RESULTS OF SEDIMENT CORE TAKEN FROM GRANITE LAKE, BARRON 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.

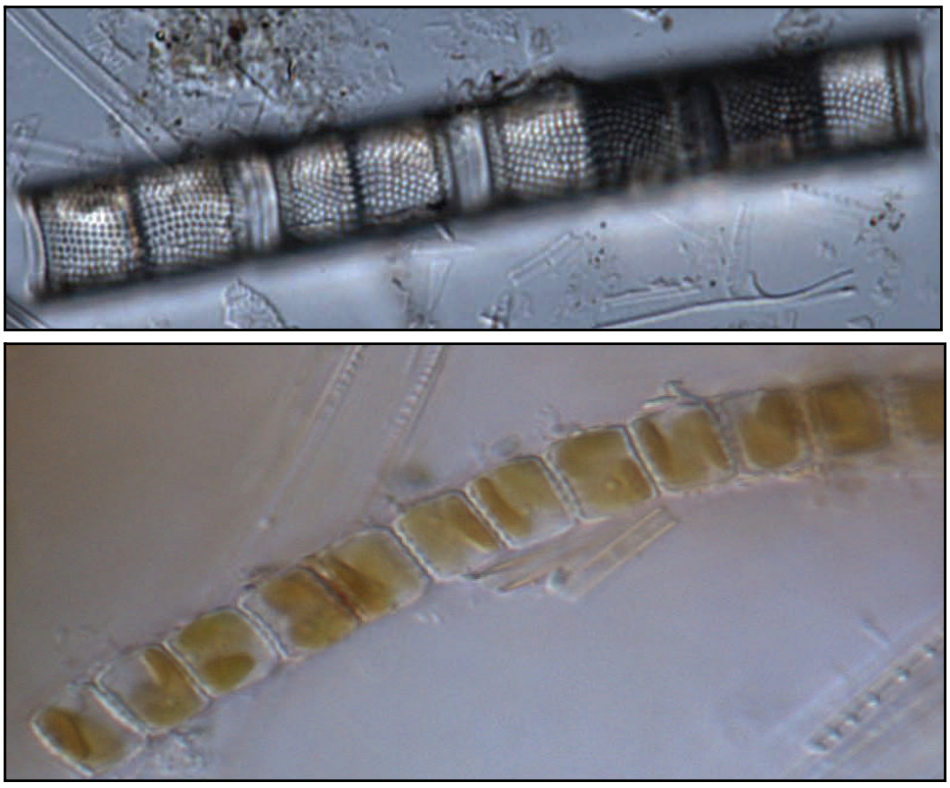

Figure 1. Photomicrographs of the diatoms *Aulacoseira am*bigua (top) and *Staurosira pinnata* (bottom). These were common diatoms found in the core. *A. ambigua* is found in the open water of the lake and is considered a planktonic diatom. *S. pinnata* is found growing attached to substrates, especially 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 29 July 2008 a sediment core were taken from near the deep area (N45.58204° W92.00701°) of Granite Lake in about 27 feet of water using a gravity corer. Samples from the top of the core (0-1 cm) and a section (45-47 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

Historically, the diatom community consisted of nearly equal parts of planktonic diatoms (those that float in the open water) and benthic diatoms (those that grow attached to substrates). The most common planktonic diatom was *Aulacoseira ambigua* (Figure 2). This diatom is very common in lakes of the Upper Midwest, especially prior to the arrival of European settlers. This diatom indicates moderate to low nutrient levels.

At the top of the core there were less planktonic diatoms and some of the diatoms present were indicative of higher nutrient levels, e.g. *Aulacoseira granulata*. There was also more diatoms of the group benthic *Fragilaria*. These diatoms typically grow attached to submerged aquatic vegetation. Their increase indicates there are more plants now than there were 150 years ago.

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 models were applied to the diatom community in the core from Granite Lake. The models indicated there has been an increase in phosphorus as well as a decline in water clarity (Secchi depth) (Table 1). There has also been an increase in the pH of the lake. The increase in pH is likely the result of increased productivity as a result of the higher phosphorus levels. When algae photosynthesize they remove carbon dioxide from the water. Since CO_2 is an acid, increased algal growth results in an increase in the pH.

Table 1. Estimated phosphorus, water clarity, and pH in pre-settlement vs present time. These estimates were derived with the diatom community.

