



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

2023 Management Activities

Indian Lake, Cass County, MI

Barr Engineering Company
May 8, 2023



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

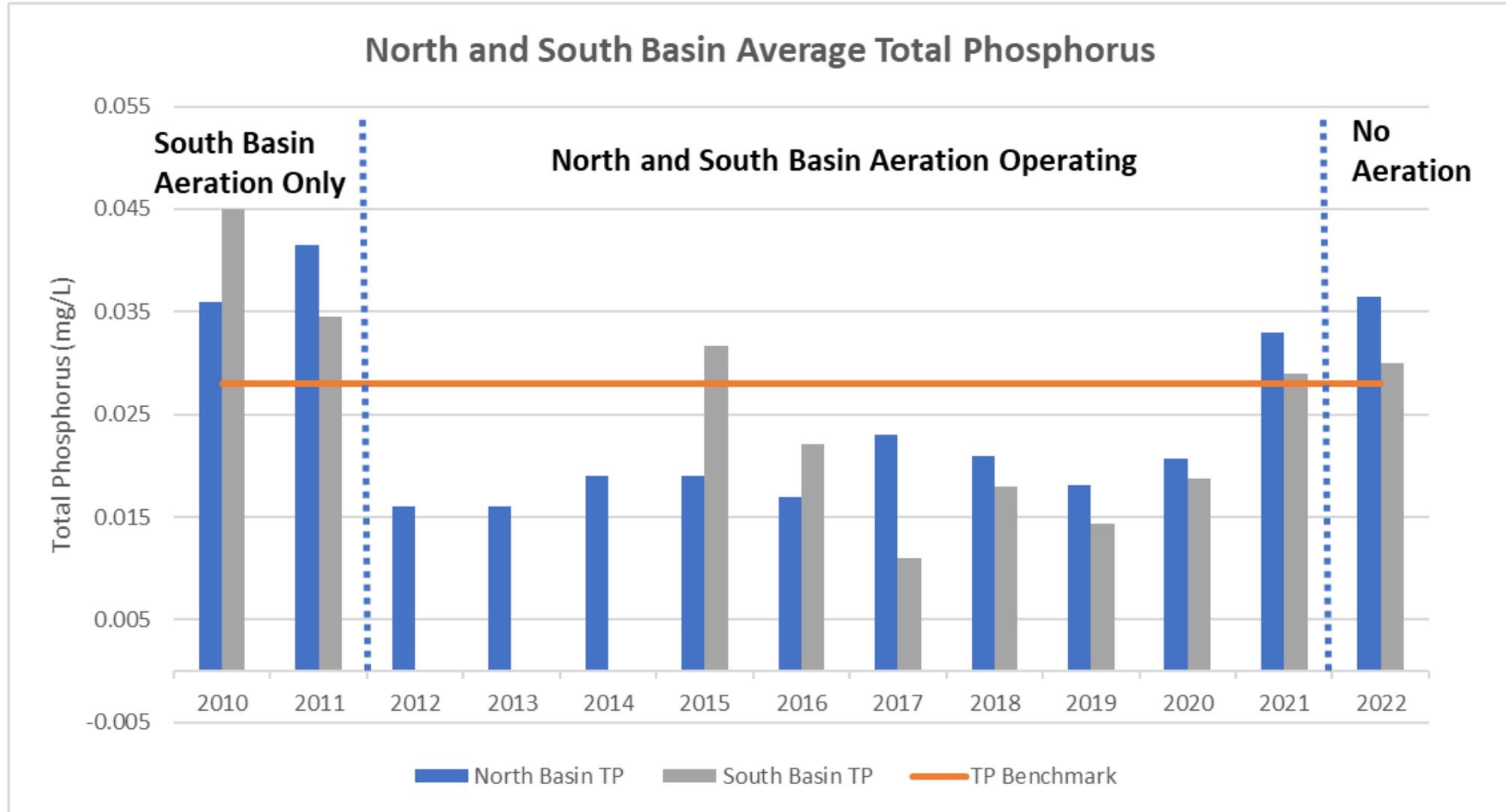


- **Reduce EWM and CLP frequencies of occurrence**
 - Whole lake fluoridone treatment followed by spot treatments
- **Maintain aquatic vegetation to support recreational use**
 - Maintain channels and dock access (harvesting)
 - Clean up floating plant fragments along shorelines (harvesting)
- **Assess 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)
 - Construction documents (30%, 60%, Complete, Construction)

2022 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
- Treated around 155 acres with diquat or diquat/procellaCOR mixture (nearshore)
 - Approximate cost \$32,000
- Purchase equipment and prepared installation of level loggers at the Mann Drain and Indian Lake
 - Install was completed in April 2023

Total Phosphorus



Note: data were not collected for year over year comparisons; 2010 and 2011 data all from NW portion of lake

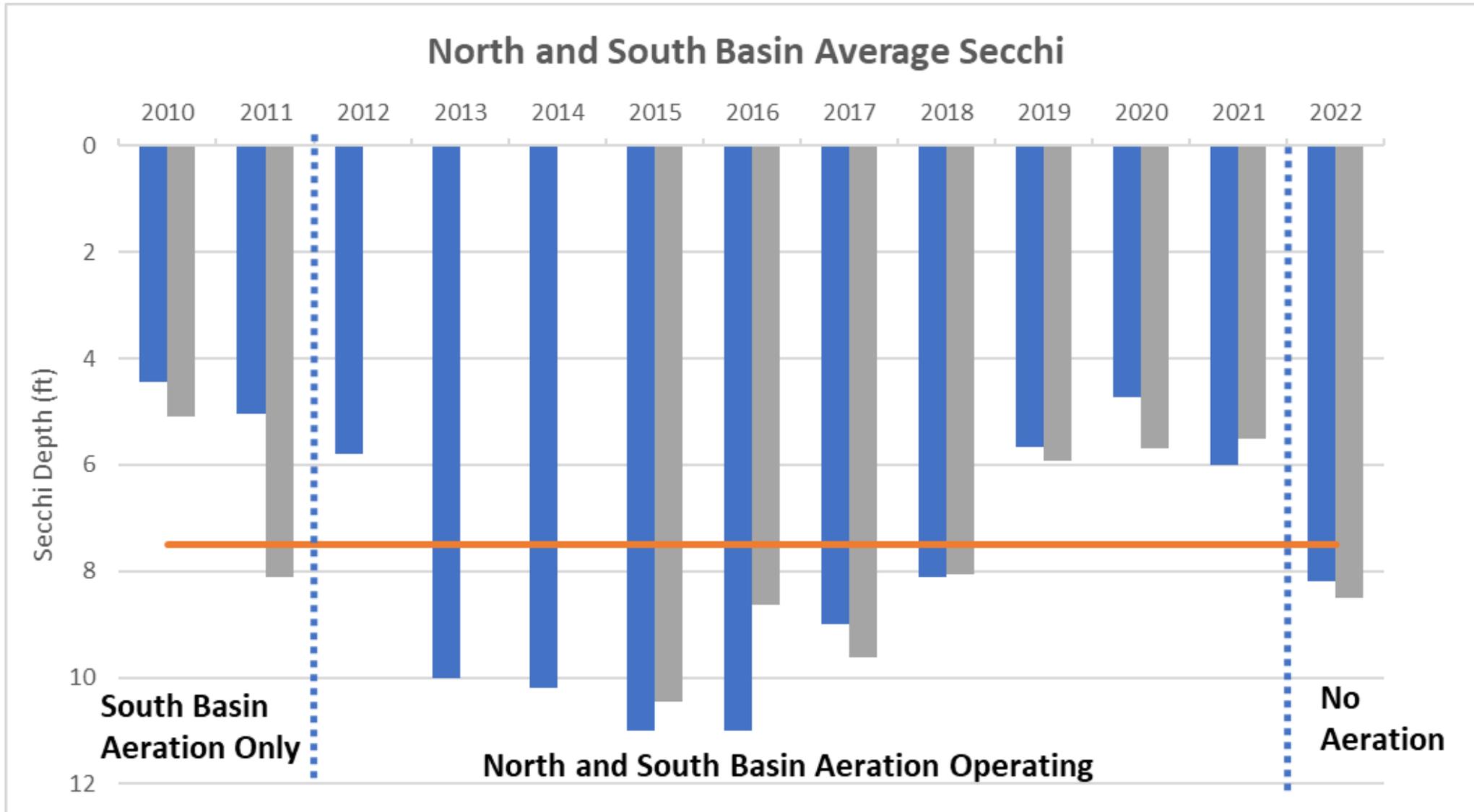
Total Phosphorus Profiles and Anoxia

	Site	5/17/2022		6/23/2022		7/19/2022		8/24/2022		9/12/2022	
		North	South	North	South	North	South	North	South	North	South
TP	Surface	0.010	<0.010	0.037	0.024	0.033	0.042	0.026	<0.010	0.076	0.064
mg/L	Bottom	<0.010		0.0		0.032		<0.010		0.131	

