

A close-up photograph of a person's hand holding a piece of green, feathery aquatic plant. The hand is wet, and the background shows a blurred lake and shoreline.

Proposal for professional services for
Development of a 5-Year implementation strategy for the management
of Indian Lake and its watershed, Cass County, Michigan

2022/23 Management Activities and Lake Update

Indian Lake, Cass County, MI

Barr Engineering Company
November 17, 2025



Indian Like Issues and Concerns

- 1. Nutrient and pollutant sources to Indian Lake**
- 2. Potential for severe or harmful algae blooms**
- 3. Aquatic vegetation extent and abundance in Indian Lake**
4. Extent of muck in the lake
5. Introduction and management of invasive species
6. Fishery management in the lake
7. Lake outlet and associated potential flooding of adjacent, downstream properties

Objectives to Address in First Five Years (2022-2027)



- **Reduce EWM and CLP frequencies of occurrence**
 - Whole lake fluoridone treatment followed by spot treatments
- **Maintain aquatic vegetation to support recreational use**
 - Maintain channels and dock access (harvesting)
 - Clean up floating plant fragments along shorelines (harvesting)
- **Assess and reduce, if necessary, nutrient loading**
 - Evaluate nutrient loading from the Mann Drain
 - Two years of detailed monitoring including flow and watershed delineations
 - Concept and engineering cost estimate in conjunction with EGLE (if necessary)
- **Develop Harmful Algal Bloom Risk and Response Plan**
 - Evaluate monitoring needs
 - Develop response plan

Five-Year Plan

Objective	Action	2022	2023	2024	2025	2026
1	Whole Lake fluoridone treatment to control invasive vegetation (EWM and CLP)	\$73,000	--	--	--	--
1	Spot herbicide treatments for invasive control	--	\$35,000	\$47,000	\$30,000	\$30,000
2	Harvesting for recreational support	\$2,000	\$4,000	\$4,000	\$4,000	\$4,000
3	Monitor Mann Drain for nutrient and sediment influx	--	\$15,000	\$15,000		
	Mann Drain improvement project (if necessary)	--	--	--	\$15,000	\$25,000
	Develop HAB response action plan		\$3,000	\$1,000	\$500	\$500
4	Bathymetric mapping of dredged areas to assess changes	--	--	--	\$10,000	--
5	Improve AIS signage and provide educational materials	--	\$2,000	--	--	--
1,2	Aquatic vegetation monitoring and management	\$ 10,000	\$11,000	\$12,000	\$13,000	\$14,000
3	Lake water quality monitoring	\$ 10,000	\$10,000	\$11,000	\$12,000	\$12,000
7	Lake level monitoring	--	\$5,000	\$500	\$500	\$500
ALL	Annual reporting and lake management support	\$ 12,000	\$12,000	\$12,000	\$13,000	\$13,000
	TOTAL	\$ 107,000	\$97,000	\$102,500	\$98,000	\$99,000

2022/2023/2024 Management Actions

- **Discontinued aeration**
 - No clear evidence that it was improving water quality
 - Unaffordable to manage aquatic plant community to the required level and continue aeration
- **Implemented whole lake fluoridone treatment for EWM and CLP control (2023)**
- **Purchase equipment and installed level loggers at the Mann Drain and Indian Lake**
 - Monitored flow and water quality at the outlet of the Mann Drain
 - Measured lake level for Indian Lake
- **Began development of a Harmful Algal Bloom strategy**
 - Recommending increased cyanobacteria and toxin monitoring
- **Continued monitoring the aquatic plant community and water quality in Indian Lake**

