RESULTS OF SEDIMENT CORE TAKEN FROM NORTH PIPE LAKE, POLK COUNTY, WISCONSIN

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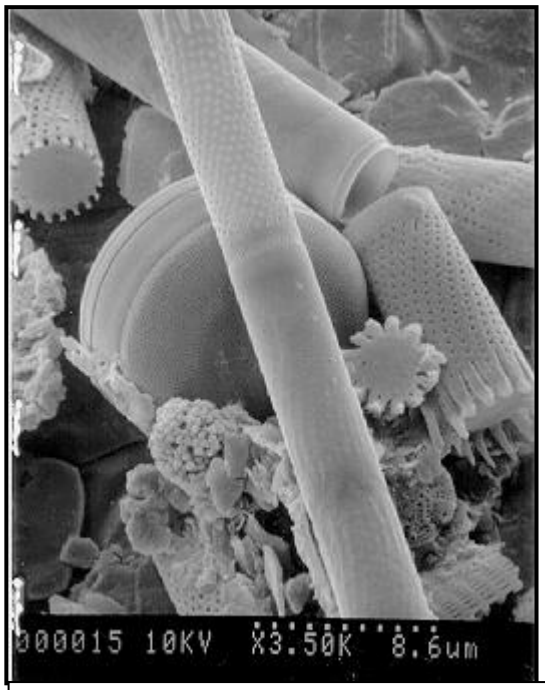
Aquatic organisms are good indicators of a lake's water quality because they are in direct contact with the water and are strongly affected by the chemical composition of their surroundings. Most indicator groups grow rapidly and are short lived so the community composition responds rapidly to changing 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 and pH conditions as well as alterations in the aquatic plant (macrophyte) community.



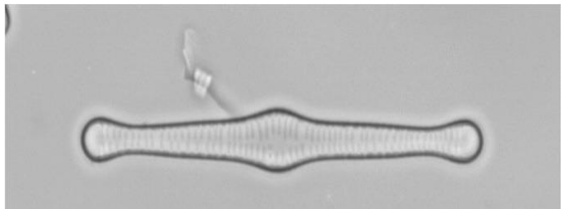


Figure 1. Micrographs of diatoms *Aulacoseira* (left), *Tabellaria flocculosa* (top right) and *Asterionella formosa* (bottom right). All of these diatoms typically are found floating in the open water. *Aulacoseira*, of the type found in N. Pipe Lake, typically is found under lower nutrient levels. *A. formosa* often increases as a result of increased nutrients, especially nitrogen.

I have examined the diatom community from the cores taken on 27 October 2004 near the deep area of North Pipe Lake. I examined sediment from the top of the core and a section deeper in the core (33-36 cm). 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. These samples will be analyzed for lead-210 and other radiometric elements, to confirm that these depths represent the time periods assumed.

In order to determine if the top of the core was deposited recently and the bottom sample was deposited at least 130 years ago they were analyzed for the naturally occurring radionuclide lead-210 (^{210}Pb) and radium-226 (^{226}Ra). Lead-210 has a half life of 22.26 years which means it can be detected after deposition for about 130-150 years. Since ^{226}Ra represents background levels, and the ^{210}Pb concentration at the bottom of the core was less than zero (meaning it was undetectable) this sample was deposited at least 130 years ago (Table 1). It is not possible from this data to determine how much older than 130-150 years ago the sample was deposited, but this analysis does confirm that the sample was deposited prior to cottage building and logging. The ^{210}Pb concentration at the top of the core is within levels found at the top of the nine cores from other softwater lakes (range = 5.11-73.78 pCi g^{-1}). This indicates that the top of the core was likely recently deposited.

Table 1. Amount of ^{210}Pb and ^{226}Ra found in the core samples. Units are pCi g^{-1}.

	Lead-210	**Radium-226**
Top	29.917	0.944
Bottom	0.339	0.779

In North Pipe Lake, historically the major component of the diatom community is those species that float in the open water of the lake. The major genera of these planktonic diatoms is the chain forming diatom *Aulacoseira* spp. (Figure 2). In the top and bottom samples the dominant species was *A. ambigua*. This diatom is common in lakes throughout the Upper Midwest with low to moderate nutrient levels. In the bottom sample, the species of secondary importance of the genera *Aulacoseira* was *A. distans* var. *tenella* but at the top of the core this species had been replaced by *A. subarctica*. *Aulacoseira distans* var. *tenella* is usually found in lakes with relatively low pH and alkalinity values and its decline likely indicates there has been an increase in pH and alkalinity during the last century. This likely was the result of land disturbance in the watershed, which would cause more soil particles to enter the lake. These particles contain chemical elements, e.g. calcium, which would increase the alkalinity and pH of the lake.

There was a significant increase in the diatoms *Asterionella formosa* and *Fragilaria crotonensis* in the top of the core (Figure 2). Both of these taxa 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. It is likely that disturbances in the watershed of North Pipe Lake have caused an increase in the delivery of nitrogen although the delivery of phosphorus has not significantly increased.

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.

