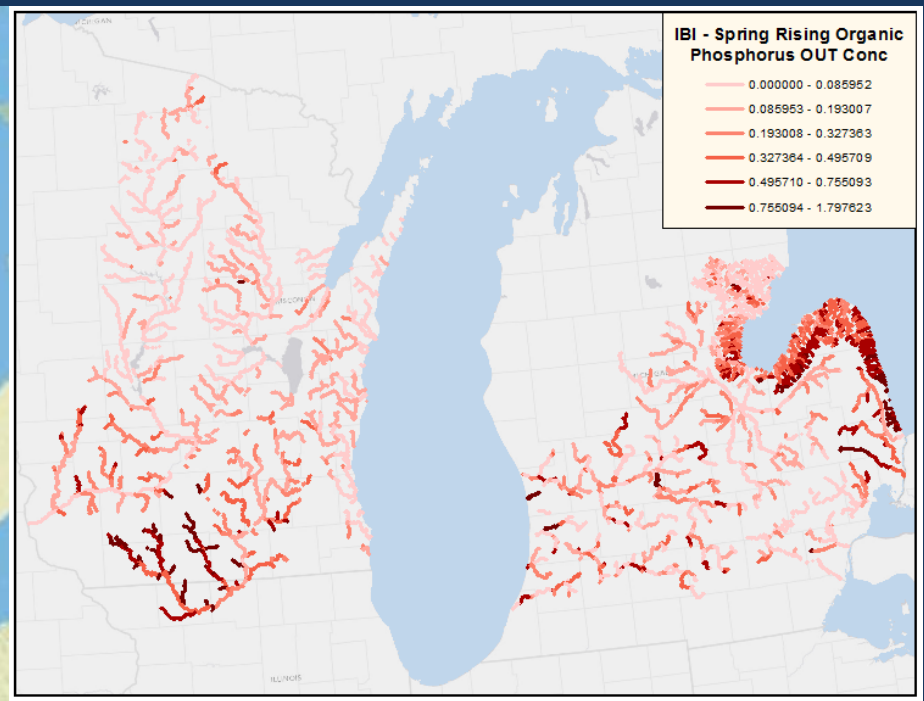
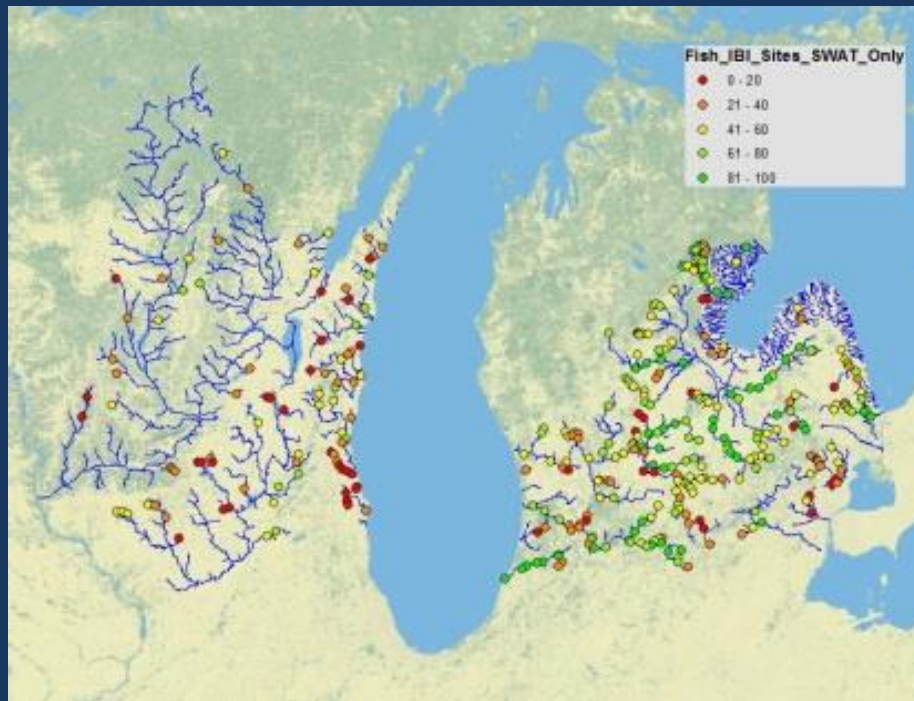
# Outcome-Based: Identifying Action Steps

- Improve Water Quality
  - Measure: Healthy Fish Community (Index of Biotic Integrity of 90 or higher)
  - Tasks:
    - Reduce sediment and nutrient levels to a point where they no longer limit the fish community health
    - Implement conservation practices
    - But How Much is Enough?



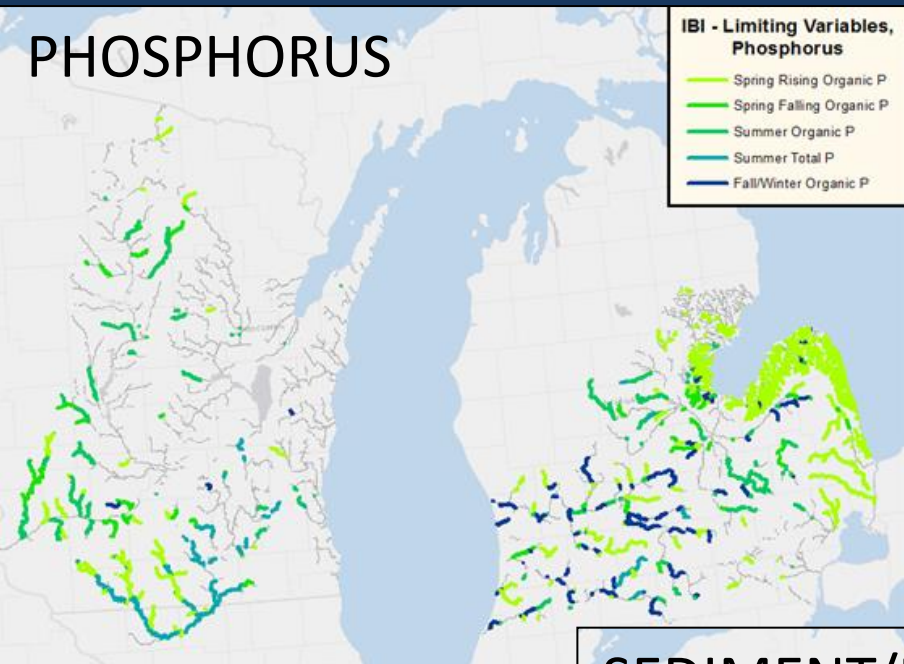
# Models Linking Fish Communities to Water Quality

- Actual Fish community health data vs. Predicted water quality (SWAT modeling)

