RESULTS OF SEDIMENT CORE TAKEN FROM POTATO LAKE, WASHBURN COUNTY, WISCONSIN

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January 2011

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.

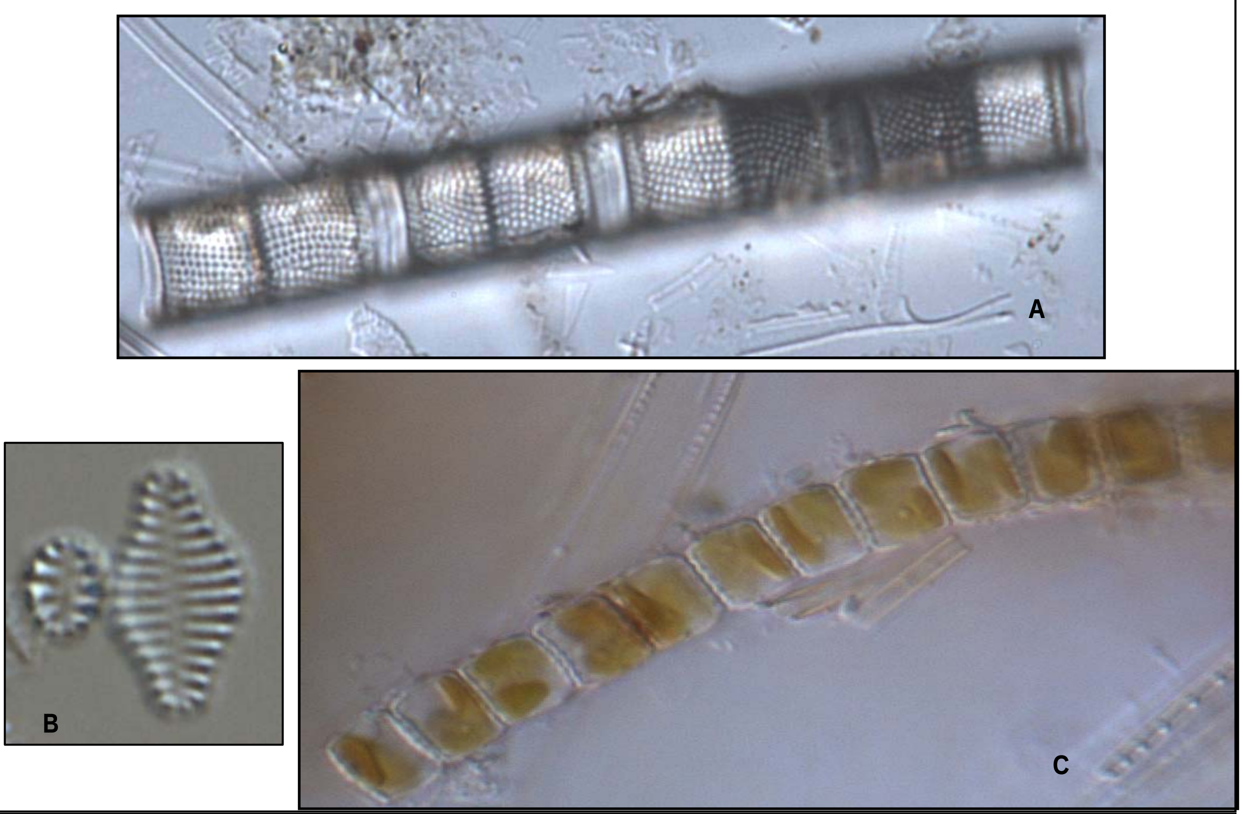

Figure 1. Photomicrographs of the diatoms *Aulacoseira ambigua* (A) and *Staurosira construens* var. *venter* (B, C). These were common diatoms found in the core. The first diatom is found in the open water while *S. construens* var. *venter* is found growing attached to substrates, especially submerged aquatic plants.

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 12 May 2010 a sediment core were taken from near the deep area (N45° 49.229' W91° 40.460') of Potato Lake in about 19 feet of water using a gravity corer. Samples from the top of the core (0-1 cm) and a section (60-62 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

Most of the diatom community, in both the top and the bottom segments of the core, is composed of species that grow attached to substrates, e.g. submerged aquatic vegetation (SAV). This is not surprising since Potato Lake is a shallow lake with relatively clear water. The low percentage of planktonic diatoms in the bottom sample indicates that this lake historically had a large SAV community. However the decline in planktonic diatoms in the top sample likely indicates an increase in the growth of SAV. The change in the SAV community likely does not mean a greater coverage of the lake bottom by SAV but instead a shift in SAV species. A study by Dr. Susan Borman in lakes in northwestern Wisconsin found that with increased shoreline development, there was a shift in the SAV community from small low growing species to larger taller species. The diatoms indicate that this may have occurred in Potato Lake over the last 100 years.

