PALEOECOLOGICAL STUDY OF

LITTLE BEARSKIN LAKE,

ONEIDA COUNTY

By

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Bureau of Integrated Science Services

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Introduction

A macrophyte survey conducted in 1992 found that the dominant macrophyte (aquatic weeds) was *Potamogeton robbinsii* (fern pondweed) although *Ceratophyllum demersum* (coontail), *P. amplifolius* (cabbage), *Vallisneria americana* (water celery), and *Myriophyllum exalbescens* (water milfoil) were common (McComas 1993). The lake residents had previously complained that coontail had been a nuisance in recent years. At the request of the lake association at Little Bearskin Lake, Oneida County, a study was undertaken to determine the history of the macrophyte community in the lake. The paleoecological study was designed to compare the historical (presettlement) macrophyte community to the present day community.

Prior to European settlement in this region the landscape was forested. Logging occurred in the region around the lake during the late 1880's. Regrowth of the region occurred after this. Presently the lake shore possesses some homes, both permanent and seasonal but otherwise there is not large development in the watershed. McComas (1993) estimated that 12 percent of the watershed was residential land.

In order to determine historical changes in the lake's macrophyte community, three sediment cores were taken from the lake. It was intended that the top (representing the recent time period) and the bottom (representing the presettlement time period, i.e. prior to 1880) segments of the core would be examined.

Methods

Coring. Three cores were extracted from the lake through the ice on 24 January 1995 (Figure 1). The cores were collected with a piston corer with an inside diameter of 8.8 cm. The core at Site 1 was used to reconstruct the abundance of the general macrophyte community in the lake. This core was 130 cm long. Sections from 0-2 cm, 60-62 cm were analyzed. Site 2 was located in a macrophyte bed composed largely of coontail and fern pondweed. This core was 130 cm long and sections from 0-2 cm, 60-62 cm, 120-122 cm were analyzed. Site 3 was located in a macrophyte bed that was composed largely of fern pondweed. This core was 139 cm long and sections from 0-2 cm, 60-62 cm, 120-122 cm were analyzed. Although we had originally only intended to analyze two sections from each core an additional section was analyzed from Sites 2 and 3 because of the amount of *Ceratophyllum* fragments that were found at the 60-62 cm depths.

Radioisotopes. In each of the three cores the top (0-2 cm) and middle (60-62 cm) of the cores were examined for their content of the naturally occurring radioisotopes ^{210}Pb and ^{226}Ra. This analysis indicates if the top of the core represents sediment recently deposited and if the deeper portion of the core represents a presettlement time period. Analysis was conducted at the State Laboratory of Hygiene in Madison, WI using a gamma counting technique similar to that described in Schelske et al. (1994)

Diatoms. Diatoms were analyzed from the core from Site 1. Samples were cleaned with hydrogen peroxide and potassium dichromate (van der Werff 1956). The sample residue was centrifuged and washed at least four times with distilled water to remove the catalyst. A portion of the diatom suspension was dried on a coverslip and samples were mounted in Hyrax®. Two slides were prepared for each sample. Specimens were identified and counted under oil immersion objectives (1400X) and at least 250 frustules were counted. Common, nationally and internationally recognized keys were used including: Hustedt (1930), Patrick and Reimer (1966, 1975), Koppen

