"Limnology 101" and the Pine Lake Plan

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What I can, and can't contribute

- I have no particular expertise in managing swimming, boating, fishing, septic systems or development
- I'm a limnologist, environment scientist and plankton biologist
- I've work on environmental issues facing our lakes for 4 decades

In developing a lake plan, a limnologist might consider..

1. What was the condition of the lake before we arrived?
2. How sensitive is the lake to human impacts?
3. What are the current local, regional and international threats to the lake, and are they reducing or worsening?
4. What are the suspected future threats?
5. What should we do to protect the lake from ongoing and future threats?

1. What was the natural, pre-development condition of the lake?

Possible approaches

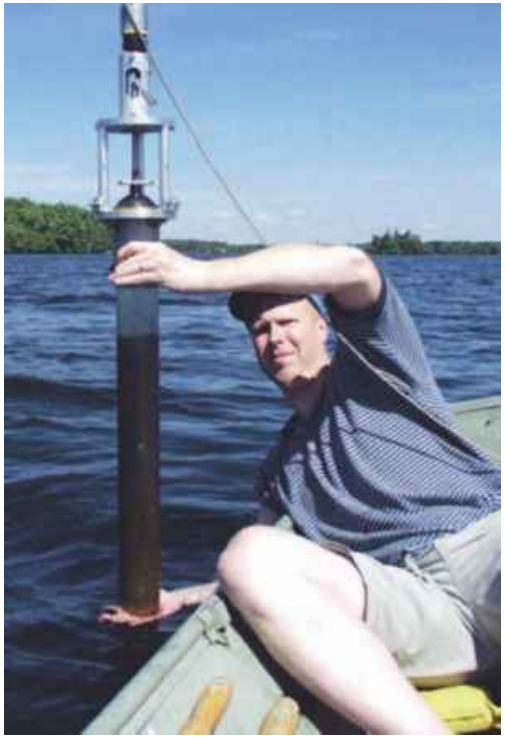
- Actual records
- Space for time substitution
- Geochemical models
- Paleolimnological assessment

The Unfortunate Reality

- Don't exist
- Complicated by other stressors
- Only for a few metrics, such as pH
- Very useful but $$

The Paleolimnological Approach*

Taking the core



Sectioning the core

*Photos from Queen's U

2. How inherently sensitive is the lake to human impacts?

- It's "young", and on the Canadian Shield
- It's located downwind of industrial North America
- It's oriented east-west, with a largish watershed
- It's long but narrow, and relatively shallow
- There's a neighbouring highway and cottages