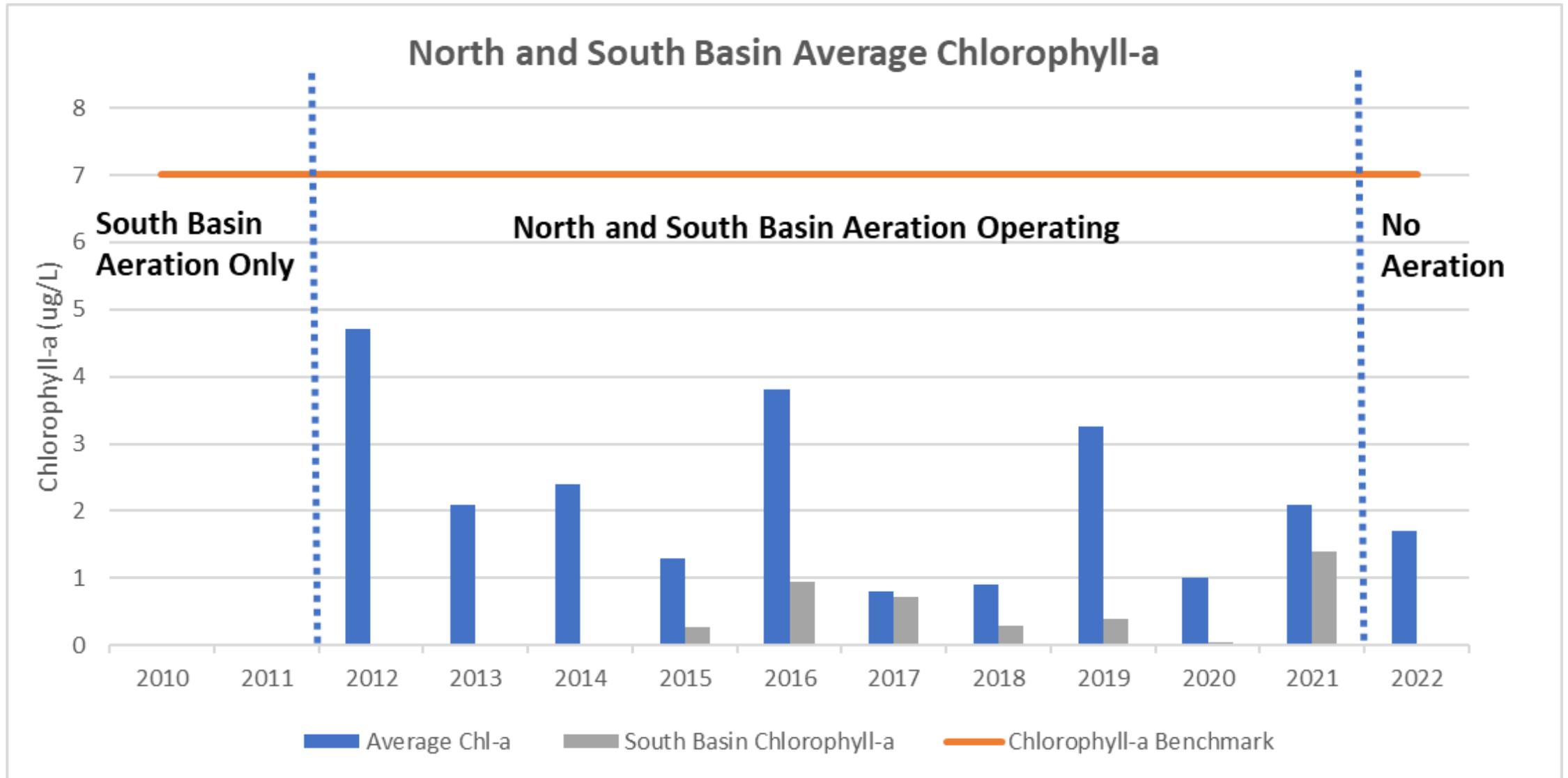
Bottom
Anoxia

Bottom anoxia occurred in 2021 with aerators running.

Secchi Depth



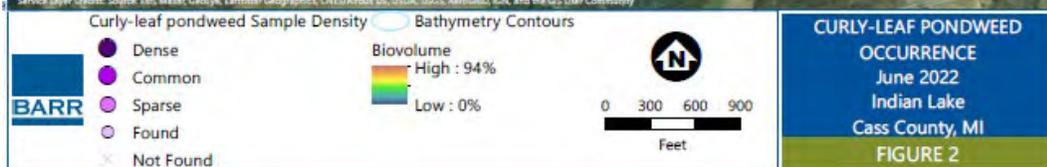
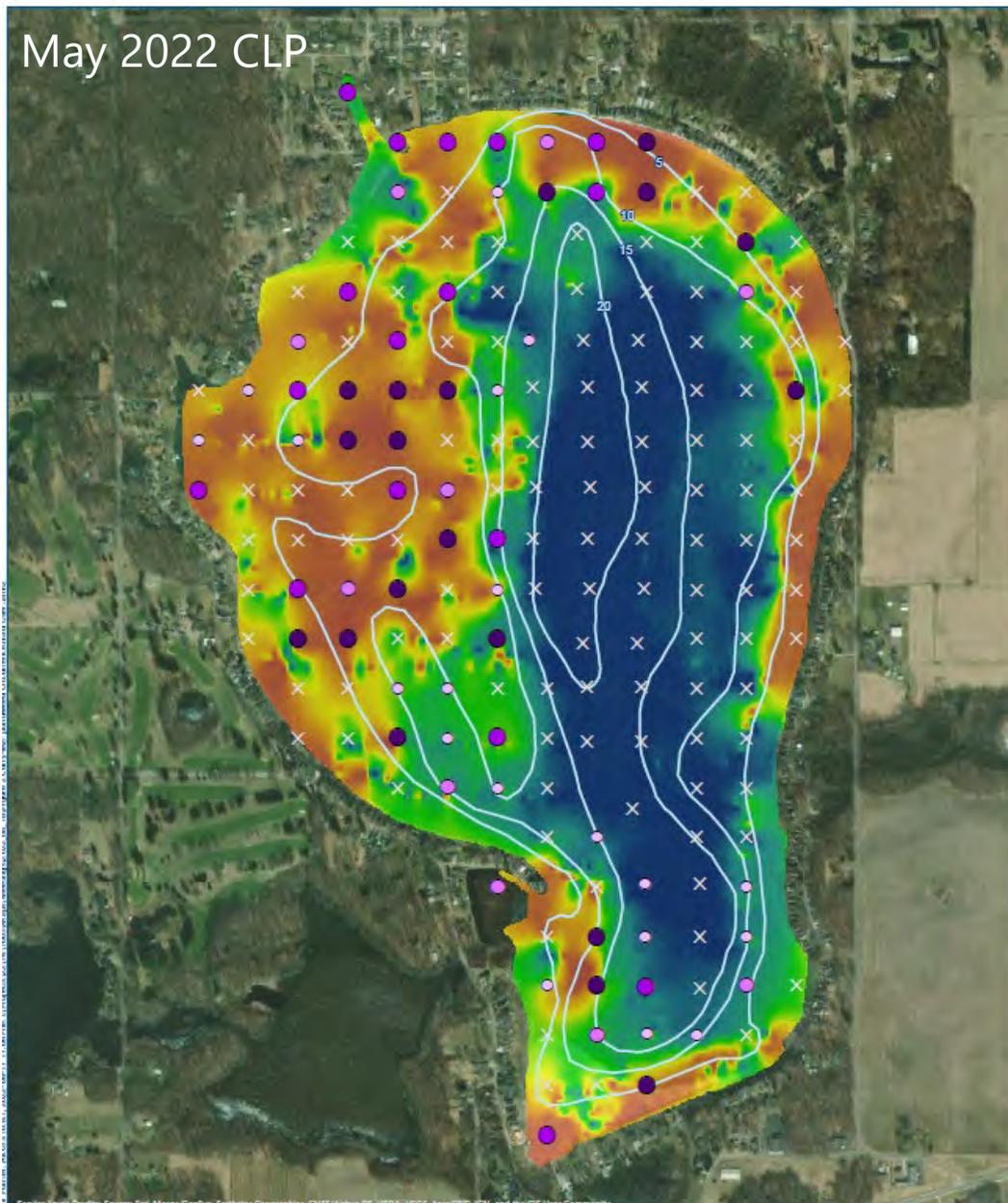
Chlorophyll-a