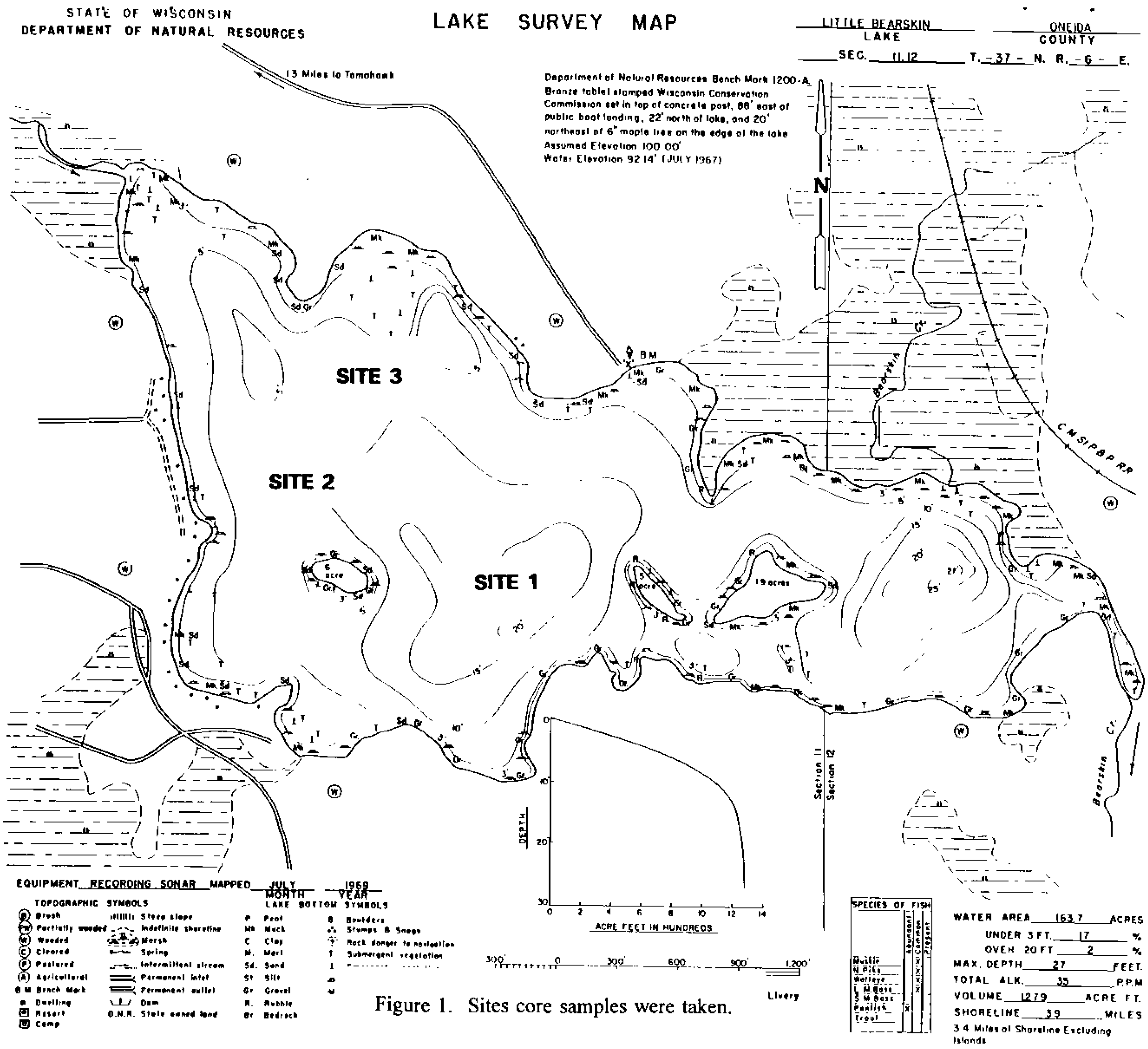

Figure 1. Sites core samples were taken.

(1975), Dodd (1987), and Krammer and Lange-Bertalot (1986, 1988, 1991a,b).

Macrophytes. To prepare samples for analysis, a known weight of wet sediment (17–23 g) was sonicated in a water bath for 1.5 minutes, treated with 10% KOH for 15 minutes, and rinsed well through nested 250 and 500 micron sieves (Warner 1990). The 120–122 cm deep samples were treated in the same manner, but steeped in the 10% KOH for one hour. Rinsed samples were preserved in 95% ethanol with glycerin added.

Plant macrofossils were viewed and counted with the aid of a dissecting microscope. Identifications were made using available herbarium specimens as well as illustrations and descriptions found in Fassett (1957), Voss (1972 and 1985), Correll and Correll (1981), and Korschgen (1981 and 1983). When plant fragments could not be identified, they were grouped with similar items and described. Only those fragments that could be discerned with a high degree of certainty were quantified.

