RESULTS OF SEDIMENT CORE TAKEN FROM MAGNOR LAKE, POLK COUNTY, WISCONSIN

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January 2006

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, water color, and pH conditions as well as alterations in the aquatic plant (macrophyte) community.

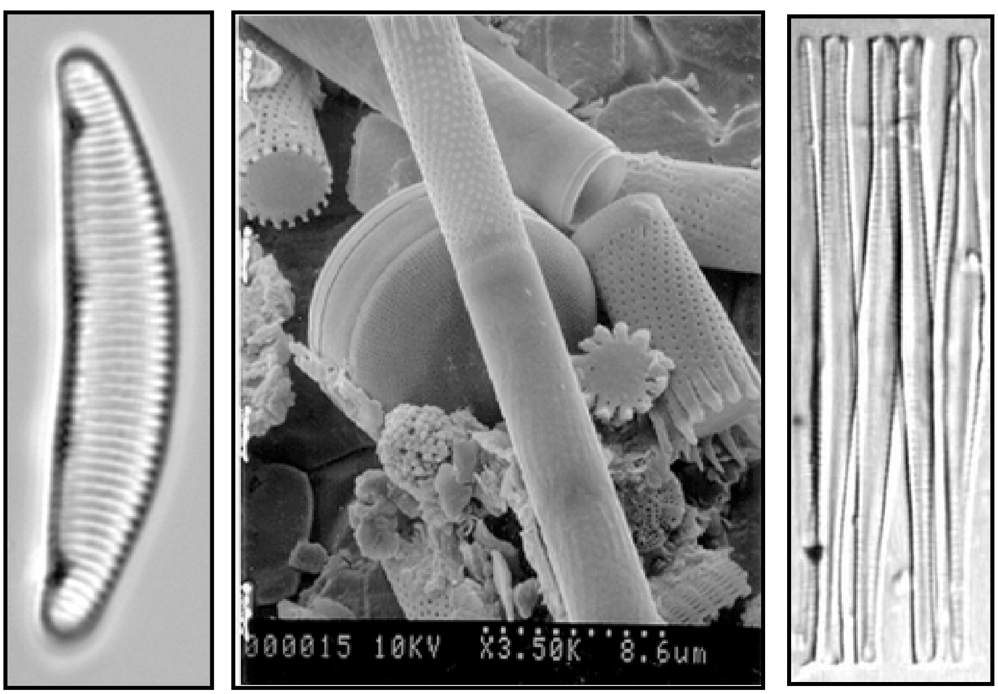

Figure 1. Photomicrographs of diatoms *Eunotia incisa* (left), *Aulacoseira* (middle), and *Fragilaria crotonensis* (left). *Eunotia* is frequently found in wetland or lower pH environments. *Aulacoseira* and *F. crotonensis* are diatoms typically found floating in the open water and are indicative of higher nutrient levels.

On 10 August 2005 cores were taken from five locations in Magnor Lake (Figure 2). At Site A a core was extracted to determine water quality changes in the lake during the last 150 years. This core was 70 cm long. The top 2 cm and bottom 2 cm were kept for analysis. It is assumed that the upper sample represents present conditions while the deeper sample is indicative of historical water quality conditions. At this and 4 other sites cores were extracted and the top 10 cm kept. These samples were used to determine the density of the upper sediment in order to estimate the depth to which alum would settle if it were applied to the lake.