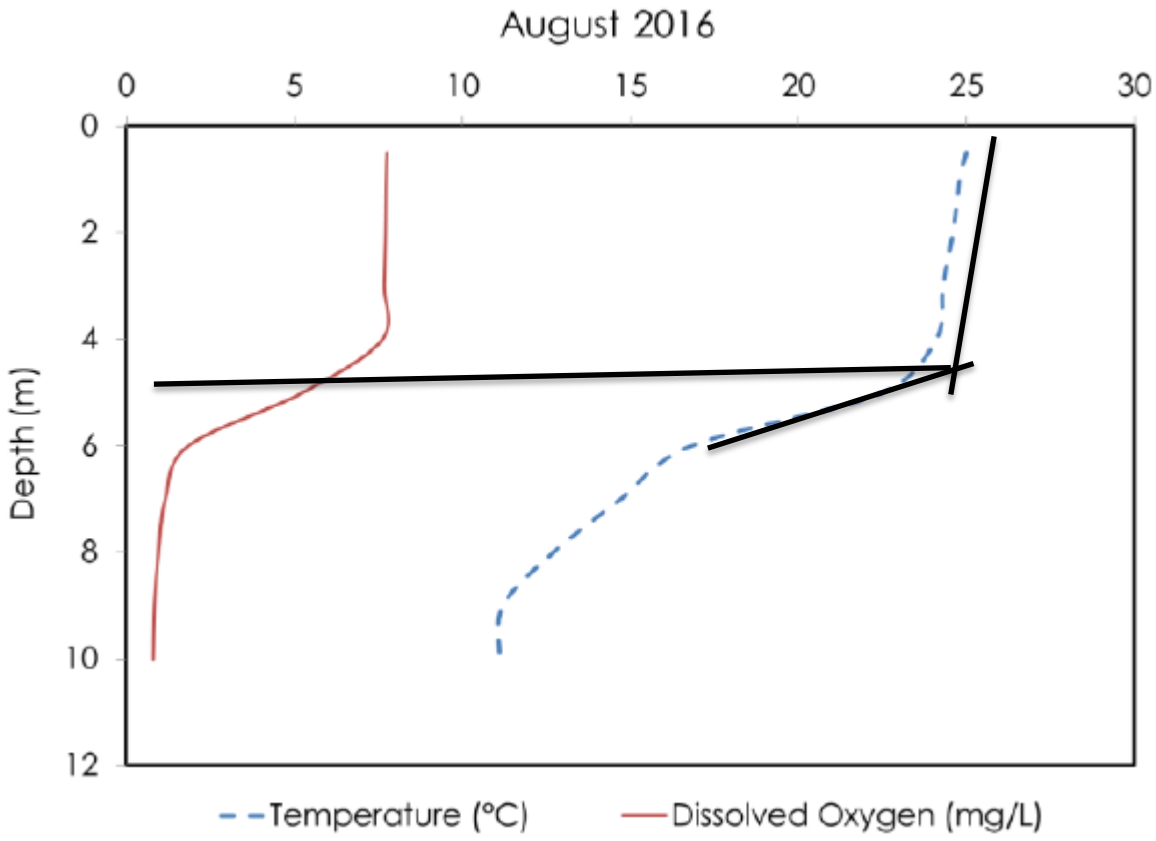
Implications of lake orientation and the wind

- Surface waters move downwind at 1.5% of wind speed
- Typical wind speeds are 15 km/hour or 360 km/day
- Surface waters typically move 5.4 km/day, i.e. the length of the lake
- Lake water is not a static pool!

Implications of lake size on mixing

- Mixing depth (m) = 4*√Fetch (km)
- Fetch of the main basin is about 1.5 km
- So mixing depth should be ~5 m.

Pine Lake mixing depth in Aug 2016



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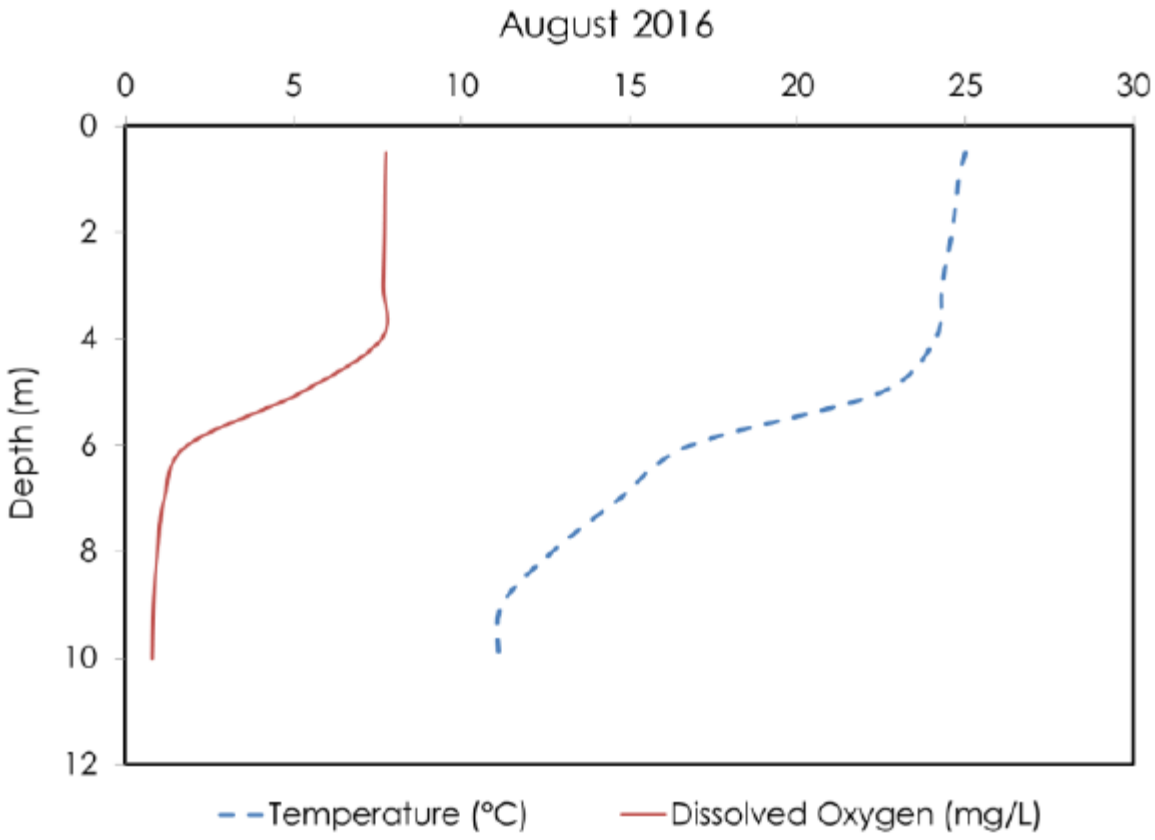
Lake depth and deep water oxygen