The dominant benthic diatoms were benthic *Fragilaria* such as *Staurosira construens* var*. venter* Figure 2)*, Staurosira construens*, and *Staurosira pinnata*. These taxa increased from the bottom of the core to the top, consistent with an increase in the SAV community. The increase in small *Fragilaria* likely indicates an increase in phosphorus levels. The presence of these attached diatoms reduces the amount of phosphorus that is available for others types of algae and thus reduce algal blooms.

The dominant planktonic diatom in the bottom sample was the chain forming *Aulacoseira ambigua* (Figure 1 and 2). This diatom is very common in lakes in the Upper Midwest with low to moderate phosphorus concentrations. *Stephanodiscus parvus* which was a subdominant species in the bottom sample is indicative of higher phosphorus levels. It decline in the top sample would seem to imply a lowering of phosphorus concentrations.

A comparison was made of the diatom communities at the top and bottom of cores from shallow, lakes somewhat similar to Potato Lake. This comparison was made using detrended correspondence analysis (DCA). This is a multivariate statistical analysis that determines relative differences in the diatom community between samples. The farther apart the top/bottom samples plot on the graph, the greater the differences in the diatom communities. This analysis is shown in Figure 3. Some lakes show little difference in the diatom communities between the top and bottom of the cores while others exhibit larger differences. The differences in Potato Lake are intermediate but demonstrate that the diatom community has changed during the last 100 years.