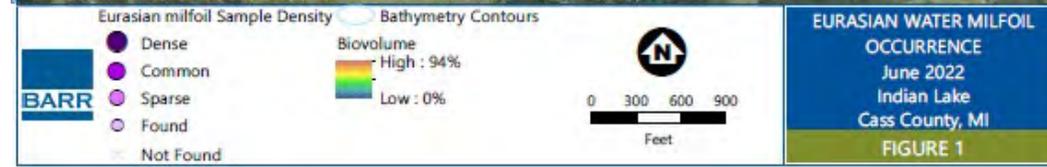
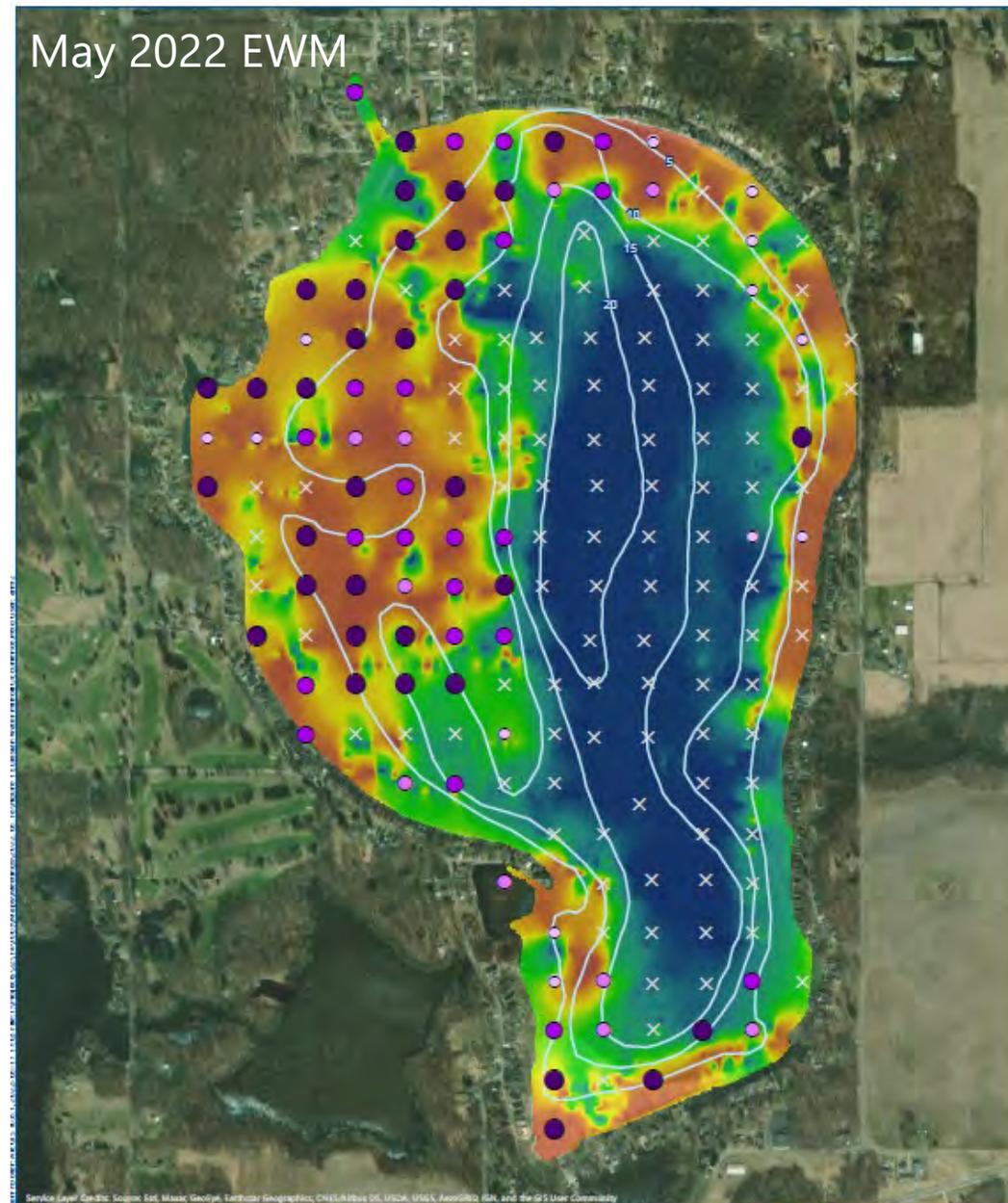
2023 Management Activities Aquatic Plant Management

- **Whole Lake Fluoridone treatment**
 - Application occurred May 4, 2023
 - Testing within 21 days of application to ensure 6 ppb
 - Bump concentration if necessary
- Water quality monitoring
 - Indian Lake (North and South locations)
 - Mann Drain