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Deep-water hypoxia and anoxia

- It's mostly natural
- It does increase vulnerability to algal blooms especially in the fall
- It eliminates cold water habitat for many species
- It might make the lake more vulnerable to additional development, as it likely reduces sedimentary retention of phosphorus

Watershed size is also important

- It controls water and pollutant retention time
- Annual water load (AWL)= (precipitation-evaporation) * (watershed + lake area)
- Retention time (RT) = AWL/Lake volume (V)
- Pine Lake is 156 ha, the watershed is 1530 ha, Precip-evap = 0.5 m, so AWL = 8,430,000 m^3
- Assuming a mean depth of 5 m, V = 7,800,000 m^3
- So RT = 7.8/8.4 or about 0.9 years, **the length of time a pollutant will stay in the lake**
- But the time to fully respond to a change in input is roughly 3RT's or about 3 years in Pine Lake.

Summary of inherent sensitivity

- Pine Lake responds fairly quickly to watershed inputs, i.e. 3 years
- Soluble pollutants will spread rapidly in the lake given the fetch and wind direction
- It naturally experiences deep water anoxia, which might lead to TP return and algal blooms, and removes deep water fish habitat
- It warms up quickly as it is shallow and somewhat coloured. This leads to surface heating

3. What is the status of known threats?

- Acid rain, lead pollution and DDT are no longer issues in the region
- Ozone depletion and UV damage aren't a problem given the colour of the lake water
- I'm not sure about mercury in the fish, but if it's an issue it will recover slowly
- Eutrophication is improving in the region, but needs constant management
- Zebra mussels are not a threat, and have likely been unsuccessfully introduced already
- Has the spiny water flea caused problems, eg. increasing accumulations of jellied plankton?

4. What are the emerging threats?

- Road salt. Is chloride >50 mg/L?
- Calcium decline. Is calcium <1.5 mg/L?
- If the lake hits 28 or 29 °C some animals may die, and they may not be able to migrate to cooler waters, given the low oxygen levels of deep waters
- The interaction of TP and climate change in an anoxic lake may increase the risk of fall algal blooms
- How the spiny water flea might complicate this situation is unknown

5. So what should be done?

- Develop a lake plan!
- Perhaps learn the natural history of the lake, with a paleolimnology profile, if affordable
- Participate in the Lake Partner program
- Understand the recognized threats, especially road salt and calcium decline
- Keep a look out for "jelly"
- If possible, supplement the District's and the Lake Partner program's documentation of status and trends, and
- Become a "Friend of the Muskoka Watershed"

Vision of the Friends of the Muskoka Watershed

- to foster the understanding, choices, actions and wise management necessary to ensure the protection of our freshwater ecosystems forever.

Our main programs

- HATSEO – Hauling Ash To Solve Ecological Osteoporosis
- A Muskoka Freshwater Research Institute
- Environment Care: testing Muskoka waters

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