What do we know about harmful algal blooms in Ontario? What are the lessons for Deer Lake?

6th Annual General Meeting and BBQ

August 30th 12pm

Josiah-Deren Dixon, BSc Environment and Physical Geography

Dan Walters, PhD Geography

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Overview

- Key Terms
- What are cyanobacteria (a.k.a blue-green algae)?
- What are causing the cyanobacteria blooms?
- What do we know about cyanobacteria blooms in Ontario?
- What are the lessons for Deer Lake?

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FRIENDS OF DEER LAKE
SOUTH RIVER, ONT.

Key Terms: Lakes are classified into different **trophic states** based on nutrient levels and biological productivity.

Lake Partner Program by MECP
Spring Total Phosphorus data

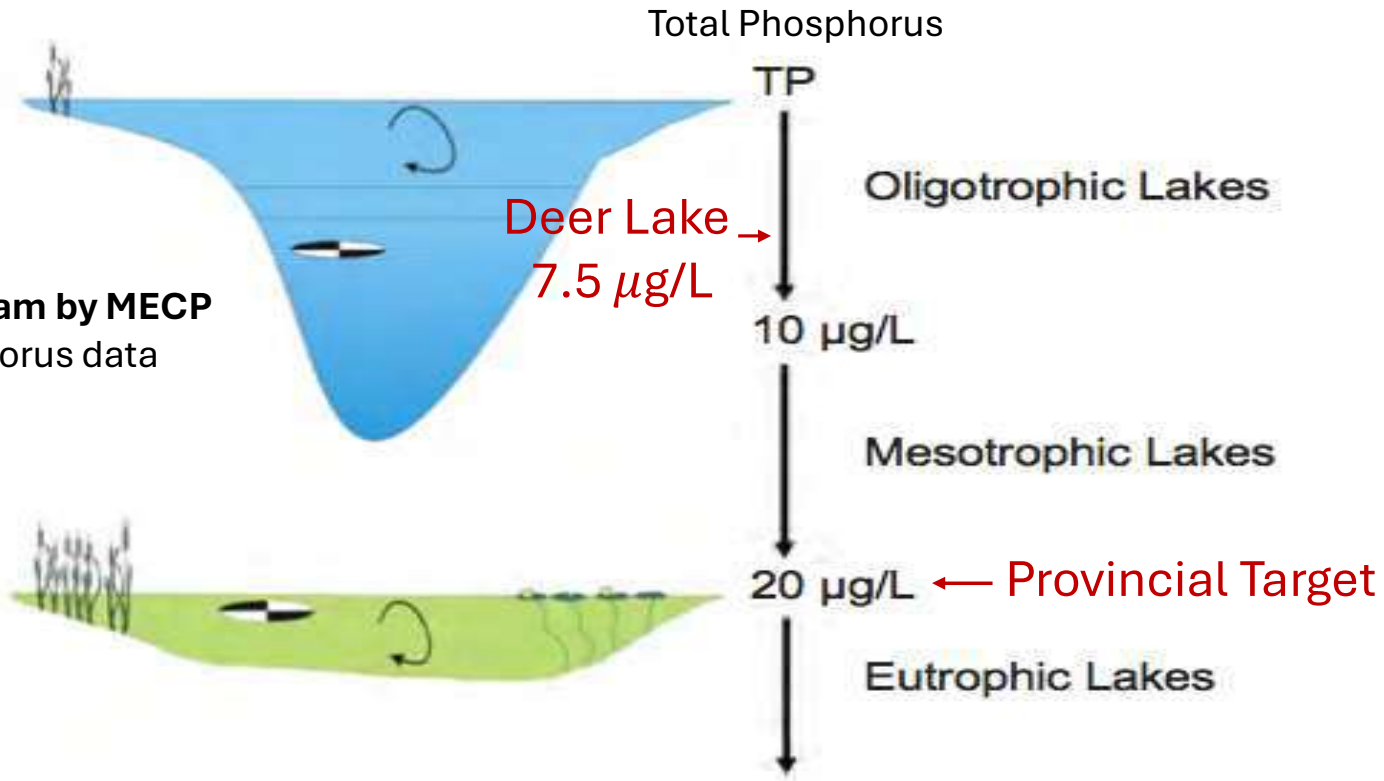


Figure 1: Trophic classification of lakes

Key Terms: Lakes are classified based on thermal stratification – dimictic, polymictic

Thermocline: A thin layer in lakes in which temperature decreases rapidly with depth, separating the warmer surface mixed layer from the colder deep water below.