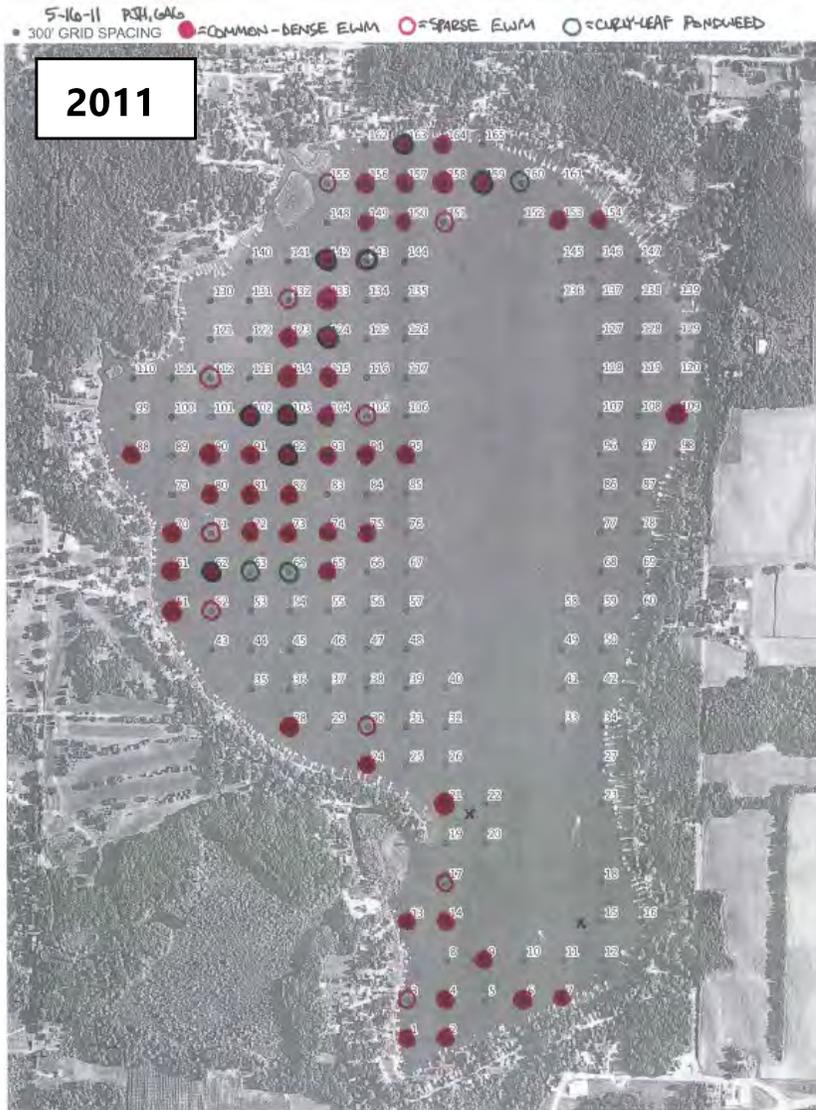
May 2022 CLP



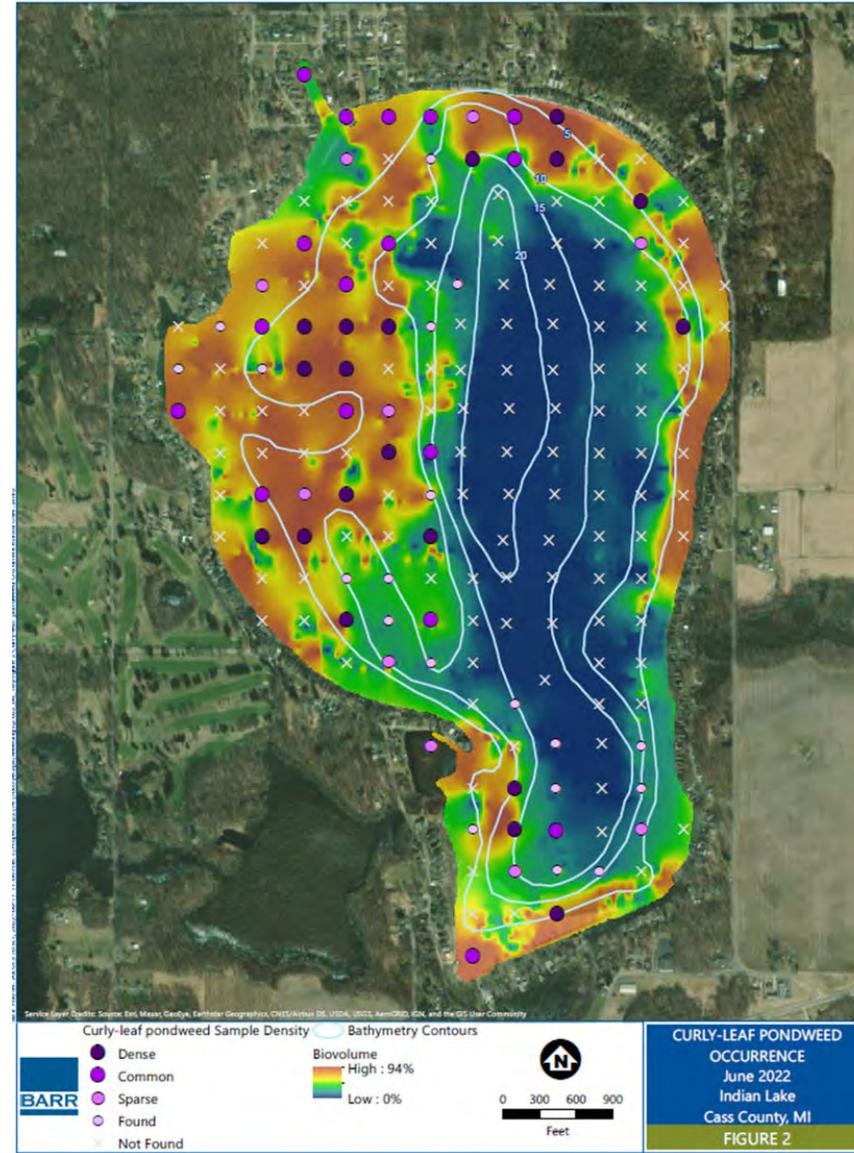
May 2022 EWM



Curly-leaf Pondweed Extent in Indian Lake



7% FOO



35% FOO

Starry Stonewort



- Starry stonewort is a bushy, bright green macro-algae. It produces a characteristic star-shaped bulbil.
- Starry stonewort impacts:
 - Dense mats at the water's surface inhibit water recreationists.
 - Overtakes habitat and outcompetes native aquatic plants, potentially lowering diversity.
 - Provides unsuitable shelter, food, and nesting habitat for native animals.

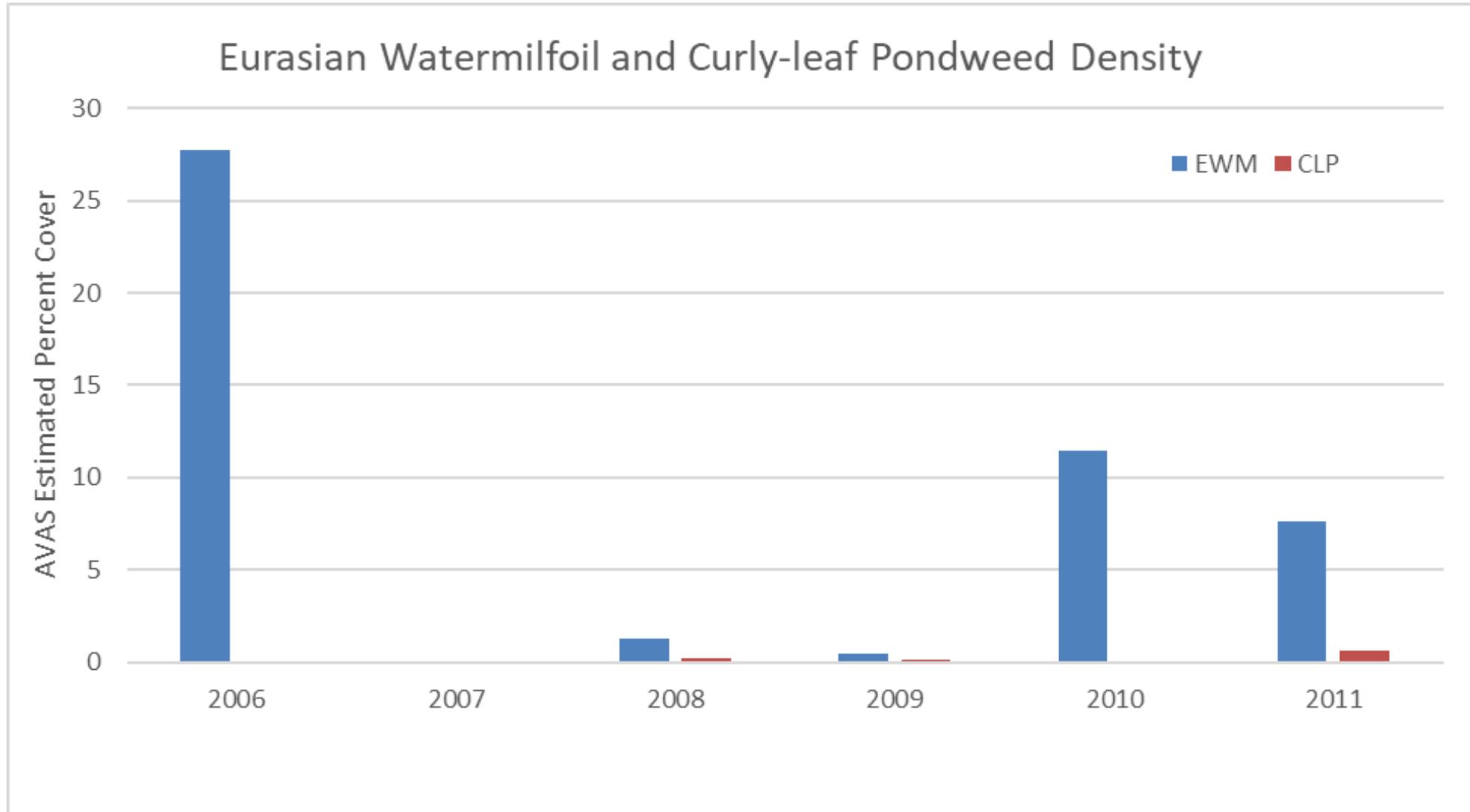
2021 Aquatic Vegetation Conditions

Common Name	Scientific Name	Frequency of Occurrence		
		September 2021	June 2022	September 2022
Eurasian milfoil	Myriophyllum spicatum	34%	42%	54%
Muskgrasses	Chara spp.	20%	13%	10%
Starry stonewort	Nitellopsis obtusa	10%	1%	3%
Slender naiad	Najas flexilis	10%	1%	9%
Naiad species	Najas sp.	7%		
Illinois pondweed	Potamogeton illinoensis	5%	3%	3%
Curly-leaf pondweed	Potamogeton crispus	4%	35%	3%
Spiny naiad	Najas marina	4%		
Coontail	Ceratophyllum demersum	3%		1%
Wild celery/eel grass	Vallisneria americana	2%		3%
Yellow pond lily	Nuphar sp.	2%		

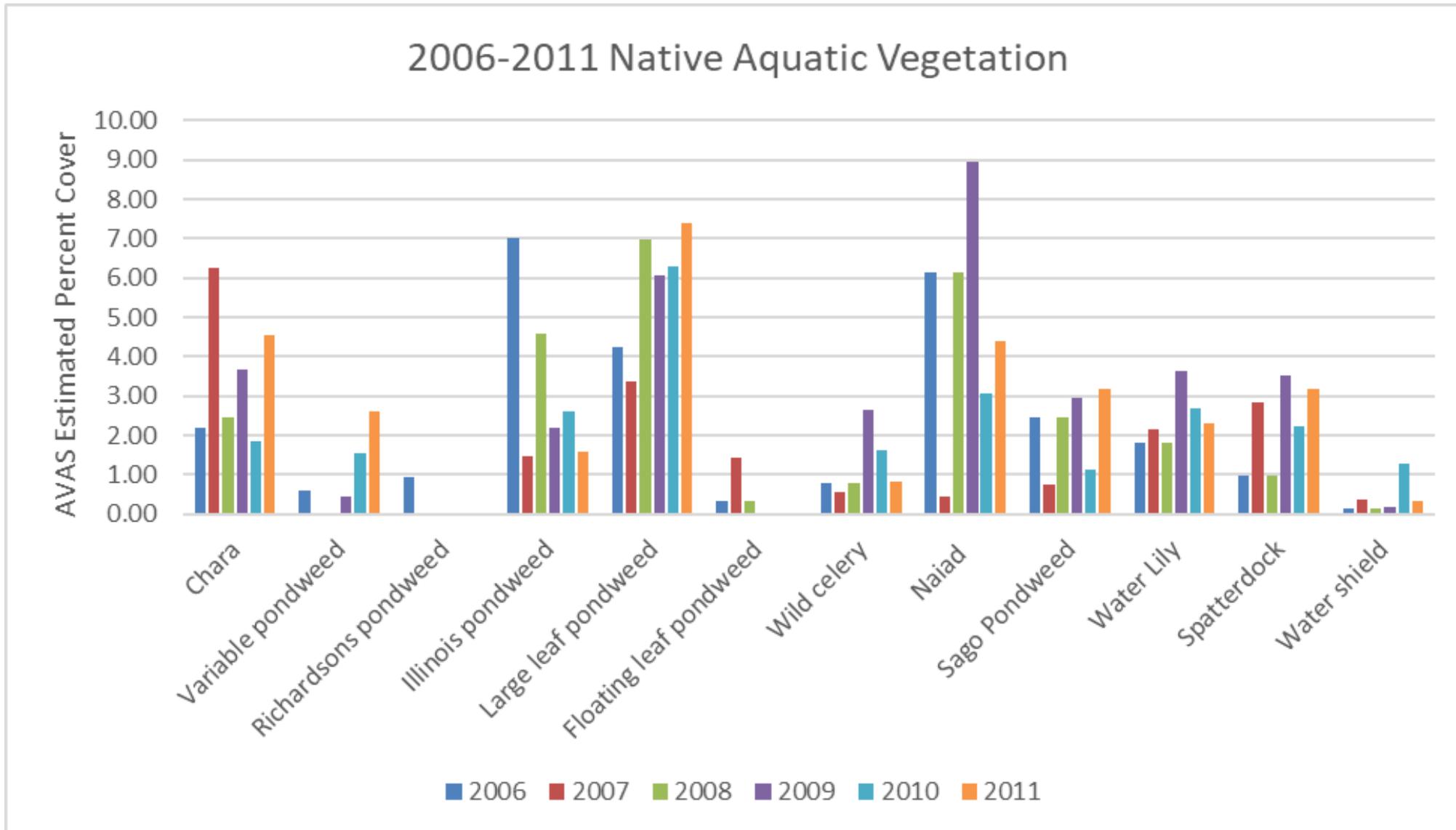
Option 2: Population control using whole lake fluoridone approach with spot treatments

