RESULTS OF SEDIMENT CORE TAKEN FROM RED LAKE, DOUGLAS COUNTY, WISCONSIN

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Aquatic organisms are good indicators of a lake's water quality because they are in direct contact with the water and are strongly affected by the chemical composition of their surroundings.

Most indicator groups grow rapidly and are short lived so the community composition responds rapidly to changing environmental conditions. One of the most useful organisms for paleolimnological analysis are diatoms. These are a type of algae which possess siliceous cell walls, which enables them to be highly resistant to degradation and are usually abundant, diverse, and well-preserved in sediments. They are especially useful, as they are ecologically diverse. Diatom species have unique features as shown in Figure 1, which enable them to be readily identified. Certain taxa are usually found under nutrient poor conditions while others are more common under elevated nutrient levels. Some species float in the open water areas while others grow attached to objects such as aquatic plants or the lake bottom.

By determining changes in the diatom community it is possible to determine water quality changes that have occurred in the lake. The diatom community provides information about changes in nutrient concentrations, water clarity, and pH conditions as well as alterations in the aquatic plant (macrophyte) community.

On 6 October 2010 a sediment core were taken from near the deep area (N46.17412° W91.76801°) of Red Lake in about 36 feet of water using a gravity corer. Samples from the top of the core (0-1 cm) and a section (30-32 cm) deeper in the core were kept for analysis. It is assumed that the upper sample represents present conditions while the deeper sample is indicative of water quality conditions at least 100 years ago.

Results

In Red Lake, historically the major component of the diatom community are those species that float in the open water of the lake. The major taxa of these planktonic diatoms in the bottom sample were the chain forming diatom *Aulacoseira ambigua* and *Cyclotella michiganiana* (Figure 2). These diatoms are common in lakes throughout the Upper Midwest with low to moderate nutrient levels. The diatom *A. ambigua* grows in the upper part of the water column while *C. michiganiana* is found in the middle part of the water column and requires good water clarity for its growth.

In the top sample these species are largely replaced by *Fragilaria crotonensis* (Figure 2) and *Asterionella formosa* (not shown). Both of these species are some of the first diatoms to increase as a result of nutrient enrichment following human disturbances. Recent studies have shown that these diatoms respond more to an increase in nitrogen and not necessarily to an increase in phosphorus.

The percentage of planktonic diatoms was lower at the top compared with the bottom sample.

The number of diatom species and the diversity of diatom community is greater at the top of the core. This because there was an increase in the diatom species that grow attached to substrates such as submerged aquatic vegetation (SAV). This indicates that there is more SAV at the present time compared with prior to the construction of shoreline cottages. The increase in plants following cottage development is common in lakes. Dr. Susan Borman recently conducted a study in lakes in the northwestern part of WI where she compared the SAV community in the 1930s with the present day community. She found that lakes with cottages have more plants and the species have shifted to those that are larger and grow closer to the lake's surface. The diatom community indicates this has happened in Red Lake.

Diatom assemblages historically have been used as indicators of nutrient changes in a qualitative way. In recent years, ecologically relevant statistical methods have been developed to infer environmental conditions from diatom assemblages. These methods are based on multivariate ordination and weighted averaging regression and calibration. Ecological preferences of diatom species are determined by relating modern limnological variables to surface sediment diatom assemblages. The species-environment relationships are then used to infer environmental conditions from fossil diatom assemblages found in the sediment core.

Such a model was applied to the diatom community in the core from Red Lake. The model indicates there has been a small increase in phosphorus of around 2-3 µg L-1. We were not able to apply the model to changes in nitrogen concentrations but it is likely the change has not be more than 0.1 mg L-1.

In summary, the sediment core indicates that the greatest change that has occurred in Red Lake during the last 100 years has been an increase in the submerged aquatic vegetation. Nutrient levels have only increased a small amount. This is very common in lakes in northern WI that have shoreline development where there is an increase in SAV but little increase in nutrient concentrations. Although there is an increase in nutrient delivery from the developed area on the lakeshore, attached algae associated with the increased plant growth intercepts the nutrients and reduces the nutrient delivery to the open water of the lake.