Results and Discussion

Radioisotopes. The top of all three cores contained levels of ^{210}Pb that are indicative of recently deposited sediments (Table 1). The concentrations were lowest at Site 1 which was the core taken in the deepest portion of the lake basin. This lowered concentration most likely is because the recent sedimentation rate is greater than at the shallower sites. In most lakes the greatest sedimentation rate occurs in the deepest portion of the lake. Levels of ^{210}Pb were undetectable at depths where the sediments are deposited at least 130 years ago. It appears that the sediments at 60-62 cm at Site 1 were deposited more recently than this. Based upon lead levels in cores from nearby Lake Minocqua, it appears that the depth at Site 1 was deposited around 1900. This is after the initial logging was completed in the watershed but well before cottage building occurred on the lakeshore. Therefore this depth adequately represents lake conditions prior to significant land disturbance in the watershed. The deeper sediments (60-62 cm) in the core from Site 2 contain undetectable levels of ^{210}Pb and indicate that these sediments represent a time period before 1860. The lab equipment malfunctioned before the sample from the deep sediments in the core from Site 3 was analyzed but it is likely that these sediments also were deposited prior to 1860. The radioisotope analysis confirms that the top portion of the three cores was recently deposited and are a valid representation of current lake conditions while the deeper samples in the cores represent conditions prior to significant disturbance in the watershed.

Table 1. Results of radionuclide analysis from the 3 cores in Little Bearskin Lake.

	210-Lead	226-Radium
<u>SITE 1</u>		
0-2 cm	23.70 ± 4.14	<1.50 ± 0.46
60-62 cm	3.05 ± 0.65	0.23 ± 0.07
<u>SITE 2</u>		
0-2 cm	26.80 ± 4.76	<1.78 ± 0.56
60-62 cm	<2.70 ± 1.10	<0.39 ± 0.12
<u>SITE 3</u>		
0-2 cm	29.10 ± 4.56	<1.11 ± 0.30

<u>Diatoms</u>. Two types of fossils were examined to reconstruct the macrophyte community of Little Bearskin Lake. They were remains of macrophytes (aquatic weeds) and diatoms. Diatoms are a special algae that have shells made of silica that allow them to be preserved in sediments, often for thousands of years. Since they also have rather restrictive requirements for their living environment, this makes them particularly useful for determining the environmental history of a lake. Some diatoms are found in high nutrient conditions while others prefer low nutrients. Some diatoms are found in the open water of lakes while many others are found growing on macrophytes, sediment, woody debris, sand, etc. By examining the diatoms deposited in lake sediments we can estimate what the lake was like at any given time. For this study diatoms were used to reconstruct the general

abundance of the macrophyte community as well as changes in the nutrient status of the lake. The diatoms will not document changes in the specific types of macrophytes, only changes in the size of the community. Diatoms were only examined in the core at Site 1. This was because since this site is in the deepest part of the basin it tends to integrate the entire basin. Because diatoms a small and relatively light, after they die they somewhat distribute throughout the lake basin. Therefore it is gives a better representation of changes throughout the lake and not in just a specific area. In contrast, the cores at Sites 2 and 3 were collected in known macrophyte beds and would be more representative of this specific environment and not the basin as a whole.

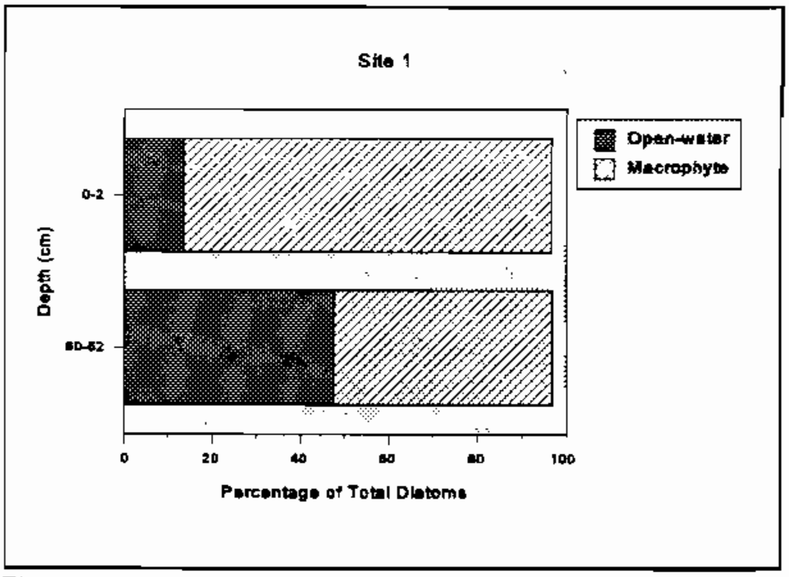

Figure 2. Percentage of diatoms that grow in the open-water environment and those that grow attached to substrates such as macrophytes.