	Core Bottom	Core Top
Phosphorus (µg L^{-1})	30	34
Secchi depth (ft)	6.0	5.6
pH	7.7	8.3

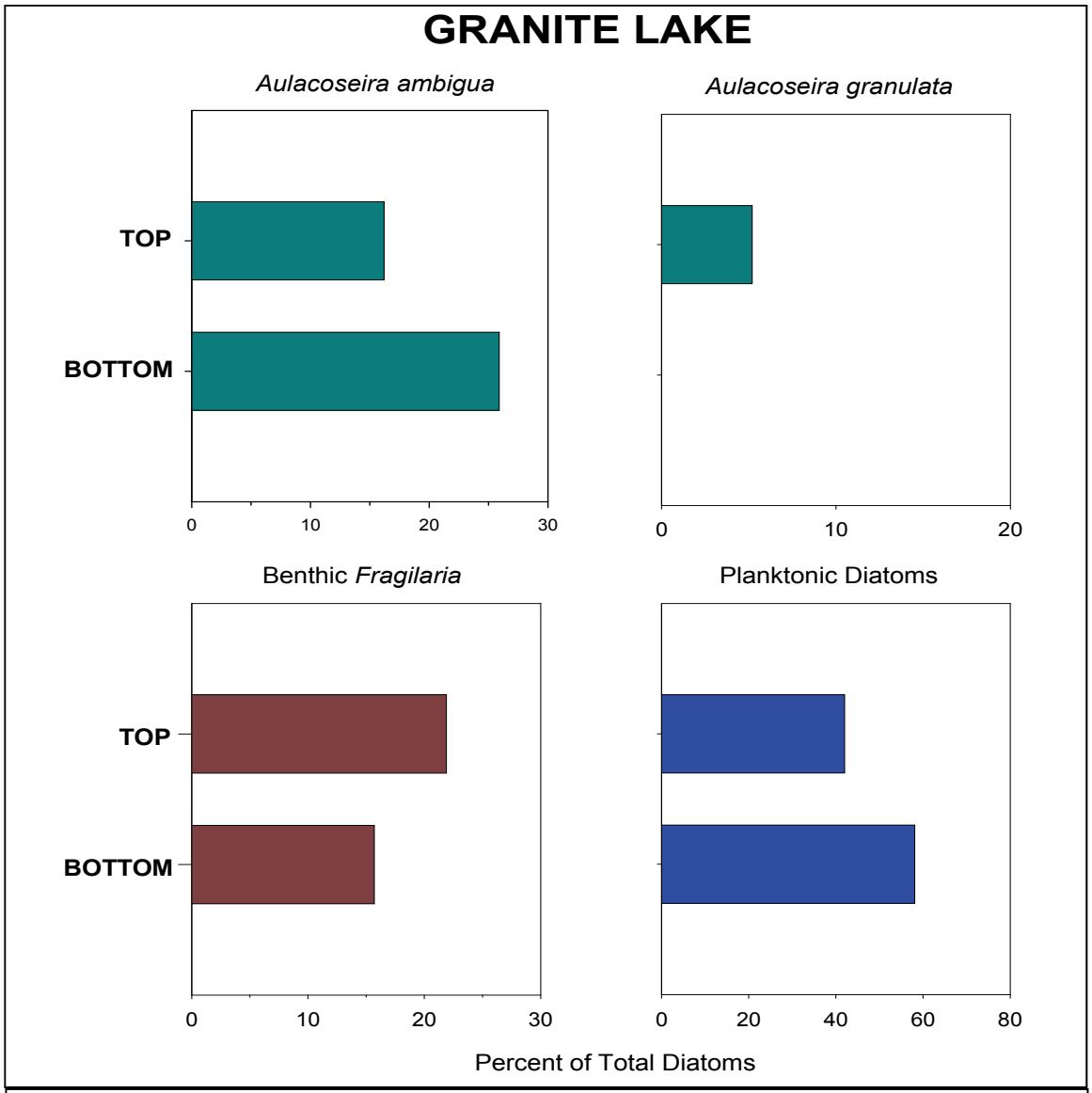

Figure 2. Changes in the abundance of important diatoms found at the top and bottom of the Granite Lake sediment core. An increase in A. granulata indicates that phosphorus levels have increased during the last 100 years. The increase in benthic Fragilaria indicates an increase in submerged aquatic vegetation.

At this point it is assumed that the bottom of the core represents a time period prior to the arrival of European settlers, around the middle of the nineteenth century. A radiochemical analysis is underway to verify this. A similar analysis will be completed on the top sample to insure that this sample is of recent deposition.

In summary, Granite Lake has experienced a moderate increase in nutrients which has resulted in a decline in water clarity as algal growth has increased. In addition to the increased nutrients, there appear to be more submerged aquatic plants at the present time. These changes are common in lakes like Granite Lake that have shoreline development as well as some agriculture in their watershed.