- **Objective:** Reduce the CLP and EWM populations to manageable levels
- **Approach:** Whole lake fluoridone treatments to reduce susceptible EWM and CLP; Spot treatments with ProcellaCOR to address resistant EWM
- **Cost:** \$75,000 for fluoridone treatment and \$790/acre for follow up ProcellaCOR treatments (\$15,000 to \$80,000)
- **Risks:** High proportion of resistant genotypes. Select for resistant population. Invasion of starry stonewort. Poor water quality while plants re-establish.
- **Notes:** Novel approach that could be a case study. May be funding from EGLE, manufacturer. Partnership with Dr. Ryan Thume at University of Montana.

Indian Lake 2006 Whole Lake Fluoridone Treatment



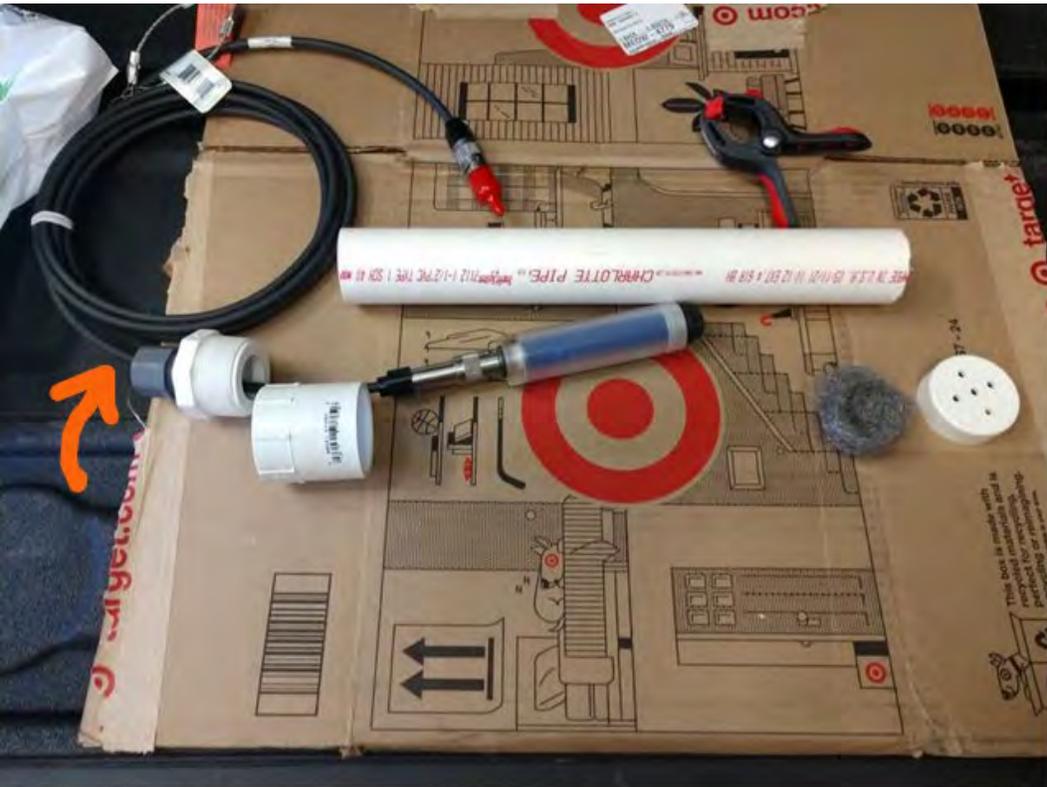
Indian Lake Native Vegetation



2023 Management Activities Monitoring

- Water quality in Indian Lake (North and South locations)
- Mann Drain
 - 5 routine events
 - 4 storm events
 - Total suspended solids, total phosphorus,

Lake Monitoring



- OBJECTIVE: Describe water quality in Indian Lake to provide long term trends. Provide evidence for possible internal P loading. Provide data to refine water balance for Indian Lake.
- Water Quality at North and South Locations
- Lake Level April-November

Mann Drain Monitoring



- OBJECTIVE: Quantify nutrient loading to Indian Lake to determine the role of the Mann Drain in Indian Lake water quality.
- Streamflow
- Water Quality
 - Total phosphorus, ortho-phosphorus, total suspended solids



Mann Drain Monitoring

- Installed level logger on Mann Drain and in Indian Lake
- Water quality monitoring to commence in May 2023
 - 5 routine samples
 - 4 storm samples
- ILIA Opportunity
 - Record level on staff gauge
 - Collect additional storm samples

Harmful Algal Bloom Response Plan

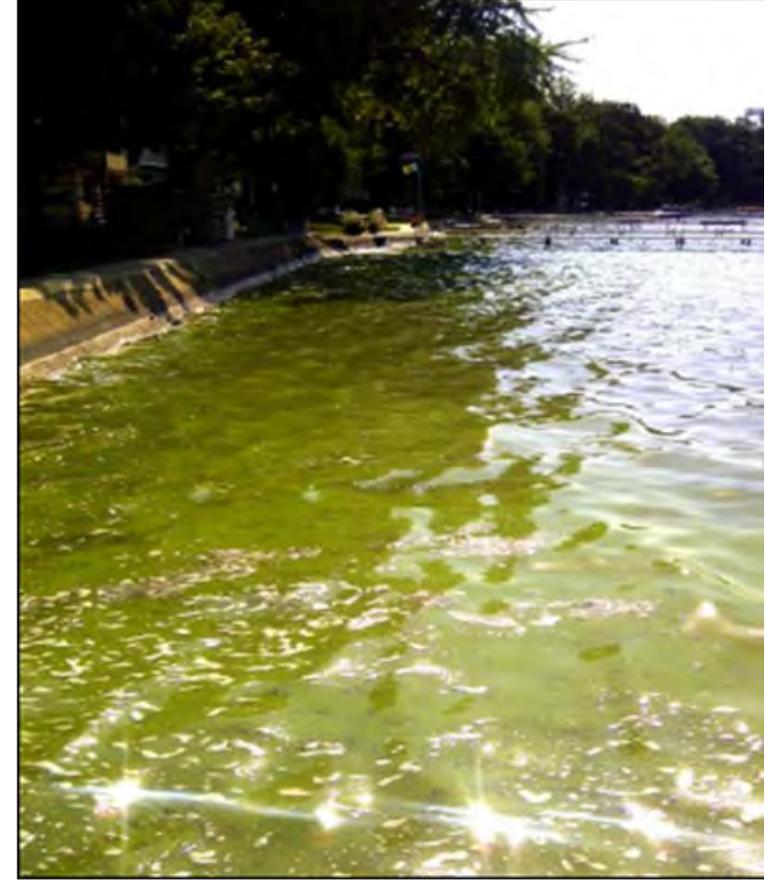


- Objective: Develop a recognition and action plan for potential Harmful Algal Bloom in Indian Lake
 - Led by PhycoTech out of St. Joseph
 - Ann St. Amand is a nationally leading phycologist
 - Identification procedures
 - Who to call
 - How to get the word out
 - Testing approach

