MI-ACE 2023

85th Annual Conference & Exhibits

Detroit River Phytoplankton

GLWA Great Lakes Water Authority

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Objectives

- Provide an update on the Detroit River Phytoplankton community
- Compare recent findings against published (historical) Detroit River Phytoplankton records
- Identify possible abiotic factors that may cause shifts within the Phytoplankton communities

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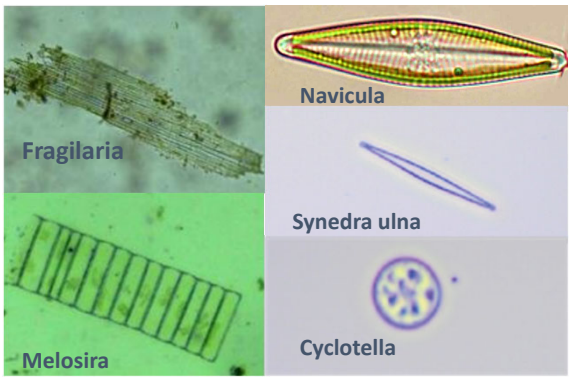
What are Phytoplankton?

- Phytoplankton are the autotrophic components of the plankton community, and are a key part of the ocean and freshwater ecosystems
- Also known as microalgae, most Phytoplankton are single-celled organisms



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What are Phytoplankton? (Cont.)

- Phytoplankton are sensitive bioindicators of change within the aquatic systems
- They can grow explosively to form blooms that may last several weeks

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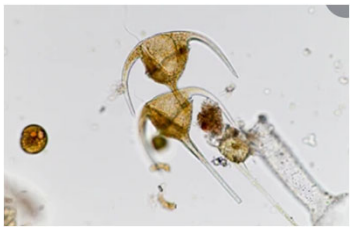
Classes of Phytoplankton

- Dinoflagellates: Use a whip-like tail, or flagella, to move through the water
- Diatoms: Depend on the ocean currents to travel through the water (do not rely on flagella to move through the water)



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Research Approach

- Harmful Algal Blooms (HABs) have been detected more often in freshwater habitats
- Since HABs pose significant challenges in regions such as the Great Lakes, they have become a key area of interest in Phytoplankton related research

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The Detroit River

- The Detroit River is the primary source of drinking water for Southeastern Michigan & Windsor, Ontario
- Currently listed as area of concern within the Great Lakes

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The Detroit River (Cont.)

- Regional and international agencies are involved in monitoring pollution and restoration initiatives in the Detroit River
- As part of their continued assessment of the health of the river, these Agencies continuously monitor and establish quantitative targets for phytoplankton bioindicators

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Data Collection

- Over the years, extensive data has been collected by the Great Lakes Water Authority (GLWA)
- Water Works Park (one of the five water treatment plants within GLWA) is being used for this initiative
- The plant's raw water intake is located in the Detroit River

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Data Collection (Cont.)

- Water from the river flows through bar racks at the intake location in order to remove large debris/particles
- Water then passes through large rotating 3/8" mesh screens to remove smaller objects before entering the treatment plant

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Data Collection (Cont.)

- Plankton counts were recorded on a bi-weekly basis for the water coming into the plant
- The water samples were collected from the raw water sample sink within the WWP operations laboratory

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Sampling

- One-liter raw water grab samples were taken and allowed to settle at 4°C for 24 hours
- 900-mL of water was then removed using a 0.13-inch rubber siphon tubing attached to a glass rod

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Sampling (Cont.)

- This allowed plankton to be concentrated by siphoning the water out very slowly and not agitating the bottom
- The result was a 100-mL sample of concentrated plankton

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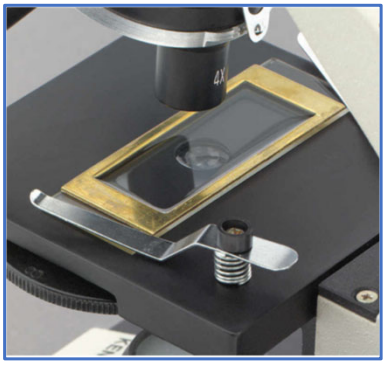
Sampling (Cont.)