GRANITE LAKE		
Barron County		
0-1 cm		
	COUNT TOTAL	
	Number	Prop.
TAXA		
Achnanthes spp.	1	0.002
Achnanthes oblongella Østrup	11	0.027
Achnanthidium catenatum (Bily et Marvan) Lange-Bertalot	11	0.027
Achnanthidium minutissimum (Kützing) Czarnecki	2	0.005
Amphora ovalis (Kützing) Kützing	2	0.005
Asterionella formosa Hassal	19	0.047
Aulacoseira ambigua (Grunow) Simonsen	65	0.162
Aulacoseira granulata (Ehrenberg) Simonsen	21	0.052
Aulacoseira subborealis Denys, Muylaert, Krammer, Joosten, Reid et Rioual	4	0.010
Cocconeis placentula (RV)	1	0.002
Cocconeis placentula var. euglypta (Ehrenberg) Grunow	1	0.002
Cocconeis placentula var. lineata (Ehrenberg) Van Heurck	6	0.015
Cyclostephanos tholiformis Stoermer, Håkansson et Theriot	1	0.002
Cyclotella spp.	1	0.002
Cymbella cf. cistula (Ehrenberg) Kirchner	1	0.002
Cymbella spp.	1	0.002
Discotella glomerata (Hustedt) Houk et Klee	5	0.012
Discotella stelligera (Hustedt) Houk et Klee	1	0.002
Encyonema silesiacum (Bleisch) Mann	2	0.005
Eolimna minima (Grunow) Lange-Bertalot	11	0.027
Epithemia spp.	1	0.002
Eunotia cf. incisa Smith ex Gregory	2	0.005
Fragilaria capucina var. capucina Desmazières	12	0.030
Fragilaria capucina var. gracilis (Østrup) Hustedt	10	0.025
Fragilaria capucina var. mesolepta Rabenhorst	3	0.007
Fragilaria crotonensis Kitton	9	0.022
Fragilaria crotonensis var. oregona Sovereign	28	0.070
Fragilaria fasciculata (Agardh) Lange-Bertalot	2	0.005
Fragilaria pinnata var. acuminata Mayer	30	0.075
Fragilaria sepes Ehrenberg	8	0.020
Fragilaria vaucheriae (Kützing) Petersen	2	0.005
Geissleria decussis (Hustedt) Lange-Bertalot et Metzeltin	1	0.002
Gomphonema minutum (Agardh) Agardh	2	0.005
Gomphonema spp.	2	0.005
Karayevia clevei (Grunow) Bukhtiyarova	4	0.010
Navicula cf. menisculus Schumann	1	0.002
Navicula phyllepta Kützing	2	0.005
Navicula seminuloides Hustedt	2	0.005
Navicula sp. 1?	4	0.010
Navicula spp.	7	0.017
Navicula veneta Kützing	2	0.005
Nitzschia gracilis Hantzsch ex Rabenhorst	1	0.002
Nitzschia palea (Kützing) Smith	1	0.002
Planothidium dubium (Grunow) Round et Bukhtiyarova	12	0.030

GRANITE LAKE		
Barron County		
0-1 cm		
	COUNT TOTAL	
	Number	Prop.
TAXA		
Planothidium frequentissimum (Lange-Bertalot) Lange-Bertalot	2	0.005
Planothidium lanceolatum (Brébisson ex Kützing) Lange-Bertalot	1	0.002
Planothidium stewartii (Patrick) Lange-Bertalot	1	0.002
Platessa conspicua (Mayer) Lange-Bertalot	1	0.002
Psammothidium didymum (Hustedt) Bukhtiyarova et Round	1	0.002
Pseudostaurosira brevistriata (Grunow) Williams et Round	20	0.050
Rossithidium pusillum (Grunow) Round et Bukhtiyarova	4	0.010
Sellaphora pupula (Kützing) Meresckowsky	1	0.002
Staurosira construens var. venter (Ehrenberg) Hamilton	3	0.007
Staurosira elliptica (Schumann) Williams et Round	8	0.020
Staurosirella leptostauron (Ehrenberg) Williams et Round	1	0.002
Staurosirella leptostauron var. dubia (Grunow) Edlund	1	0.002
Staurosirella pinnata (Ehrenberg) Williams et Round	2	0.005
Staurosirella pinnata var. intercedens (Grunow) Hamilton	6	0.015
Stephanodiscus niagarae Ehrenberg	5	0.012
Synedra rumpens Kützing	4	0.010
Synedra sp. 1?	1	0.002
Synedra ulna (Nitzsch) Ehrenberg	1	0.002
Tabellaria flocculosa (strain III) sensu Koppen	5	0.012
Tabellaria flocculosa (strain IIIp) sensu Koppen	15	0.037
Tabellaria spp.	1	0.002
unknown pennate	3	0.007
TOTAL	402	1.000
Planktonic diatoms		0.420
Nonplanktonic diatoms		0.580
Chrysophyte scale	1	
Chrysophyte cyst	19	