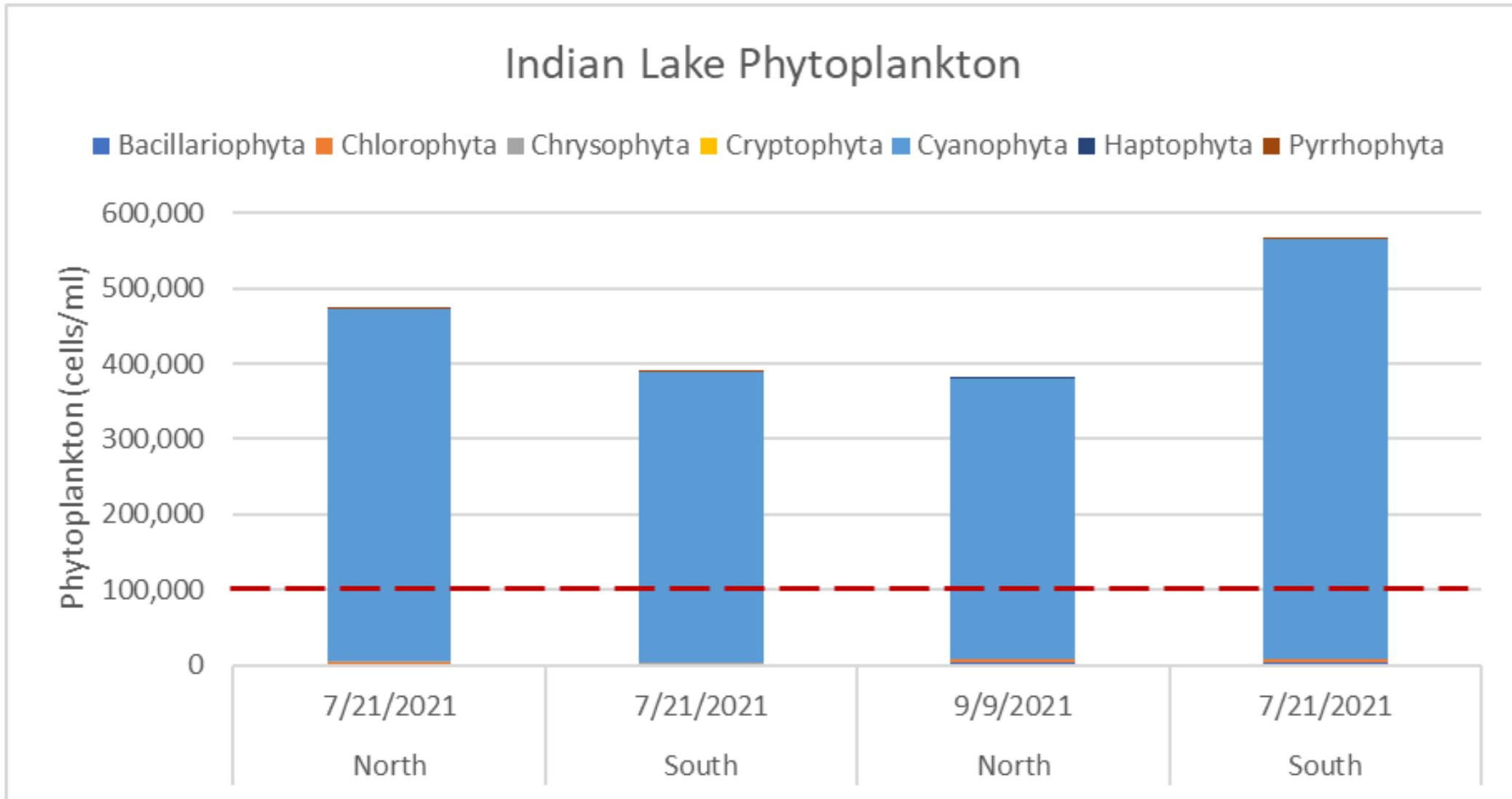
Potential for Severe or Harmful Algal Blooms

**September, 2011
Microcystis Bloom**

**North End of Indian
Lake**



Indian Lake Phytoplankton



October 31, 2022 Cyanobacteria Bloom



- Jar test method
 - If refrigerated and floats to the surface it is cyanobacteria
 - Late season blooms like this can be toxic

Photo: Angelo Ippilito

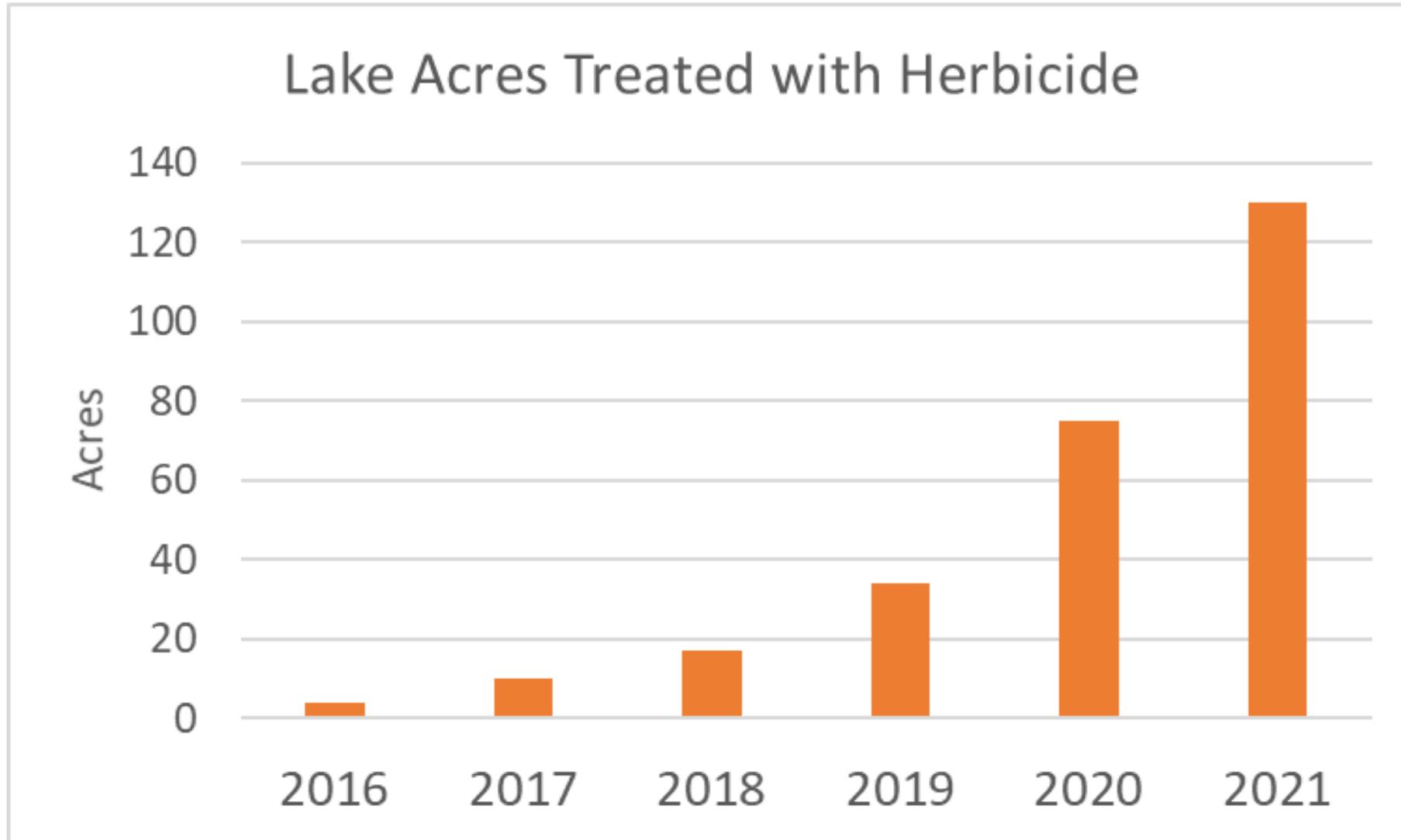
2023 Schedule of Activities

Activity	Projected Date
Water Quality Monitoring (Mann Drain and Indian Lake)	Week of May 15, 2023
Fluoridone testing (48-hour testing)	May 4, 2023
Spring Vegetation Survey	Week of May 22, 2023
Fluoridone testing (14-day testing)	May 17, 2023
Fluoridone bump treatment	May 23/24, 2023
Mann Drain storm sampling	May/June/July/August 2023
Water Quality Monitoring (Mann Drain and Indian Lake)	June 2023
Water Quality Monitoring (Mann Drain and Indian Lake)	July 2023
Water Quality Monitoring (Mann Drain and Indian Lake)	August 2023 (phytoplankton sampling)
Water Quality Monitoring (Mann Drain and Indian Lake)	September 2023
Fall Vegetation Survey	September 2023

Questions?