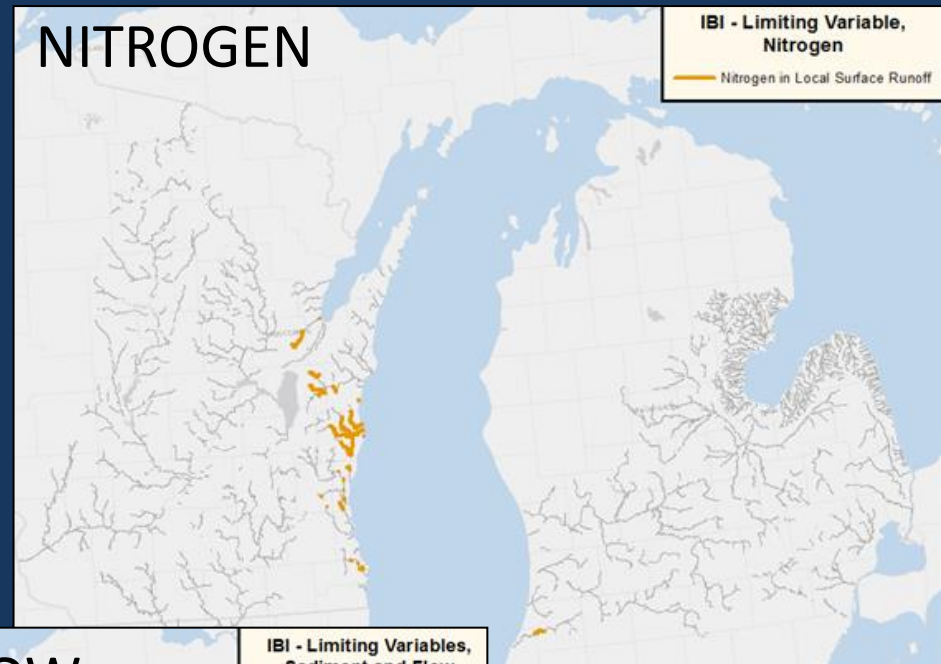


# Which Variables Are Limiting and Where?

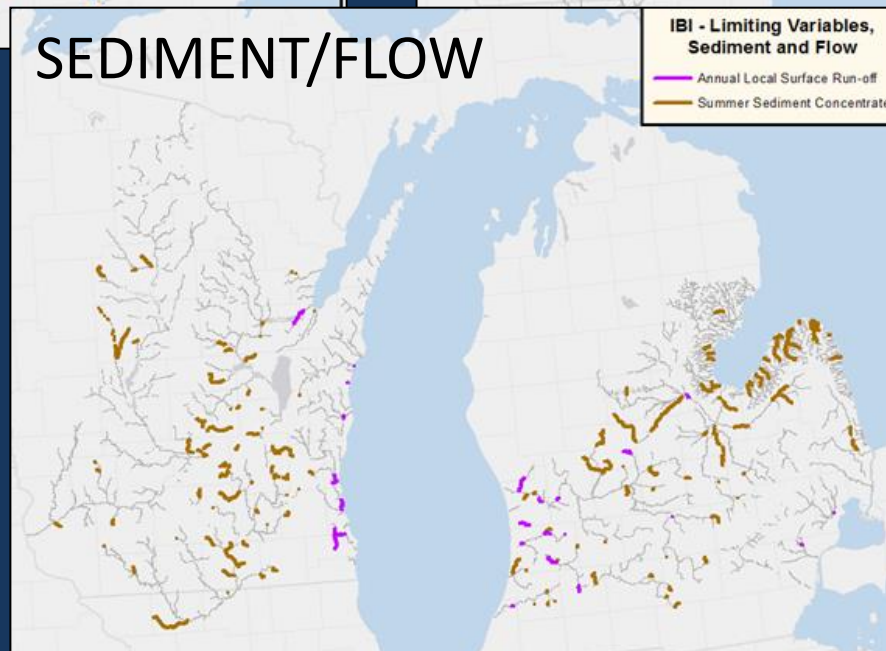
## PHOSPHORUS



## NITROGEN

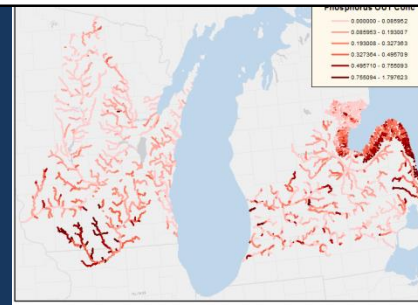
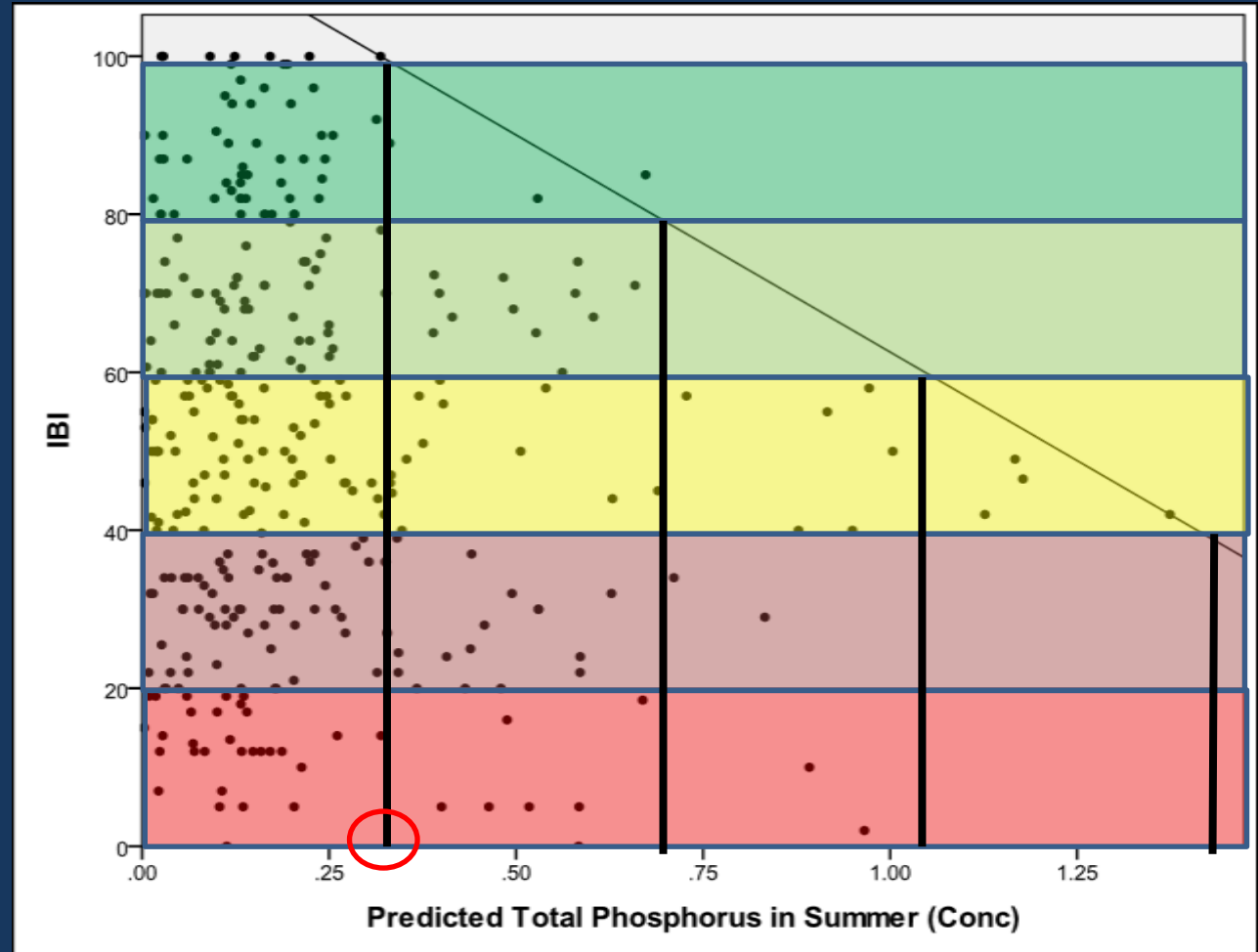
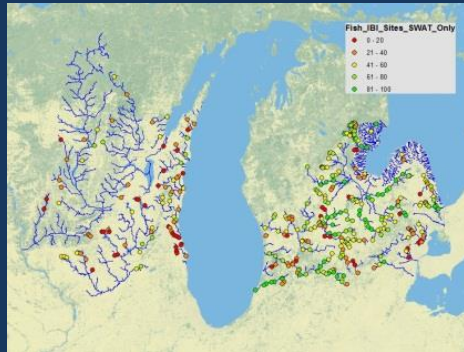


## SEDIMENT/FLOW





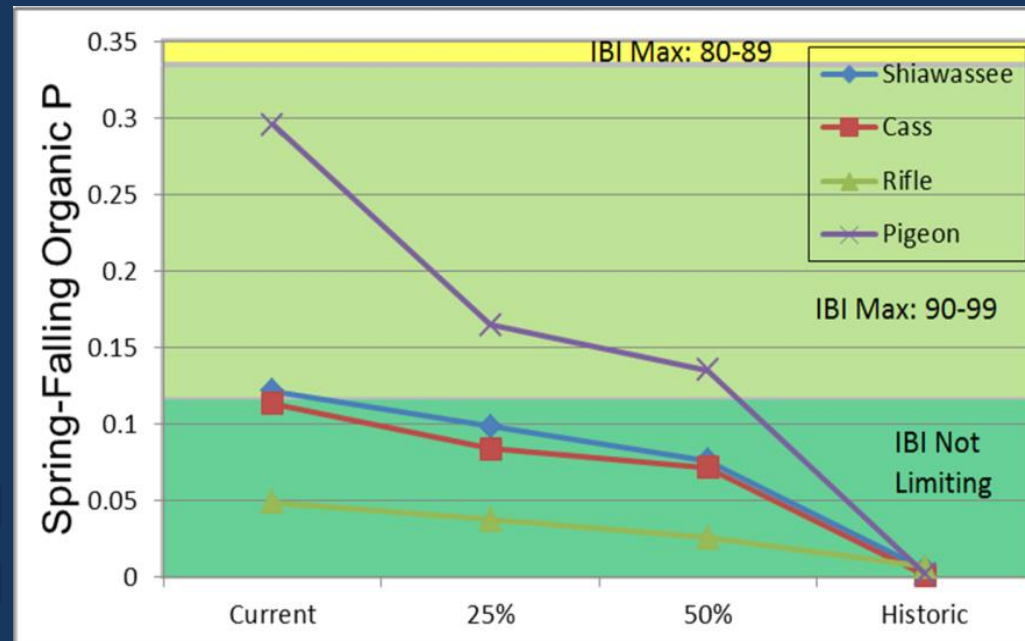
# Phase 1 – Identify “ceilings” to set goals



# Phase 2:

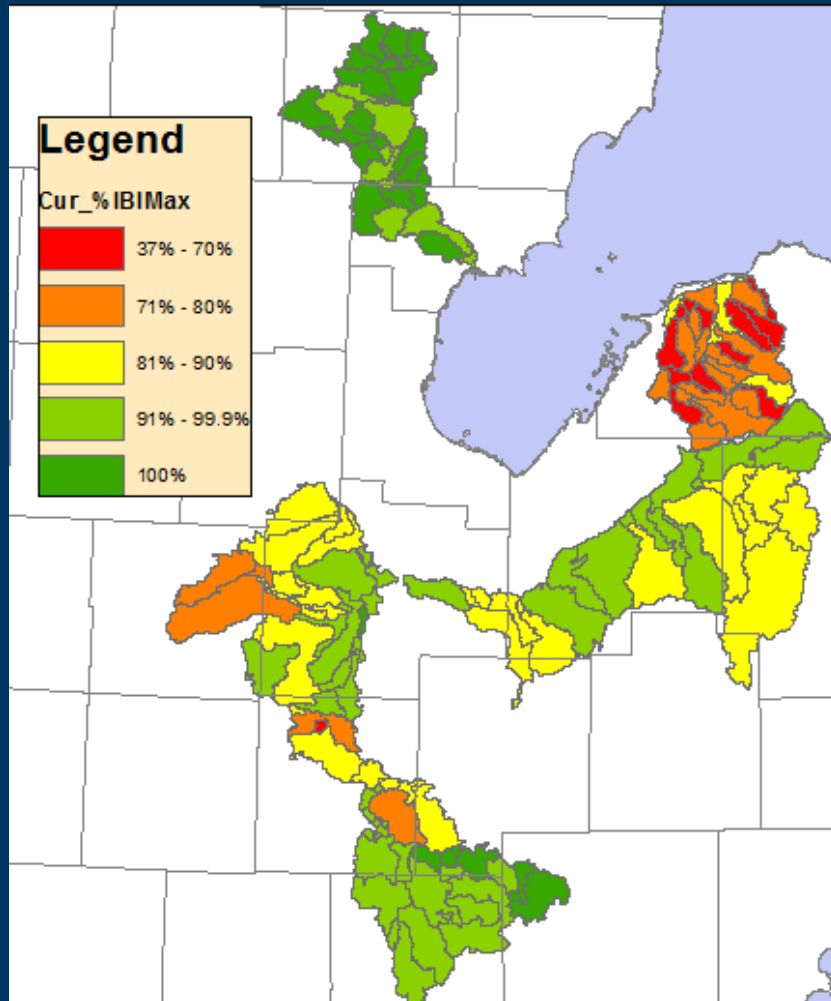
## Linking Practices to Water Quality and Fish