- A 1-mL sample was then obtained using a pipette and transferred to a Sedgewick Rafter counting chamber
- Plankton identification and counting was done by using a compound microscope
- A simplified diatoms key was then prepared for the GLWA laboratory



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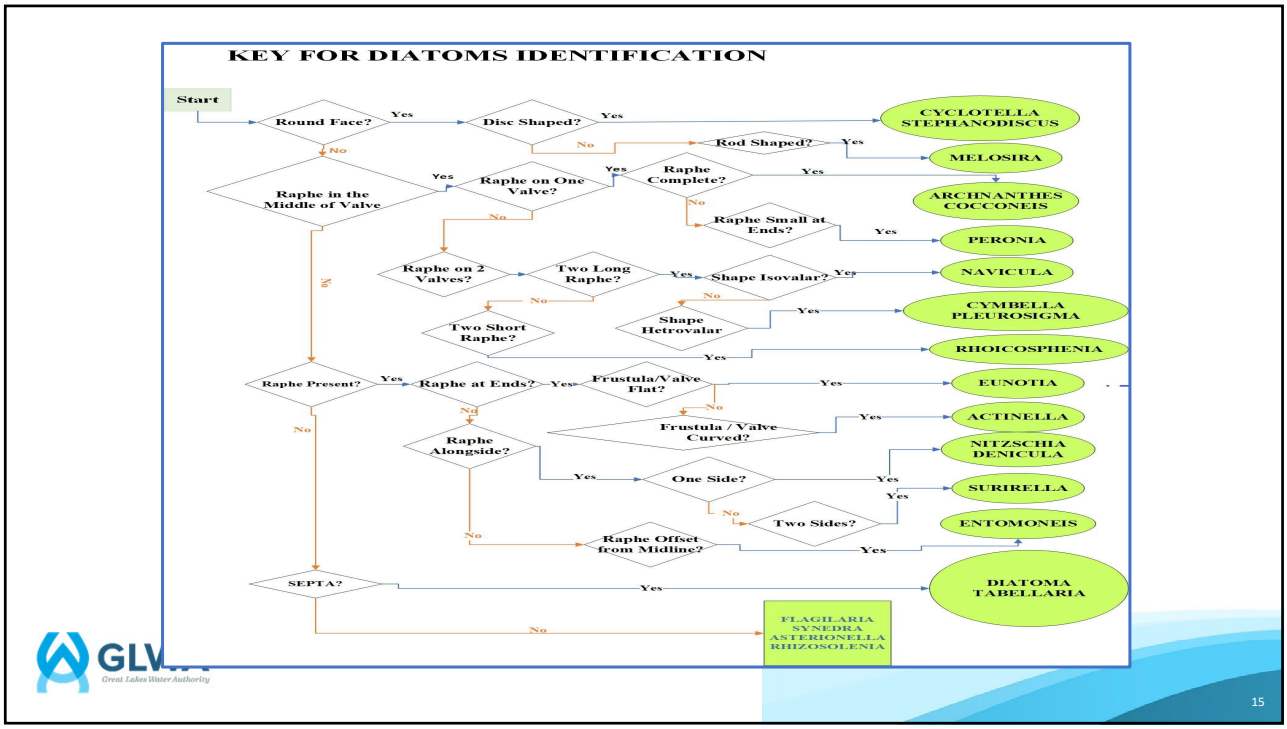

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Study Observations

- The study resulted in two years' worth of Phytoplankton data being collected and analyzed
- The data analysis yielded indicators of additional changes within the Detroit River

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Study Observations (Cont.)

- Phytoplankton count:
  - May-December 2018: 2,021
  - January-November 2019: 4,012
- Total Genera: 39
  - 2018: 20
  - 2019: 29

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Study Observations (Cont.)