Herbicide Use in Indian Lake



Curly-leaf pondweed



Indian Lake
August 27, 2021

Turion production and
sprouting

Adaptive Management

- Aquatic vegetation management is challenging
 - Shallow depth increases challenge
 - Species specific response to management actions
 - Manage multiple goals (habitat, sediment stabilization, biodiversity)
- Management Objectives
 - Immediate: Harvesting, herbicide, physical controls
 - Long term: community structure, sediment, hydrology



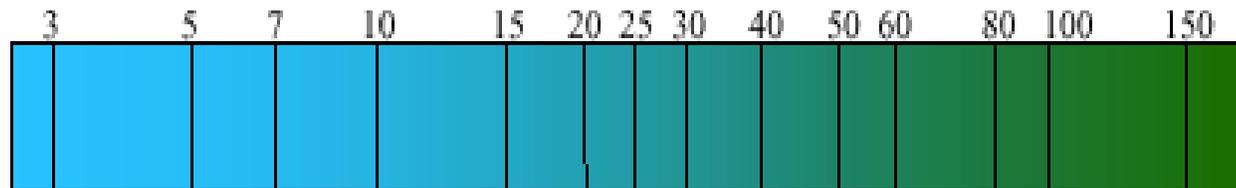
Relationship between TP and Transparency

Oligotrophic

Mesotrophic

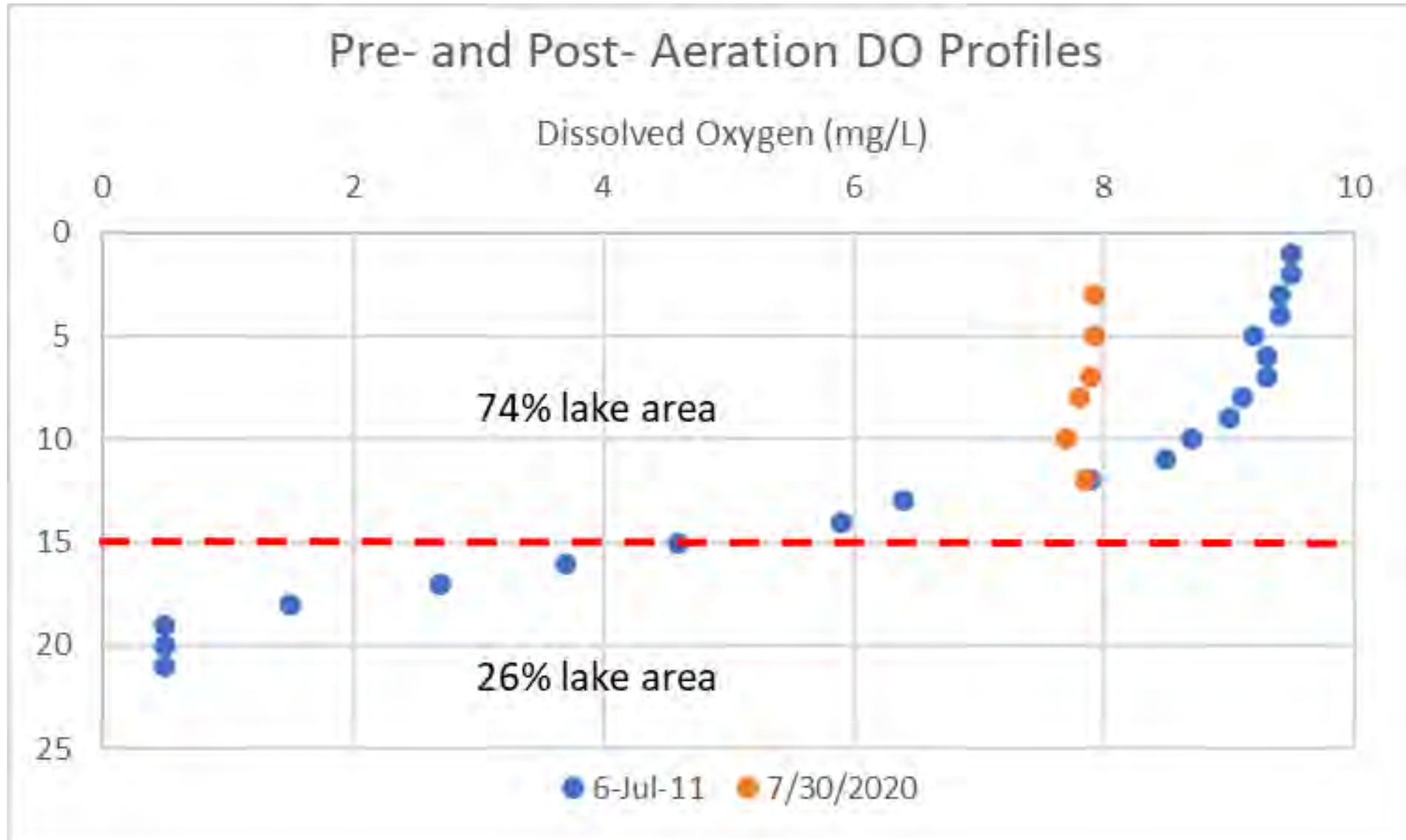
Eutrophic

Hyper-
Eutrophic

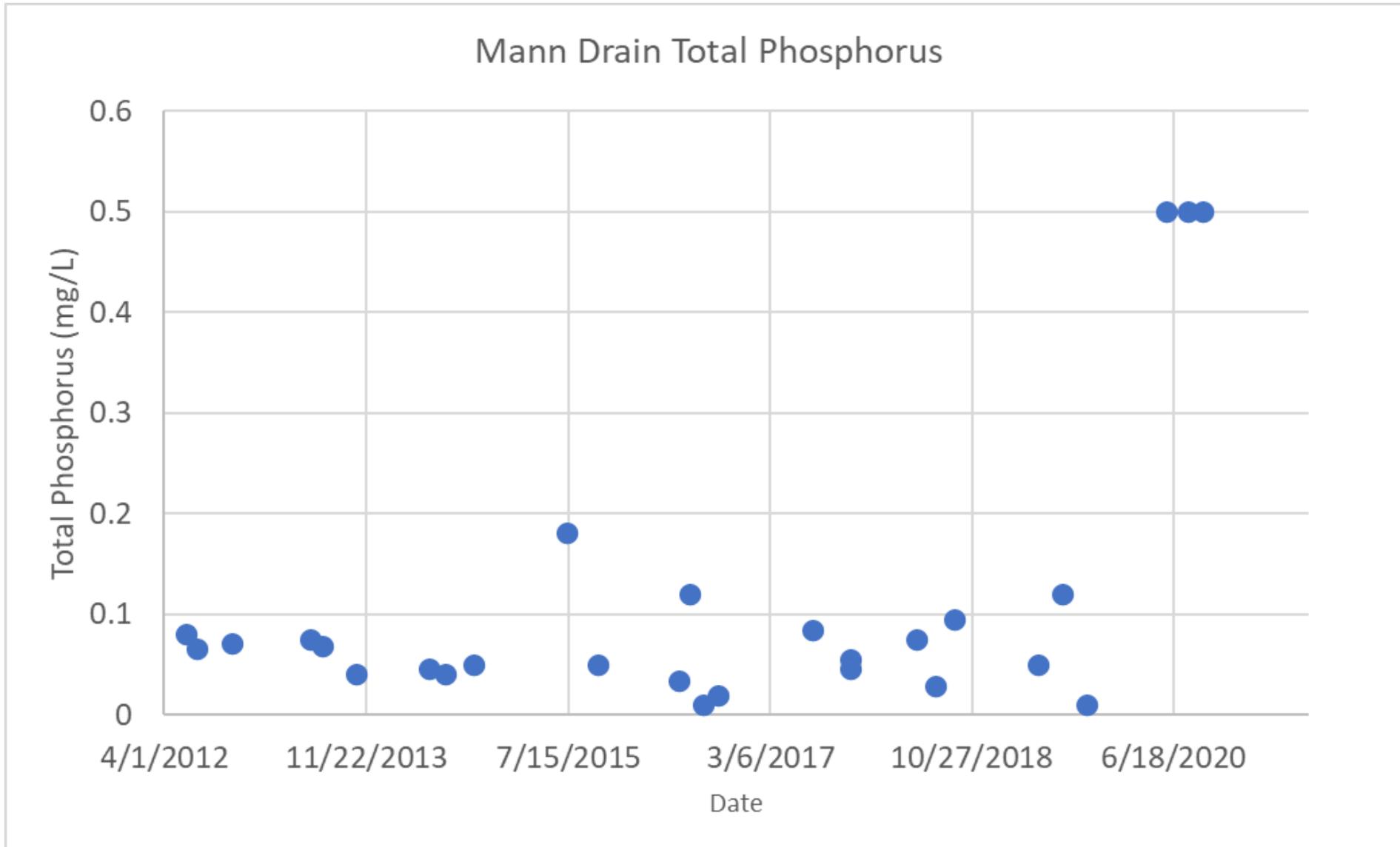


Total Phosphorus (µg/L)