Indian Lake Aquatic Plant Management



Curly-leaf pondweed



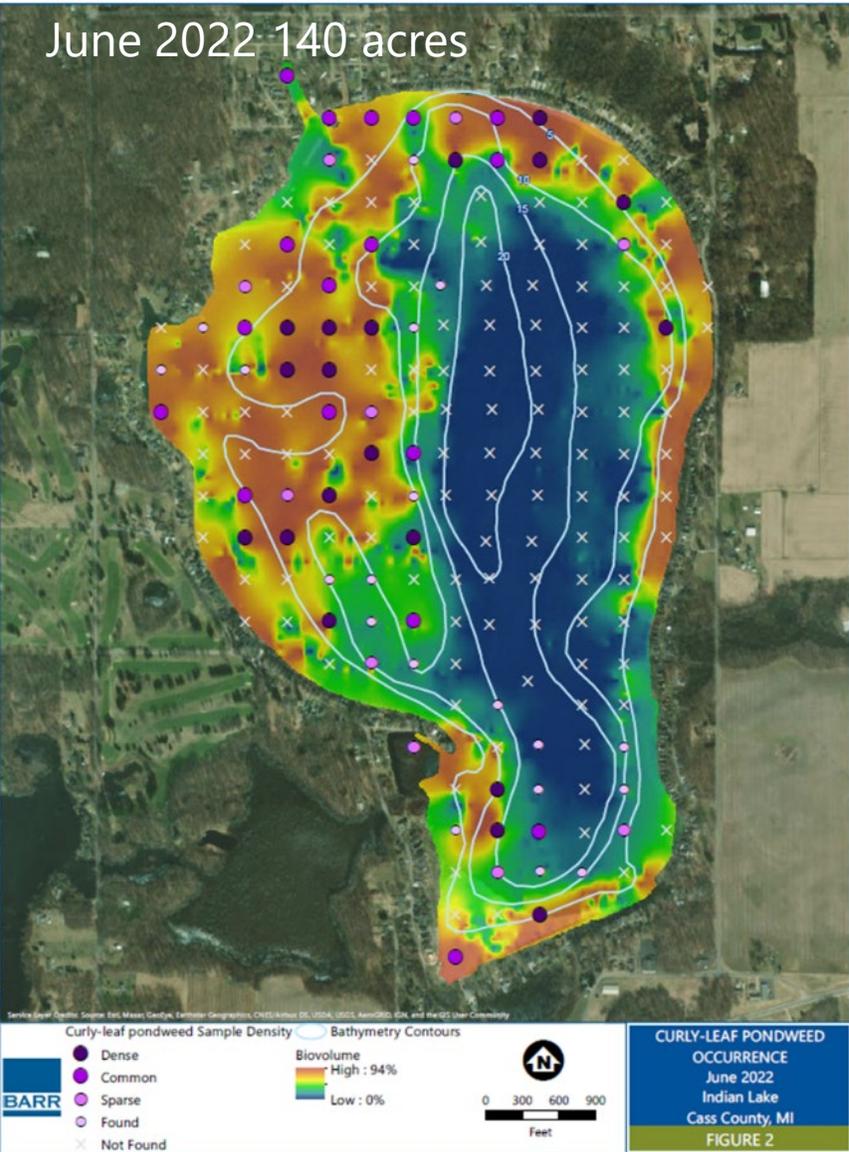
Indian Lake
August 27, 2021

Turion production and
sprouting

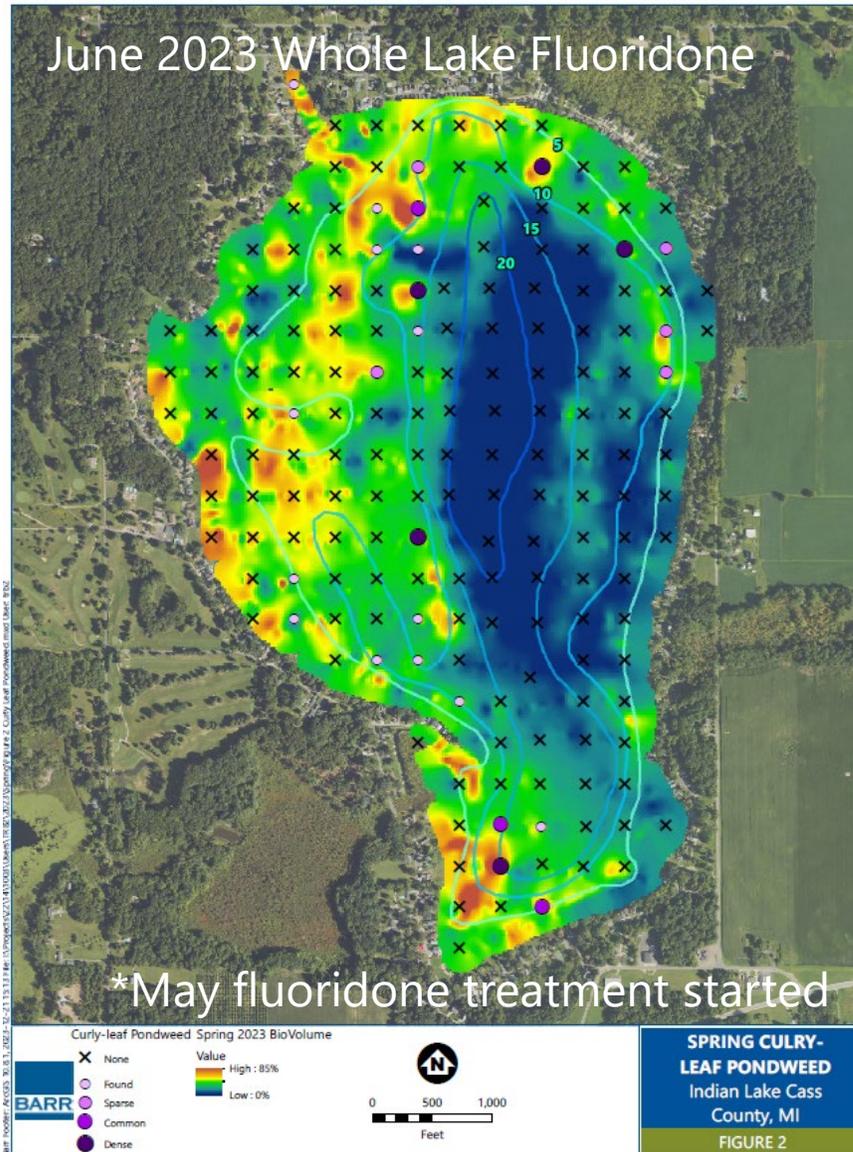


Curly-leaf Pondweed Extent in Indian Lake Spring 2022-2024

June 2022 140 acres



June 2023 Whole Lake Fluoridone



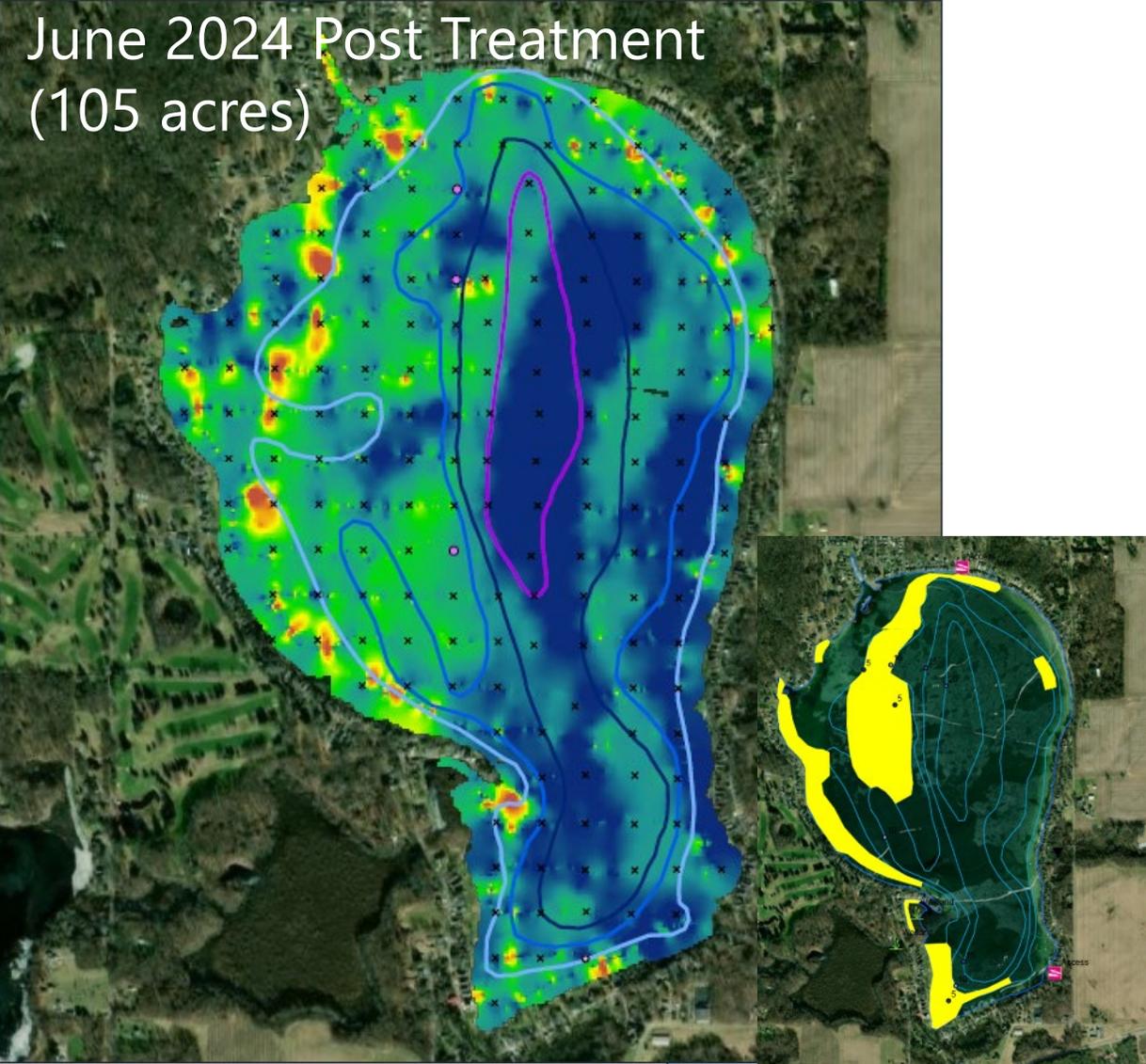
*May fluoridone treatment started

May 2024 105 acres

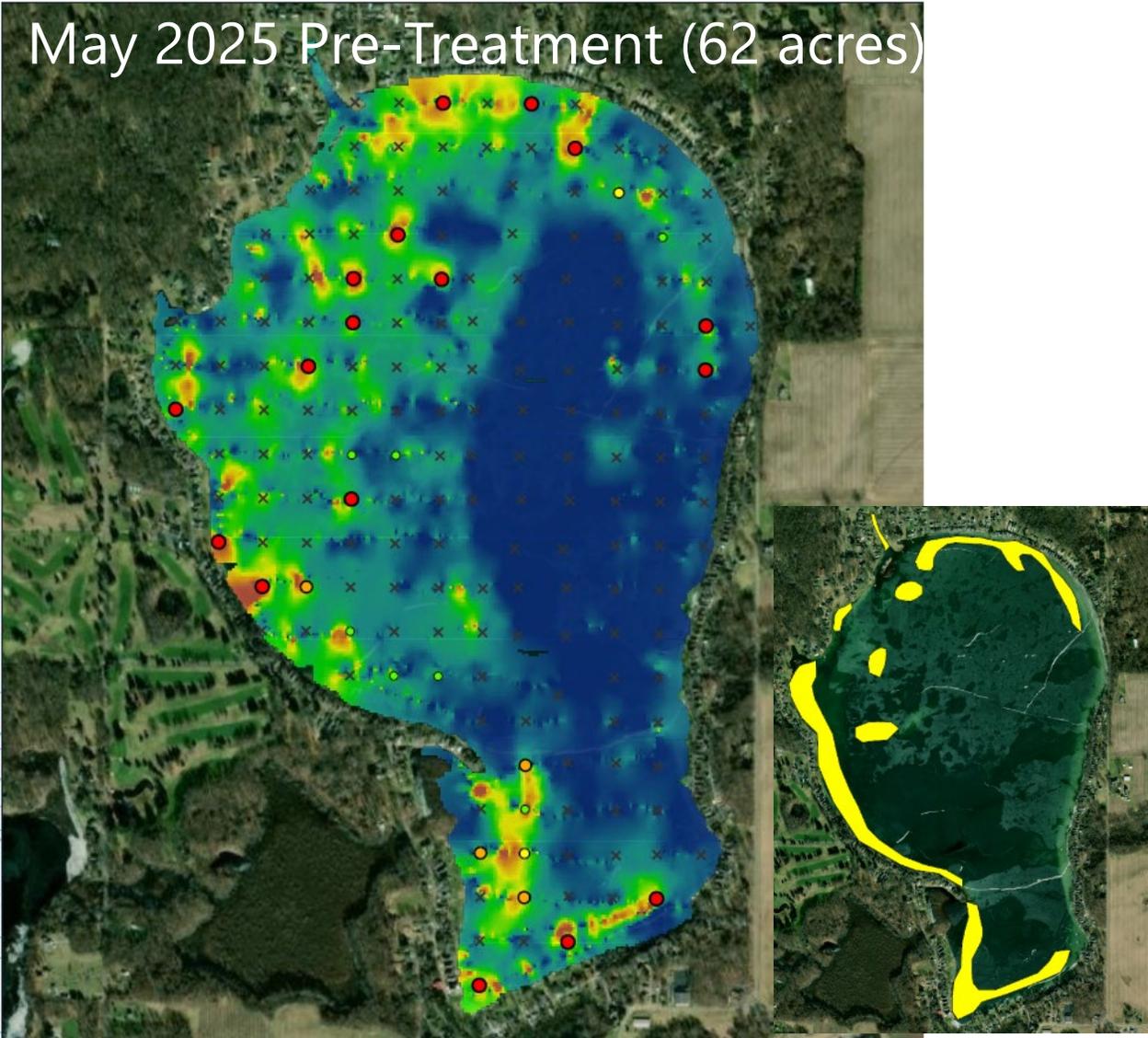


May 14, 2024 Curly-leaf Pondweed Treatment (diquat)

June 2024 Post Treatment
(105 acres)

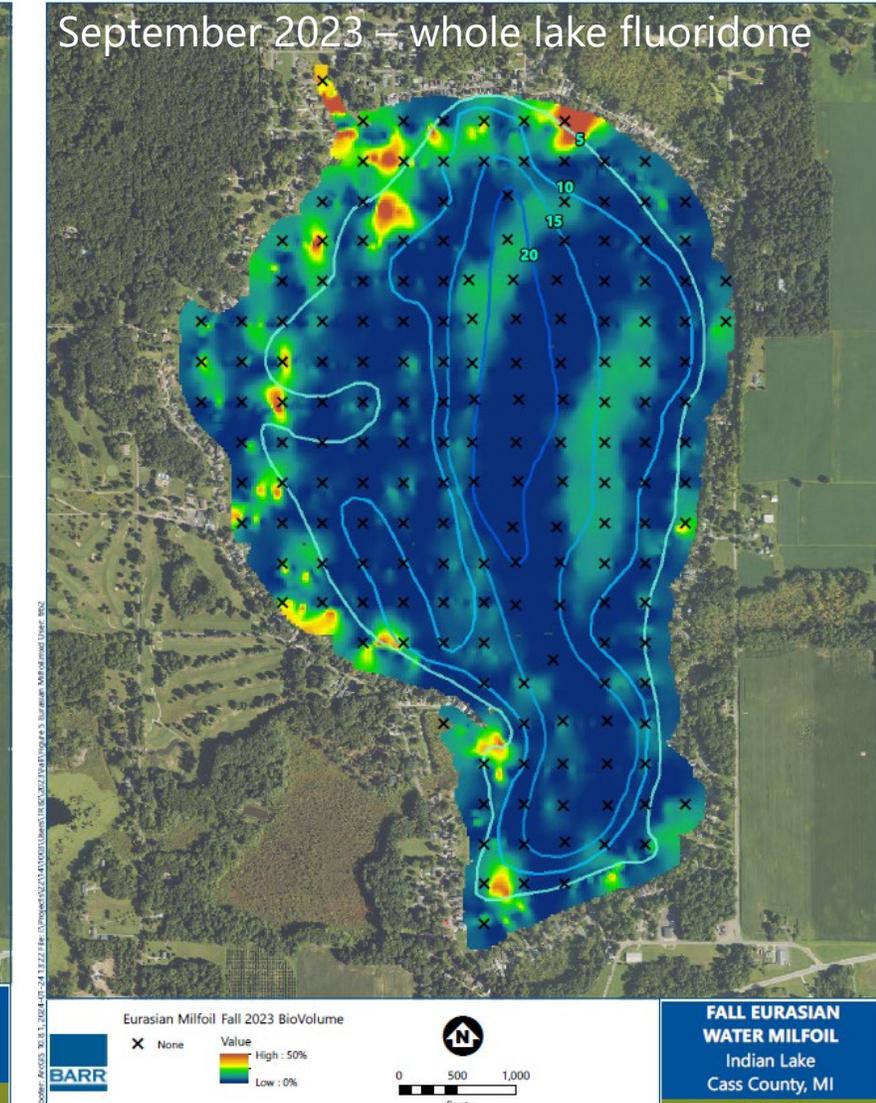
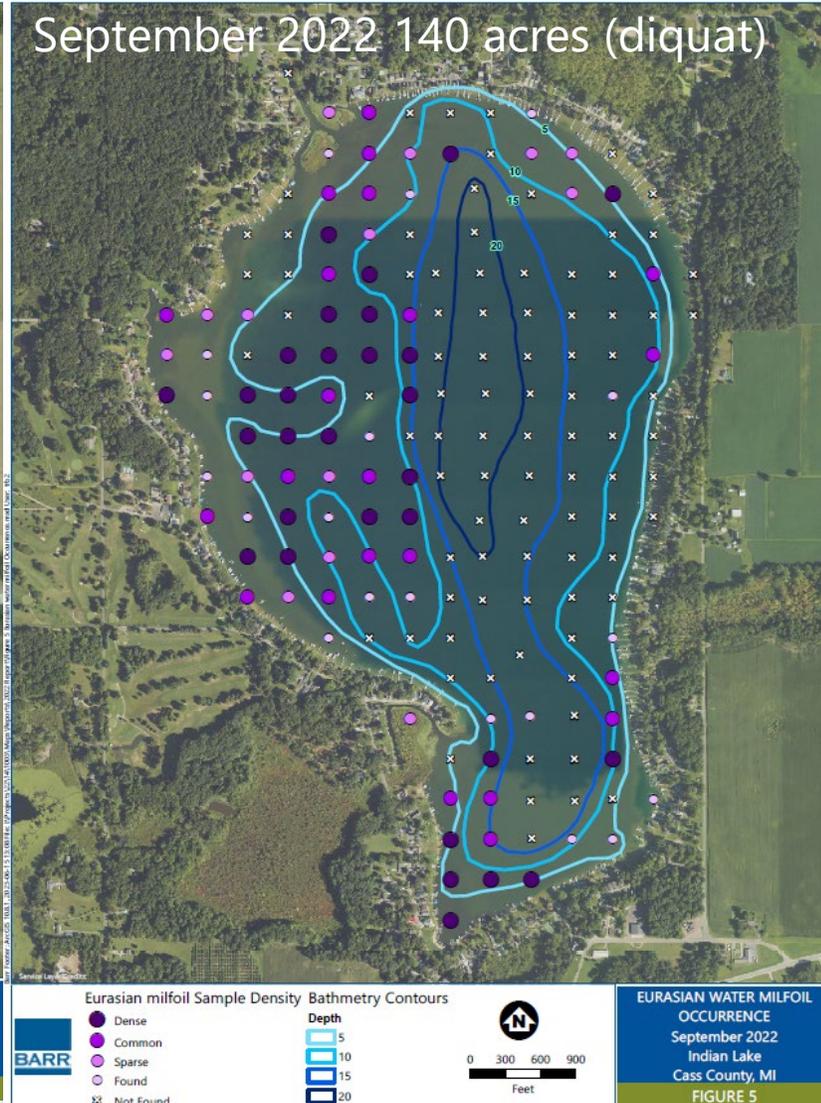
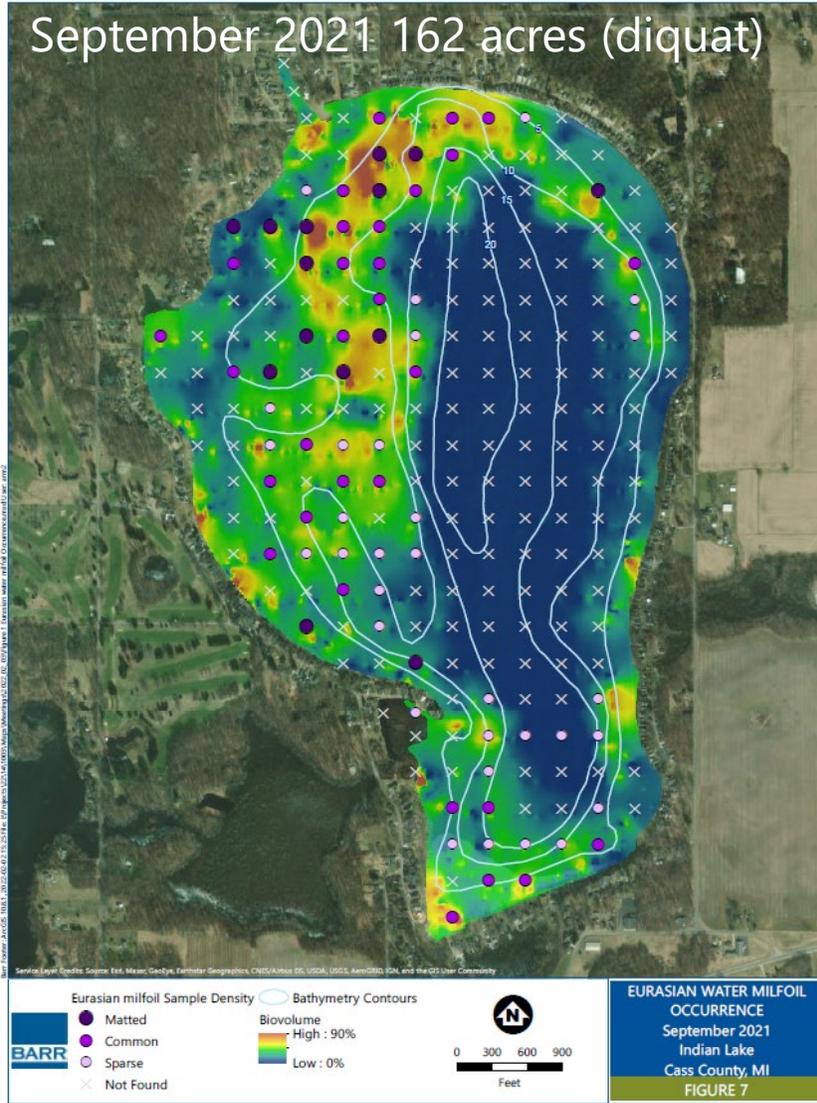


May 2025 Pre-Treatment (62 acres)