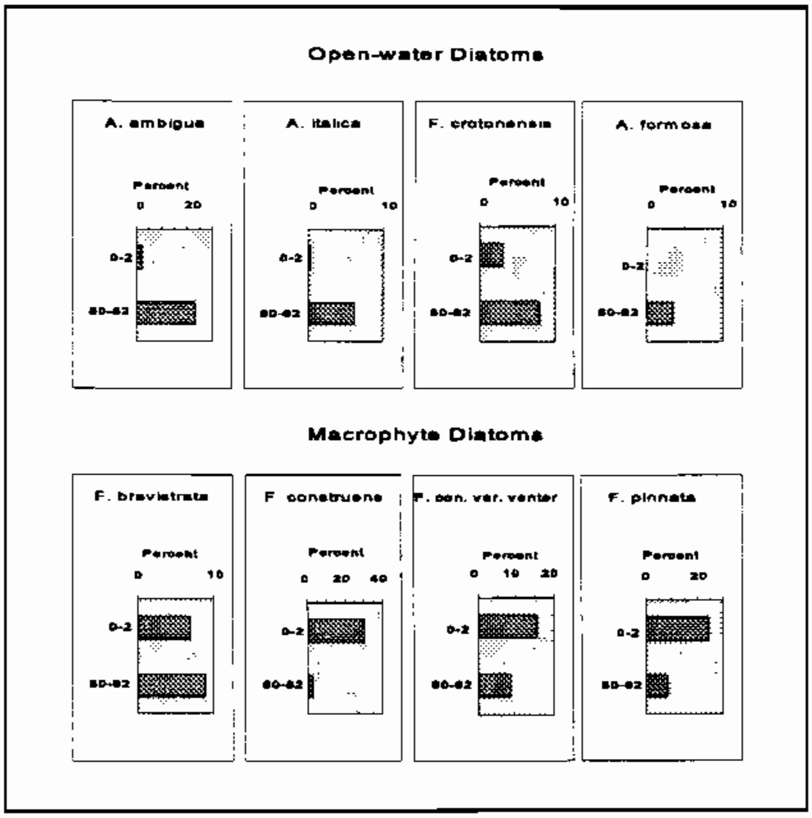

Figure 3. Representative diatoms from the core at Site 1. The diatoms in the upper panels are those that live in the open water. Those in the lower panel grow on substrates such as macrophytes.

The dominant diatoms found in the deep sample (60-62 cm) were evenly distributed between open water habitats and those found growing attached to macrophytes (Figure 2). Diatoms associated with habitats like macrophytes increased from 49% at 60-62 cm to 83% in the surface sediments. This indicates that historically, there were some macrophytes growing in the lake but they would not have been in dense concentrations In contrast, the surface sediments which represent the last few years, possess relatively few open-water diatoms and instead most of the diatoms were those that usually are found growing on substrates such as macrophytes. In Lake Sallie, Minnesota it was observed in a sediment core that *Fragilaria construens* increased in response to an increase in the growth of macrophytes (Bradbury and Winter 1976). This species of diatom showed the largest increase from historical to recent times in Little Bearskin Lake (Figure 3). It is clear the macrophyte densities are greater at the present time than they were historically.

Table 2. Estimated phosphorus concentrations in the open water portion of the lake as determined from sediment diatoms

Depth	Phosphorus Concentration
0-2 cm	22 $\mu g\ L^{-1}$
60-62 cm	22 $\mu g\ L^{-1}$

Diatoms also are used to document changes in nutrient concentrations in the lake, especially phosphorus. Although the extent of the macrophyte coverage has increased in recent years, the phosphorus concentration in the open-water has changed little (Table 2). The lake phosphorus concentration as determined by the diatom community in the surface sediments was 22 $\mu g\ L^{-1}$ which is the same as measured in 1992 (McComas 1993). The phosphorus concentration during the time period represented by 60-62 cm (assumed to be about 90 years ago) was also about 22 $\mu g\ L^{-1}$. It seems reasonable that the amount of phosphorus entering the lake has increased in the last century because of residential homes on the lake shore as well as other watershed changes. Most of this increased phosphorus has probably been incorporated by the macrophyte community which is part of the reason there are more macrophytes at the present time than there were historically.

