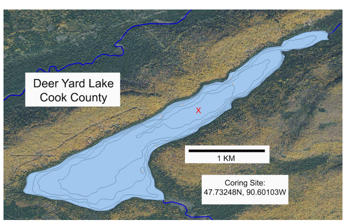
A Paleoecological Investigation of Deer Yard Lake, Lutsen, MN

Issue: Deer Yard 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, when and why it has changed?

Deer Yard Lake coring, 2016



Deer Yard Lake core site

A blustery day on Deer Yard

Deer Yard Lake

- ✓ Deer Yard Lake is located in Cook Co, by Lutsen, Minnesota. It is a 346 acre lake with a maximum depth of about 20 ft with most of the shoreline undeveloped. Deer Yard Lake is currently mesotrophic (total phosphorus reaches into the low 20s ppb), but has shown a trend toward lower water clarity as measured with a Secchi disk. In Oct 2016, a sediment core was recovered from the the center of Deer Yard Lake to determine the lake's ecological and water quality history.

Sediment core analysis

- ✓ 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 Deer Yard 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

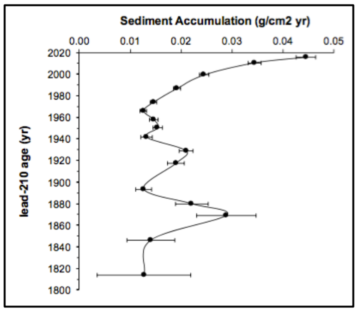
Organics – a measure of biological material in a core from the breakdown of pollution, plant, algae, and animal remains

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

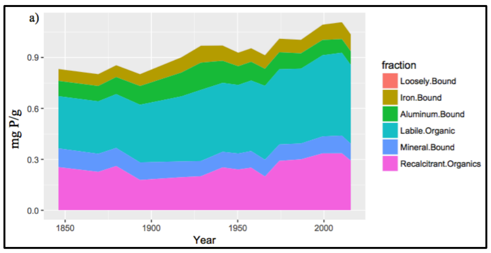
Biogenic silica – a measure of the amount of historical diatom growth; diatom accumulation normally increases with increased nutrients

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 Deer Yard Lake



Phosphorus in Deer Yard Lake

Deer Yard diatoms, 1800s

Deer Yard diatoms, 2000s

The research shows...

✓ Core dating shows that sediments that are deeper than 25 cm (10 ins) were deposited before Euroamerican settlement. That is low sediment accumulation compared to many MN lakes.

...that Deer Yard Lake hasn't changed a lo

✓ Sedimentation rates (how fast sediment is accumulating) have increased in Deer Yard Lake. The accumulation of sediments increased initially with logging and settlement and has continued to increase after the 1980s. Current rates of accumulation are 2-3 times greater than before 1900.

✓ Sediments in Deer Yard 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 increase slightly moving up the core from Deer Yard Lake. The top of the core is dominated by organic forms of phosphorus. Key types of P that drive internal loading (Iron-bound) do not increase upcore indicating that there has not been large changes in the nutrient budget nor an increased threat of internal loading.

✓

✓ Diatoms in Deer Yard Lake show no dramatic shifts in the last 200 years. A shift toward fewer planktonic forms (live in the open water) does occur after the 1950s. Because the community makeup is not dramatically changed, this suggests some habitat shifts may have occurred with more diatoms growing attached and on the bottom.

✓ The diatoms show that Deer Yard Lake has long been mesotrophic with total phosphorus (P) in the 20 ppb range similar to current monitored values. Changes in diatom communities in Deer Yard are not strongly indicative of change in P levels.

✓ Fossil algal pigments confirm a relatively stable long-term condition of Deer Yard Lake as pigment records do not show major changes in algal communities, and in particular do not show any evidence of increased cyanobacteria (blue-green algae) growth. There is a slight increase in algae in recent decades.

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 Deer Yard Lake sediment core are indicative of consistent mesotrophic nutrient availability and slightly increased sedimentation and algae growth since the 1980s.

✓ Deer Yard 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

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