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

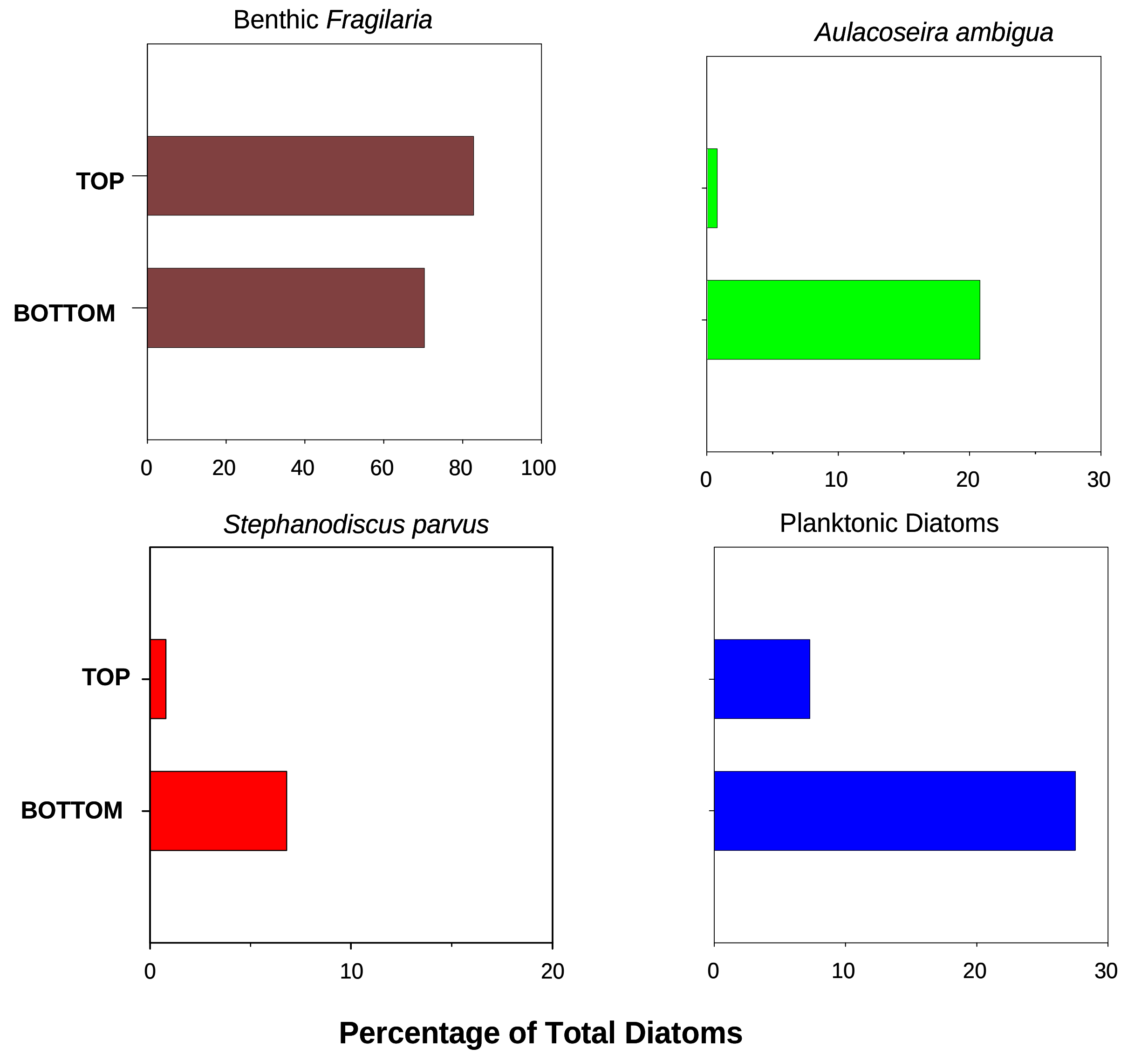

Figure 2. Changes in the abundance of some important diatoms found in the sediment core. The dominant diatoms were those attached to substrates, e.g. SAV. The decline in planktonic diatoms indicates that although SAV were common historically, the community has expanded in recent decades.

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 Potato Lake. The model indicates there has been a decrease in phosphorus of about 4 µg L^{-1} (Table 1). This is unusual and may reflect the increase in SAV which would allow diatoms and other algae attached to the plants to remove phosphoruss from the water. It may also mean that the bottom sample was deposited after significant landuse changes had occurred in the watershed.