- Within 4 watersheds of Saginaw Bay
- Used SWAT to model changes in water quality under different scenarios (12 BMPs)
  - Current condition
  - Medium (25%)
  - High (50%)
  - Historic Condition
- Assess costs and benefits
  - 25% scenario costs **\$22 M**
  - 50% scenario costs **\$44 M**

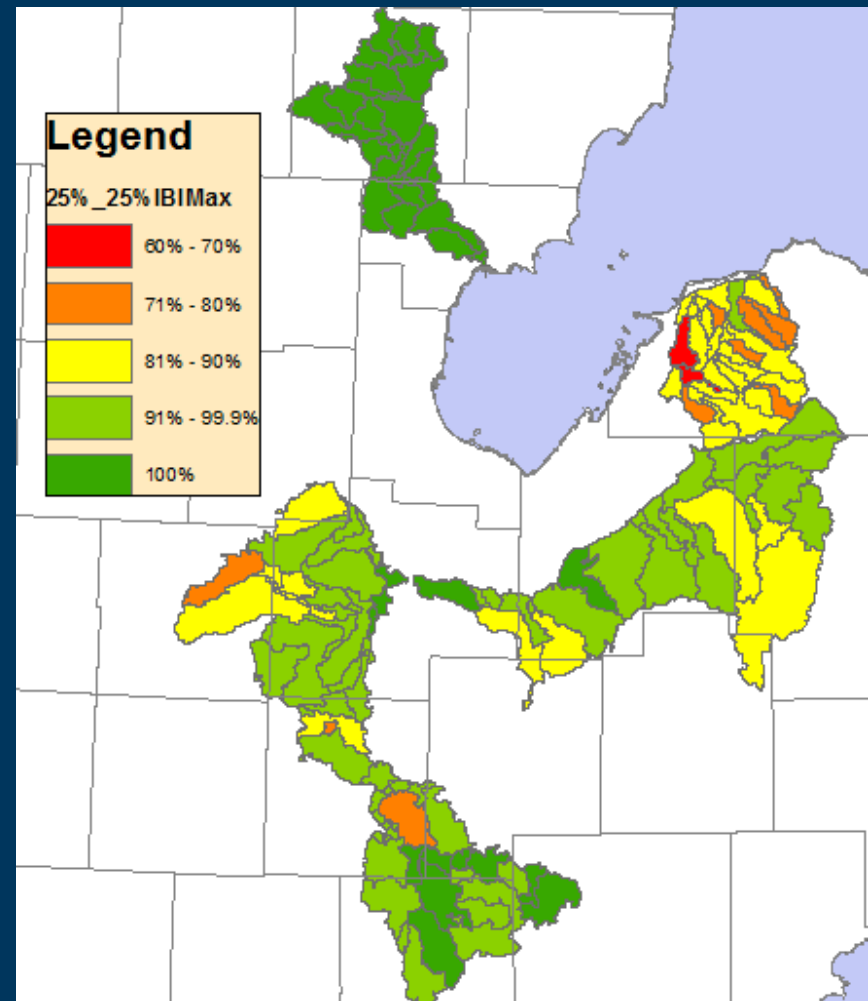


# Sub-watershed Comparison: Fish Community Health

## Current Condition



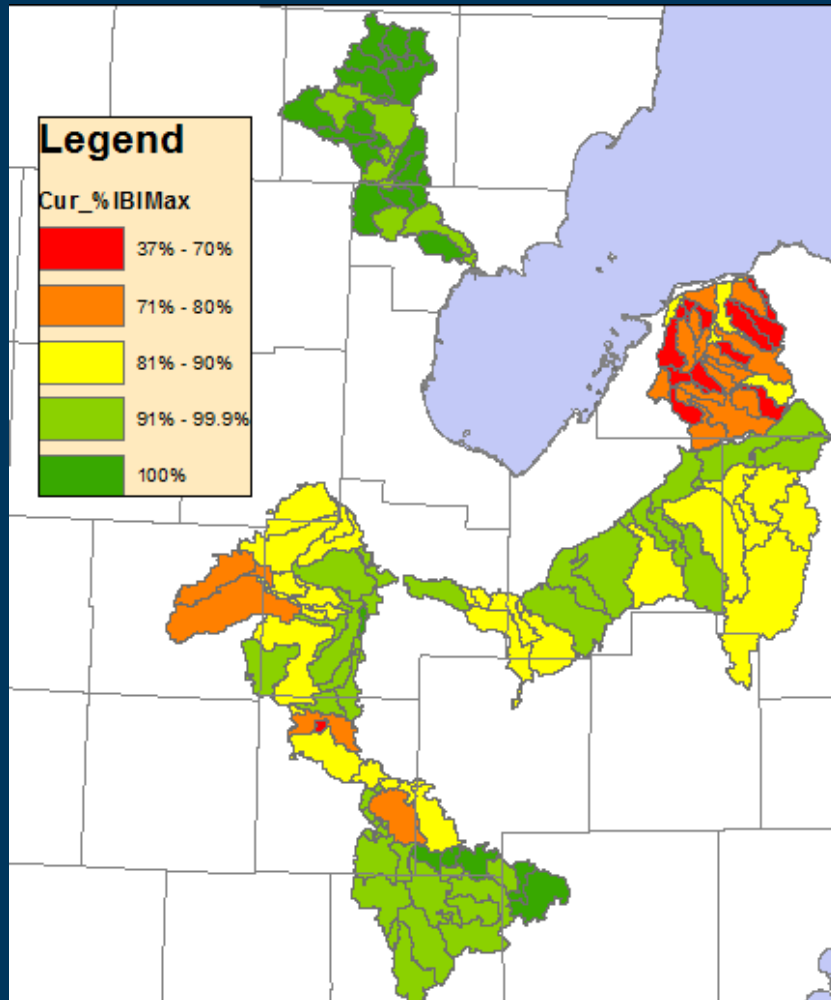
## 25% BMP



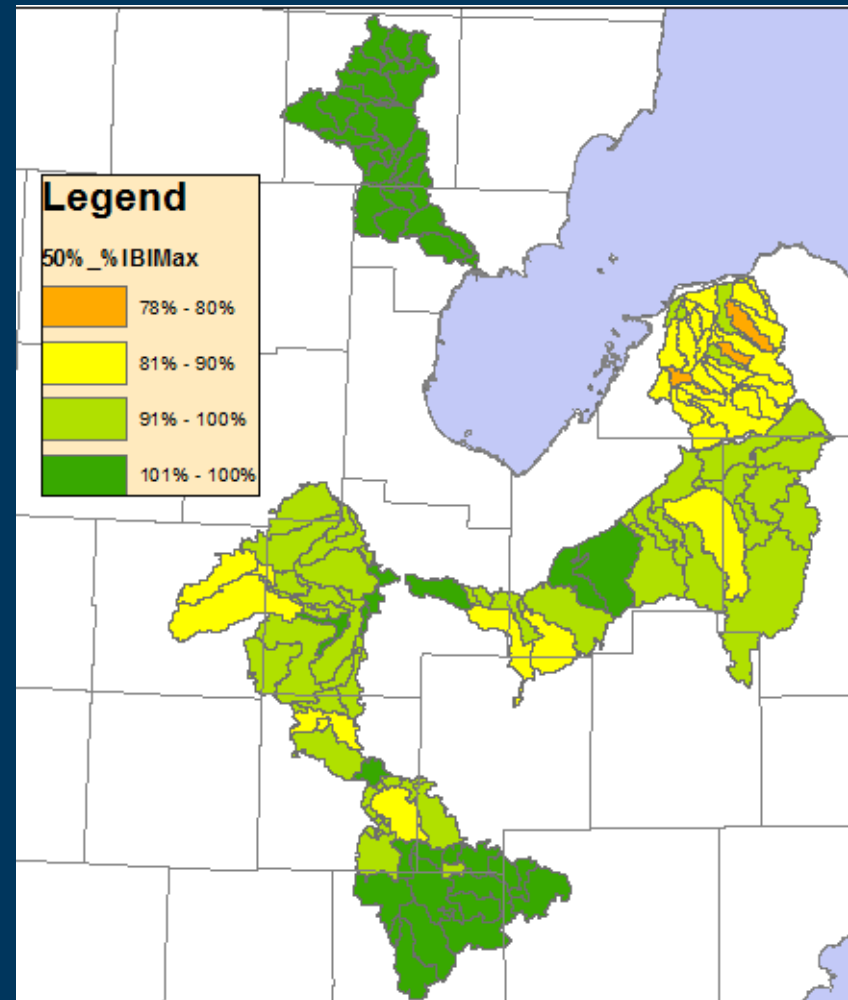


# Sub-watershed Comparison: Fish Community Health

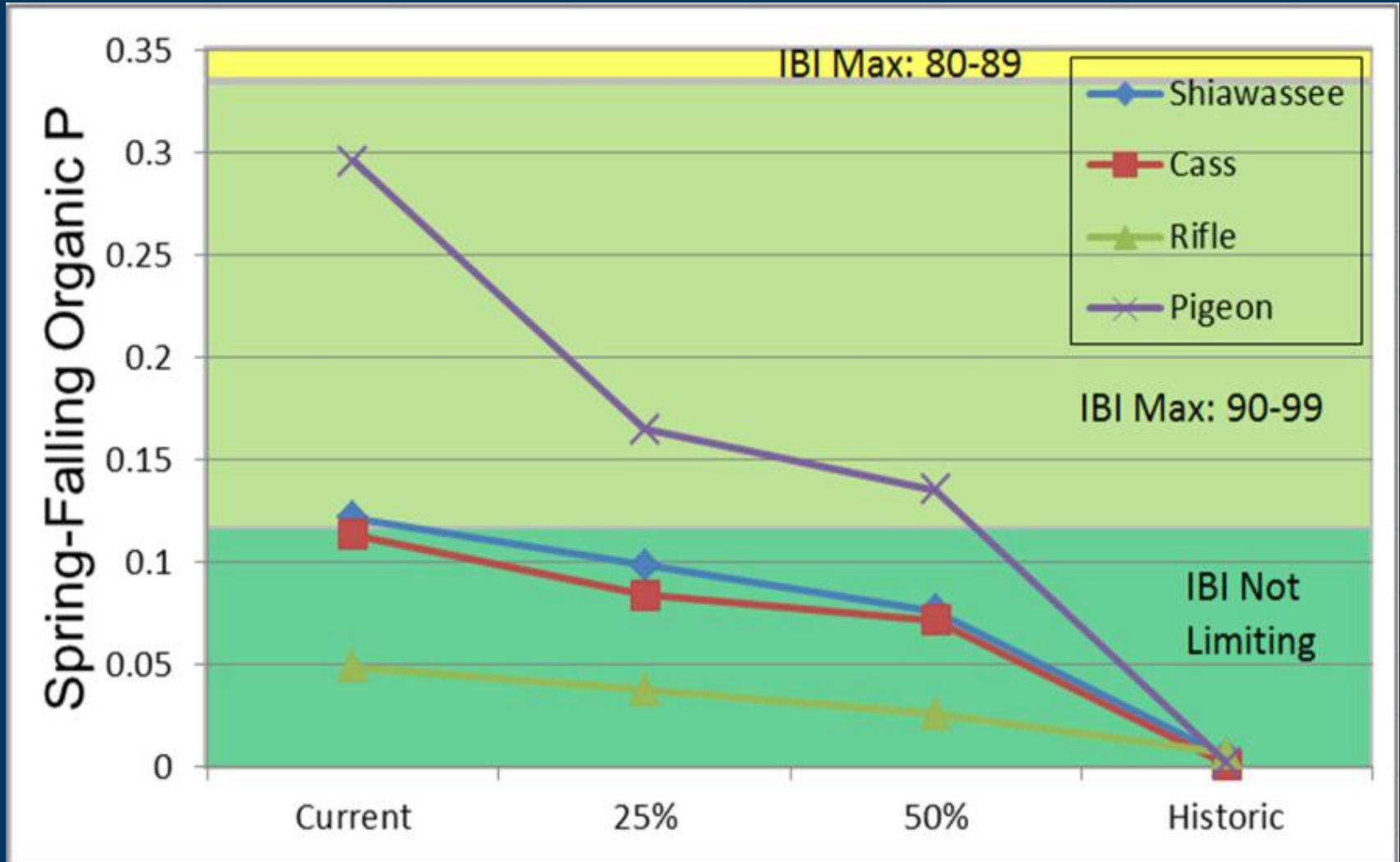
## Current Condition



## 50% BMP



# Dose Response Curve



# QUICK SUMMARY

TNC and partners have developed the science so we can determine:

1. **HOW MUCH:** What percentage of the land needs to be treated with practices
2. **WHERE:** Where conservation practices need to be implemented
3. **OUTCOME ORIENTED:** All the work is tied to improving fish community health



# Calculator Tools in the Saginaw Bay Watershed

Technology to target and track progress towards the goal:

1. Sediment Calculator
2. Nutrient Calculator
3. Groundwater Recharge Calculator
4. Accounting System (BMP tracker)