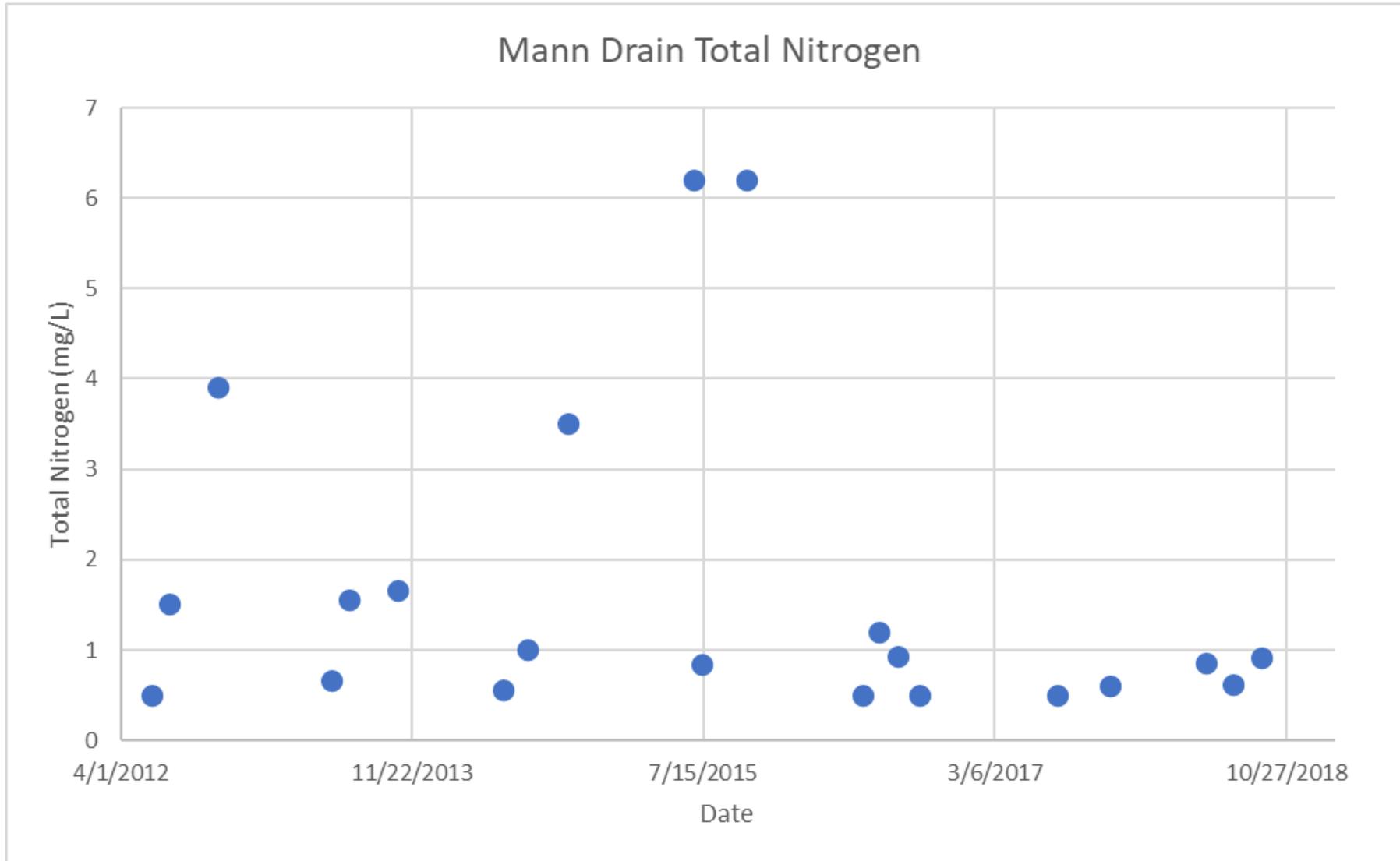
Dissolved Oxygen



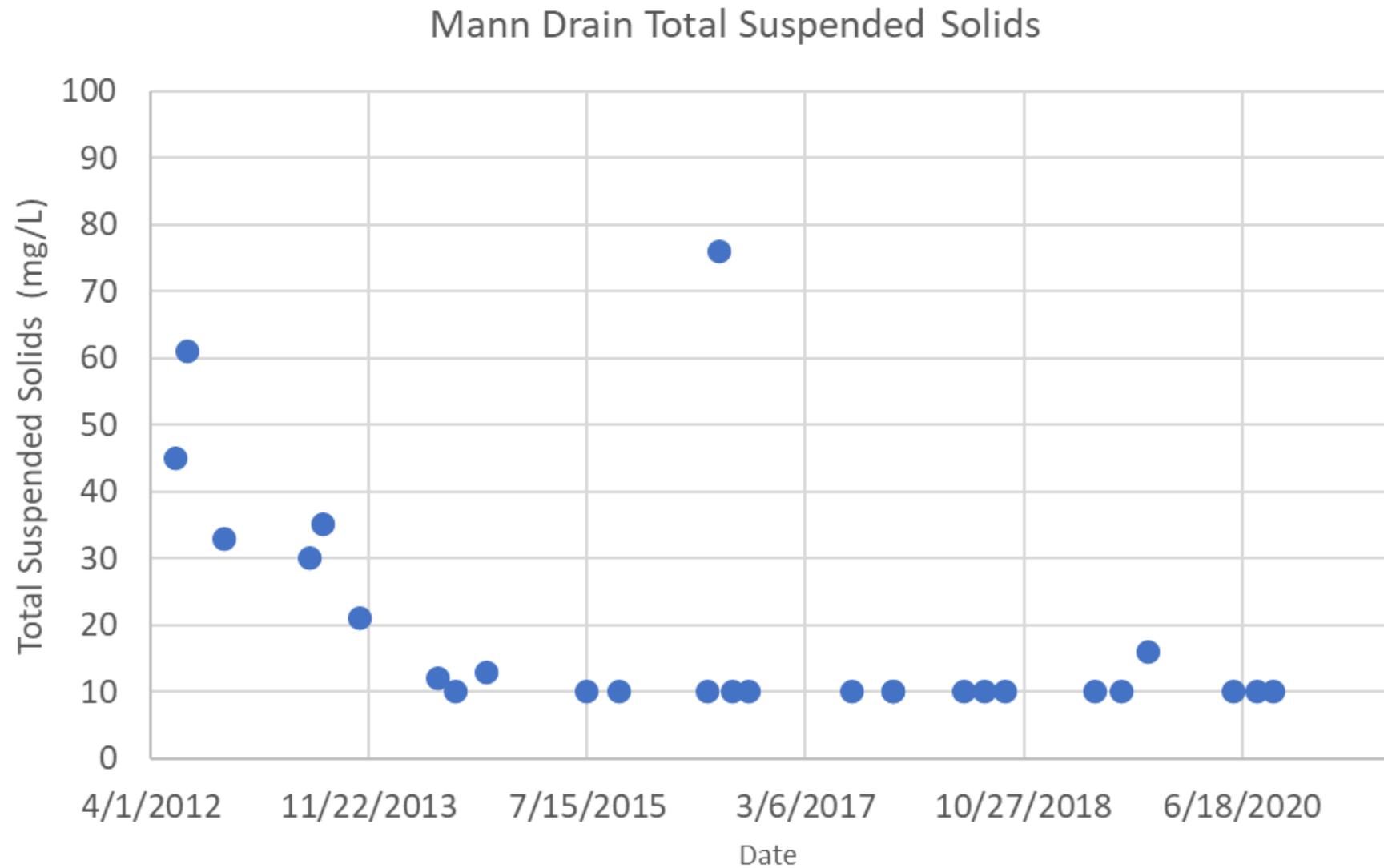
Mann Drain Total Phosphorus



Mann Drain Total Nitrogen



Mann Drain Total Suspended Solids



Objective	Action	2022	2023	2024	2025	2026
1	Whole Lake fluoridone treatment to control invasive vegetation (EWM and CLP)	\$75,000	--	--	--	--
1	Spot herbicide treatments for invasive control		\$35,000	\$47,000	\$30,000	\$30,000
1	Evaluate milfoil weevil program for long term control	volunteer	volunteer	volunteer	volunteer	volunteer
2	Harvesting for recreational support	\$2,000	\$5,000	\$5,000	\$5,000	\$5,000
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	\$500	\$500	\$500
4	Bathymetric mapping of dredged areas to assess changes				\$15,000	
5	Improve AIS signage and provide educational materials		\$1,000		\$1,000	\$1,000
1,2	Aquatic vegetation monitoring and management	\$ 8,000	\$9,000	\$10,000	\$11,000	\$12,000
3	Lake water quality monitoring	\$ 10,000	\$11,000	\$12,000	\$13,000	\$14,000
7	Lake level monitoring		\$5,000	\$1,000	\$1,000	\$1,000
ALL	Annual reporting and lake management support	\$ 10,000	\$10,000	\$10,000	\$10,000	\$10,000
	TOTAL	\$ 105,000	\$94,000	\$100,500	101,500	\$98,500

Note(s):

(1) Table footnotes should be numbered (no special characters) and should be superscript in the table and not superscript in the footnote