Genera that comprised of at least 10% of the specimens:

2018	2019
Cyclotella (21%)	Cyclotella (13%)
Navicula (29%)	Melosira (10%)
Nitzschia (11%)	Navicula (25%)
	Synedra ulna (10%)

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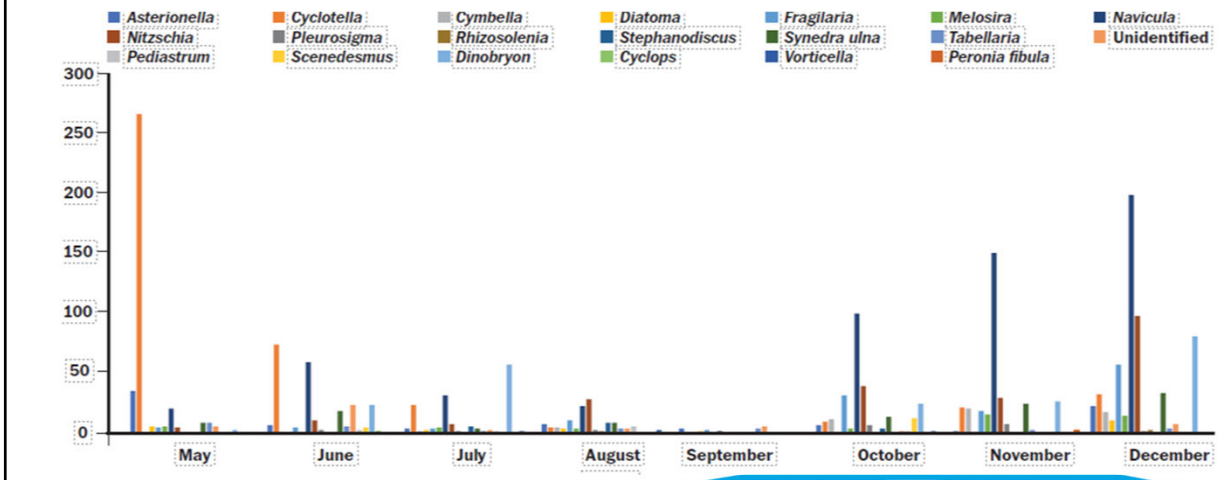
Phytoplankton Abundance (2018)



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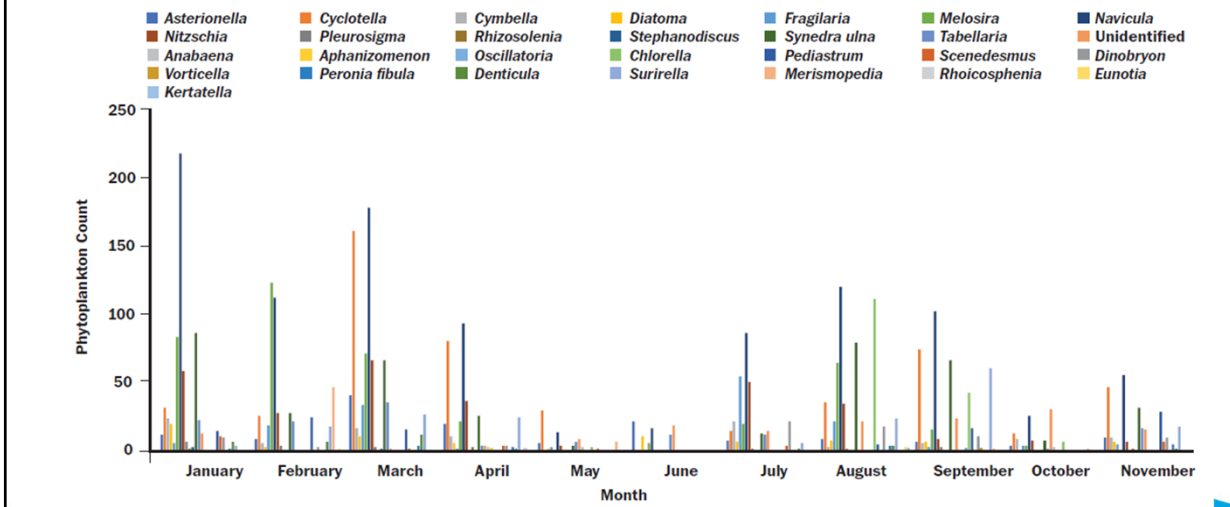
Phytoplankton Abundance (2019)