All currently being developed by MSU-IWR

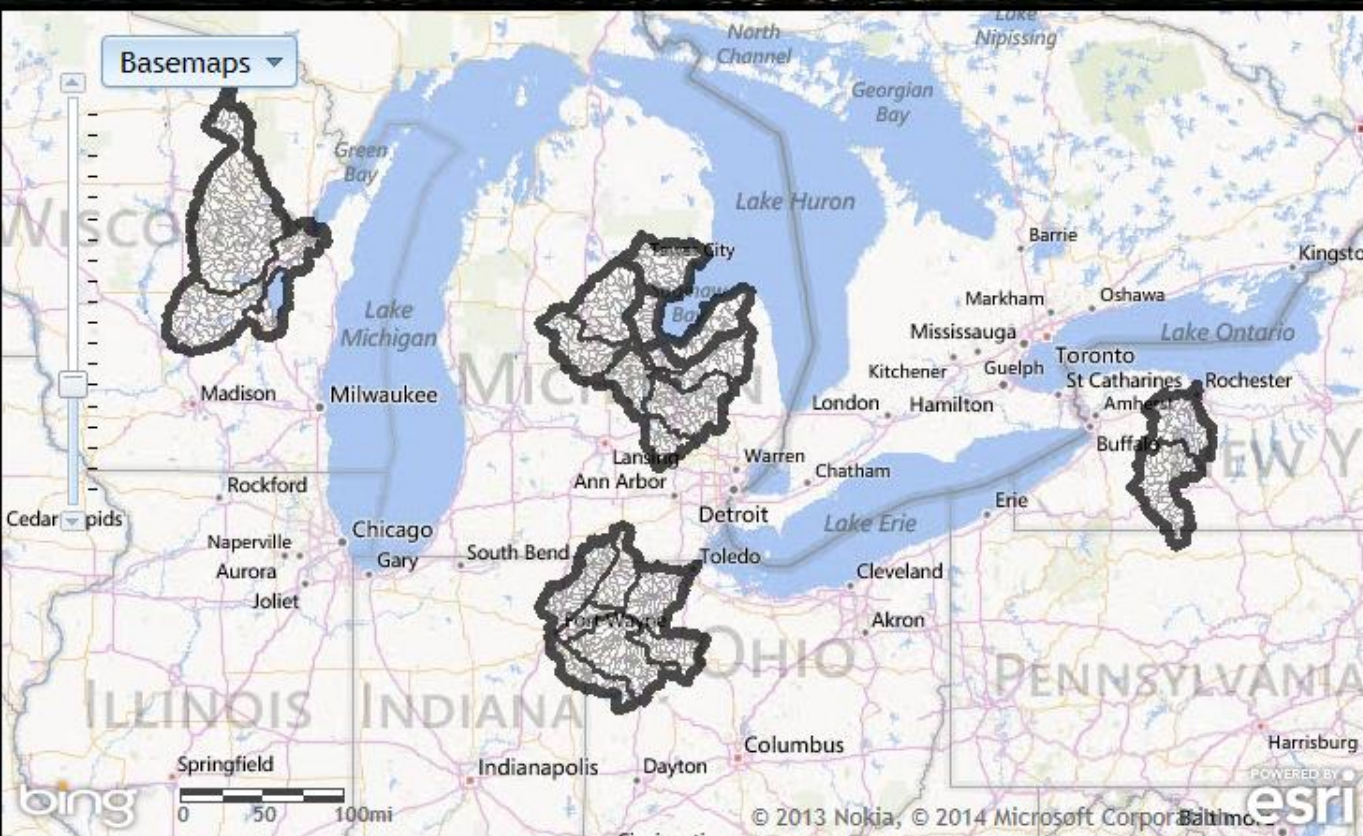
Will be completed by March 2014 & available online

# Sediment and Nutrient Calculators

<http://35.8.121.111/glwms/>

## Great Lakes Watershed Management System

login/logout



### Introduction

The Great Lakes Watershed Management System (GLWMS) is an on-line tool that allows users to evaluate non-point source (NPS) pollution model estimates at watershed and field scales. The system links two water quality models, [High Impact Targeting \(HIT\)](#) from the [Institute of Water Research at Michigan State University](#), and the [Long Term Hydrologic Impact Assessment \(L-THIA\)](#) from [Purdue University's Department of Agricultural and Biological Engineering](#). [HIT](#)

### Navigation

### Map Layers

### Legend

### Analysis

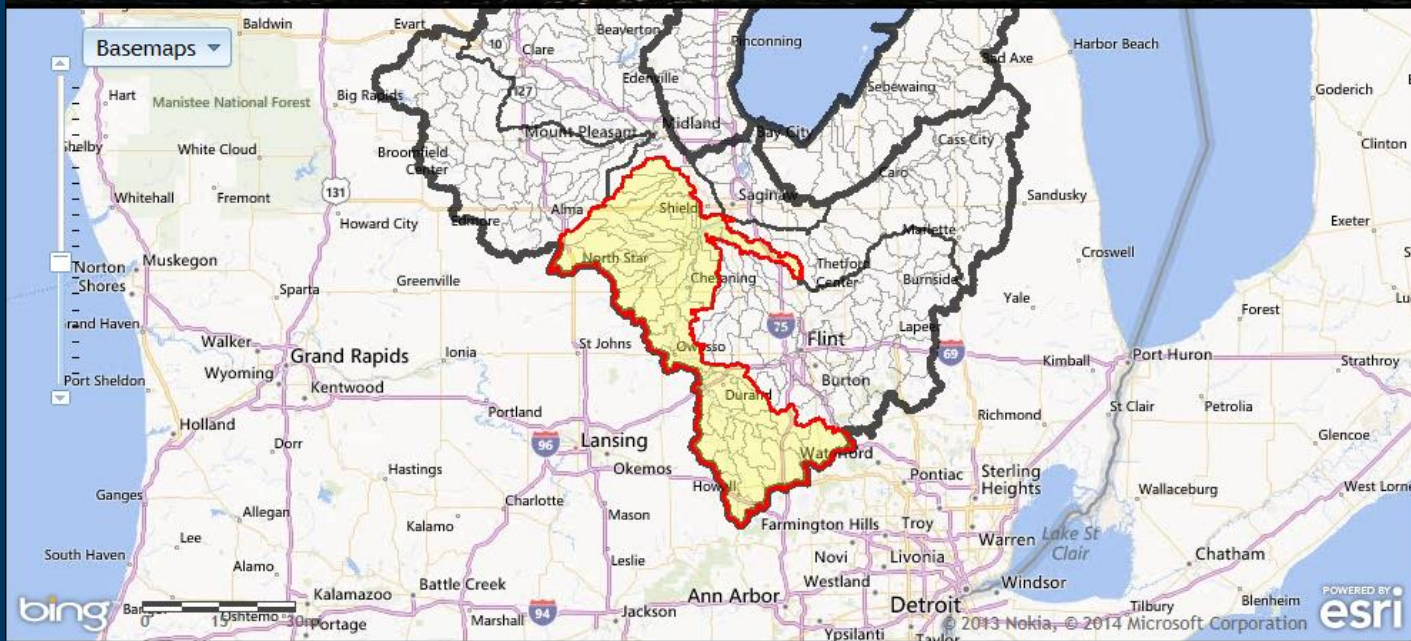
### About the Tool



# Watershed Scale Analysis

**Great Lakes Watershed Management System** login/logout

UR PURDUE ENGINEERING The Nature Conservancy Protecting nature. Preserving life.™



Basemaps

Introduction

Navigation

Map Layers

Legend

Analysis

To analyze data at the field level, or run land-cover change scenario models click on 'Field-scale Analysis'.