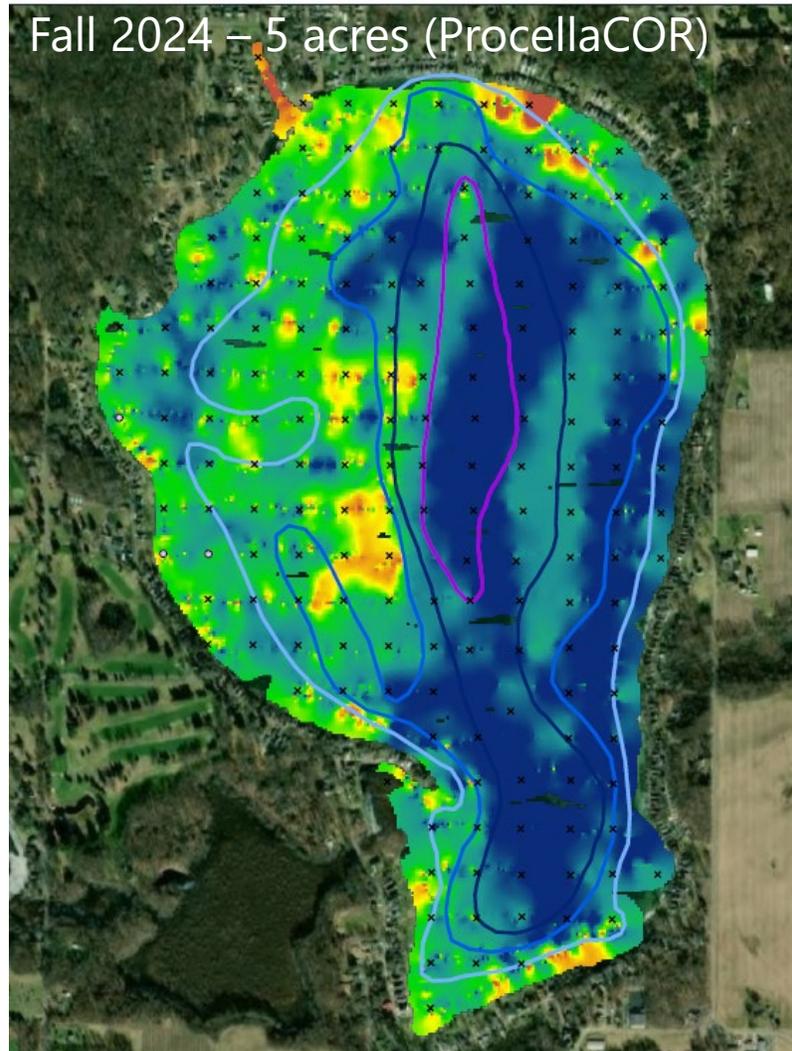
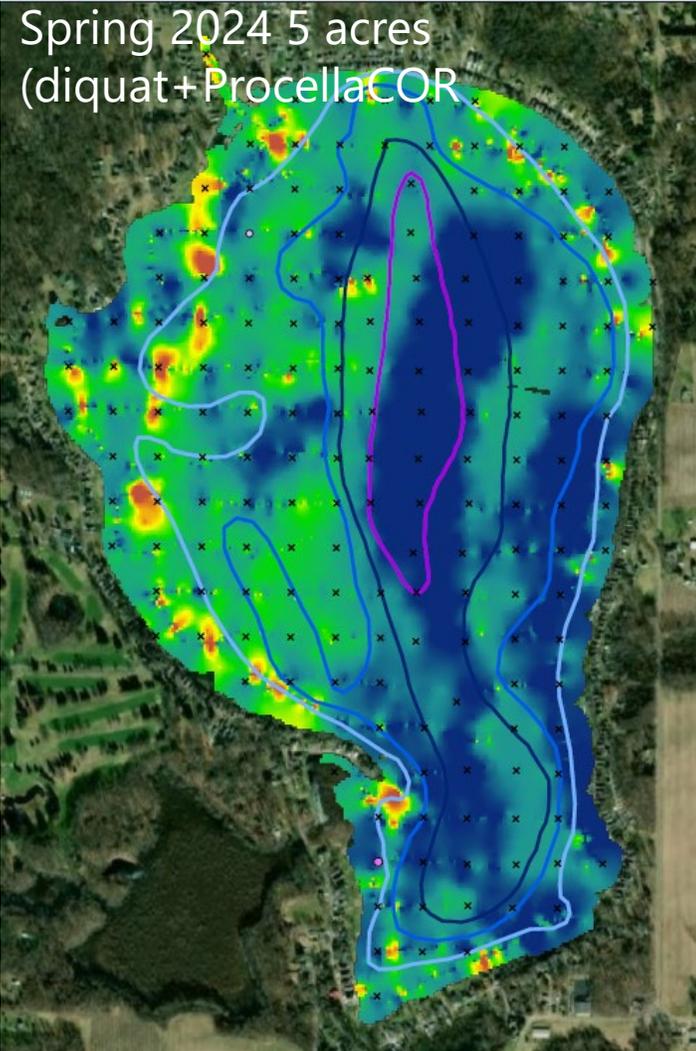


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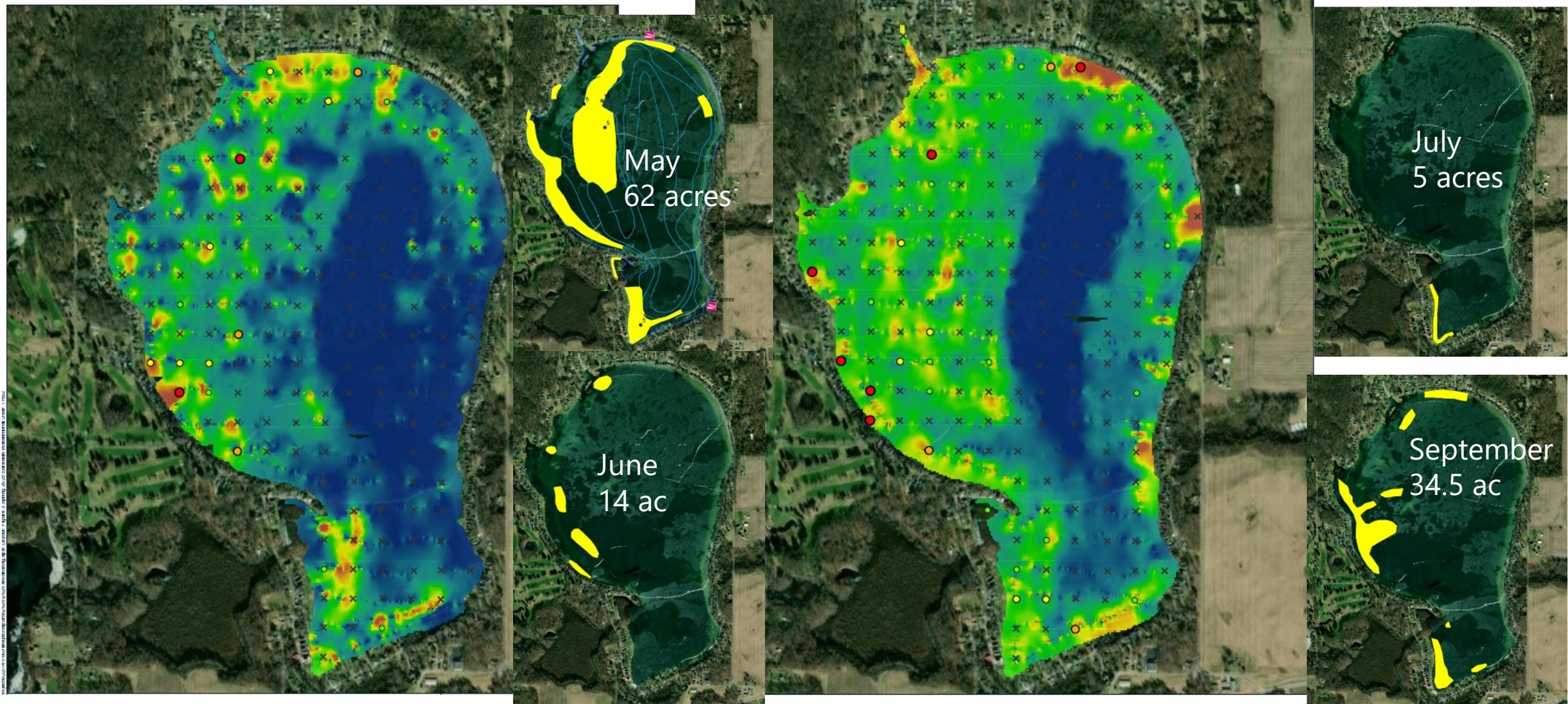
September Eurasian Watermilfoil 2021-2023



Eurasian Watermilfoil 2024-2025

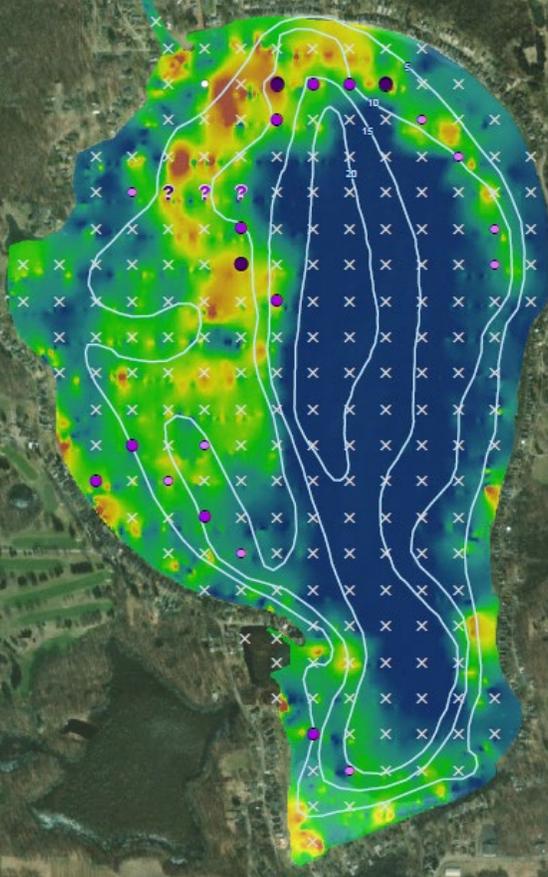


Eurasian Watermilfoil 2025



Starry Stonewort Fall 2021-2025

September 2021



STARRY STONEWORT OCCURRENCE
 September 2021
 Indian Lake
 Cass County, MI
FIGURE 8

Starry Stonewort Sample Density

- Matted ? , A
- Common ? , C
- Sparse
- None
- None Found

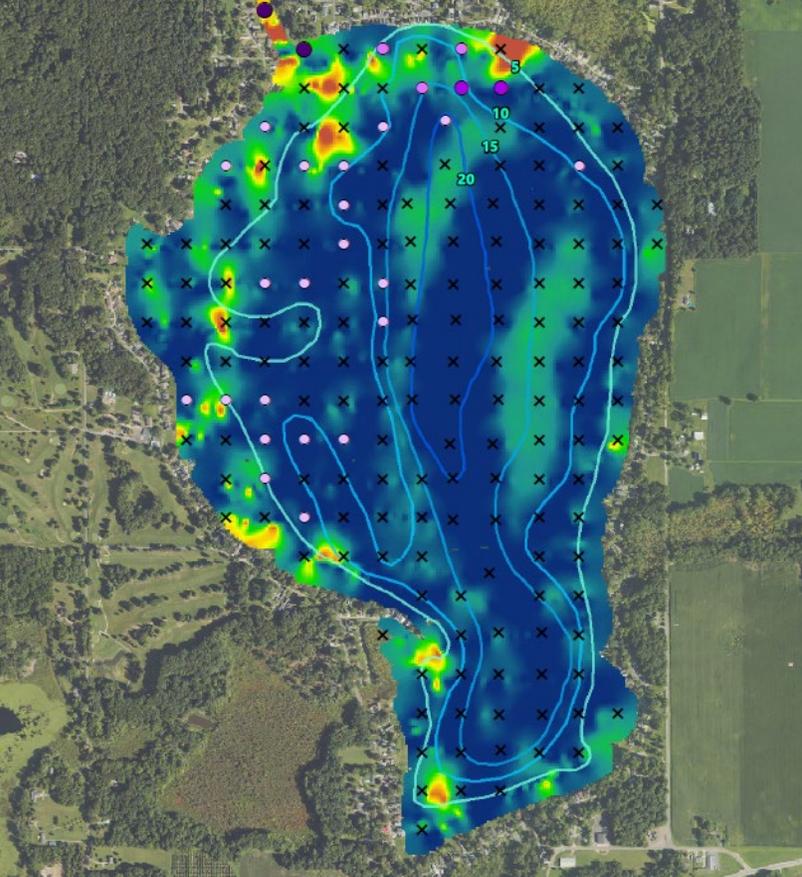
Bathymetry Contours

Biovolume

- High : 90%
- Low : 0%

0 300 600 900
 Feet

September 2023



FALL STARRY STONEWORT
 Indian Lake
 Cass County, MI
FIGURE 7

Starry Stonewort Fall 2023 BioVolume

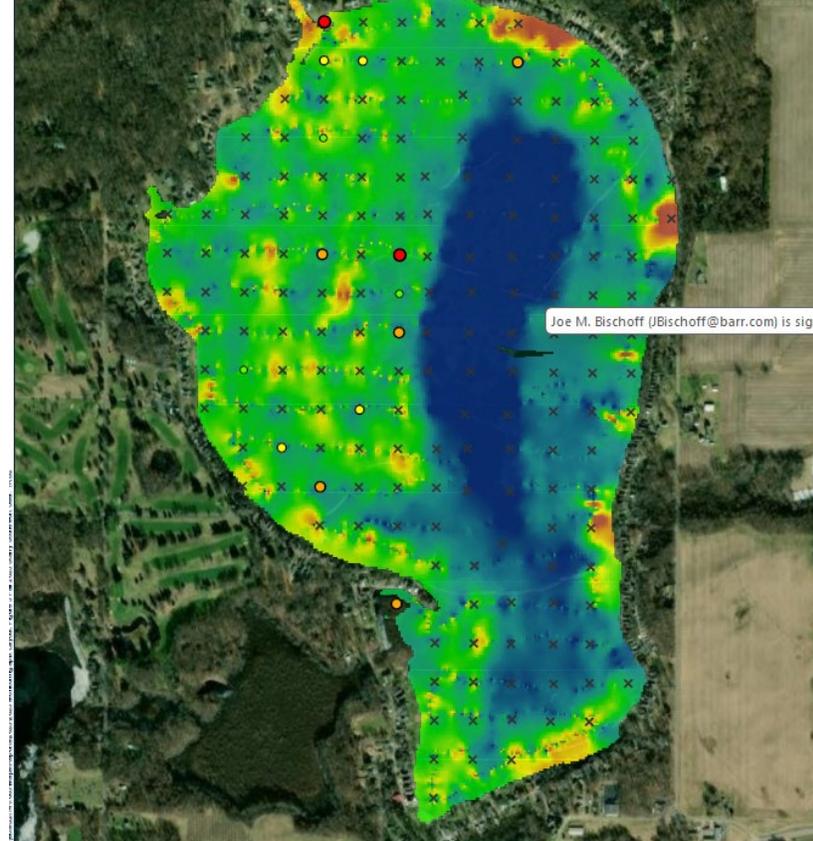
- None
- Found
- Sparse
- Common
- Dense