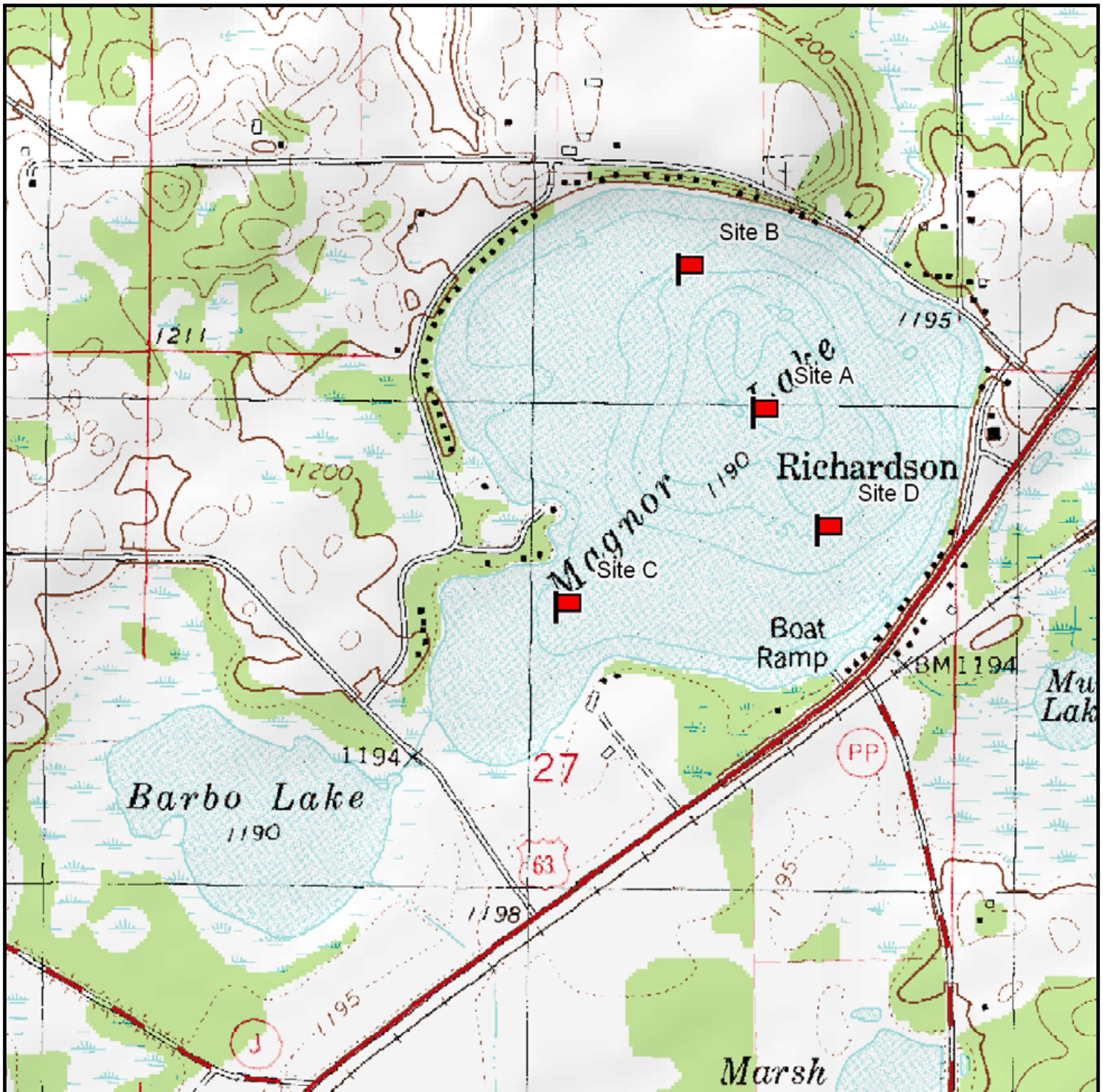

Figure 2. Location of sampling sites of cores collected on 10 August 2005. The top/bottom core was collected at Site A in about 25 feet of water.

Water Quality Changes

In Magnor Lake, at the present time and historically, the major component of the diatom community were those species that grow on the lake bottom or are associated with aquatic plants. The relatively low percentage of planktonic species (those that float in the open water area of the lake) in the sample from the bottom of the core is indicative of the relatively shallow depth in the lake (mean depth 3 meters) as well as good water clarity. If the lake had experienced large and frequent algal blooms there would not be enough light reaching the lake bottom to allow the growth of benthic diatoms.