Internal Loading: Anoxic sediments release **phosphorus**, and a specific form of iron, called '**ferrous iron**' →

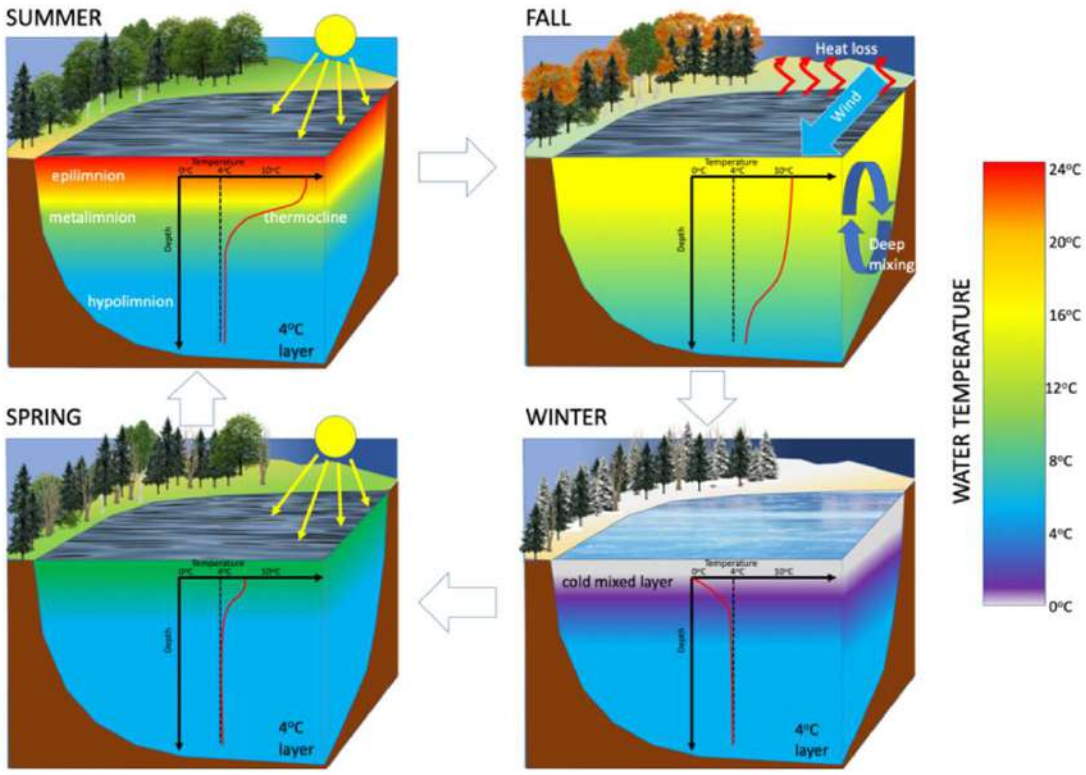
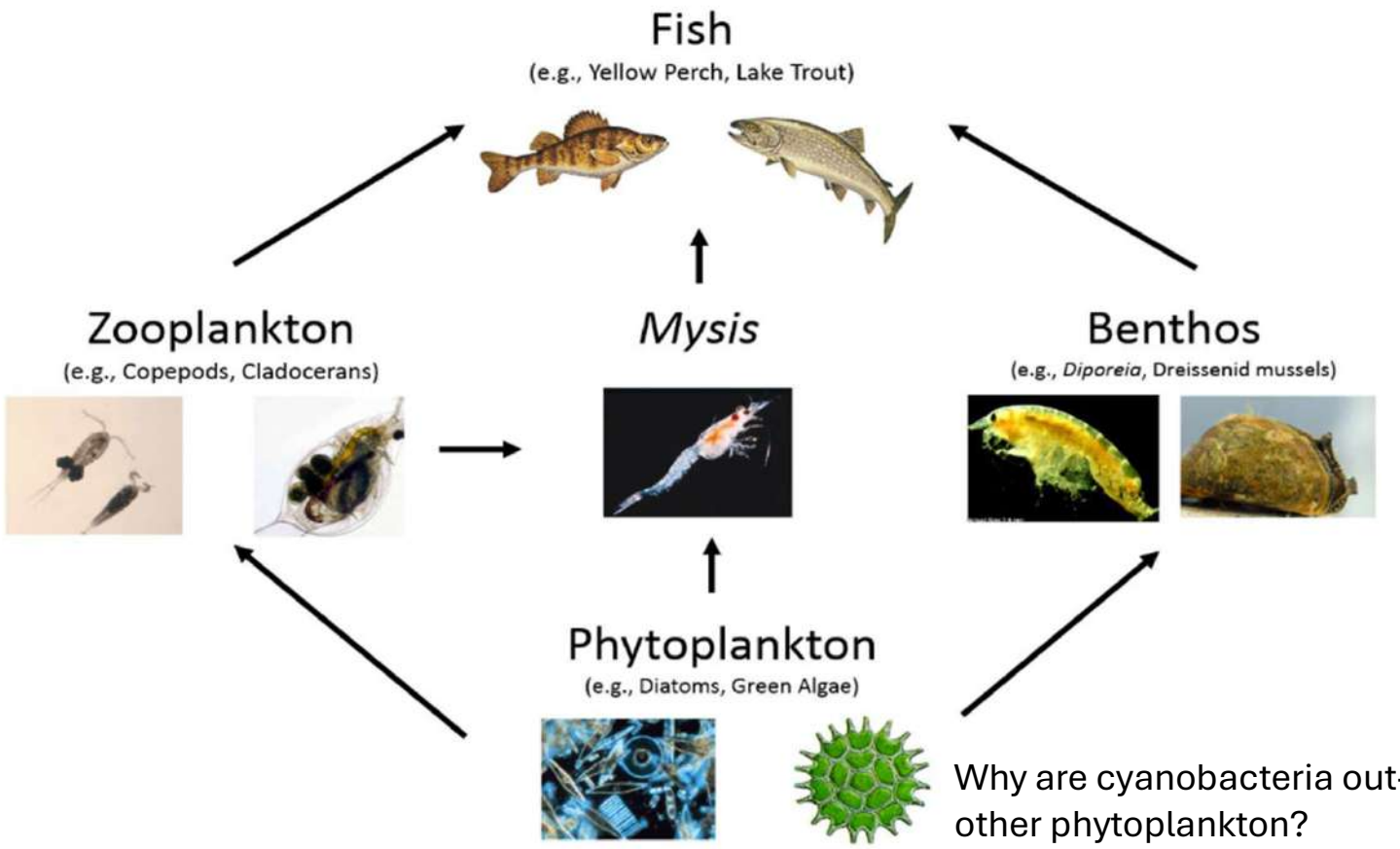