Value

- High : 50%
- Low : 0%

0 500 1,000
 Feet

September 2025



Starry Stonewort Vegetation Survey
 Fall 2025
 Indian Lake
 Cass County, MI
FIGURE 5

Fall BioVolume

Value

0 100

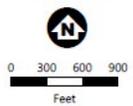
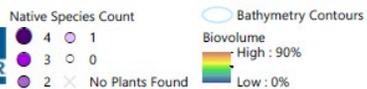
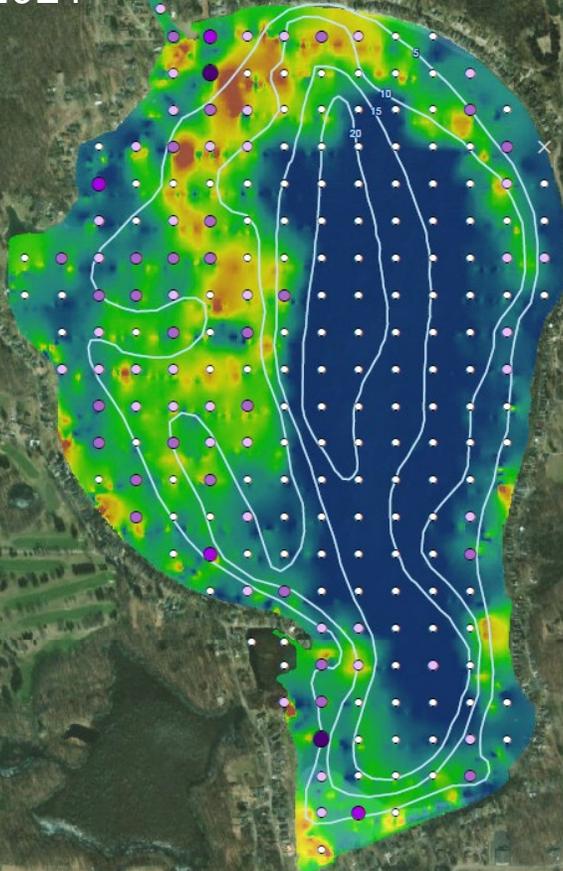
0 625 1,250
 Feet

Joe M. Bischoff (JBischoff@barr.com) is signed

BARR

Native Vegetation

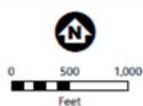
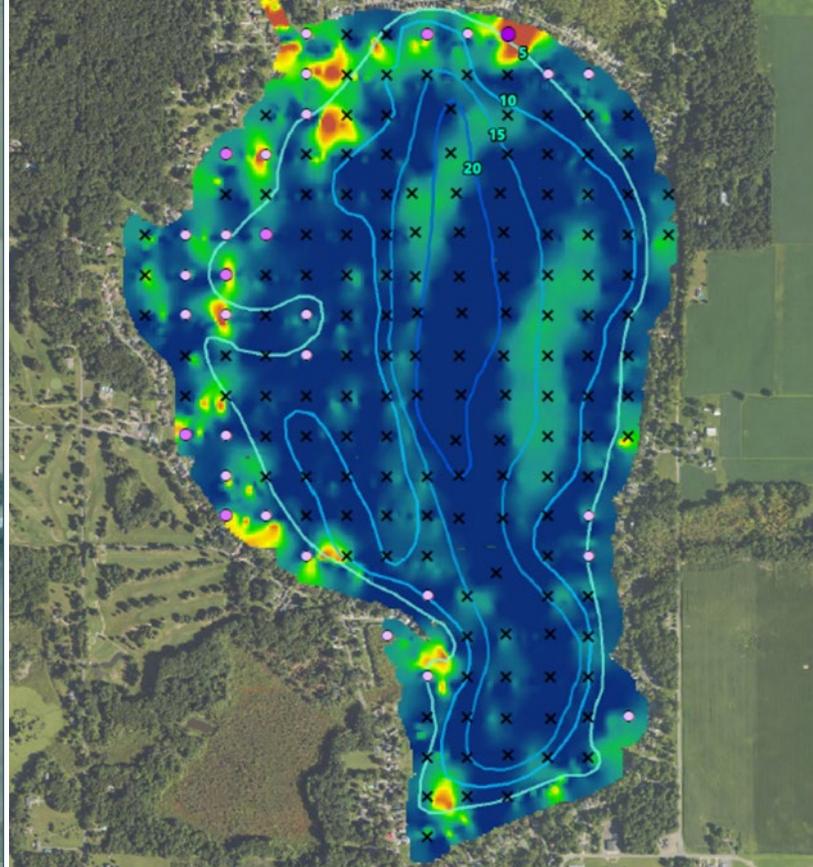
Fall 2021



NATIVE SPECIES COUNT
September 2021
Indian Lake
Cass County, MI

FIGURE 10

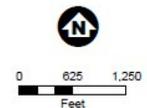
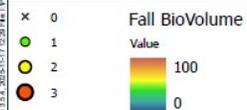
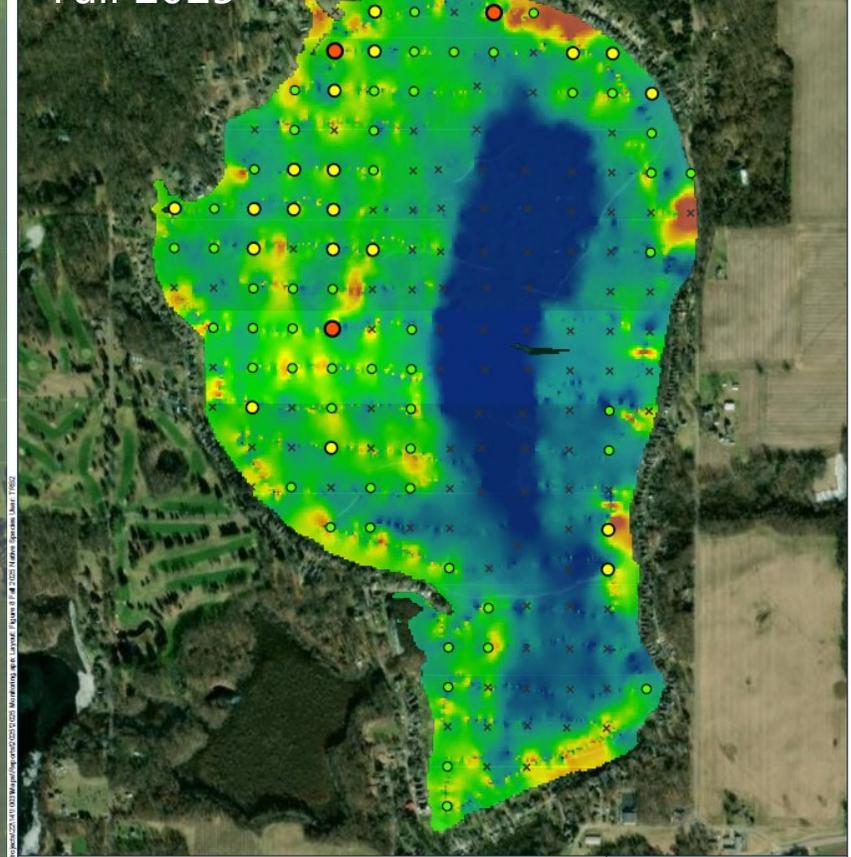
Fall 2023 Native Plants



FALLNATIVE SPECIES COUNT
Indian Lake
Cass County, MI

FIGURE 6

Fall 2025



Native Species Occurrence Vegetation Survey
Fall 2025
Indian Lake
Cass County, MI

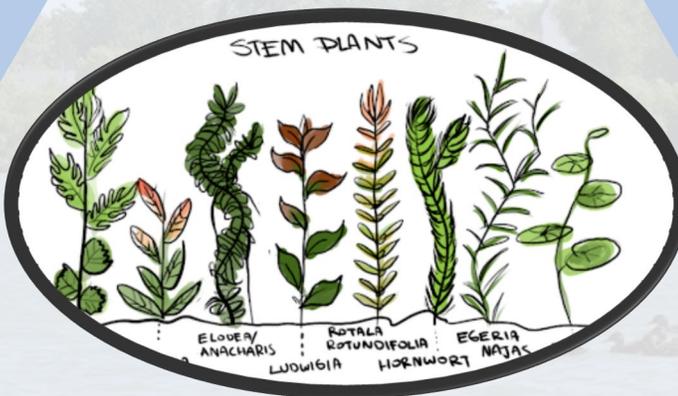
FIGURE 8

Balancing Aquatic Vegetation and Recreation in Shallow Lakes

why the plant dominated state?

Aquatic Life

TP < 60 ug/L
Chlorophyll-a < 20 ug/L
Secchi > 1 meter



Recreation

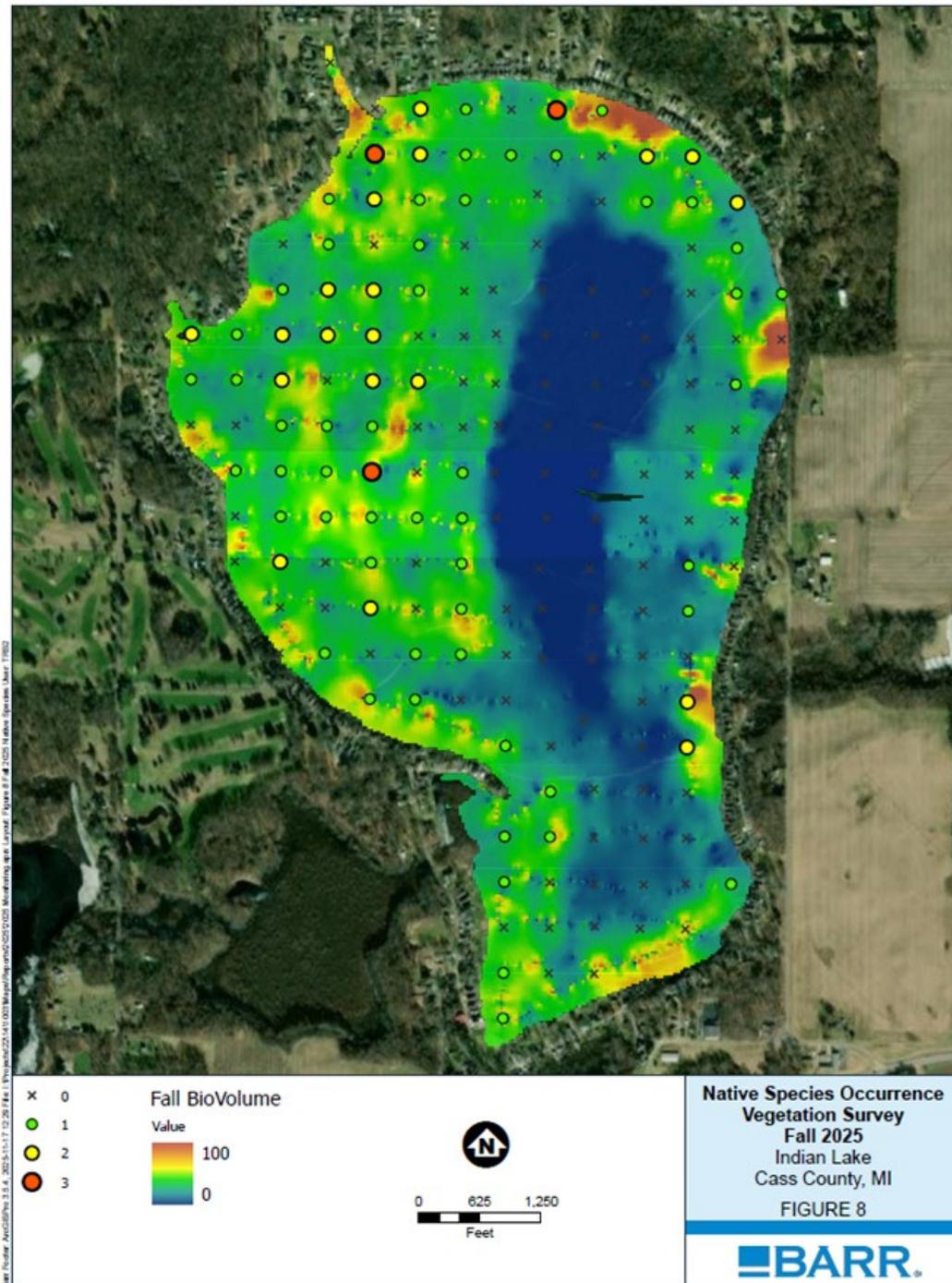
TP < 60 ug/L
Chlorophyll-a < 20 ug/L
Secchi > 1 meter