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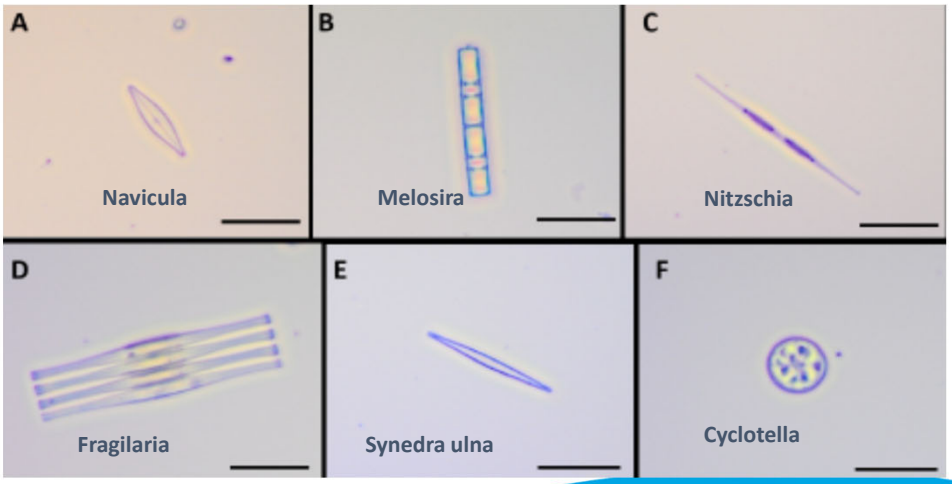
Phytoplankton Species Found within Detroit River



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Phytoplankton Observations (Cont.)

- Composition of Phytoplankton assemblages in the Detroit River remained stable for more than 80% of the sampling events
- May 2018 and June 2019 had community shifts
- These community shifts could be due to the spring turnover that generally occurs in Lake St. Clair around this time from large storm events are known to affect phytoplankton assemblage

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Comparison with Historical Data

- Historical data regarding Phytoplankton diversity and abundance in the Detroit River were obtained from literature, largely from the Detroit WWP drinking water plant
- Our data (May–December 2018 & January–November 2019) was compared against two data sets collected in 1928–1929 (Hudgins 1931) and 1962–1963 (Wujek 1967)

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Phytoplankton Sampling Sites in the Detroit River:

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Comparison with Historical Data (Cont.)

- A comparison with the historical plankton data revealed that the genus Navicula was not reportedly seen in the river during the late 1920s (Hudgins' 1931 study did not report the presence of Navicula)

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Comparison with Historical Data (Cont.)

- Navicula was seen as the most abundant Phytoplankton present during the years 2018 and 2019, a notable difference when compared with historical Phytoplankton data obtained from peer-reviewed literature
- Hudgins (1931) observed that Navicula caused problems at other drinking water plants but was not reported in the Detroit River water samples

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Average % Abundance of Genera

Genus	1928 July-Dec. [a]	1929 Jan-June [a]	2018 May-Dec. [b]	2019 Jan-Nov. [b]
Asterionella	6.4	1.6	4.1	3.4
Synedra	8.2	8.3	5.3	10
Tabellaria	7.3	17.2	1.2	3.1
Fragilaria	19.2	14.1	6.4	3.7

[a]Data from Hudgins (1931)
[b]Data from current study

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Diatom Genera Percent Abundance

Genus and # of Species Represented	1962-63 May-June [a]	2018 May-Dec [b]	2019 Jan-Dec [c]
Cyclotella (2)	>10	21.3	12.6
Melosira (3)	>10	22	10
Coscinodiscus (1)	>10	Not Observed	Not Observed
Stephanodiscus (2)	>10	0.79	.07
Fragilaria (2)	>10	6.4	3.7
Synedra (2)	>10	5.3	10
Tabellaria (1)	>10	1.2	3.1
Navicula[c]	<10	28.9	25.4

[a]Data from Wujek (1967)
[b]Data from current study
[c]Historically, Navicula was <10% and now is the most abundant.
Data for 1962–1963 are shown as less than or greater than 10%.

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Comparison with Historical Data (Cont.)

- Comparing GLWA's data against historical Detroit River Phytoplankton abundance data revealed several shifts within the Phytoplankton community
  - Navicula (presently the most abundant Phytoplankton taxa in the Detroit River) was not widely reported in the earlier historical studies
  - Fragilaria was observed in high numbers in the late 1920s and 1960s, but was found in lower numbers in current data

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Comparison with Historical Data (Cont.)