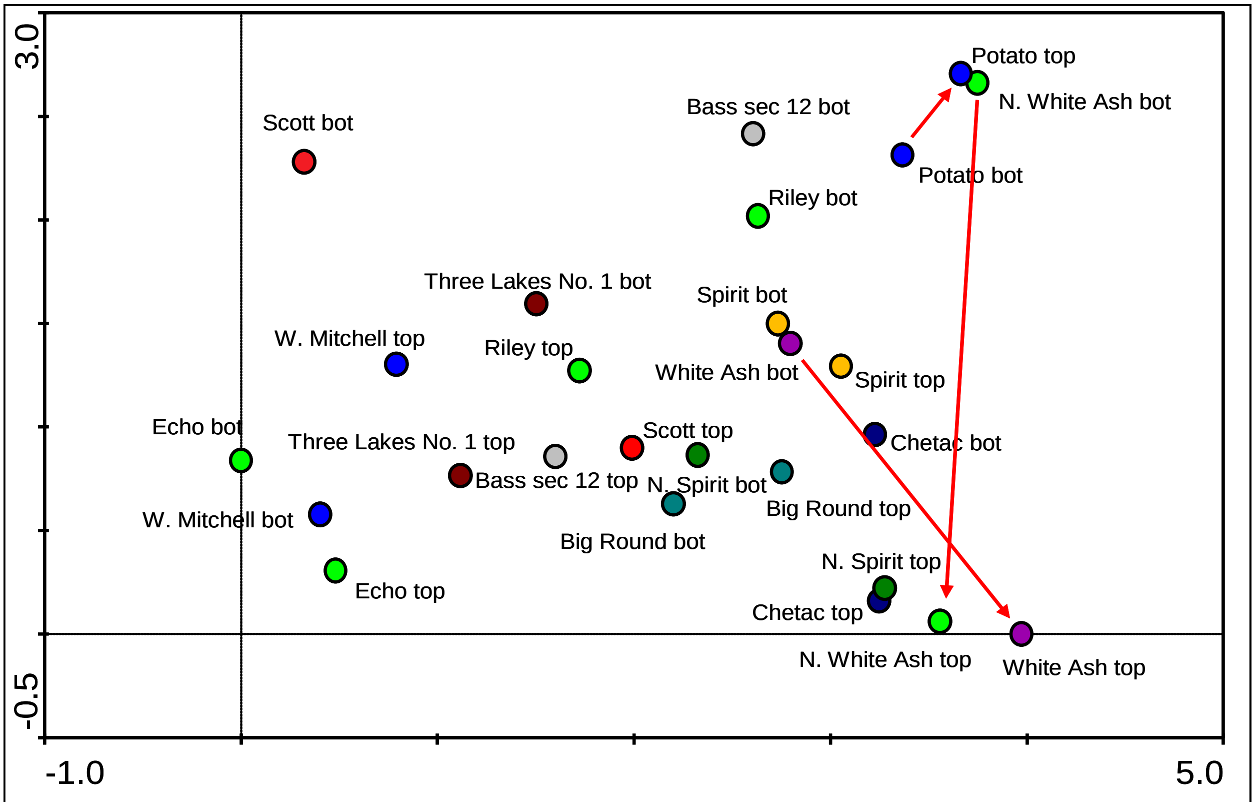

Figure 3. A DCA analysis of top/bottom cores in shallow lakes similar to Potato Lake. This analysis is based upon the diatom community. The closer the samples are, the less change that has occurred in the diatom community. The arrows follow the temporal change in the community. Potato Lake has changed less than many other lakes.

Table 1. Diatom inferred phosphorus concentrations in the sediment core samples.

	Diatom Inferred Summer Phosphorus (µg L^{-1})
Top Sample	26
Bottom Sample	30

In summary, the present day phosphorus concentration of 27 µg L^{-1} is similar or lower than historical concentrations. At the present time there are more SAV in the lake compared with historical times but the lake has historically had a large SAV community. The change in the SAV community may not mean a wider distribution but more likely a change in the type of plants with the present community consisting of larger plants.

POTATO LAKE		
Washburn County		
Top (0-1 cm)		
	COUNT TOTAL	
	Number	Prop.
TAXA		
Asterionella formosa Hassal	9	0.023
Aulacoseira ambigua (Grunow) Simonsen	2	0.005
Aulacoseira granulata (Ehrenberg) Simonsen	1	0.003
Cyclotella bodanica var. lemanica Müller	8	0.020
Fragilaria capucina Desmazières	1	0.003
Fragilaria crotonensis Kitton	6	0.015
Geissleria acceptata (Hustedt) Lange-Bertalot et Metzeltin	1	0.003
Navicula minima Grunow	20	0.050
Navicula sp. 2 Idaho SEH	1	0.003
Navicula vitabunda Hustedt	14	0.035
Nitzschia dissipata (Kützing) Grunow	1	0.003
Nitzschia frustulum (Kützing) Grunow	1	0.003
Platessa conspicua (Mayer) Lange-Bertalot	1	0.003
Pseudostaurosira brevistriata (Grunow) Williams et Round	38	0.095
Pseudostaurosira trainorii Morales	12	0.030
Staurosira construens Ehrenberg	132	0.330
Staurosira construens var. venter (Ehrenberg) Hamilton	124	0.310
Staurosirella pinnata (Ehrenberg) Williams et Round	25	0.063
Stephanodiscus parvus Stoermer et Håkansson	2	0.005
Stephanodiscus vestibulis Håkansson,Theriot et Stoermer	1	0.003
unknown pennate	0	0.000
TOTAL	400	1.000

POTATO LAKE		
Washburn County		
Bottom (60-62 cm)		
	COUNT TOTAL	
	Number	Prop.
TAXA		
Aulacoseira ambigua (Grunow) Simonsen	83	0.208
Navicula minima Grunow	2	0.005
Navicula vitabunda Hustedt	4	0.010
Nitzschia archibaldii Lange-Bertalot	1	0.003
Planothidium joursacense (Héribaud) Lange-Bertalot	1	0.003
Platessa conspicua (Mayer) Lange-Bertalot	1	0.003
Pseudostaurosira brevistriata (Grunow) Williams et Round	19	0.048
Pseudostaurosira trainorii Morales	13	0.033
Staurosira construens Ehrenberg	119	0.298
Staurosira construens var. venter (Ehrenberg) Hamilton	68	0.170
Staurosirella pinnata (Ehrenberg) Williams et Round	61	0.153
Staurosirella pinnata var. lancettula (Schumann) Siver et Hamilton	1	0.003
Stephanodiscus niagarae Ehrenberg	3	0.008
Stephanodiscus parvus Stoermer et Håkansson	21	0.053
Stephanodiscus vestibulis Håkansson,Theriot et Stoermer	3	0.008
unknown pennate	0	0.000
TOTAL	400	1.000