Ecosystem Services

Fish habitat
Waterfowl habitat
Biodiversity

Aquatic Plant Management – Next Steps

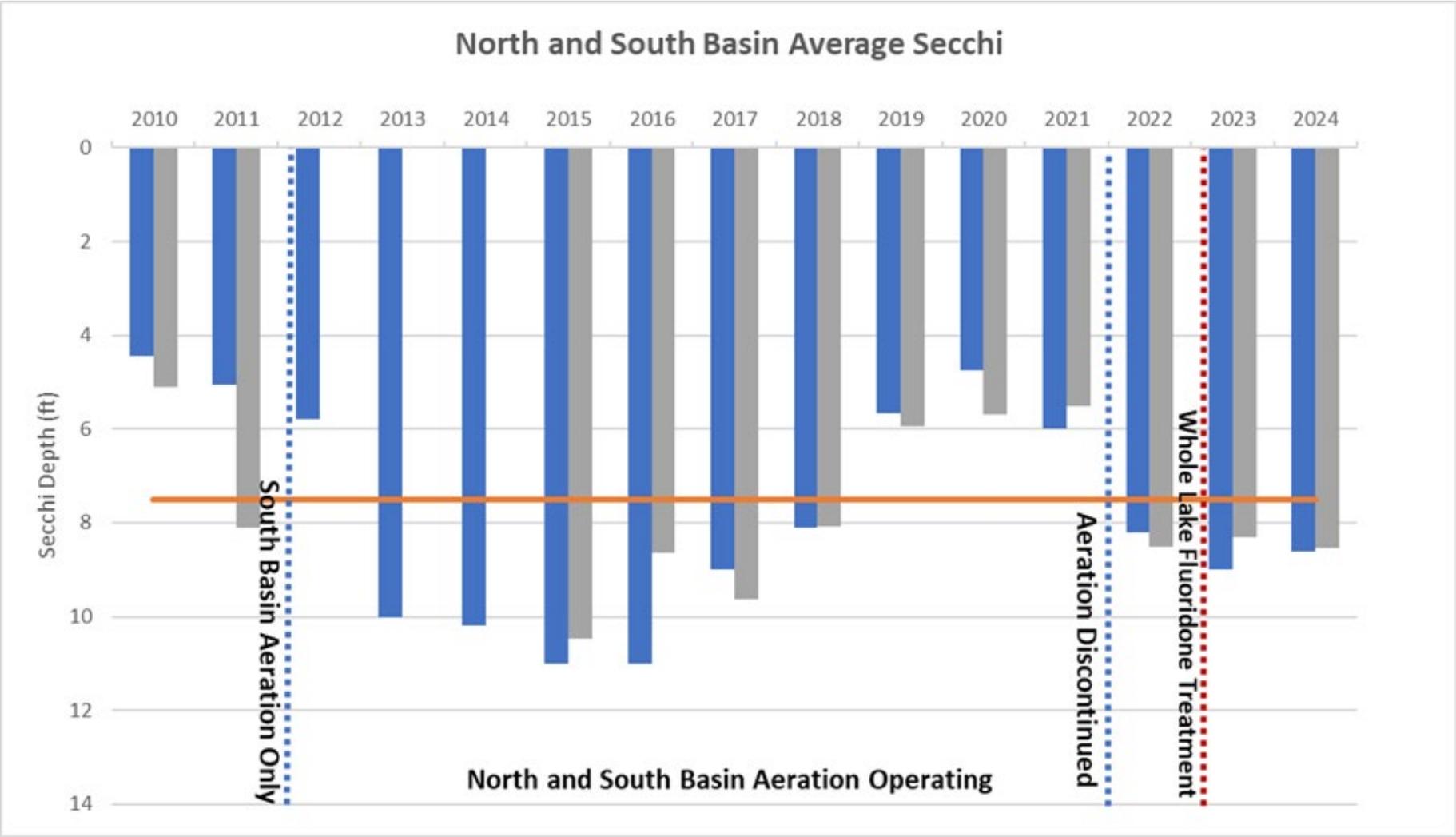
- **Some native plants/macroalgae thriving following fluoridone treatment**
 - Chara or Muskgrass, Illinois Pondweed, Wild Celery
- **Manage CLP and EWM to allow natives to repopulate**
 - EWM continues to expand following fluoridone treatment
 - Spring CLP/EWM spot treatments (starve sediments of turions)
 - Fall EWM treatments with systemic herbicide
 - *Potential summer starry stonewort copper treatments*
 - Harvesting CLP and starry stonewort (avoid EWM)
 - Fragment collection



Indian Lake Water Quality and Harmful Algal Blooms

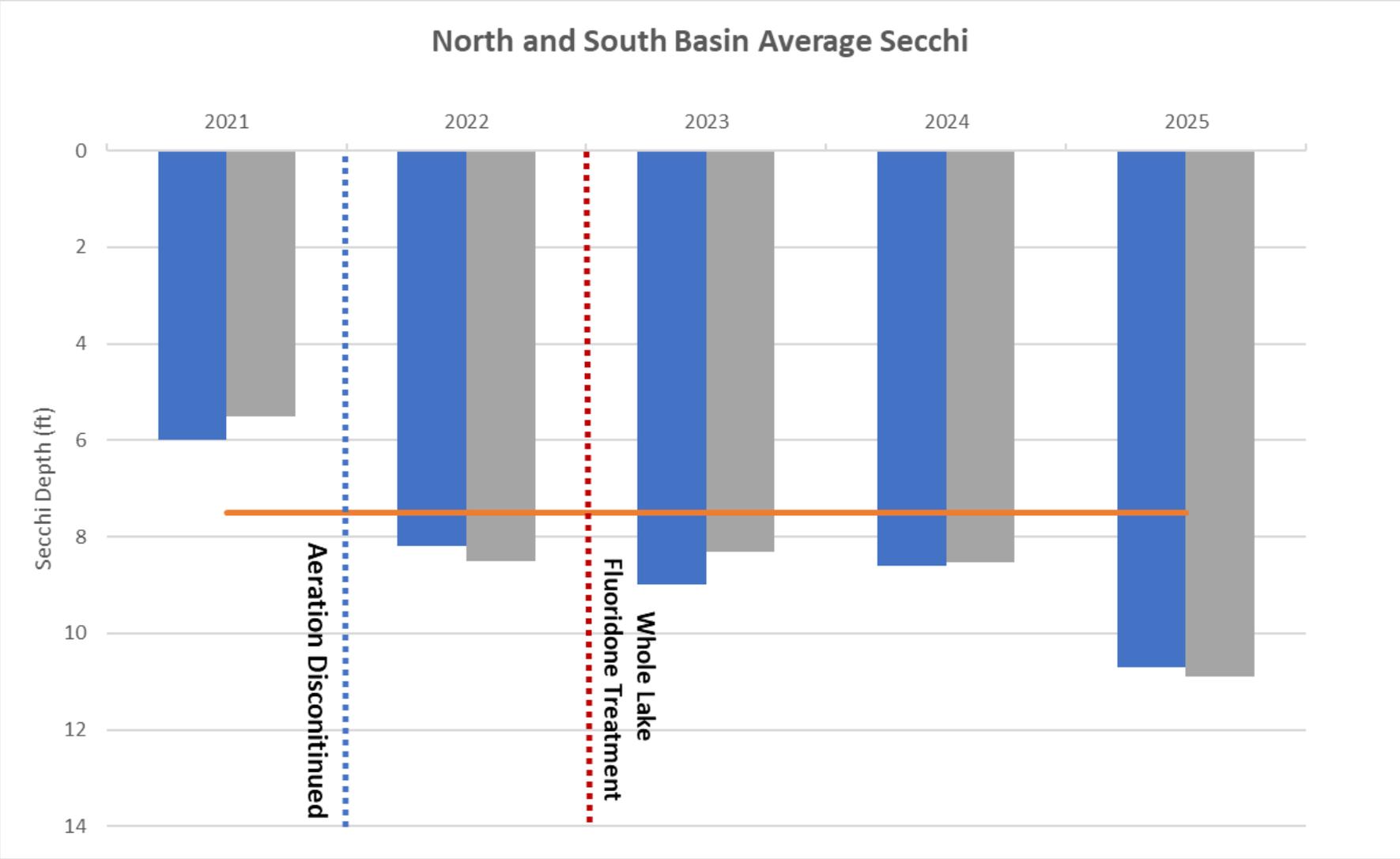


Secchi Depth – Water Clarity



Note that data prior to 2021 represent May, July, and September samples. After 2020, samples include May, June, July, August, and September. The orange line represents the boundary between mesotrophic and eutrophic conditions based on the Michigan Lakes Assessment.

Secchi Depth – Water Clarity



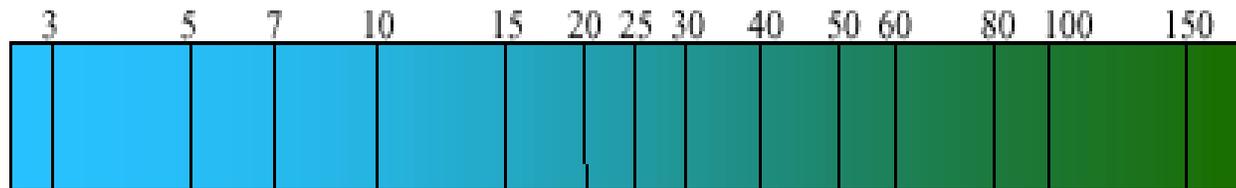
Relationship between TP and Transparency