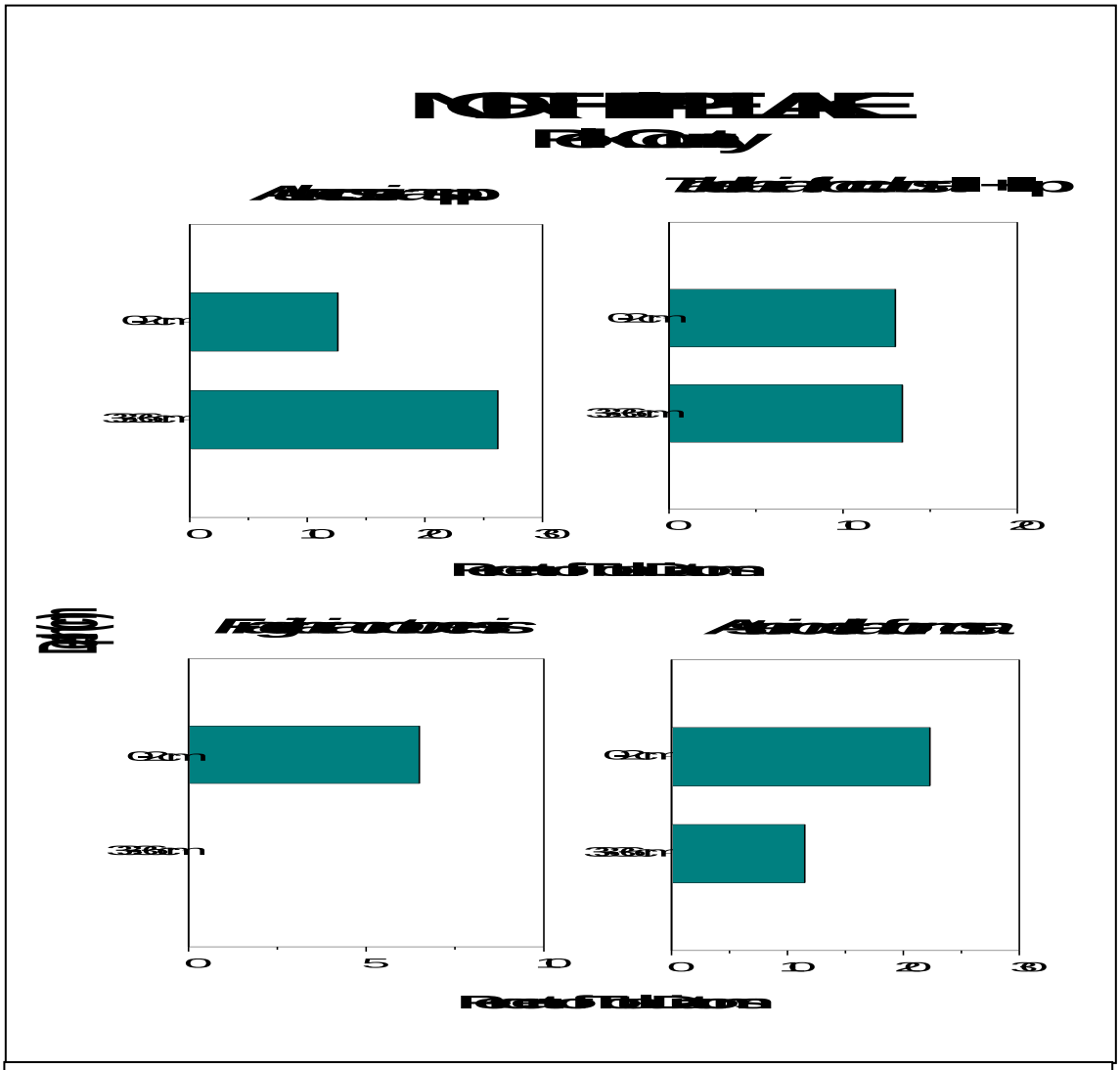


Figure 2. Changes in the abundance of important diatoms found at the top and bottom of the North Pipe Lake sediment core. An increase in A. formosa and F. crotonensis indicates that nitrogen levels have increased during the last 100 years.

Such models were applied to the diatom community in the core from North Pipe Lake. The models indicated there has not been an increase in phosphorus but there has been a small increase in nitrogen. Both the predicted values of phosphorus and nitrogen were lower than values measured in recent years. This is likely because of the relatively high color of the lake's water. The model was not developed for waters with color values experienced in North Pipe Lake. Nevertheless, it appears that phosphorus values have not increased in the lake while nitrogen values have increased a small but significant amount.

Many other sediment core studies in Wisconsin have found a significant increase in aquatic plants as a result of shoreline development. This does not appear to be the case in North Pipe Lake. The diatom community indicates that increases in the plant community are small or localized and not on the scale of other northern Wisconsin lakes.

In summary, the diatom community indicates historical nutrient levels in North Pipe Lake are similar to phosphorus levels in the lake at the present time. There has been a small but

significant increase in the nitrogen levels. There does not appear to be an increase in the amount of macrophytes (aquatic plants) during the last century.