Figure2: Dimictic lake turn over twice a year – fall and spring

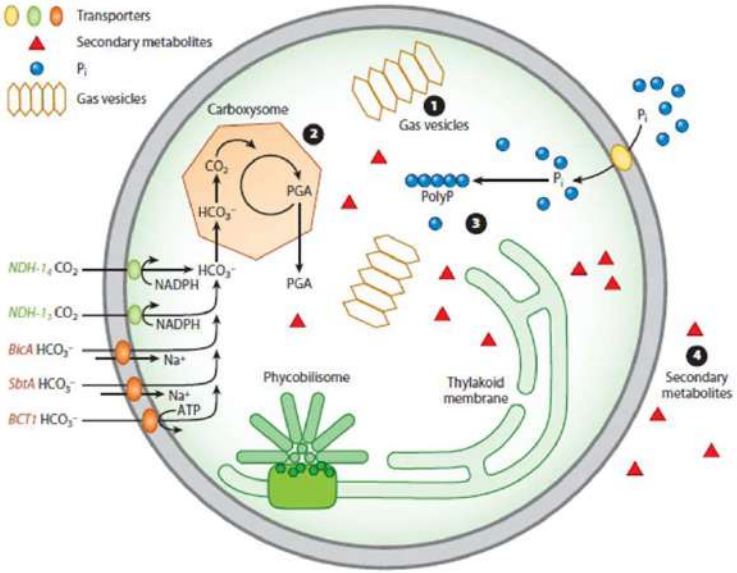
What are cyanobacteria (a.k.a blue-green algae)?



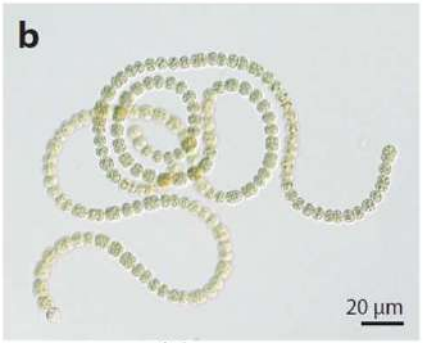
Why are cyanobacteria out-competing other phytoplankton?