Oligotrophic

Mesotrophic

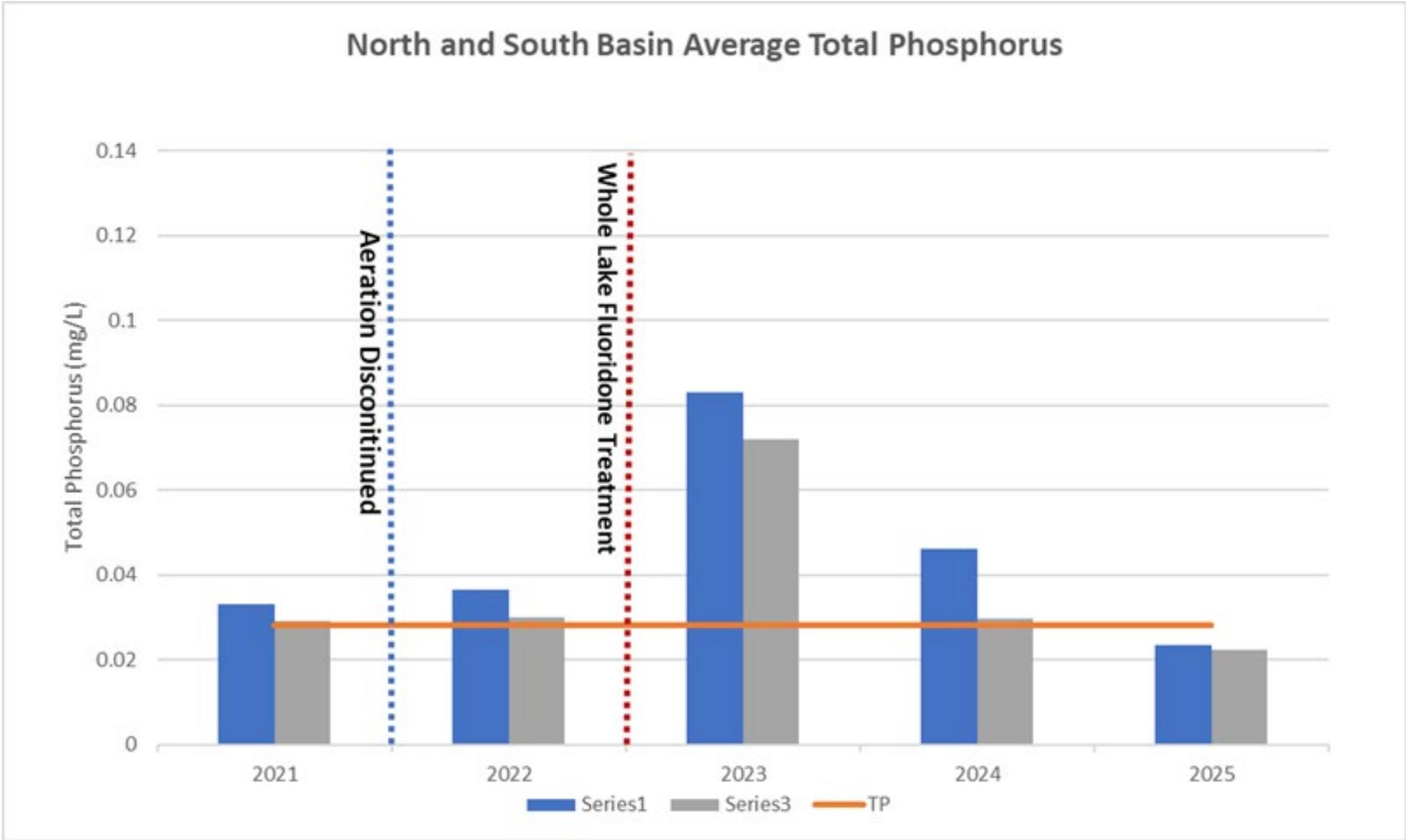
Eutrophic

Hyper-
Eutrophic

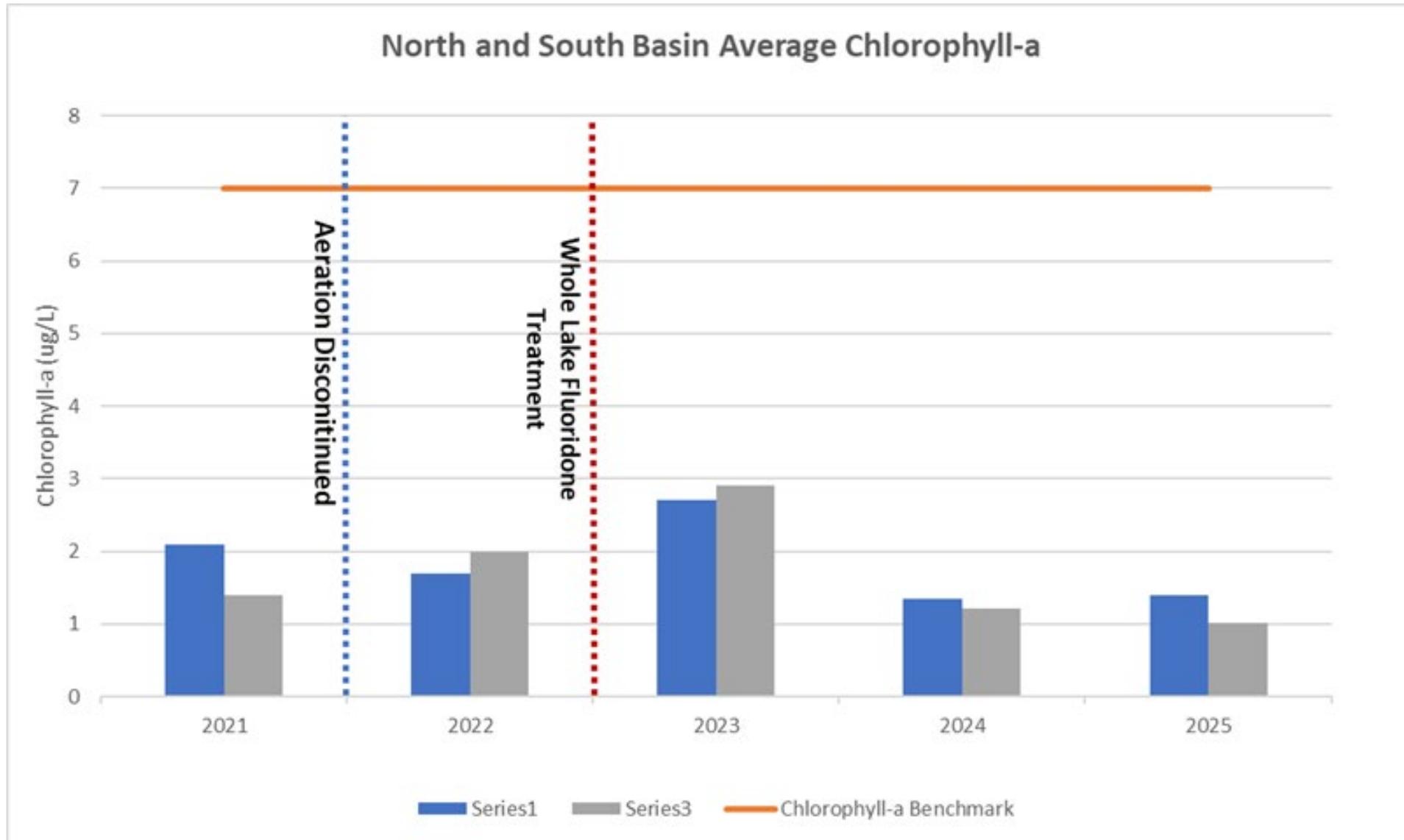


Total Phosphorus (µg/L)

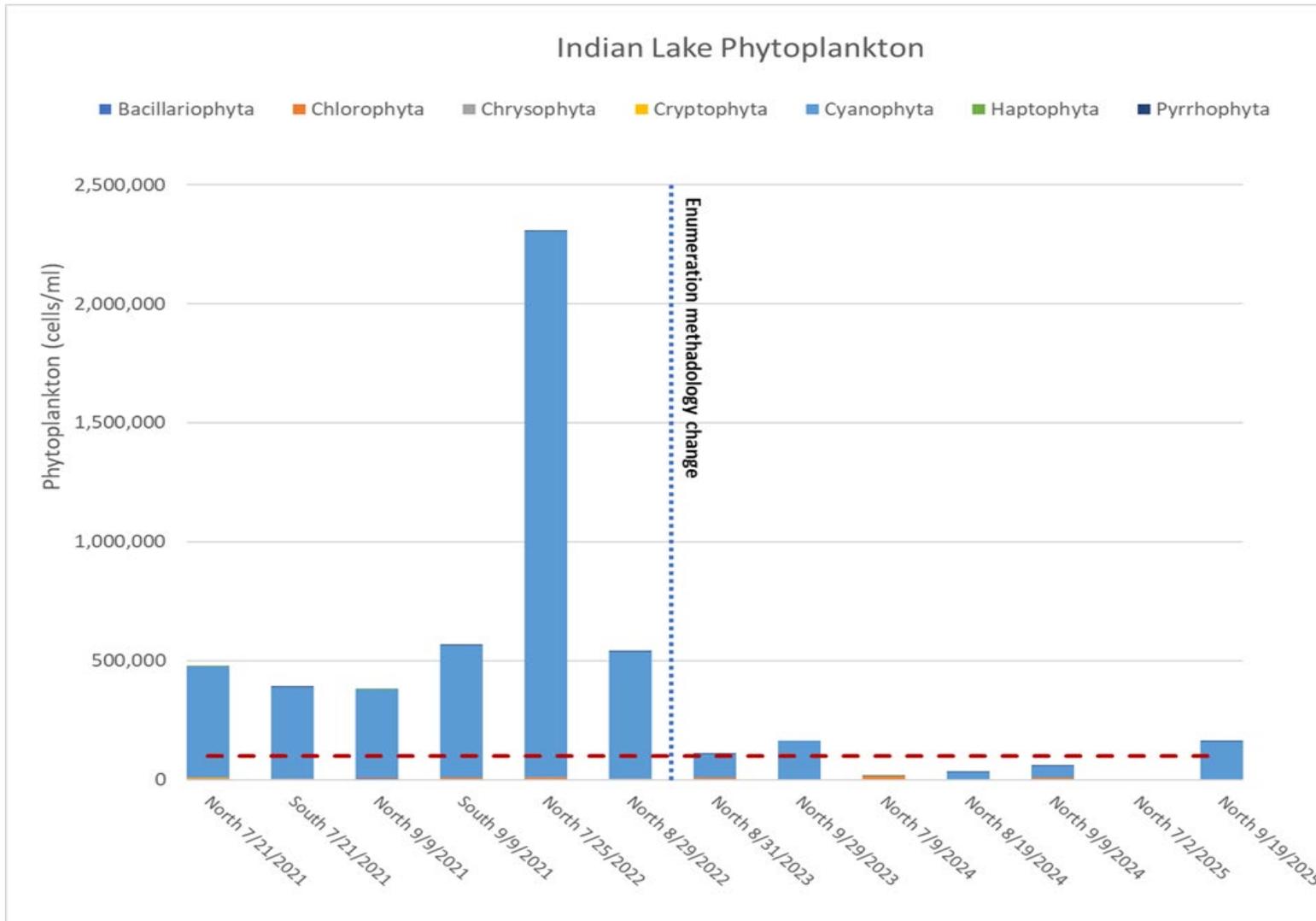
Total Phosphorus



Chlorophyll-a



Indian Lake Phytoplankton Community



Dominated by cyanobacteria

- Use pigments other than chlorophyll-a

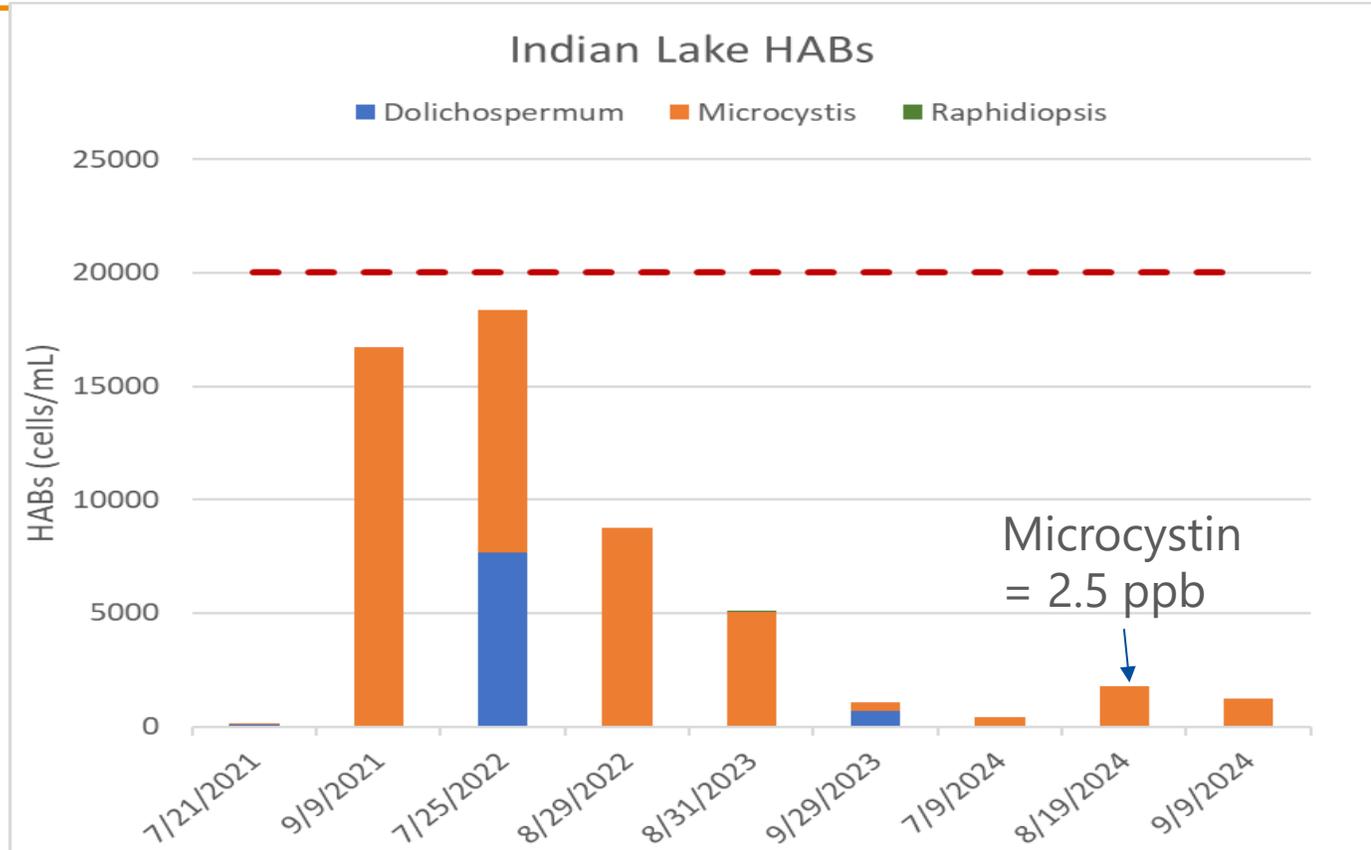
Cell counts historically exceed WHO risk guidelines

- Lots of picoplankton (small cells)
- Often dominated by species that do not produce toxins
- Toxin producing cyanobacteria occur at a concerning level

Potential for Severe or Harmful (Toxic) Algal Blooms



Photo: Angelo Ippilito October 29, 2022

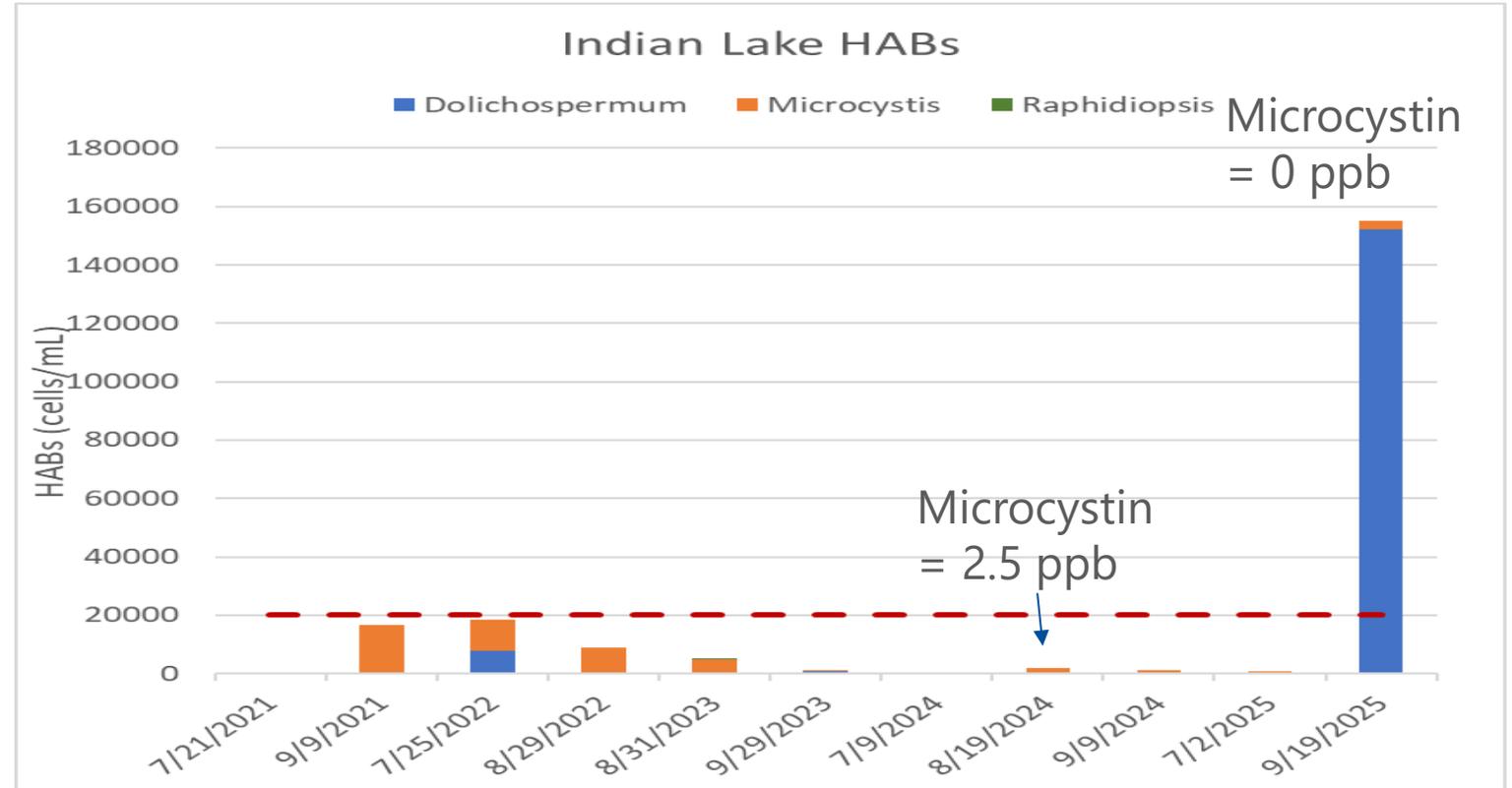


Severe ***Microcystis*** blooms likely occurred in **2011, 2012, 2013, 2014, 2015, 2018 and 2019** based on previous reports where cyanobacteria counts were greater than 25,000 cells/ml and *Microcystis* reported as the dominant species.

