Science Museum of Minnesota

St. Croix Watershed Research Station

A Paleoecological Investigation of Poplar Lake, Cook Co., MN

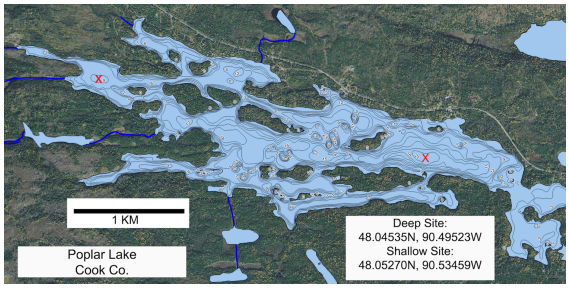
Issue: Poplar Lake is mostly surrounded by undeveloped land. But the water clarity seems to be declining. What can the sediments tell us about the historical condition of the lake, and when and why it has changed?

Poplar Lake coring, 2016

Poplar Lake

✓ Poplar Lake is located in Cook Co., Minnesota, up the Gunflint Trail. It is an over 750 acre lake with a maximum depth of about 73 ft with most of the shoreline undeveloped. Poplar Lake is currently mesotrophic (total phosphorus reaches into the low 20s ppb), but has shown a trend toward lower water clarity (measured by Secchi disk). In Oct 2016, two sediment cores were recovered from a western shallow bay and in deeper central Poplar Lake to determine the lake's ecological and water quality history.

Sediment core analysis



Poplar Lake core site

Sectioning a Poplar core

Tetracyclus, Poplar's own diatom

✓ Sediments in lakes provide a record of physical, chemical, and biological clues for determining how and when a lake has changed.

✓ To establish a date-depth relationship for a core, we use natural (Lead-210) or man-made (Cesium-137) radioisotopes. This tells us the approximate year that a layer of sediment was deposited.

✓ The Poplar Lake core was analyzed for changes in geochemical and biological clues including inorganics (mineral matter), carbonates, organics, phosphorus, biologically produced silica, diatom fossils, and fossil algae pigments. Each provides information on the lake and its history:

Inorganics – a measure of the mineral matter in the core. Inorganics may increase with erosion or rising water levels

Carbonates – carbonates accumulate due to input of hard groundwater and as a natural product of plant and algae photosynthesis

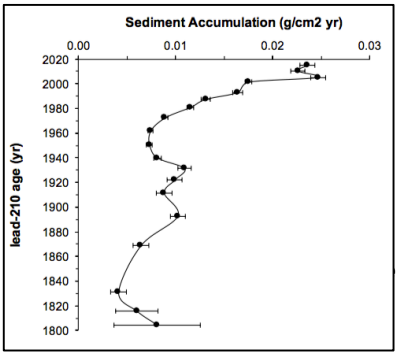
Organics – a measure of biological material in a core from the breakdown of pollution, plant, algae, and animal remains

Phosphorus – a measure of all types of phosphorus (P) in a core, generally increases when nutrient loading and plant/algae production increase. We also measured the different types of P – some types are indicative of internal loading of nutrients from the sediments

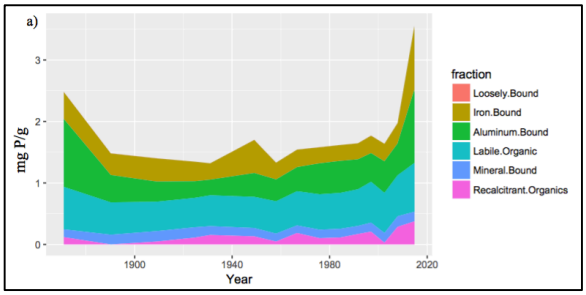
Biogenic silica – a measure of the amount of historical diatom growth; diatom accumulation normally increases with increased nutrients

Diatoms – many organisms leave identifiable remains in sediments. We can determine their abundance and when they appear or disappear. Diatoms are a group of microscopic algae with cells covered in biologically produced glass. The species found in a lake will change as a lake changes from nutrients, acidity, salinity, temperature, etc. We can also use diatoms to estimate water quality. Diatoms are used to predict historical P levels using models designed for Minnesota lakes.

Pigments – different algae produce different types of pigments. Pigments are preserved in the sediments and tell us about past algae.



Sedimentation in shallow Poplar



Phosphorus in deep Poplar

Poplar diatoms, 1800s

Poplar diatoms, 2000s

The research shows...

✓ Core dating shows that sediments that are deeper than 20 cm (8 ins) in shallow Poplar and 18 cm (7 ins) in deep Poplar were deposited before Euroamerican settlement. That is very low sediment accumulation rate.

...that Poplar Lake hasn't changed a lot

✓ Sedimentation rates (how fast sediment is accumulating) have increased in Poplar Lake. The accumulation of sediments increased initially with logging and settlement in both cores and has continued to increase after the 1980s. Current rates of accumulation are 2 times greater than before 1900.

✓ Sediments in Poplar Lake are dominated by inorganic and organic fractions. There has been little change in sediment makeup indicating sources of sediment to the lake have also not changed.

✓ Phosphorus levels change little in the shallow core but increase at the top of the deep Poplar core. Key types of P that drive internal loading (Iron-bound) increase upcore in the deep core indicating that there has not been large changes in the nutrient budget but that an internal loading can take place in deep Poplar.

✓ Diatoms in both Poplar Lake cores show no dramatic shifts in the last 200 years. Both cores are dominated by planktonic forms (live in the open water). This type of minimal change is very uncommon in MN lakes.

✓ The diatoms show that Poplar Lake has long been mesotrophic with total phosphorus (P) only reaching the 20 ppb range in both cores and similar to current monitored values. Poplar does not show evidence of changes in P levels.

✓ Fossil algal pigments confirm a relatively stable long-term condition of Poplar Lake. Algal pigment records show minimal change in Poplar's algal communities. While there is evidence of the long-term presence of potential bloom-forming cyanobacteria, their levels do not indicate any historic or recent threat of noxious cyanobacterial blooms.

How can we use this information?

✓ Excess nutrients, especially phosphorus, cause unsightly algae blooms, nuisance plant growth, and deplete oxygen levels. Lakes get nasty and have poor conditions for swimming, fishing, and boating.

✓ Most of the changes recorded in the Poplar Lake sediment core are indicative of consistent mesotrophic nutrient availability and slightly increased sedimentation and algae growth since the 1980s.

✓ Poplar Lake has not undergone dramatic changes in the last 200 years. Mangement recommendations include citizen monitoring programs to help detect any trends in lake condition, continued sound management of lakeshore properties including regular septic maintenance, maintaining shoreline buffers, minimizing use of chemical in lawns, driveways, and roads, cautious new development or landuse in the watershed, and preventing introduction of aquatic invasive species.

Funding Partners
Minnesota Pollution Control Agency

Contact
Mark B. Edlund, Ph.D.
St. Croix Watershed Research Station
16910 152nd St. N
Marine on St. Croix, MN 55047
651-433-5953, medlund@smm.org

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