Macrophytes. The two cores collected in known macrophyte beds (Sites 2 and 3) were examined for macrophyte fossils These fossils were used to reconstruct specific changes in the macrophyte community. Unlike diatoms, macrophyte fossils are largely deposited within a short distance of where they are produced. Therefore reconstruction from cores reflects the macrophyte community only in the area where the core was collected. One core was taken in a bed that contained predominantly fern pondweed (*Potamogeton robbinsii*) (Site 3) and the other core was taken in a bed that contained fern pondweed as well as coontail (*Ceratophyllum demersum*) (Site 2). We had planned to use seeds and fruits but they were very rare in the cores. Only a few *Najas flexilis* seeds were recovered as well as some undeveloped seeds and/or perigynia of Cyperaceae (most likely *Carex* sp.). Fossils examined instead were vegetative remains and as listed in Table 3. Although we had planned to only examine the 0-2 cm and 60-62 cm sections of the cores, because of the high amount of fragments from coontail in the 60-62 cm section we also examined macrophyte fragments from the bottom of the core.

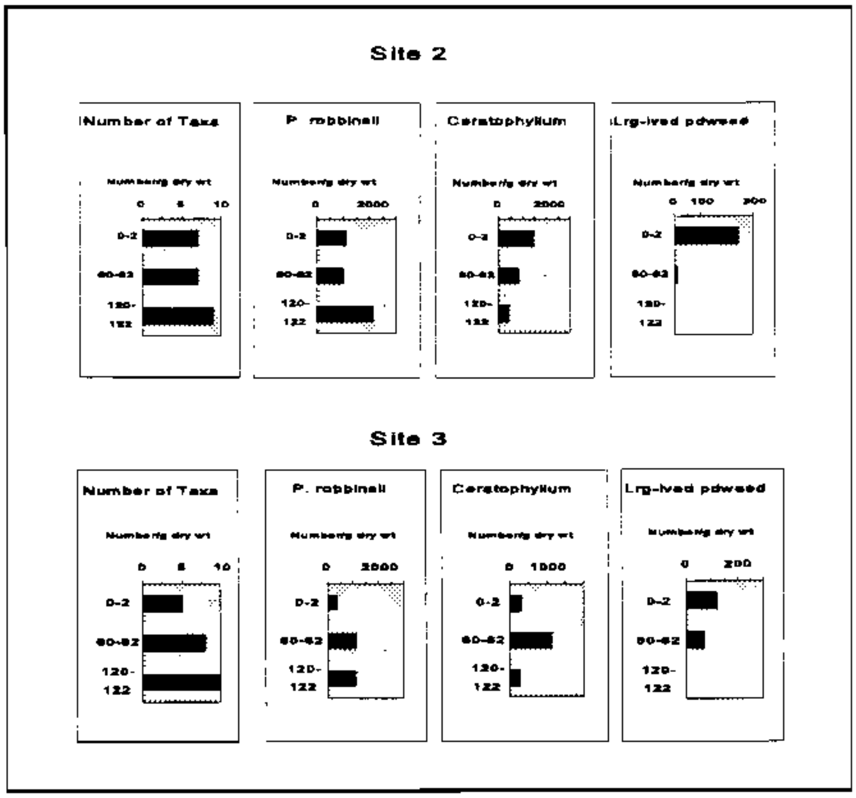

Figure 4. Changes in the abundance of the dominant macrophyte species and the species richness at both coring sites in the macrophyte beds.

Overall, species richness (number of taxa) was greater in the deeper (older) sediments (Figure 4). This could be in part due to the larger sample size as deeper sediment layers had lower water content. However, greater diversity would be expected in more recent deposits since there would be less plant material lost through decomposition. Since there were a greater number of taxa at depth, the community was probably more diverse historically.

P. robbinsii and *Ceratophyllum* were the most abundant species in the both cores and at all depths that were examined (Figure 4). They were likely among the dominant species in the lake, but this cannot be ascertained as other species may not appear in the fossil record. These cores characterize only a small portion of the littoral area and aquatic plant macrofossils are often localized (Birks 1980).

More leaf fragments from *Ceratophyllum* were found in Site 2 than in Site 3 (Figure 4), which corresponds with its abundance in 1992 (McComas 1993). Large-leaved pondweeds/ *Vallisneria* are more common in the macrophyte community in recent years (Figure 4). It should be considered that their relative absence in the lower sediment strata may reflect poorer preservation in older sediments.