What are cyanobacteria (a.k.a blue-green algae)?

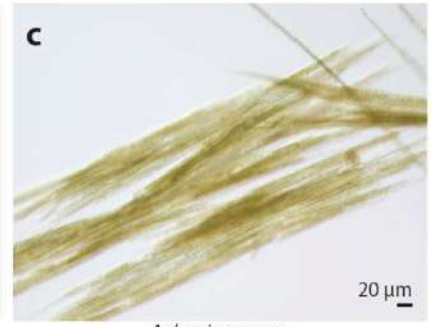
- **Buoyancy control**
- Growth rates **higher when water above 25°C + sediment anoxia***
- **Higher nutrients (phosphorus)** increases risk of cyanobacteria blooms
  - Cyanobacteria growth is limited by availability of **phosphorus**, and a specific form of iron, called '**ferrous iron**' → needed for photosynthesis and respiration
- >5000 species, some **producing Secondary metabolites** (cyanotoxins)



Microcystis



Dolichospermum



Aphanizomenon

What are causing the cyanobacteria blooms?

Water Temperature

Dissolved Oxygen

Stagnant water (low flow)

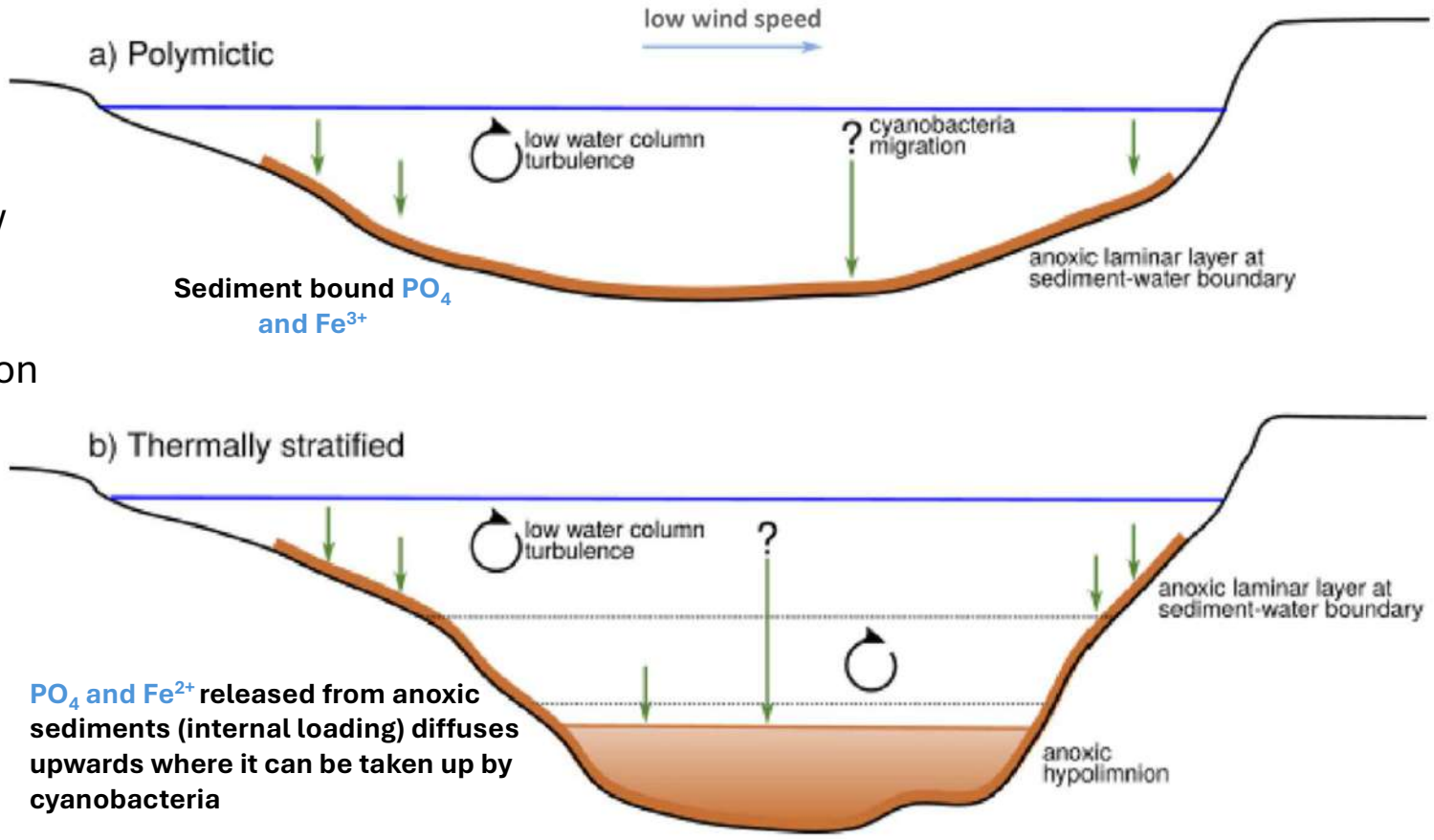
Thermal Stratification

Anoxia

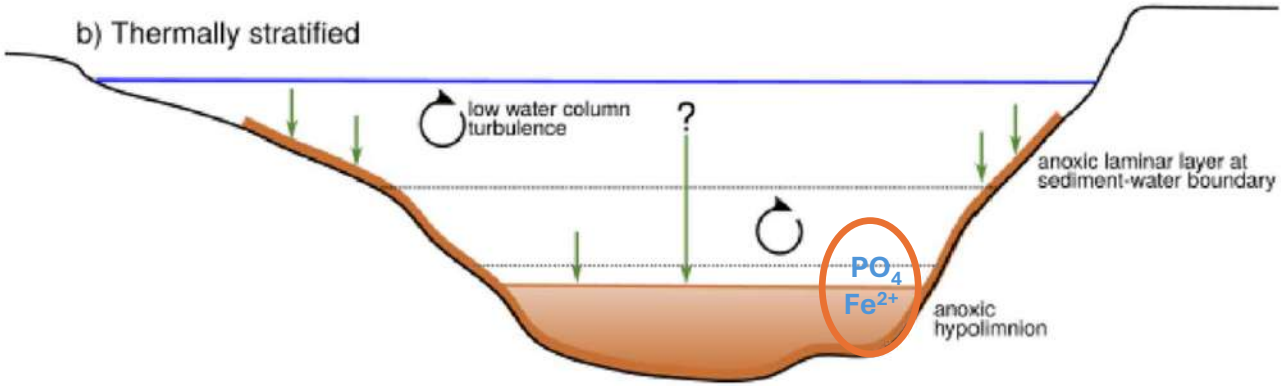
Internal loading

Phosphorus (PO_4)

Iron (Ferrous Fe^{2+})



What are causing the cyanobacteria blooms?



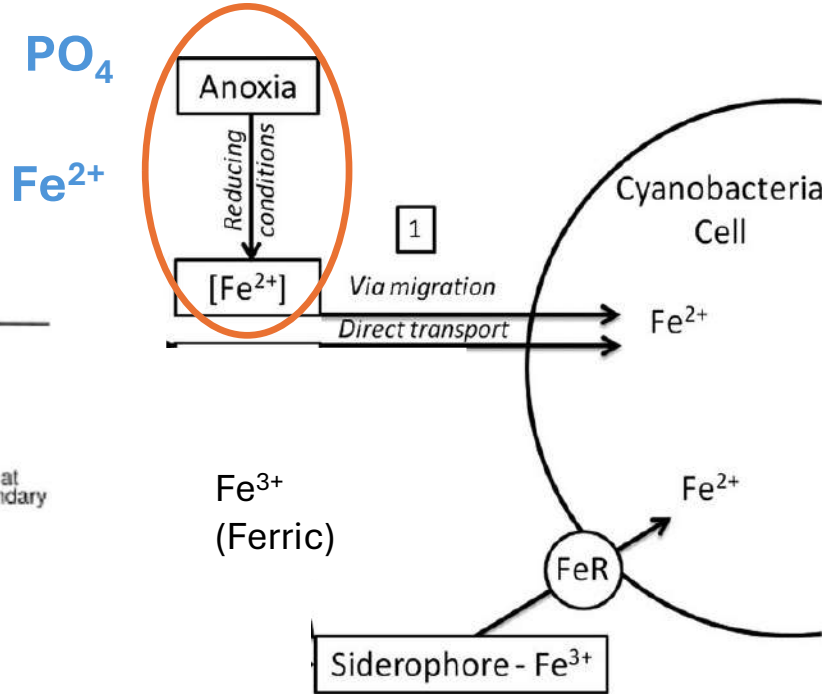


Figure: A novel model for cyanobacteria bloom formation: the critical role of anoxia and ferrous iron

Molot et al. 2014 Freshwater Biology, Volume: 59, Issue: 6

What are causing the cyanobacteria blooms?