To analyze sediment and nutrient loading at watershed scales click on 'Watershed-scale Analysis'.

Field-scale Analysis

Watershed-scale Analysis

My Projects

About the Tool

Active Map Tool: Identify features on-click

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# Select Watersheds to Analyze

**Watershed-scale Analysis** ✕

Select watersheds to analyze | Selected watersheds and data | HIT analysis | L-THIA analysis | Apply a Map Legend

Select watersheds to gather data on. You can select watersheds interactively on the map, by searching for a watershed name, or by searching for a hydrologic unit code (HUC).

**Watershed selection scale:** Sub-watershed-HUC12 ▾

**Map Selection:**  
Press the 'Activate Watershed Map Selection' button; then specify the selection tool shape and watershed scale.

Deactivate Watershed Map Selection

**selection tool shape:** point ▾

**Attribute Query:**  
Type in a watershed name or HUC, specify the appropriate attribute type, and click the 'Find Watershed(s)' button.

**Example queries:** "Maple River" (find all watersheds with the phrase 'Maple River' in their name)  
"04050005" (find the watershed with that HUC)  
"04050005%" (find all watersheds whose HUC begins with those numbers)

**Query against:** Watershed HUC ▾

**Query text:** 04080203% ✕

Find Watershed(s)

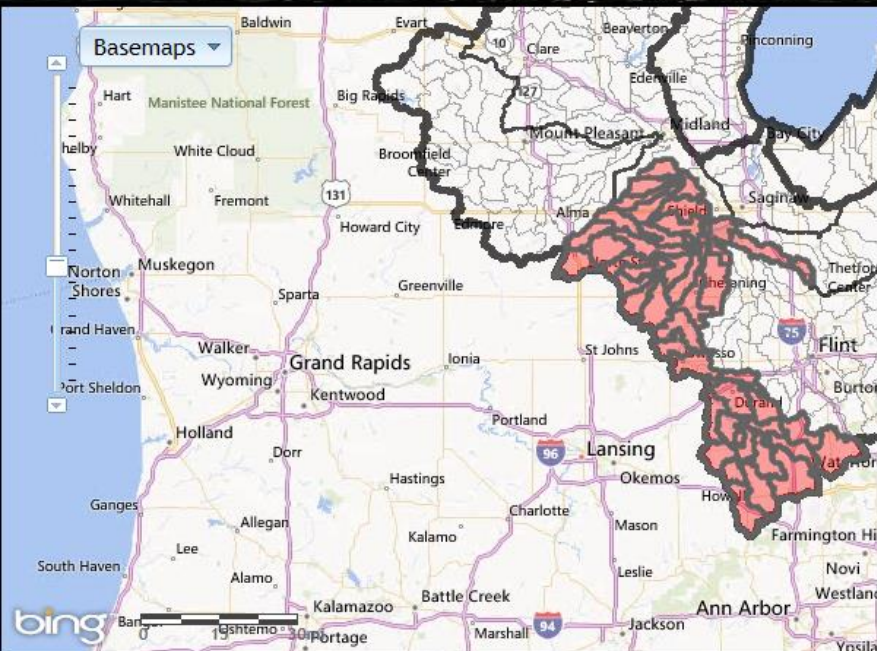
Clear Watershed Selections



# Select Watersheds to Analyze

Great Lakes Watershed Management System

login/logout



## Watershed-scale Analysis

Select watersheds to analyze

Selected watersheds and data

HIT analysis

L-THIA analysis

Apply a Map Legend

Search:		
HUC	Name	Acres
040802030103	Cook Lake-South Branch Shiawassee River	10454
040802030406	Hatch Run-Swan Creek	10529
040802030302	Limbocker Creek	11196
040802030110	South Branch Shiawassee River	11719
040802030204	Webb Creek	11922
040802030402	Jo Drain	11987
040802030306	Potato Creek	12212
040802030305	Headwaters Potato Creek	13006
040802030307	Upper Beaver Creek	13508
040802030405	Weeks Drain	13639
040802030202	Kanause Lake Drain-Shiawassee River	13700
040802030403	Fleming Drain	13845
040802030207	Sawyer Drain-Shiawassee River	13961
040802030311	Lower Beaver Creek	14041
040802030303	Olney Drain-South Fork Bad River	15637
040802030111	Byron Millpond-Shiawassee River	15971

Showing 1 to 43 of 43 entries

Clear Selections

Active Map Tool: Select Watersheds

Banner photograph credit: [Andrea L. Jaeger-Mishals](#)

Institute of Water Research

# HIT Analysis: Sediment

**Watershed-scale Analysis** ✕

Select watersheds to analyze | Selected watersheds and data | **HIT analysis** | L-TMIA analysis | Apply a Map Legend

Use the options below to view erosion, sediment loading, or BMP targeting impacts in the selected watersheds.

Current number of selected watersheds: 1

**dataset:** ☒ sediment ☐ erosion

**output:** ☒ totals (tons/yr) ☐ rates(tons/acre/yr)

**BMPs: (optional)**

- ☐ no-till on worst 5 % of sediment contributing areas, at a cost of \$ 24 \* / acre.
- ☐ mulch-till on worst 5 % of sediment contributing areas, at a cost of \$ 31 \* / acre.
- ☐ grass on worst 5 % of sediment contributing areas, at a cost of \$ 393 \* / acre.
- ☐ 30-foot grass buffer on all streams adjacent to ag land, (cost currently unavailable for buffers)

\* Default costs are based on [Michigan 2013 EQIP payments](#)

Generate HIT Data

# HIT Analysis: Sediment

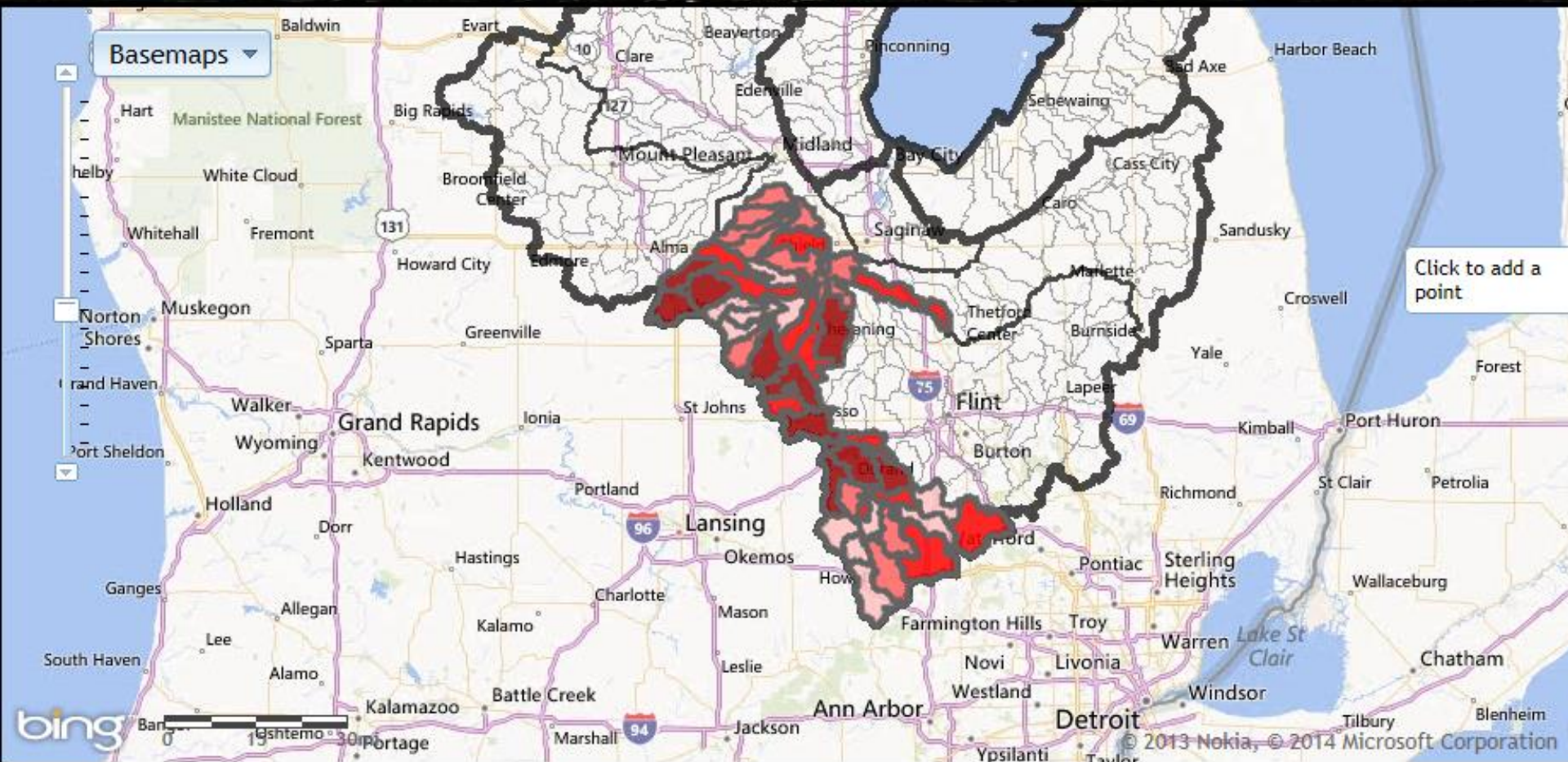
Watershed-scale Analysis			
Select watersheds to analyze		Selected watersheds and data	<div>HIT analysis</div> <div>L-THIA analysis</div> <div>Apply a Map Legend</div>
<div>Search:</div>			
HUC	Name	Acres	Sediment loading (t/yr)
040802030301	Brady Creek-Bad River	18791	2573
040802030309	Shad Creek-Bad River	22998	2207
040802030208	Mickels Creek-Shiawassee River	24642	2193
040802030304	Lamb Creek	24267	2188
040802030401	Bear Creek	30450	1942
040802030203	Holly Drain	22627	1724
040802030201	Jones Creek	16212	1704
040802030206	Osburn Drain-Shiawassee River	22182	1522
040802030205	Scribner Drain-Shiawassee River	20193	1511
040802030307	Upper Beaver Creek	13508	1455
040802030209	Deer Creek-Shiawassee River	20061	1356
040802030106	North Ore Creek	37922	1169
040802030312	Pickerel Creek	17339	1094
040802030407	Swan Creek	21891	1053
040802030409	Birch Run	25480	1040
040802030207	Sawyer Drain-Shiawassee River	13961	1035
Totals		810045	43815
Showing 1 to 43 of 43 entries			
Clear Selections			