- Other phytoplankton taxa more abundant in the 1920s were flagellates.
- In our collections, the only genus Dinobryon was observed, in 2018 at 11% and in 2019 at 2%
- The 1960s study only focused on diatoms and thus, no comparison could be made with flagellates during that collection year

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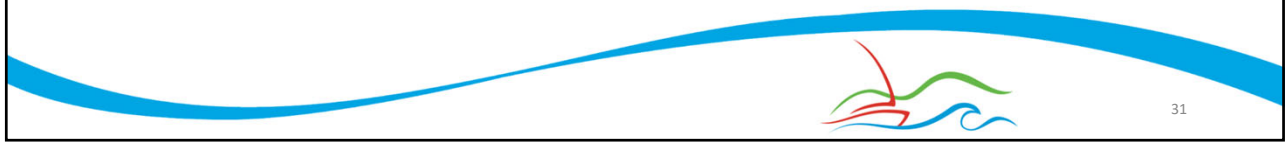
Possible Reasons for Shifting

- A possible reason for the shift in the Phytoplankton communities could be the invasion of Dreissenid (Zebra & Quagga) mussels in the Great Lakes, during the 1980s
- Mussel species of the Dreissena genus have been known to have selective preferences



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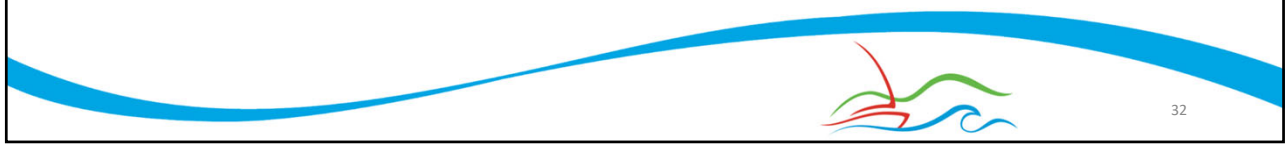
Possible Reasons for Shifting (Cont.)

- Once Dreissena mussels were introduced into the Great Lakes, they eventually dispersed throughout all of the Great Lakes, and are believed to be one of the primary causes for the plankton shift
- Studies identifying the shift within the plankton communities (by mussels), however are inconclusive as the exact correlation cannot be determined



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Possible Reasons for Shifting (Cont.)

- Navicula could be rejected by Dreissena mussels since the mussels prefer flagellates over diatoms for food sources. Thus, the shift of Phytoplankton taxa may be a result of the mussel's feeding preferences
- Therefore, the use of Phytoplankton monitoring has great potential to help us better understand the ecological impacts of invasive species

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Abiotic Factors

- The US Army Corps Engineers (USACE) collects distribution data (annually) from the Detroit River
- The analysis yielded significant differences (when compared between 1900 and 2019), as the average discharge values were found to have increase by an average of 5.5 m3/s per year
- The changes in flow also explain the observed changes in Phytoplankton communities

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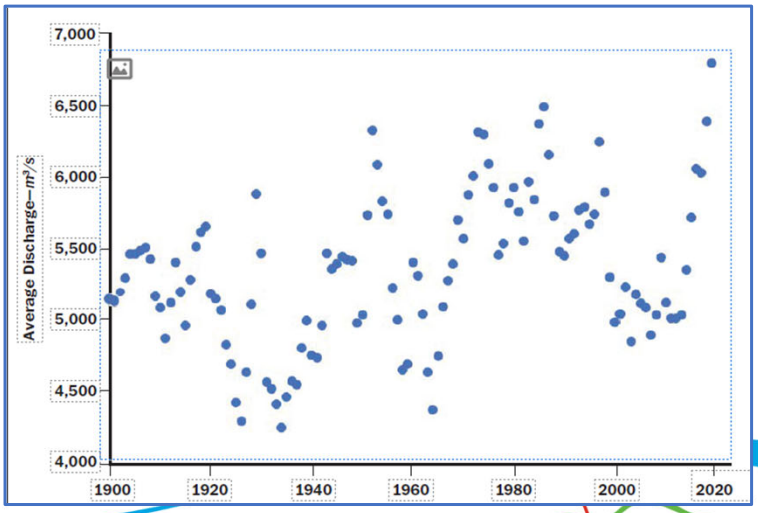
Changes in the Annual Average Discharge Values Between 1900 and 2019



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Abiotic Factors (Cont.)