Climate change can bolster cyanobacterial blooms**:**

(1) **increasing water temperature and declines in wind speed** that **enhance thermal stratification**, which **alters internal nutrient loading dynamics** and **gives cyanobacteria with buoyancy regulation a competitive edge** over algae phytoplankton.

(2) **altered and extreme precipitation patterns** and **water levels**, which can shift the **timing and magnitude of nutrient delivery** to fuel cyanobacterial blooms.

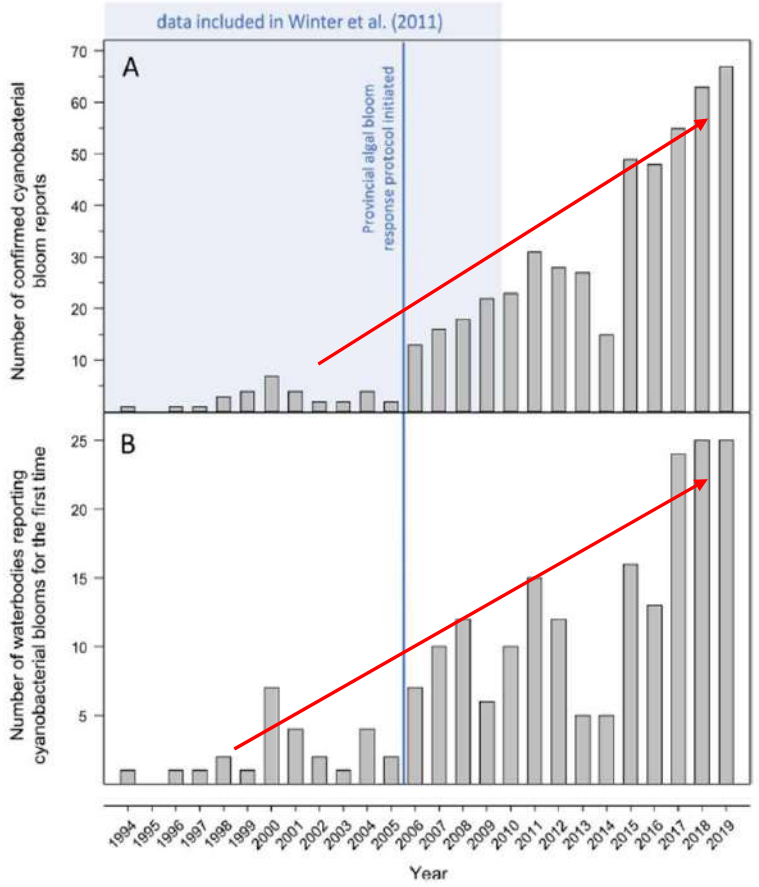
3) Some studies have shown **water temperature to be a predictor of cyanobacterial dominance equally as important as macronutrient** levels and predict that cyanobacteria **will become more dominant in more lakes in response to climate warming, irrespective of nutrient levels**.

What do we know about cyanobacteria blooms in Ontario?

Cyanobacterial blooms in Ontario, Canada: Continued increase in reports through the 21st century

Elizabeth J. Favot[a], Claire Holeton[b], Anna M. DeSellas[c] and Andrew M. Paterson[a,c]

(A) Number of confirmed cyanobacterial blooms reported by the public to the Ontario Ministry of the Environment, Conservation and Parks and (B) number of waterbodies reporting first confirmed cyanobacterial blooms by year between 1994 and 2019.



What do we know about cyanobacteria blooms in Ontario?

