A Paleolimnological Study in the Comfort Lake-Forest Lake Watershed District

SHIELDS LAKE

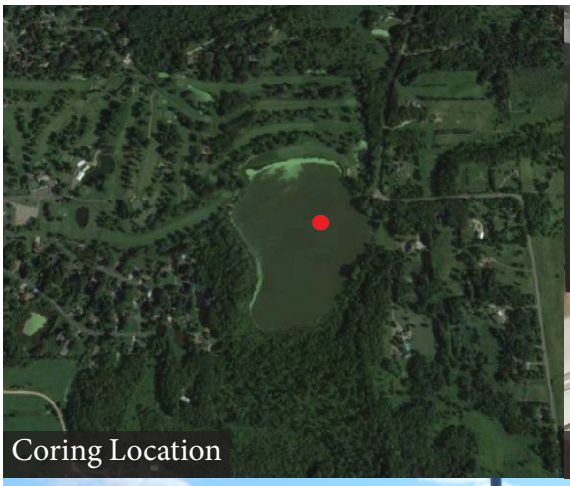
THE PROBLEM:

Shields Lake (pictured left) is impaired due to high nutrient levels. This study used sediments from the lake bottom to tell us about the historical condition of the lake, and when it changed, to help inform lake management decisions.

ANALYSIS:

Lake sediments provide a record of physical, chemical, and biological clues for determining how and when a lake has changed. Scientists (paleolimnologists) work from an anchored boat or the surface of the ice to recover sediment cores. A piston corer uses a clear tube that is lowered to the lake bottom using alloy rods that thread together. The tube is fitted with a piston held in place with a cable; as the tube is pushed into the mud, the piston helps "pull" the sediment into the tube.

Physical, chemical, and biological indicators preserved in the sediment are analyzed to reconstruct the ecological history of the lake. For example, naturally occurring radioisotopes, which decay at a known rate, allow scientists to establish a age-depth relationship for the core; and fossil diatoms (algae that were preserved due to their biologically produced glass cell walls) tell us about historical water quality and ecology.



Coring Location

Core Processing

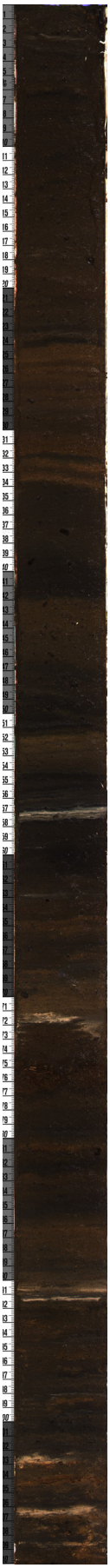
Field Work

THE LAKE:

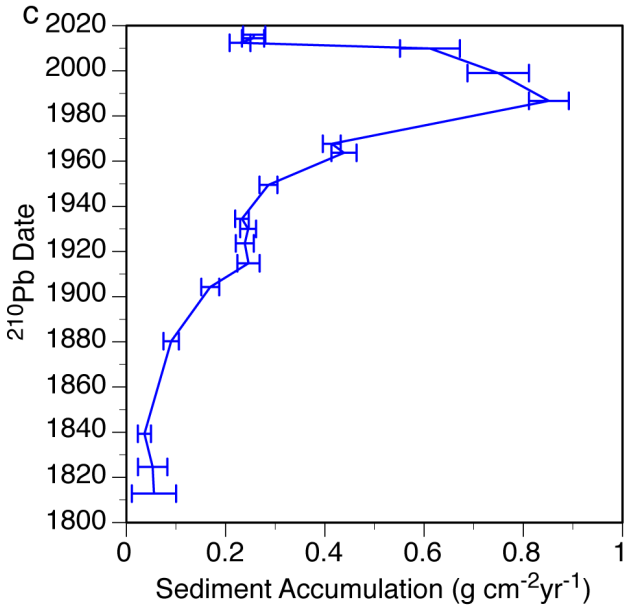
Shields Lake is shallow, with a maximum depth of 7.8 m (26 feet), and surface area of 30 acres. Rooted plants grow in 87% of its area and it is used mainly for fishing. The lake drains 538 acres, mostly from the south; Shields Lake drains to Forest Lake to the north. The lake borders the Forest Hills Golf Club, which began construction in 1958. In 2006, the lake was placed on MN's Impaired Waters List due to high nutrient levels; summer average TP concentrations are near 200 µg/l. In February of 2016, a sediment core was collected through the ice to determine the lake's ecological history.

THE CORE:

The image to the right represents a portion of the sediment core recovered from Shields Lake. The top of the image shows sediments that were deposited in recent years, and sediments get older downcore. Naturally-occurring radioisotopes (lead-210) were used to establish a date-depth relationship for the core. Sediments were sectioned into 2-cm increments for analysis.



THE RESULTS:



The sedimentation rate (how fast sediment is accumulating) has changed over time in Shields Lake. **The rate started to increase in the late 1800s and reached a peak in the 1980s.** Even though the sedimentation rate has declined in recent decades, it still remains about five times higher than it was in the 1800s.

- **Shields experienced a large shift in sediment composition,** in the form of an increase in organic material being delivered to the lake, that began in the 1940s and persisted through about 2010 (a similar and synchronous change was found in the sediment core from Comfort Lake). During the post-World War II era, agricultural practices shifted in many areas to include tile drainage, ditching, and increased fertilizer use; the pulse of organic matter from the landscape may have been the result of these practices in the watershed.

- Golf course construction began almost two decades after the large sediment change in Shields Lake. The golf course may have had impacts on Shields Lake, but these **localized impacts were difficult to discern** due to the other large-scale changes in the watershed.

- Results of the diatom analysis suggested that Shields Lake has been **high in nutrients since the early 1900s**.

- An alum treatment on Shields Lake in about 1995 may have had an effect on the sediment phosphorus concentration around that time. However, the effect was small, and there was **no significant change to the diatom community assemblage during that time** (we would expect the diatoms to respond if there was a sustained change in phosphorus concentration).

- Algal pigment analysis showed that types of blue-green algae (cyanobacteria) that have the potential to form toxic blooms first appeared in the late 1930s, at the time of the large influx of organics, and have persisted in Shields Lake since that time.

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