Potential for Severe or Harmful (Toxic) Algal Blooms



Photo: Angelo Ippilito October 29, 2022



Severe ***Microcystis*** blooms likely occurred in **2011, 2012, 2013, 2014, 2015, 2018 and 2019** based on previous reports where cyanobacteria counts were greater than 25,000 cells/ml and *Microcystis* reported as the dominant species.

HAB Action Plan



YouTube video on identifying Harmful Algal Blooms
(Cyanobacteria)



- **Learn to Identify blooms**
 - Jar test
 - Stick test
- **Monitoring**
 - PhycoTech in St. Joseph, MI
 - Cytobot rapid test
 - Microcystin test strips
 - Bloom timing (August/September)
- **When in doubt, stay out**
 - Know the risk

Potential Nutrient Sources to Indian Lake



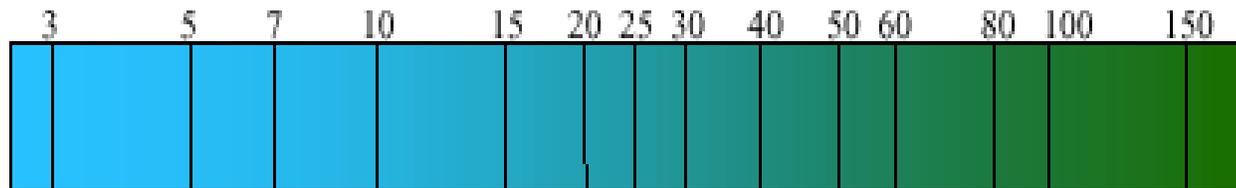
Relationship between TP and Transparency

Oligotrophic

Mesotrophic

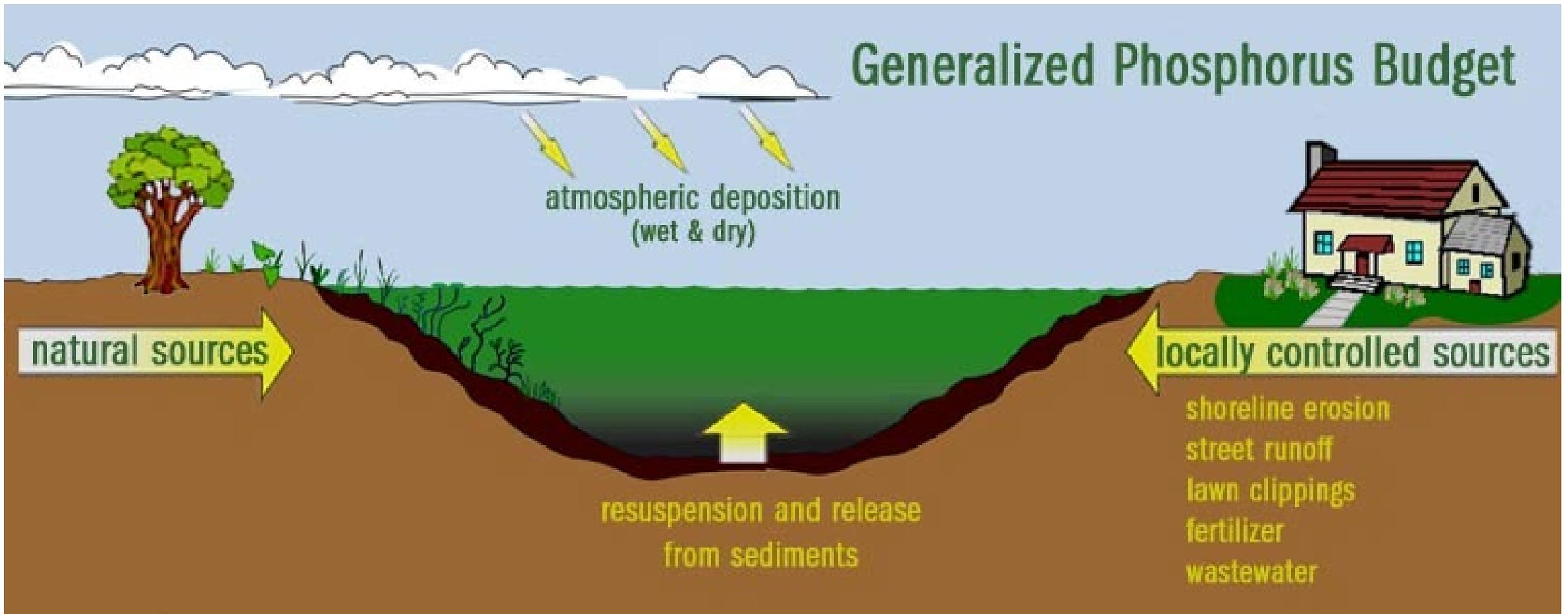
Eutrophic

Hyper-
Eutrophic



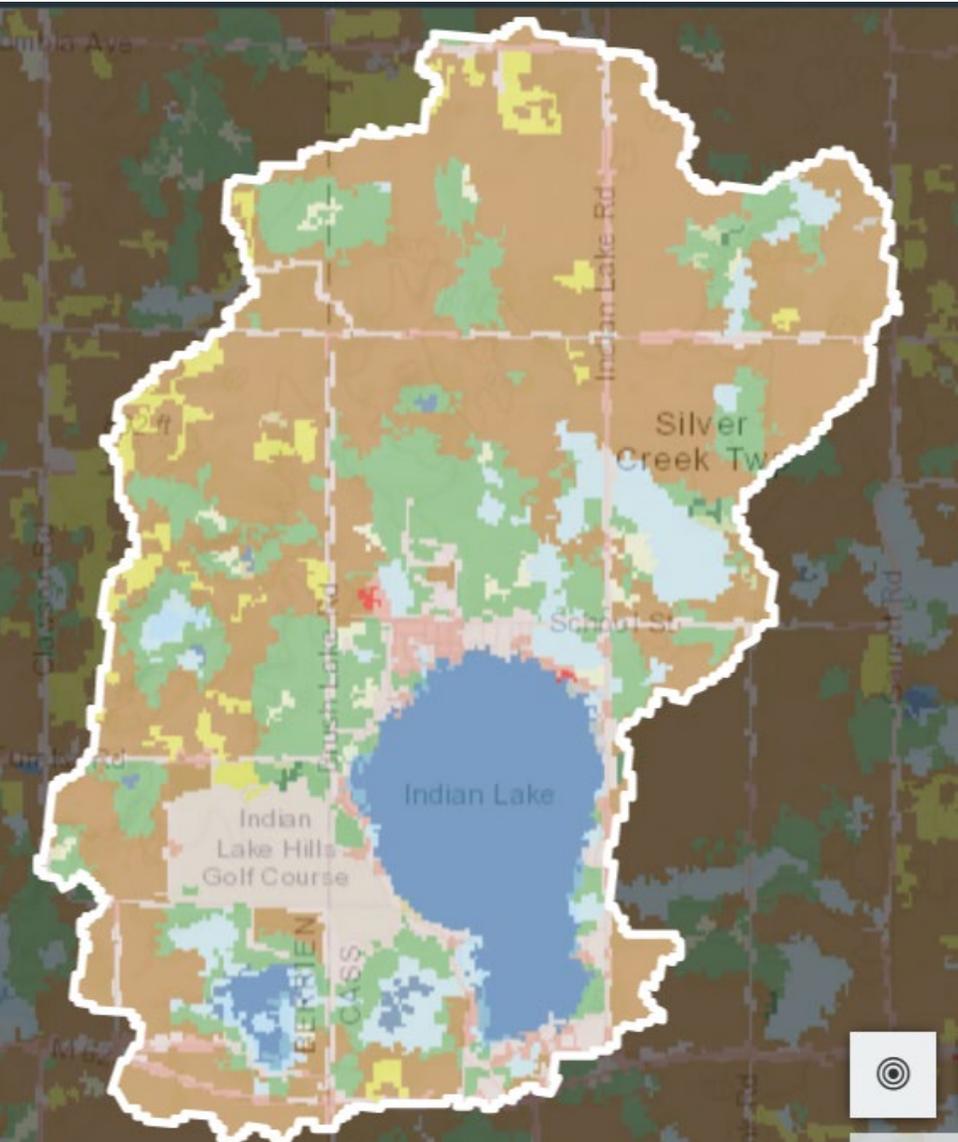
Total Phosphorus (µg/L)

Issue: Nutrient and Pollutant Sources to Indian Lake



$$\text{Lake P Concentration} = \text{Watershed} + \text{Internal} - \text{Sedimentation}$$

Indian Lake Watershed Land Use



Land cover distribution

Related Layer: National Land Cover Database Turn on

Source: National Land Cover Database (NLCD 2011) ⓘ

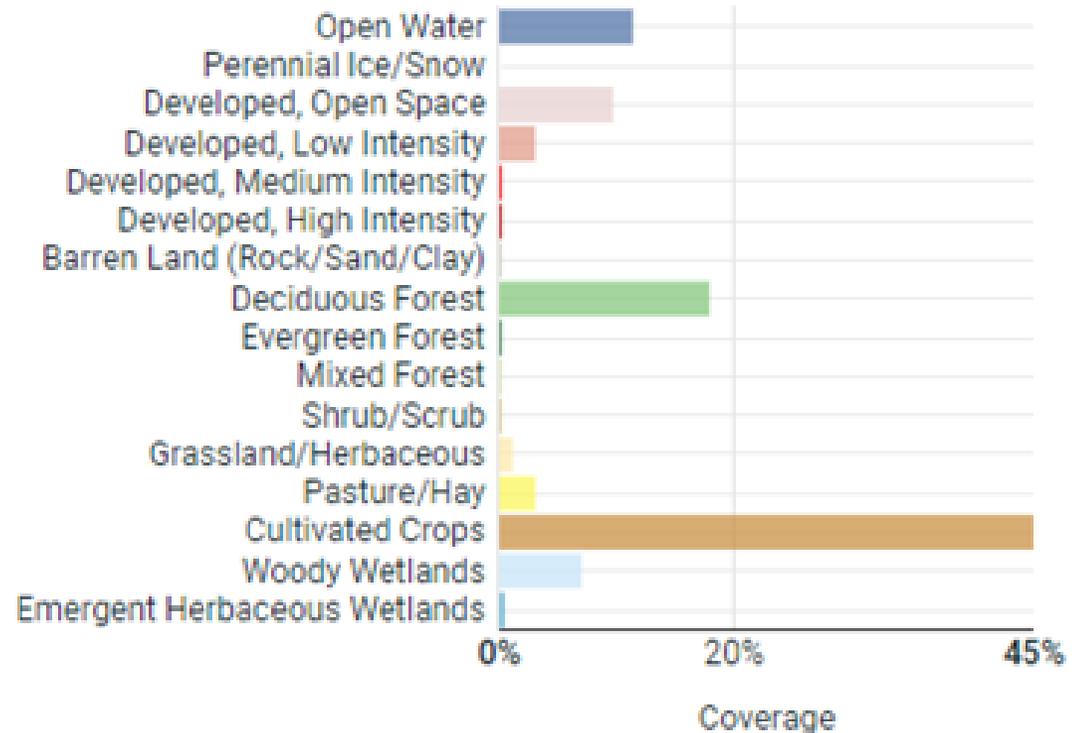
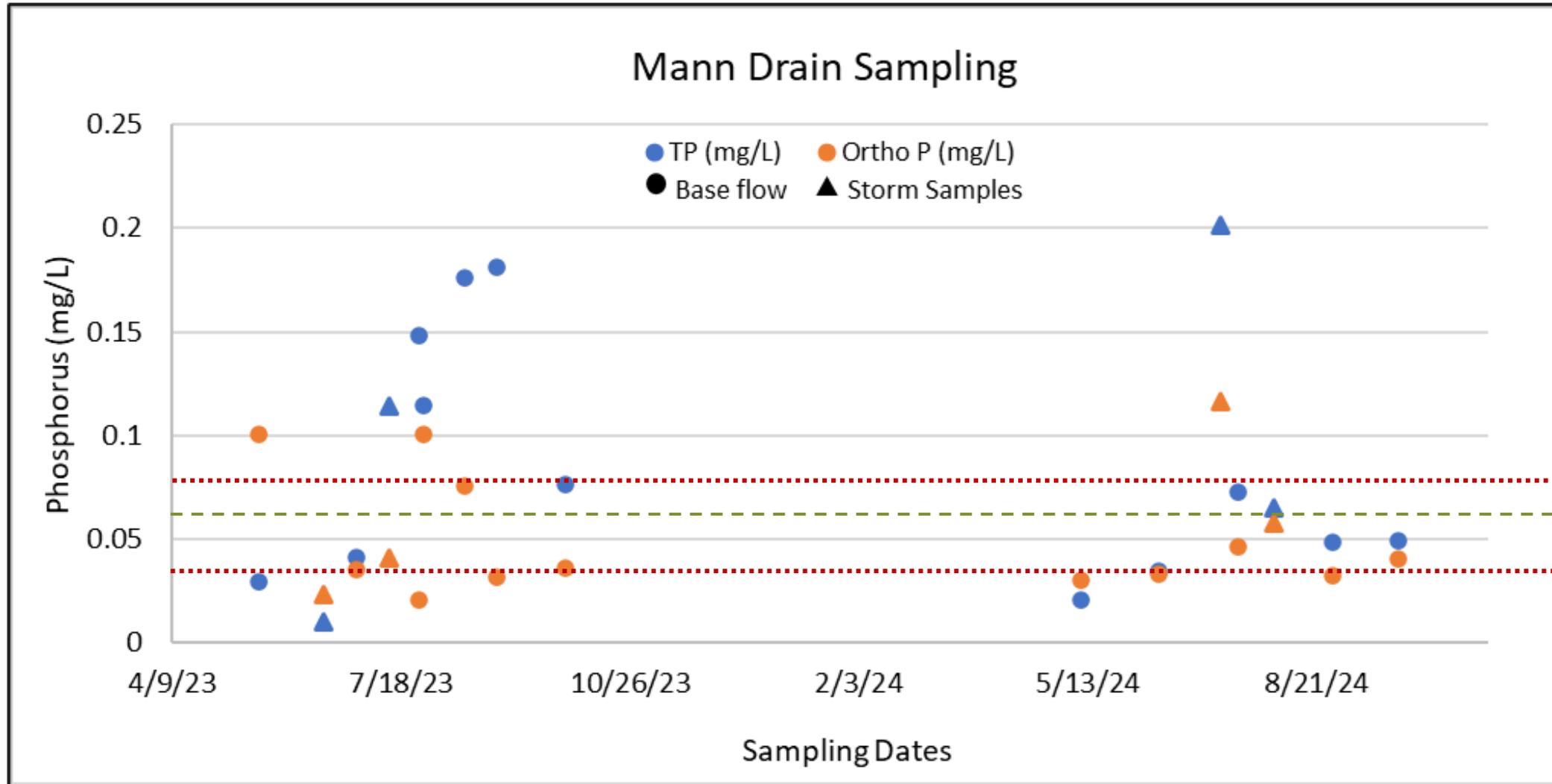