# Total Sediment Loading

## Great Lakes Watershed Management System

[login/logout](#)





# Zooming in on Specific Farm Field

## Great Lakes Watershed Management System



Introduction

Navigation

Map Layers

Click on a map layer name for a description.

- ☒ [Basin](#)
- ☒ [Watershed-HUC8](#)
- ☐ [Sub-watershed-HUC10](#)
- ☒ [Sub-watershed-HUC12](#)
- ☐ [sediment](#)
- ☐ [erosion](#)

Legend

Analysis

About the Tool

# Look at Risks on a Specific Farm Field

Great Lakes Watershed Management System

UN PURDUE ENGINEERING The Nature Conservancy

Basemaps

erosion

Introduction  
Navigation  
Map Layers  
Click on a map layer to toggle it on or off.  
Legend  
Analysis  
About the Tool

erosion

Basin  
Watershed-HUC8  
Sub-watershed-HUC10  
Sub-watershed-HUC12  
sediment  
erosion

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# Look at Risks on a Specific Farm Field

Great Lakes Watershed Management System

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The Nature Conservancy  
Protecting nature. Preserving life.™

Basemaps

SEDIMENT

Click on a

- ☒ Basin
- ☒ Watershed-HUC8
- ☐ Sub-watershed-HUC10
- ☐ Sub-watershed-HUC12
- ☒ sediment
- ☐ erosion

Legend

Analysis

About the Tool





bing

Map data © 2011 MapData Sources, Inc.


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# Drawing Specific Parcel Boundaries

## Great Lakes Watershed Management System



Basemaps ▾



bing

Image courtesy of USGS, State of Michigan. © 2012 MapData Solutions

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Introduction

Navigation

Map Layers

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Analysis

To analyze data at the field level, or run land-cover change scenario models click on 'Field-scale Analysis'.

To analyze sediment and nutrient loading at watershed scales click on 'Watershed-scale Analysis'.

Field-scale Analysis

Watershed-scale Analysis

About the Tool



# Running Field Scale Analysis

## Field-scale Analysis

View Baseline NPS

Calculate a Baseline Change

Compare 2 Scenarios

Results

Click the 'Activate' button to activate the digitizer, then draw an area to see how erosion, sediment loading, runoff, or pollutant loading may change between two different land cover scenarios.

Digitizer:

De-activate

Clear Digitized Features

Project Name:

Project 1

(for saving and organizing results)

Model(s) to use:



HIT (for soil erosion and sediment loading to streams from ag lands)



L-THIA (for surface run-off volumes and pollutant loading to streams)

(click on a column title for a description)

Edit optional HIT parameters +

	Feature ID - Scenario	HIT: LC Change/BMP	Acres	Cost/acre (\$)
X	3-1	CTL	113.9	Click to edit
	3-2	NCC	113.9	Click to edit

Calculate

Conventional till to No till with Cover Crops

## Selecting BMPs to Model Sediment Loading (HIT Model)

## HIT: LC Change/BMP

ALF (alfalfa)

GRA (grass)

FOR (forest)

PAS (pasture)

RCA (row-crop agriculture)

WET (wetland)

BUF (buffer strip)

GRW (grass waterway)

NTL (no-till)

MTL (mulch-till)

CTL (conventional-till)

NCC (no-till with cover crop)

MCC (mulch-till with cover crop)

~~CCC (conventional-till with cover crop)~~

MAN: manually selected parameters

[illegible]

# Evaluating Erosion Results:

## Conventional Till –to- No Till w/Cover Crops

### Field-scale Analysis

View Baseline NPS

Calculate a Baseline Change

Compare 2 Scenarios

Results

#### Results:

Project 1() +

remove

Project 1() -

remove

Calculation type: Change in NPS between two scenarios

digitized acres: 113.9 (green area on map)

total acres (including affected upland): 287.8 (blue area on map)

HIT land cover change / BMP: CTL to NCC

#### HIT Results:

Job ID: j6ce06a980e9e4d3b86f6796c60e4646f

Erosion in affected areas, Scenario 1 (tons/yr): 384.35

Erosion in affected areas, Scenario 2 (tons/yr): 234.27

Erosion **DECREASE** (tons/yr): 150.08

Sed. load in affected areas, Scenario 1 (tons/yr): 80.83

Sed. load in affected areas, Scenario 2 (tons/yr): 31.91

Sediment loading **DECREASE** (tons/yr): 48.92

150 ton/yr reduced erosion

49 tons/yr reduced sediment loading

61% reduction!

# Selecting BMPs to Model Nutrient Loading: LTHIA Model

## Agriculture

No Till (100 %)  
Conservation Tillage (30%)  
Reduced Till  
Mulch Till  
30 ft grass buffer  
Riparian Buffer Strip  
Detention Basin  
Grass swale  
Cropland generalized  
Row Crops (5-20% residue)  
Small Grain (5-20% residue )  
Small Grain st rows  
Close Seeded legumes  
Row Crops (5-20% residue and contour)  
Small Grain (5-20% residue and contour)  
Close Seeded legumes contour  
Pasture/Hay

## Forest

Forest/Woods  
Trees/Orchard  
Woods fair  
Woods good  
Woods poor

## Woods poor

### Impervious surfaces

Impervious surface-10%  
Impervious surface-20%  
Impervious surface-30%  
Impervious surface-40%  
Impervious surface-50%  
Impervious surface-60%  
Impervious surface-70%  
Impervious surface-80%  
Impervious surface-90%  
Impervious surface-100%

### Industrial/Urban

Commercial  
Commercial/Industrial/Transportati  
Industrial  
Parking lot  
Parking lot with porous pavement g  
Parking lot with porous pavement f  
Parking lot with porous pavement p  
Paved street with curbs and gutters  
Paved Surface Driveway or Parking  
Street/Road  
Street with curbs and gutters and p  
Street with swales  
Street with swales and porous pave  
Streets / other  
roof cistern  
green roof

## Grass land

Open space-dirt or grass cover < 50%  
Open space-gravel or grass cover 50%-75%  
Open space-wooded or grass cover > 75%  
Open Space/Park  
Open space with bioretention  
Other Open/Unused Land  
Barren Land

## Residential

High-density Res. (townhomes - 1/4 ac lots)  
Low-Density Residential (general 1/3 - 2 ac lots)  
Residential - 1 ac lots  
Residential - 1/2 ac lots  
Residential - 1/3 ac lots  
Residential - 1/4 ac lots  
Residential - 1/8 ac lots  
Residential - 2 ac lots

Driveway with porous pavement  
Patio

Permeable patio

## Roof

Roof rain barrel  
Sidewalk  
Sidewalk with porous pavement

## Water

Open Water  
Perennial ice or snow

## Wetlands

Emergent Wetlands (marsh)  
Woody Wetlands (swamp)



# Evaluating Nutrient Reduction Results

## Field-scale Analysis

View Baseline NPS

Calculate a Baseline Change

Compare 2 Scenarios

Results

### Results:

Project 1() + remove

Project 1() + remove

Project 1() - remove

Calculation type: Change in NPS between two scenarios  
digitized acres: 113.9 (green area on map)  
total acres (including affected upland): 287.8 (blue area on map)  
L-THIA land cover change / BMP: CROPGEN to NTL