At the top of the core there are fewer benthic diatoms than at the bottom of the core. At the bottom of the core benthic diatoms comprise 95% of the diatom community but 71% at the top of the core (Figure 3). Besides the decrease in relative amounts of benthic diatoms, there has also been a significant change in the dominant species of bottom dwelling diatoms. Historically the dominant diatom was the group *Eunotia* (Figure 3). These diatoms frequently are associated with wetland plants. The loss of these diatoms indicates there has been a significant decline in the acreage of wetlands or their water quality. Small *Fragilaria* also were present at lower levels compared with the sample from the bottom of the core (Figure 3). These species are often associated with submerged aquatic vegetation. Their decline indicates there likely are fewer plants at the current time compared to historical times.

Planktonic diatoms comprise 3% of the community at the bottom of the core but increase to 29% at the top of the core. The major species are *Aulacoseira ambigua* and *Fragilaria crotonensis*. The increase in planktonic diatoms from the bottom to the top of the core indicates a significant increase in phosphorus and resultant decline in water clarity. The increase in these two species is also indicative of higher nutrients since they prefer higher nutrient levels.

Frequently, when watersheds of lakes have undergone landuse changes, e.g. shoreline development or development of agriculture, the lake experiences an initial increase in submerged aquatic plants. In the core this would be indicated by an increase in species such as the small *Fragilaria*. This was not evident in this core but it is likely Lake Magnor has proceeded past this point and eutrophication has advanced to the point where frequent algal blooms are occurring such that they are inhibiting submerged plant growth because of low water clarity.

In summary, the diatom community indicates there has been a significant increase in phosphorus levels in the lake during the last 100 years. This is indicated by the large increase in planktonic diatoms. These types of diatoms are known to increase in response to increased nutrient levels in the water. There has also been a significant loss of wetlands in the watershed. This is indicated by the large decline in the diatom *Eunotia* from the bottom to the top of the core. Frequently modeling methods using weighted averaging regression and calibration can be used to quantitatively estimate historical phosphorus levels. This was attempted in this core but it was unsuccessful. The model underestimated the present day phosphorus levels (ca. 120 µg L^{-1}). The model predicted historical phosphorus levels are about 13 µg L^{-1} which seem reasonable.