Other studies have shown, as the amount of nutrients that runoff from the watershed increases, eventually the algae attached to the SAV is not able to incorporate all of the nutrients and algal blooms result.
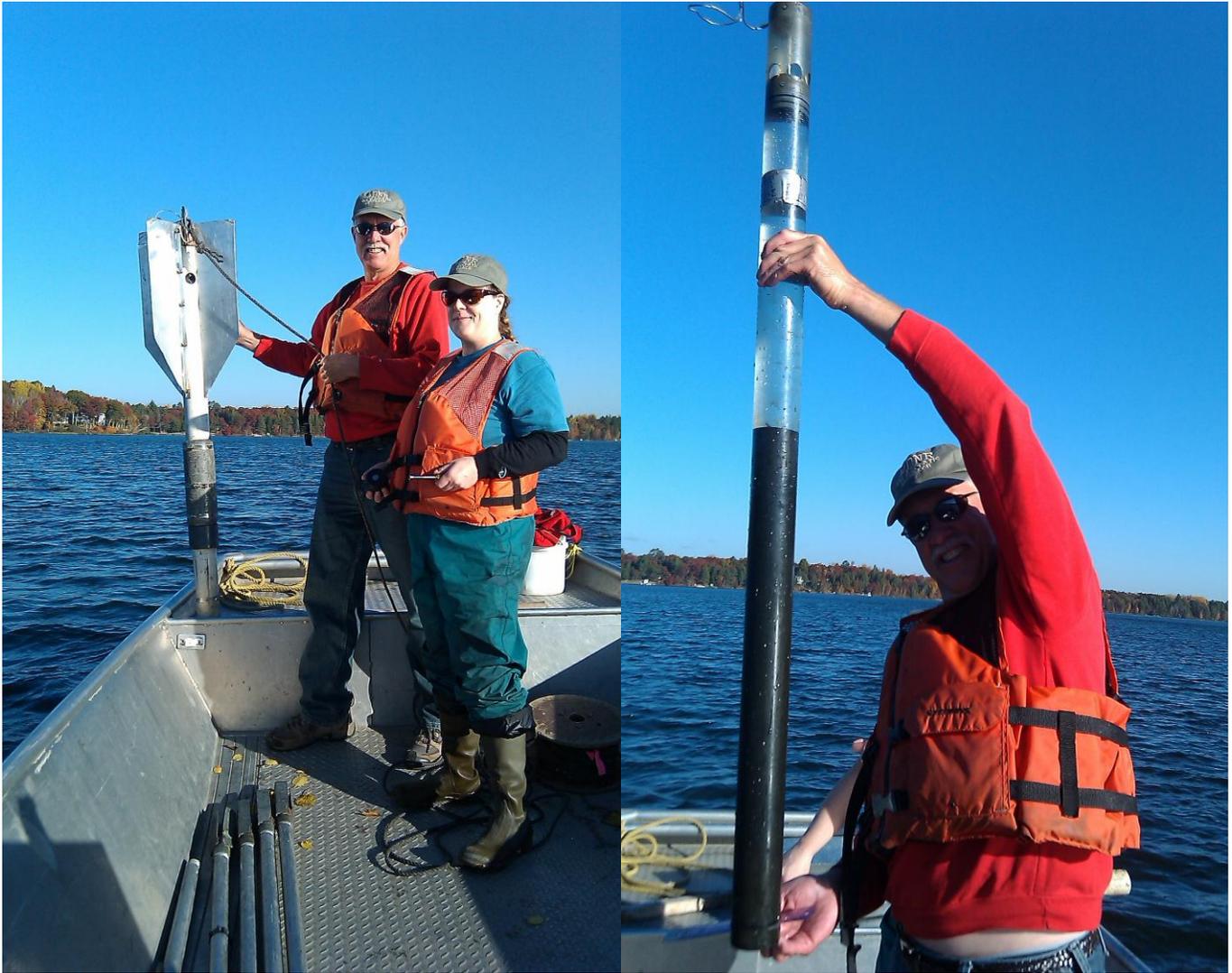
Paul Garrison and Gina LaLiberte with the DNR gravity corer about to drop into Red Lake's deepest area.

Paul holding up the sediment sample taken from the bottom of the lake – with 100 years of sediment to be analyzed.