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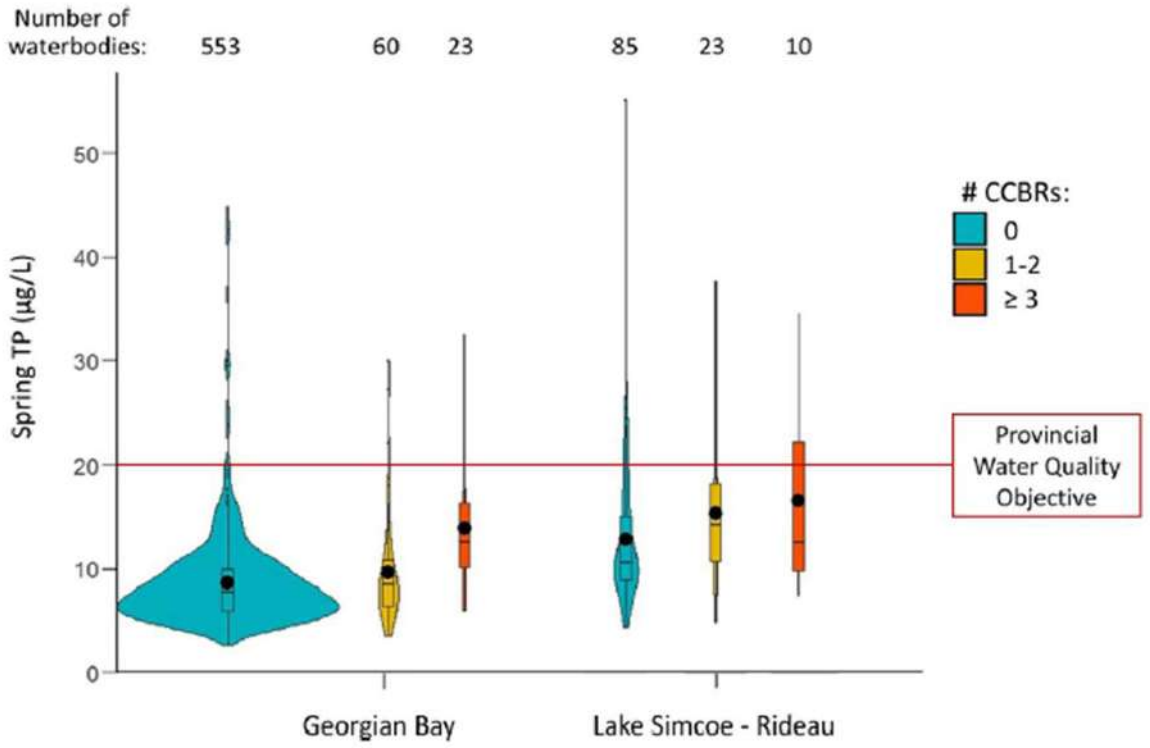
Comparison of spring total phosphorus (TP) concentrations in inland lakes and rivers that have had no confirmed cyanobacterial bloom reports (CCBRs), with those that have had 1–2 or 3 or more years with CCBRs within the Georgian Bay and Lake Simcoe–Rideau ecoregions.



Cyanobacterial blooms in Ontario, Canada: Continued increase in reports through the 21st century

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Key Findings:

1) TP declining in mesotrophic and eutrophic lakes BUT CCBR increasing
2) Large % of lakes (84%) with CCBRs had TP concentrations less than 20 µg/L, and 44% had spring TP concentrations less than 10 µg/L
3) In the lakes with reoccurring cyanobacterial blooms (i.e., with 3 or more years of CCBRs) had significantly higher average spring TP concentration.

All confirmed harmful cyanobacteria blooms reported in the NBPSDHU since 2011

What are the lessons for Deer Lake?

1) Does Deer Lake thermally stratify?
2) Is Deer Lake anoxic?