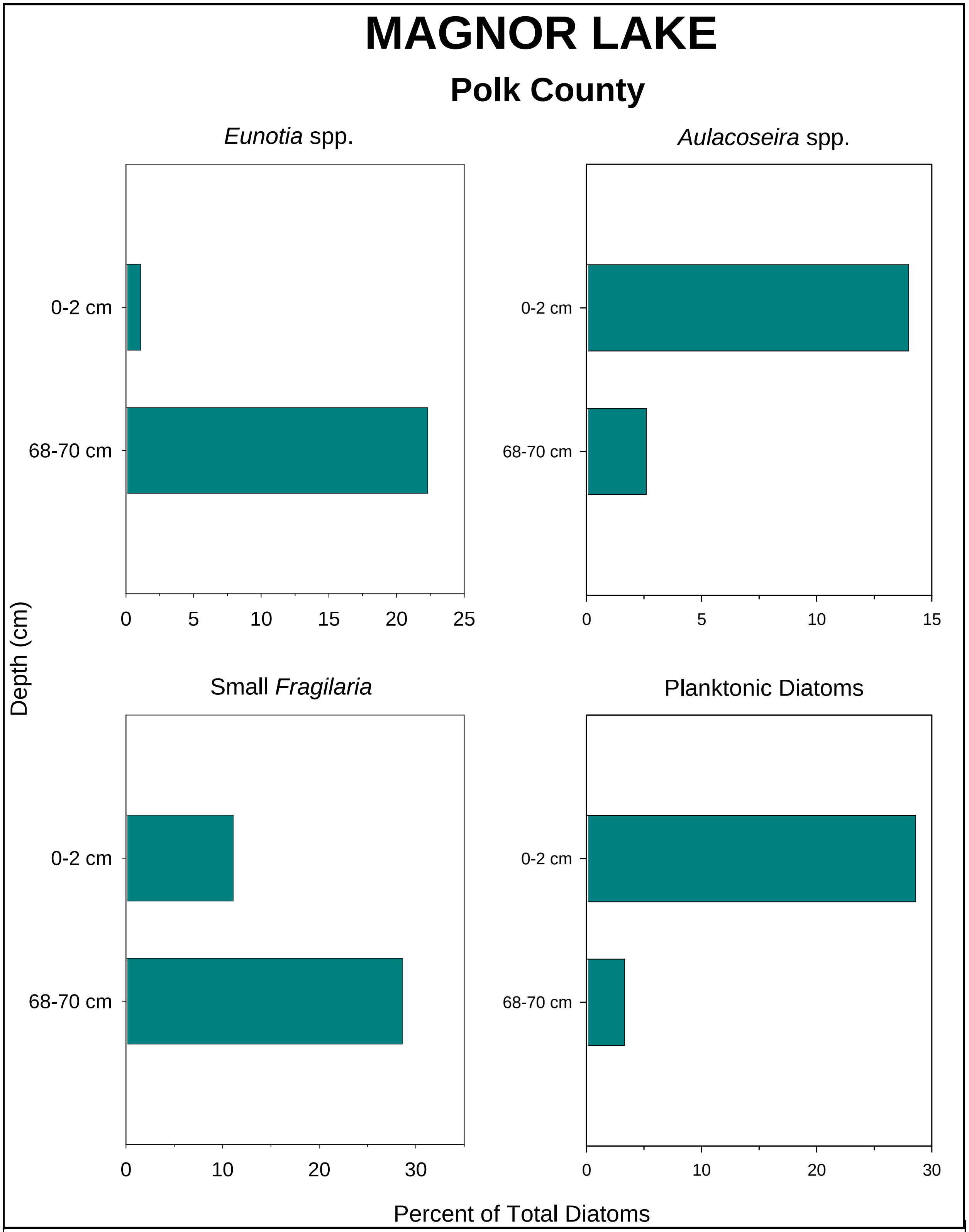

Figure 3. Changes in abundance of important diatoms found at present and presettlement times. *Eunotia* and small Fragilaria grow attached to substrates. *Aulacoseira* is a plank-

Sediment density

The density of the top 10 cm of sediment was measured at 5 locations in the lake. The purpose of this measurement was to estimate how deep alum (aluminum sulfate) might penetrate the sediments. Alum treatments have been successfully used to significantly reduce internal phosphorus loading from bottom sediments. Phosphorus is released when water overlying these sediments is devoid of oxygen. The lack of oxygen results in the form of iron changing from ferric (+3) to ferrous (+2). When this happens phosphorus that was bound to the iron is solubilized and moves from the sediments to the overlying water. Aluminum bound phosphorus does not become soluble in the absence of oxygen and thus stays in the sediment. Alum often is denser than lake sediments and when this is the case, alum will settle into the sediments until is reaches a depth where its density is equal to, or less than the sediments.

In most of the samples from Lake Magnor the percentage of water was greater than 90% (Table 1). Other studies have found that this can be a reasonable estimate of the depth alum will settle. This analysis indicates that an alum treatment may not be appropriate for this lake since alum is likely to sink into the sediments. A more accurate test of the effectiveness of alum would be to extract cores from the lake and treat them with sequential amounts of alum. This analysis will better estimate the amount of alum necessary to bind the sediment phosphorus. This analysis will also give a better estimate of the cost of an effective alum treatment.

TABLE 1. Percent water in the top 10 cm of sediments at 5 locatio-ins in Magnor Lake. Refer to Figure 1 for locations.

Site A

Depth	% Water
0-2	95.2
2-4	94.0
4-6	92.8
6-8	92.0
8-10	91.9

Site B

Depth	% Water
0-2	95.2
2-4	93.7
4-6	92.2
6-8	91.8
8-10	89.4

Site C

Depth	% Water
0-2	93.6
2-4	93.3
4-6	92.6
6-8	92.9
8-10	93.1

Site D

Depth	% Water
0-2	94.0
2-4	92.9
4-6	92.7
6-8	92.3
8-10	92.0