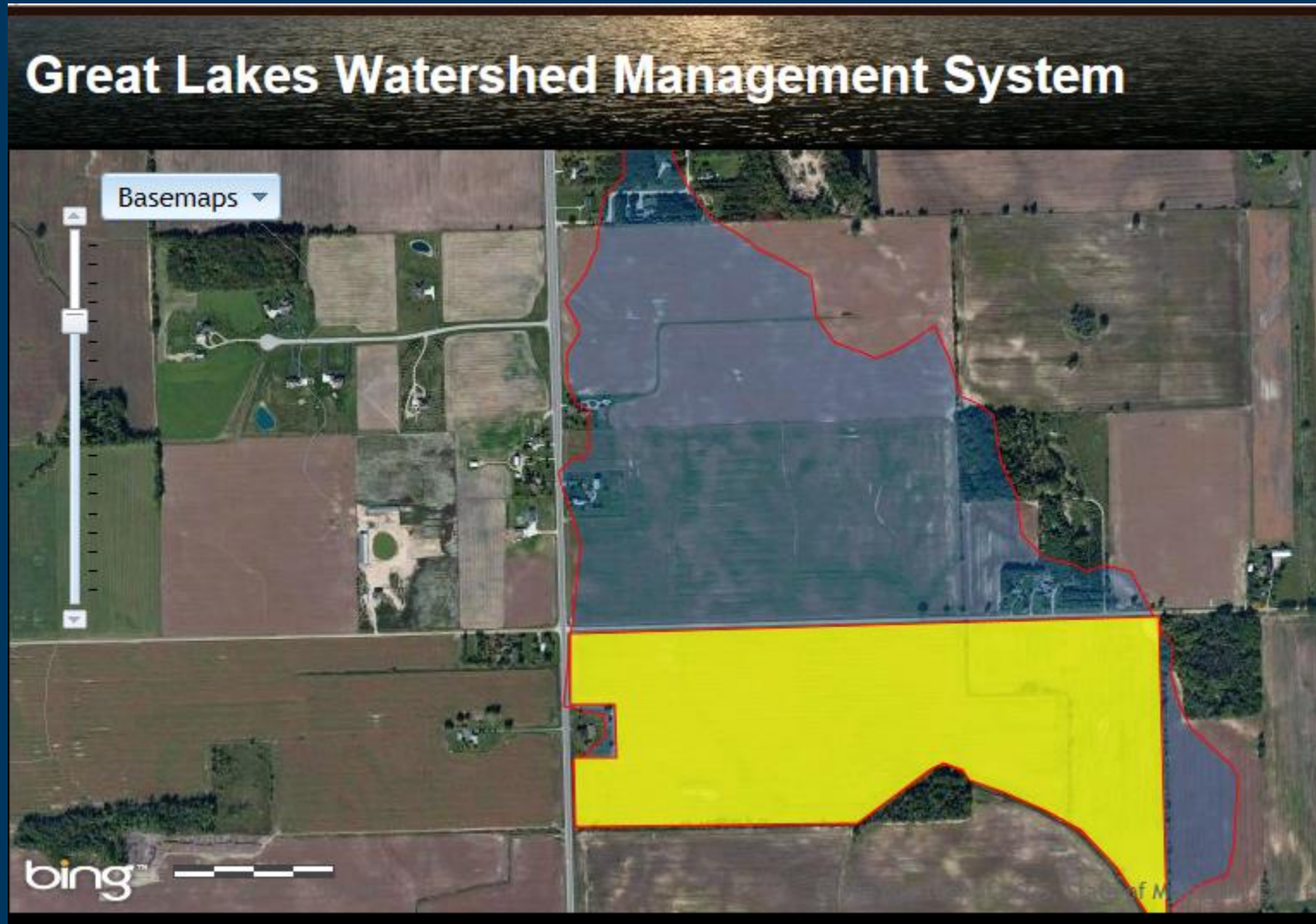
### L-THIA Results:

total runoff (acre-ft/yr) DECREASE:	27.55
nitrogen (lbs/yr) DECREASE:	8016.79
phosphorus (lbs/yr) DECREASE:	97.4
suspended solids (lbs/yr) DECREASE:	329.66
lead (lbs/yr) DECREASE:	0.11
copper (lbs/yr) DECREASE:	0.11
zinc (lbs/yr) DECREASE:	1.2
E coli (MPN/100mL) DECREASE:	638910772449999

8017 lbs/yr  
reduced nitrogen  
loss

97 lbs/yr reduced  
phosphorus loss

# Affected Area Shaded in Blue



# Putting the Science into Practice

1. Via traditional Farm Bill cost-share programs
2. Via the Supply Chain Influences
3. Via Pay for Performance

## PROJECT: Cass River Watershed

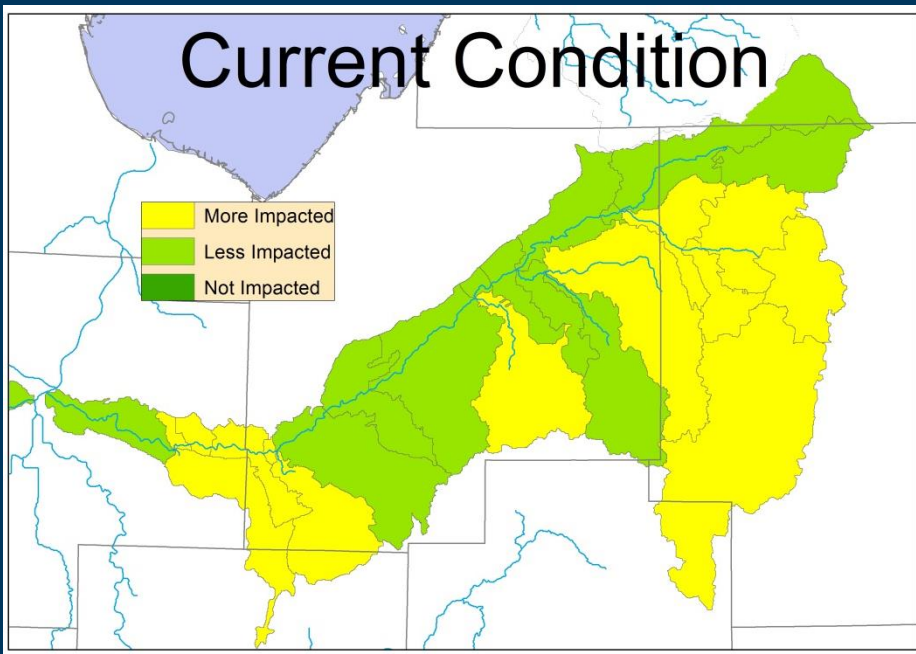
- Partnering with Conservation Districts
  - \$120,000 C.S. Mott Foundation
- Targeted outreach to areas with largest potential for impact