Deployed July 19th

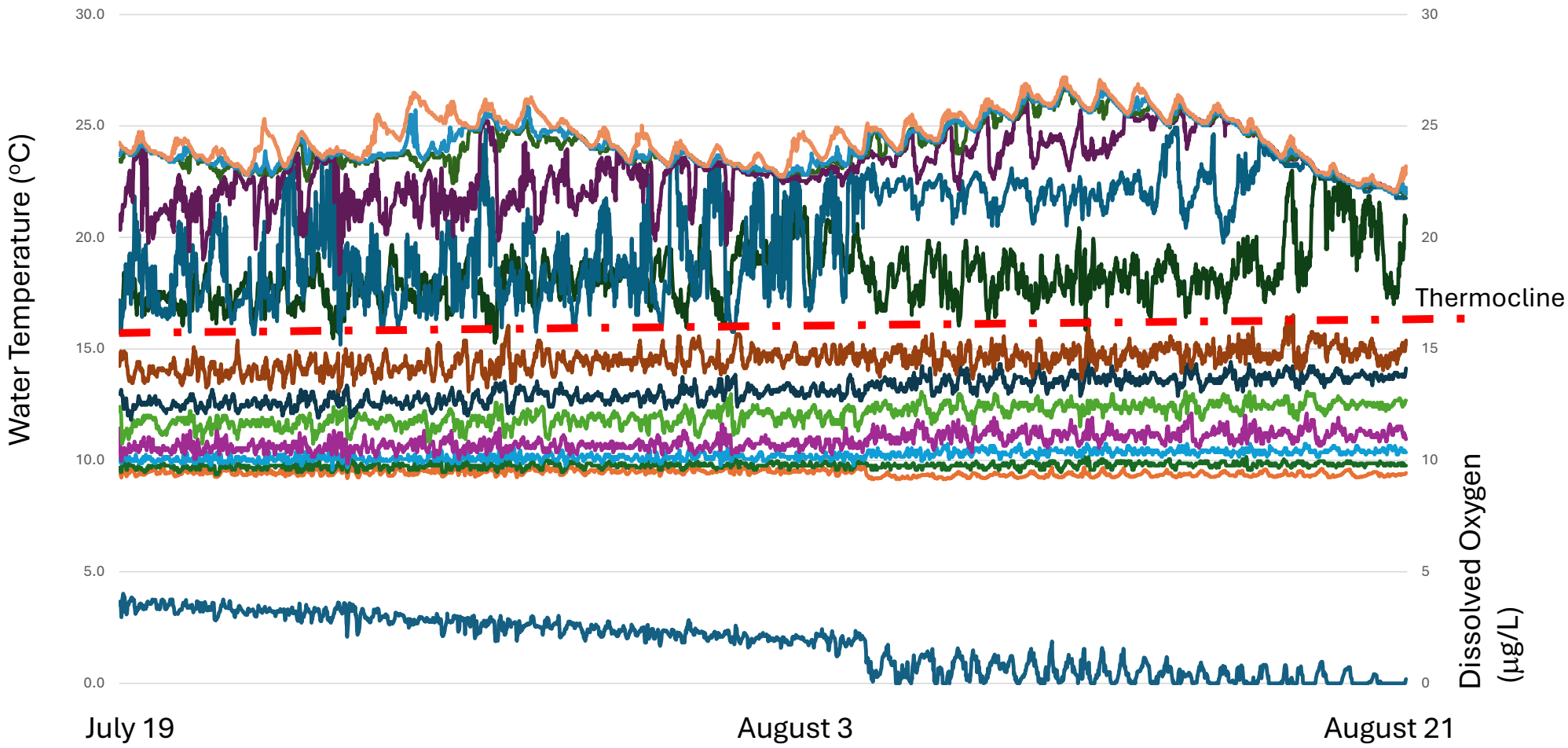
16 m temperature chain

DO sensor

Deer Lake

Water Temperature Profile and Dissolved Oxygen above the Sediment

July 19 - August 21, 2025



What are the lessons for Deer lake?

1) Does Deer Lake thermally stratify?

   Yes, the lake was thermally stratified between 8m and 9m below the surface (warm and cold water).

2) Is Deer Lake anoxic?

   Yes, there were several brief periods of anoxia 1m above the sediment (15m below surface.

Implications for cyanobacteria bloom risk:

1) Water temperature below the thermocline is ~ 10-15 ^{o}C
2) Internal loading (**PO_4 and Fe^{2+}**) stops under oxygenated conditions
3) Cyanobacteria not known to migrate below 12m since they need sunlight

The risk is no greater than other oligotrophic lake in the Georgian Bay ecoregion. We did not monitor the shallow embayments that are also susceptible to algal blooms.

What are the lessons for Deer Lake?

1. Continue involvement in the Lake Partner Program
2. Get involved. Consider joining Muskoka Watershed Council's Algae Monitoring Program.
3. Let representatives at the municipal, provincial and federal levels know that funding is needed for research on cyanobacteria blooms on the many possible contributing factors.
4. We know that phosphorus is essential for the growth of all types of algae that can degrade the health and appearance of our waterbodies, so continue efforts to reduce phosphorus loading.

Climate-change impacts likely make it more important than ever to avoid releasing phosphorus into water by managing septic tanks properly, protecting shorelines from erosion, and protecting wetlands that keep phosphorus from entering lakes.

Acknowledgement to the Crew!

Thank You

Questions?


Duckweed


Filamentous Algae


Filamentous Algae