Figure 2. Land-cover distribution in the Indian Lake Watershed (modelmywatershed.org)

Mann Drain Total Phosphorus



Median: 69 ug/L; small streams: 77 ug/L; St. Joseph streams: 36 ug/L; Indian Lake Model: 59 ug/L

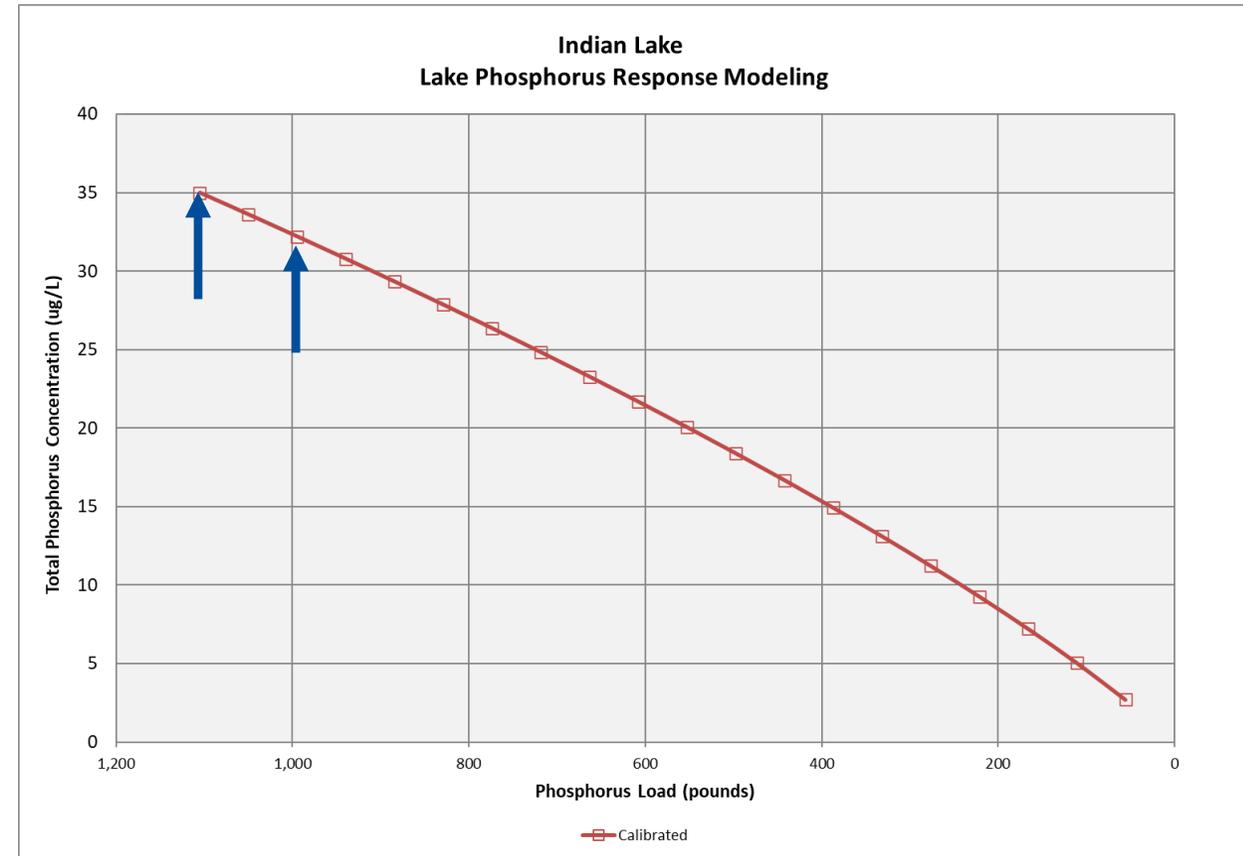
Watershed Load and Lake Response

- **Largest storm:**

- 2.8 inches rainfall
- 20 pounds P
- Raise lake P by 1.5 ug/L

- **Mann Drain TP Load**

- 284 pounds P; 30% of lake load
- 100 pound reduction = 3 ug/L change in lake



Mann Drain Summary

- **Mann Drain total phosphorus is moderately high during growing season**
 - Large proportion of soluble reactive phosphorus
 - Not likely impacting aquatic plant community in north end
- **TP load reductions would benefit Indian Lake**
 - Modest change in total phosphorus
- **Focus on reducing soluble reactive load**

Wetland Drainage to Indian Lake



2026 Indian Lake Action Plan



Five-Year Plan

Objective	Action	2022	2023	2024	2025	2026
1	Whole Lake fluoridone treatment to control invasive vegetation (EWM and CLP)	\$73,000	--	--	--	--
1	Spot herbicide treatments for invasive control	--	\$35,000	\$47,000	\$30,000	\$30,000
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3	Monitor Mann Drain for nutrient and sediment influx	--	\$15,000	\$15,000		
	Mann Drain improvement project (if necessary)	--	--	--	\$15,000	\$25,000
	Develop HAB response action plan		\$3,000	\$1,000	\$500	\$500
4	Bathymetric mapping of dredged areas to assess changes	--	--	--	\$10,000	--
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ALL	Annual reporting and lake management support	\$ 12,000	\$12,000	\$12,000	\$13,000	\$13,000
	TOTAL	\$ 107,000	\$97,000	\$102,500	\$98,000	\$99,000

2026 Schedule of Activities

Activity	Projected Date
Water Quality Monitoring (Indian Lake)	Week of May 15, 2026
Spring Vegetation Survey	Week of May 15, 2026
Curly-leaf pondweed and Eurasian watermilfoil treatment	Week of May 19, 2026
Water Quality Monitoring (Indian Lake)	June 2026
Water Quality Monitoring (Indian Lake)	July 2026 (phytoplankton sampling)
Water Quality Monitoring (Indian Lake)	August 2026 (phytoplankton sampling)
Water Quality Monitoring (Indian Lake)	September 2026
Fall Vegetation Survey	September 2026

Mann Drain Wetland Restoration



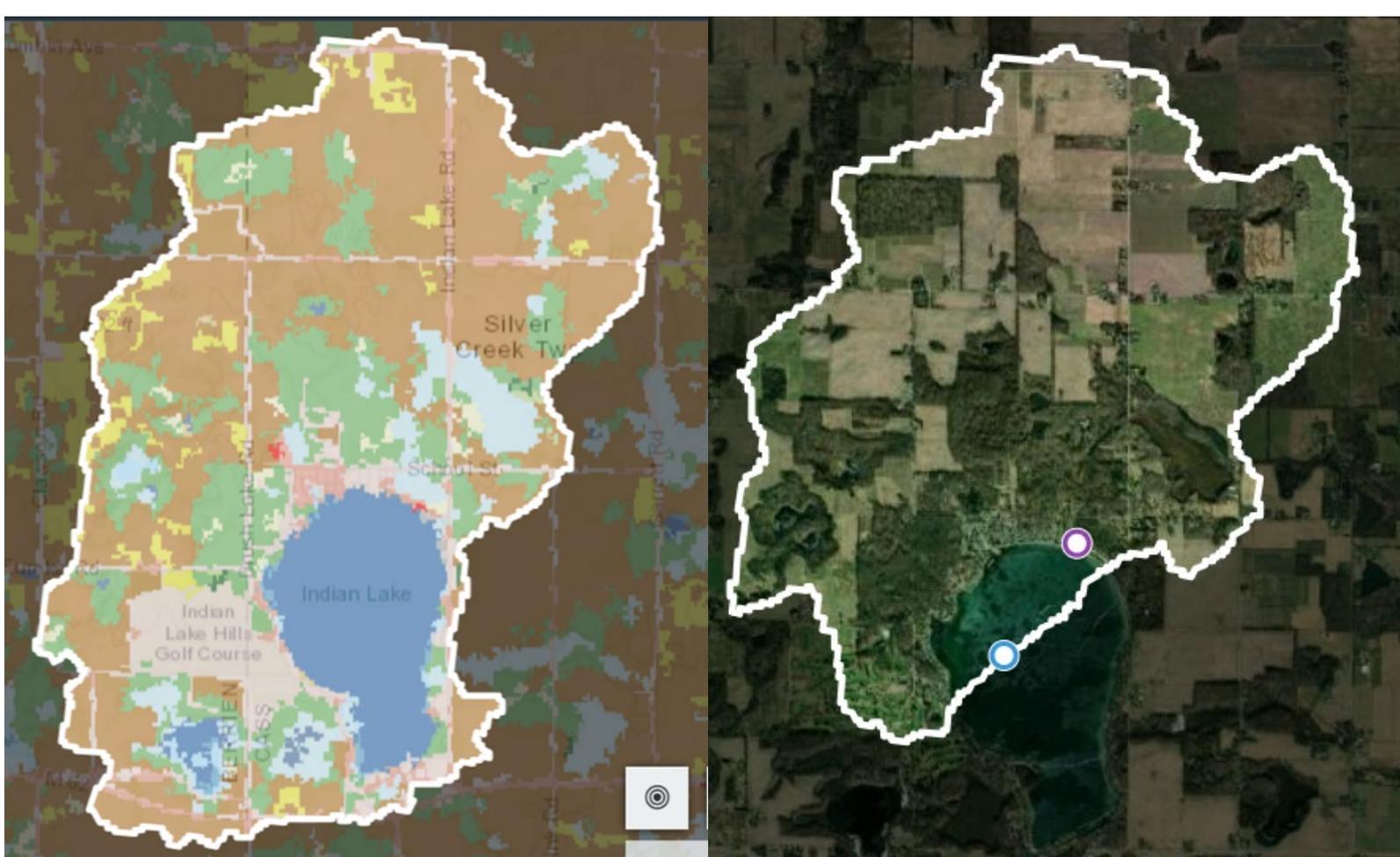
- **Objective:** Reduce sediment loading from Mann Drain to *protect* water quality
- **Restoration Plan Development Steps**
 - Develop conceptual restoration plans
 - Desktop review and site visit
 - Develop concepts for restoration (channel restoration, wetland restoration)
 - Use concept plans to identify grant opportunities and permits
 - Restoration costs
 - \$30,000 to \$150,000+
- Bring work plan to ILGLB (\$15,000)

Other Tasks – Survey Outlet



- Survey outlet channel
 - Control elevation
 - Tie to lake level

Other Tasks – Delineate subwatershed



- Subwatersheds
 - P sources
 - Drainage patterns
 - On-line tools limited
 - County LiDAR data

2027 -2031 Indian Lake SAD 5 Year Plan



Five Year Plan for Indian Lake, Cass County, MI

Prepared for
Indian Lake Improvement Association

September 8, 2021

- **Plan for 2027 – 2031 Activities**
 - *Water quality monitoring*
 - *HAB monitoring and action plan (Task Force)*
 - *Vegetation monitoring*
 - *Herbicide applications*
 - *Harvesting management*
 - **Other**
 - Mann Drain wetland restoration
 - watershed nutrient reduction projects
 - Signage (AIS, fisheries, etc.)
 - Shorelines

Action Items

- Approve 2026 monitoring plan
- Direct Barr to develop work order for Mann Drain Project
- Direct Barr to develop work order for subwatershed delineation and outlet survey
- Start planning for 2027-2031 SAD and 5-year Plan

Questions?