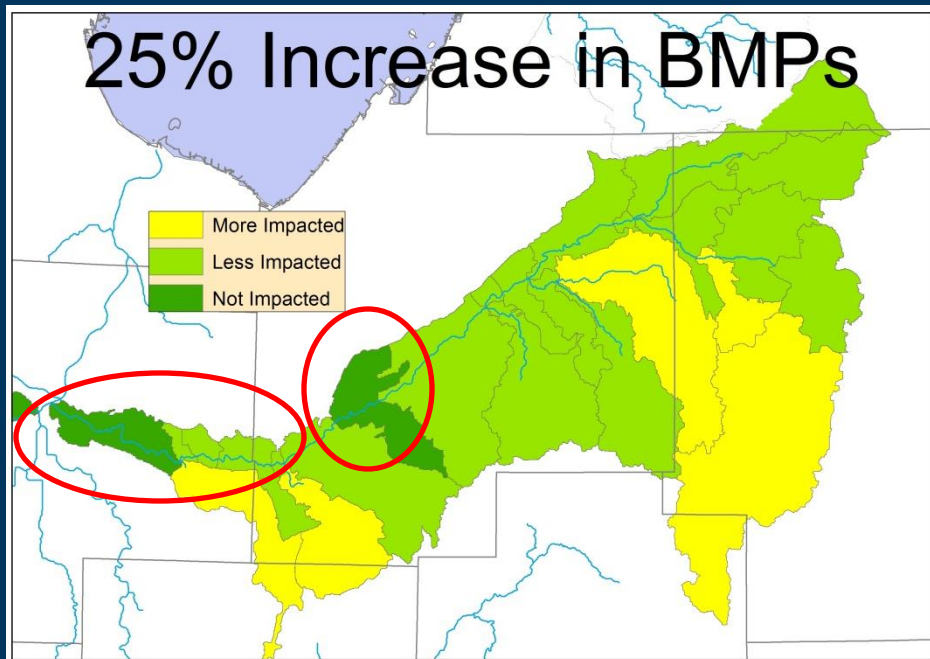
# Cass River Subwatershed Comparison

## Health of the Local Fish Community

### Current Condition

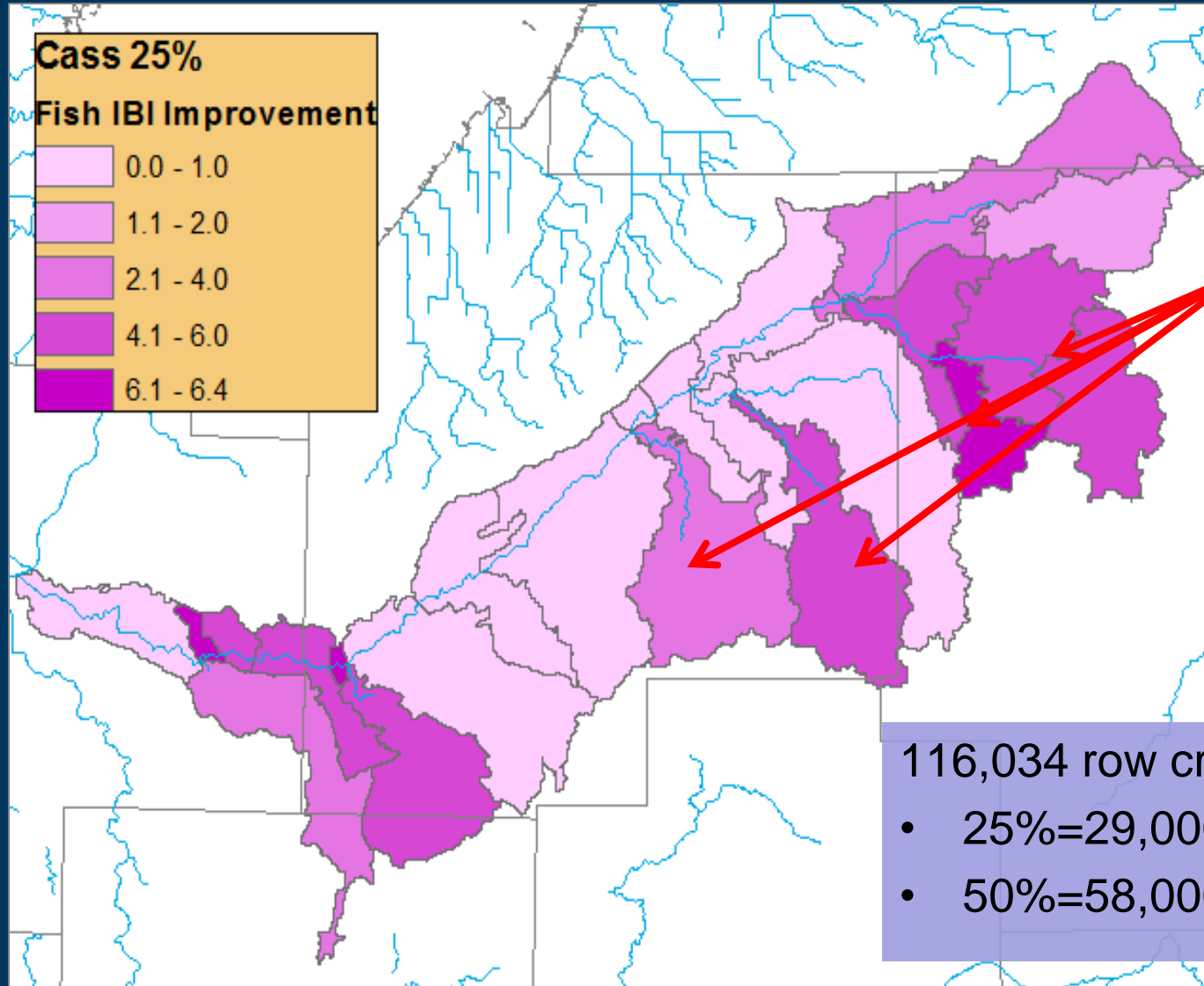


### 25% Increase in BMPs





# Where do fish improve the most?



Sanilac and  
Tuscola  
Conservation  
Districts will be  
focusing in these  
areas for  
Implementation

116,034 row crop acres total

- 25%=29,000 acres
- 50%=58,000 acres

# Cass River Watershed Demo Project



STRIP TILL



COVER CROPS



WETLAND RESTORATION



EDUCATION

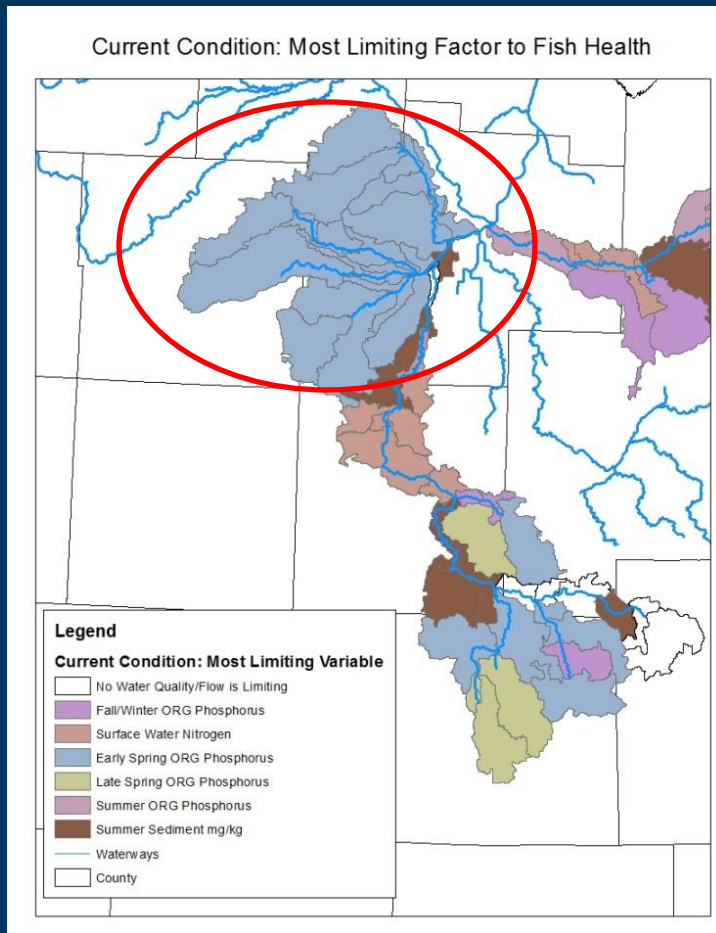
# Cass River Watershed Demo Project

Practice	Goal Acres	Oct 2013 Update
Nutrient Management	12,000	8,687
Conservation Crop Rotation	3,000	1,191
Tillage Mgt (No Till, Strip Till, Mulch Till)	15,000	1,506
Cover Crop	3,000	881
Filter Strip		7.3 acres
Wetland Creation/Restoration	5-7 sites (min 1 acres)	13 acres (8 sites)

These goals are contingent on securing funding via Farm Bill program.



## Sediment Reduction in the Bad River Watershed



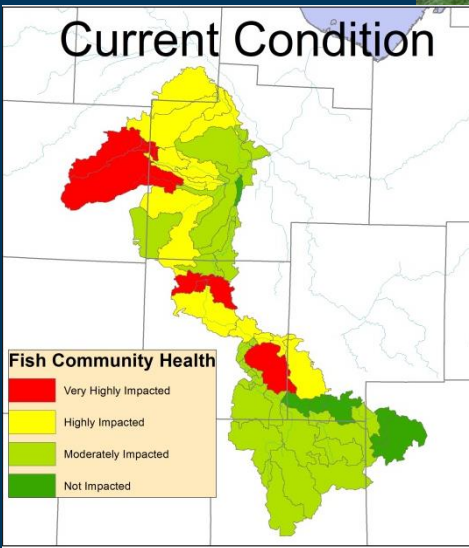
- Partner: Gratiot Conservation District, NRCS
- Great Lakes Commission Grant (\$250,000)
- Develop a watershed goal for sediment reduction
- Set a payment rate for sediment reduction (\$/ton)
- Using the sediment calculator to determine reduction amount



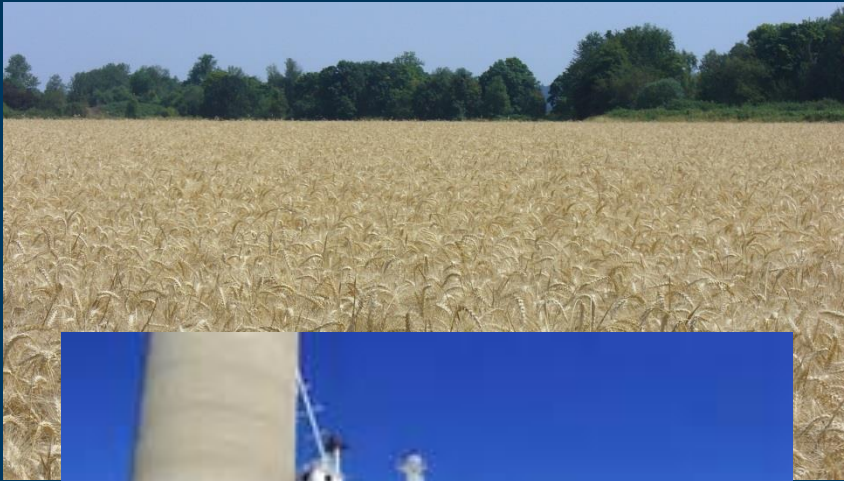
# Testing Transactions: Drain Fee Reduction Project

## Shiawasse River Watershed

- Partners: County Drain Commissioner, MSU-IWR, local conservation district
- Cook Family Foundation invited proposal
- **Develop a watershed goal for sediment reduction**
- **Set a discount value for sediment reduction (\$/ton)**
- **Using the sediment calculator to determine reduction amount**



# Supply Chain: Kellogg influences wheat farmers to implement conservation practices



## Cass River Pilot Project

- Partners: Kellogg, Star of the West Milling Co, MSU-IWR
- Set a watershed sustainability goal (P reduction in lbs)
- Train crop advisors on use of calculators
- Voluntary implementation
- Track progress towards goal using BMP tracker

*Kellogg's*



# Many Stakeholders Involved in Implementation!

## Funders

- C.S. Mott Foundation
- USDA-NRCS CEAP
- Great Lakes Commission
- Great Lakes Protection Fund
- Kellogg Company
- U of M Water Center (Erb)
- Cook Family Foundation
- Herrick Foundation
- Americana Foundation

## Partners/Stakeholders

- MSU-IWR, SVSU
- County Drain Commissioners
- Conservation Districts
- Private Companies (Star of the West, Michigan Sugar)
- Natural Resources Conservation District (NRCS)
- MDEQ, MDNR, MDARD
- USFWS, USGS
- Saginaw Bay WIN
- Farm Bureau
- Legislative Leaders
- Cass River Greenway, Friends of the Shiawassee River

# Great Lakes Project AG Strategy: Theory of Change

## Strategic Agricultural Conservation

### Setting Watershed Goals

- Data
- Research
- Monitoring
- Goal setting

### Site Specific Solutions

- Target practices & measure outcomes using sediment, nutrient & groundwater recharge calculators

### Innovative Incentives

- Alternative to USDA cost-share model
- Market-based incentives
- Pay-for-outcome performance
- County drainage system fee reductions

### Effective Policy & Practices

#### Partnerships with:

- State & Federal agencies
- Agricultural suppliers
- Universities
- Local communities