GRANITE LAKE		
Barron County		
45-47 cm		
	COUNT TOTAL	
	Number	Prop.
TAXA		
Achnanthidium minutissimum (Kützing) Czarnecki	6	0.015
Asterionella formosa Hassal	32	0.080
Aulacoseira ambigua (Grunow) Simonsen	104	0.259
Aulacoseira italica (Ehrenberg) Simonsen	1	0.002
Aulacoseira muzzanensis (Meister) Krammer	15	0.037
Aulacoseira subarctica (Müller) Haworth	12	0.030
Aulacoseira tenella (Nygaard) Simonsen	7	0.017
Cocconeis placentula (RV)	1	0.002
Cocconeis placentula var. euglypta (Ehrenberg) Grunow	1	0.002
Cocconeis placentula var. lineata (Ehrenberg) Van Heurck	2	0.005
Cyclostephanos dubius (Frick) Round	4	0.010
Cyclotella spp.	1	0.002
Cymbella spp.	1	0.002
Discotella stelligera (Hustedt) Houk et Klee	5	0.012
Eolimna minima (Grunow) Lange-Bertalot	1	0.002
Eolimna subminuscula Manguin	5	0.012
Eunotia bilunaris (Ehrenberg) Mills	1	0.002
Eunotia cf. incisa Smith ex Gregory	5	0.012
Eunotia spp.	1	0.002
Eunotia zasuminensis (Cabejszekowna) Körner	1	0.002
Fragilaria capucina var. gracilis (Østrup) Hustedt	9	0.022
Fragilaria capucina var. mesolepta Rabenhorst	35	0.087
Fragilaria crotonensis Kitton	27	0.067
Fragilaria crotonensis var. oregona Sovereign	11	0.027
Fragilaria pinnata var. acuminata Mayer	6	0.015
Fragilaria vaucheriae (Kützing) Petersen	2	0.005
Geissleria decussis (Hustedt) Lange-Bertalot et Metzeltin	1	0.002
Gomphonema apuncto Wallace	2	0.005
Gomphonema cf. truncatum Ehrenberg	2	0.005
Gomphonema spp.	5	0.012
Karayevia clevei (Grunow) Bukhtiyarova	1	0.002
Mayamaea atomus var. permitis (Hustedt) Lange-Bertalot	2	0.005
Meridion circulare (Greville) Agardh	1	0.002
Navicula festiva Krasske	2	0.005
Navicula radiosa Kützing	6	0.015
Navicula sp. 1?	2	0.005
Navicula spp.	1	0.002
Navicula tantula Hustedt	2	0.005
Nitzschia amphibia Grunow	4	0.010

GRANITE LAKE		
Barron County		
45-47 cm		
	COUNT TOTAL	
	Number	Prop.
TAXA		
Nitzschia palea (Kützing) Smith	4	0.010
Nitzschia spp.	2	0.005
Pinnularia spp.	1	0.002
Planothidium lanceolatum (Brébisson ex Kützing) Lange-Bertalot	1	0.002
Planothidium rostratum (Østrup) Lange-Bertalot	1	0.002
Pseudostaurosira brevistriata (Grunow) Williams et Round	2	0.005
Rossithidium linearis (Smith) Round et Bukhtiyarova	1	0.002
Sellaphora pupula (Kützing) Meresckowsky	1	0.002
Sellaphora seminulum (Grunow) Mann	2	0.005
Staurosira construens Ehrenberg	1	0.002
Staurosira elliptica (Schumann) Williams et Round	7	0.017
Staurosirella pinnata (Ehrenberg) Williams et Round	10	0.025
Stephanodiscus hantzschii Grunow	1	0.002
Stephanodiscus niagarae Ehrenberg	10	0.025
Synedra minuscula Grunow	6	0.015
Synedra rumpens Kützing	10	0.025
Tabellaria flocculosa (strain IIIp) sensu Koppen	1	0.002
Unknown centric	1	0.002
unknown pennate	12	0.030
TOTAL	401	1.000
Planktonic diatoms		0.581
Nonplanktonic diatoms		0.419
Chrysophyte scale	1	
Chrysophyte cyst	18	