May & June Data: Although the shifts could have been caused by natural events, they could also be a response to upstream dredging, as the Detroit River must be dredged periodically to facilitate transportation

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Abiotic Factors (Cont.)

- Abiotic factors that were specifically related to changes in Phytoplankton abundance were silica, dissolved oxygen, pH, and the river's temperature
- Dredging may influence the availability of silica (and other minerals such as phosphorus), which affect phytoplankton abundance and diversity

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Conclusion

- The Detroit River Phytoplankton study revealed significant changes to the ecological and environmental conditions
- Measures to remediate river health in recent years must be evaluated through analysis of abundance and diversity of Phytoplankton communities at a higher taxonomic resolution

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Conclusion (Cont.)

- By working with the community partners to measure Phytoplankton communities in the long term, water treatment plants can use the data gained to design early-warning systems in order to monitor the river changes

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Reference

Vasquez, Adrian A., et al. “Detroit River Phytoplankton Analysis from Water Treatment Plant Data.” Journal AWWA, vol. 113, no. 10, 2021, pp. 34–43., https://doi.org/10.1002/awwa.1825

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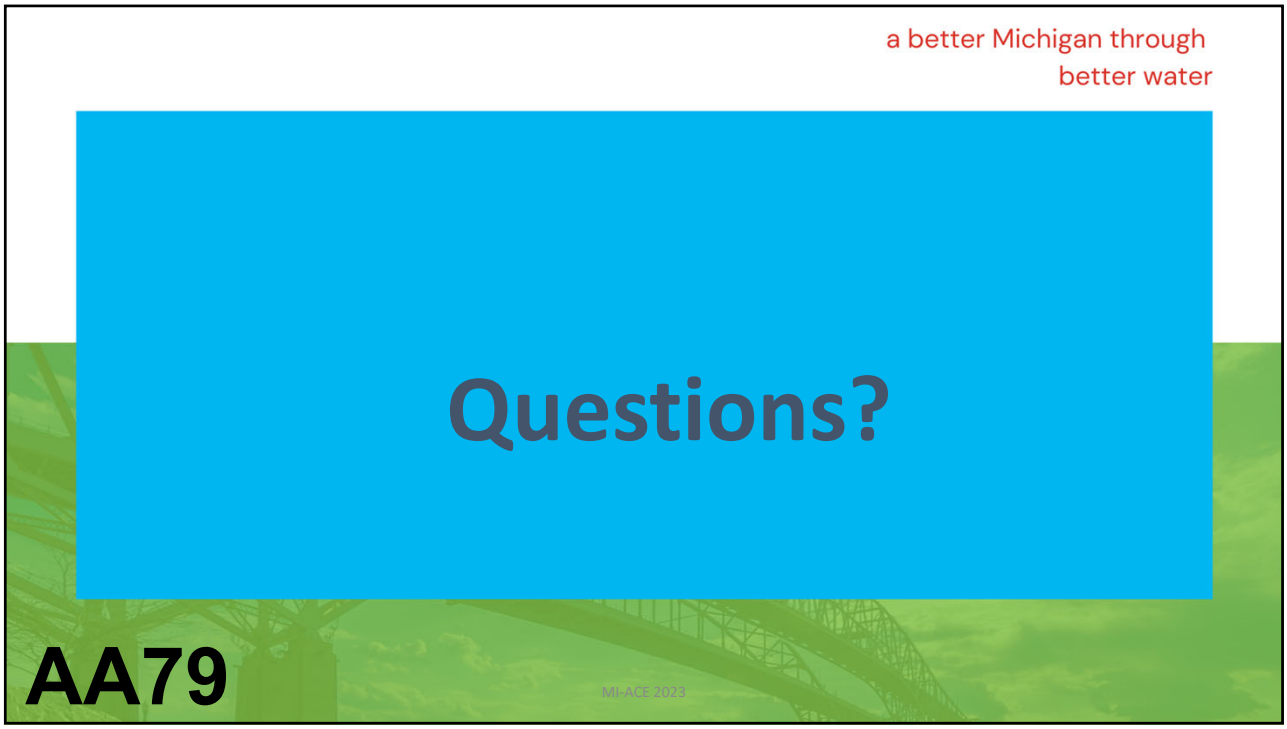
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Questions?
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