PALEOLIMNOLOGY OF OTTER LAKE

In 2002 a very interesting study was published in the Journal of Limnology: 61 (2) by Dr John Smol of Queens University. Dr Smol is a world renowned paleolimnologist who has a keen interest in using lake sediment fossils to document the environmental conditions that existed over a period of time well before water quality sampling was routine. The science of paleolimnology is relatively new and has expanded behind much of the groundbreaking work done at Queen's University.In the study Dr Smol and his staff studied Otter Lake and three lakes in the Rideau chain to determine how the construction of the Rideau canal, which was completed in 1832, affected conditions in the Rideau system. Since Otter Lake was not part of the canal system but was located in the same watershed, it was used as a control lake. In other words, conditions should be about the same in all four lakes except for the effects of the canal construction. The study, which is also available in its original format, is summarized here in plain language.

Paleolimnology:

Limnology is the study of fresh water and paleolimnology is the study of the fossils of fresh water aquatic life, largely those of the microscopic algae classified as "Diatoms". Diatoms are excellent bioindicators because they have a silica-based shell which persists indefinitely after death and is species-specific for easy identification. Also there are many species of Diatoms and each species lives in a very specific and narrow range of conditions. So phosphorous loading in the water, acidity, turbidity, and temperature, can all be predicted with scientific certainty based on the kinds of Diatoms that are found in lake sediments.

Gravity Core Sampling:

In most lakes in Ontario sedimentation occurs at a rate of 0.5 cm per year. This sedimentation is composed of much of the detritus that falls into the lake but very importantly the sedimentation also includes the remains of the Diatoms that die and then settle to the lake bottom. Therefore a one meter (100 cm) core sample of lake sediment would yield a fossil record of 200 years. In this study, a one meter core sample represents the history of the lake back to about 1800 and the Rideau Canal construction began in 1826, so the core length would adequately cover the pre-construction period as well as the long recovery period since construction.

Sampling and Analysis:

Once the core sample is taken, it is transported to the lab and analyzed in thin slices. The diatomaceous algae species are recorded, the pollen of some weed species are noted, and isotopes of lead are detected. The significance of weed pollen indicates the initiation of land clearing for agriculture and the presence of lead in varying levels acts a time check since previous studies have established a precise time template that is proportional to the use of lead additives in gasoline.

Water Quality in 1800:

The results of the study indicate that before the canal construction, all four lakes were meso-oligotrophic. This means that the lakes would have supported some cold-water fish such as trout, the phosphorous levels were in the 8-12 ug/l range on average, and the clarity of the water if measured by secchi disk, would have been about 5 meters. The types of Diatoms found in the first few centimeters of the core sample are consistent with those species that exist in this range of lake conditions. In 1800 the impacts from agriculture and shoreline

development were minimal and what development existed at the time had a minimal environmental impact.

Impacts That Occurred1826-1932:

Canal construction had two major immediate impacts. Firstly, the dredging and shoreline construction that occurred released hundreds of tons of organic material into the Rideau Lakes. This would be a mixture of organic material and bottom sediments that probably released phosphorous. Secondly, the three canal lakes experienced an increase in water levels of about one meter due to establishing minimum depths in the canal. This increase flooded wetlands and fields, eroded shorelines of organic matter, and linked the lakes which were previously separate. Any unique organisms to one lake would then have access to all. The Diatom record indicates that the Rideau Lakes became turbid (cloudy due to bacteria and algae content) and had a much higher nutrient content in this period and for several years afterwards. It is evident that Otter Lake had a similar but less pronounced reaction at this time, and it is suggested that agricultural activity around Otter Lake was responsible for this weaker response. The pollen records indicate that introduced species of grasses, and weeds that typically exist in cleared fields, became common just after the canal construction. It is probable that the canal stimulated development throughout the area which caused the release of organic matter after clear-cutting trees.

1832 to 1950:

For many years the impact of construction, water level changes, and nutrient loading caused the Rideau Lakes to be more mesotrophic and less oligotrophic. Otter Lake was more stable and remained meso-oligotrophic although development did have a noticeable effect especially as cottage development began in 1930. Development advanced rapidly on the Rideau Lakes especially around Portland, Rideau Ferry, Westport, and Perth which was linked to the Rideau by the Tay canal. This development enhanced the nutrient loading which resulted in a reversal of the improving water conditions. Otter Lake did not show as great an impact from development during this period.

1950 to 1970:

Nutrient loading of all lakes was evident as development increased and phosphorous was released into the lakes, but especially noted in the Rideau Lakes. Most of the municipalities around the region had no sewage treatment at this time. Livestock activities were common and contributed to the decline in water quality.

1970 to 2000:

Water quality in the Rideau Lakes improved significantly during this period. It is significant that phosphorous detergents were reduced and eliminated, municipalities constructed sewage treatment plants, and agricultural activities in the area were reduced during this period. Many fields have grown back to forests and it is known that this will stabilize soils and reduce nutrient runoff. Otter Lake showed some improvement based on the Diatom records but the water quality had never declined to the levels in the lakes of the Rideau Canal system so the transition was not as dramatic.

Karl Fiander, 2007