Table 3. Descriptions of plant macrofossils found in sediment cores from Little Bearskin Lake. (V = vegetative fragment; S = seed; R = reproductive structure).

Taxa	Type	Core
Ceratophyllum sp. (coontail)	V	2,3
Cyperaceae, probably *Carex* (sedge)	R	2,3
Myriophyllum sp. (water milfoil)	V	2,3
Najas flexilis (slender naiad)	S	2,3
Potamogeton robbinsii (fern pondweed)	V	2,3
Potamogeton zosteriformis (flat-stemmed pondweed)	V	2,3
Large-leaved pondweed/*Vallisneria* (water celery)	V	2,3
Narrow-leaved pondweed	V	3
Macroalga (*Chara* spp.)	V	2,3

The decreasing ratio of *P. robbinsii* to *Ceratophyllum* suggests that the latter has recently increased in the lake (Table 4). This trend is especially marked in the Site 2 core where the ratio has decreased from 5.7 to 0.8. While more vegetative parts in the older sediment may be attributed to breakdown, differences in fragment size was not as apparent as the increase in the number of fragments.

Table 4. Ratio of *Potamogeton robbinsii* to *Ceratophyllum* plant fragments.

Sample	Depth (cm)	*P. robbinsii* : *Ceratophyllum*
LBS-2	0–2	0.8
LBS-2	60–62	1.2
LBS-2	120–122	5.7
LBS-3	0–2	1.3
LBS-3	60–62	1.0
LBS-3	120–122	3.8

Although few seeds and fruits were found in the sediment cores, there are a number of reasons for this. The occurrence of seeds and fruits in sediment samples are notably variable (M. Winkler, University of Wisconsin, Madison, WI, pers. comm.). A lack of reproductive structures may be attributed to the patchiness of the aquatic seed bank, which may not have been adequately sampled by 2 cores (A. Vander Valk, University of Iowa, Ames, IA, pers. comm.). However, *P. robbinsii* rarely produces seeds (Aalto 1974) and *Ceratophyllum*, which flowers infrequently, reproduces mostly vegetatively (Nichols, S.A., University of Wisconsin Extension, Madison, WI, pers. comm.). In addition, the macrophytes observed in the lake in 1992 are mostly perennial species, which show less seed production than annuals. Of the submersed species, only *Vallisneria americana* and *Myriophyllum sibiricum* (formerly *M. exalbescens)* are likely to produce abundant seeds, (A. Vander

Valk, University of Iowa, Ames, IA, pers. comm.). Likewise, the floating species (*Nuphar advena* and *Nymphaea odorata*) produce variable amounts of seeds Since none of these are dominant species in the current macrophyte community, their seeds may be sparse in the recent sediment record.

There is currently a diverse assemblage of macrophytes in Little Bearskin Lake (McComas 1993). Many of these species are desirable and considered valuable habitat (e.g. *Potamogeton robbinsii*, *Potamogeton amplifolius*, *Vallisneria americana*; Wis. Admin. Code NR 107). Not all of these species were found in the upper layers of the cores that were examined, which may be due to the area sampled, patchiness, as well as the way that these species are preserved in the sediments. The present day macrophyte community appears to be less diverse than historically and coontail composes a larger portion of the community.

Summary

1. The sediment diatoms indicated that phosphorus concentrations in the lake have not changed in the last century. Although there likely is more phosphorus entering the lake at the present time, it is being incorporated by the macrophyte community and does not appear in the open water in form of algal blooms.

2. Historically, the macrophyte community was more diverse. The macrophyte community was also not as dense as it is at the present time. The area of macrophyte coverage probably has not changed over time but the density of the macrophyte growth has increased. This is supported by the increased percentage of diatoms found in the core which grow on macrophytes.

3. Few macrophyte seeds and fruits were found in the sediment cores. Instead vegetative fragments were used to reconstruct the macrophyte community.

4. Fern pondweed (*P. robbinsii)* is not currently as dominant as it was historically but current densities may be greater.

5. Coontail (*Ceratophyllum*) has been present in the lake for at least the last century but the amount has increased in recent years, especially at Site 2.

General Condition of the Lake

Evidence from the three sediment cores indicates that the general water quality condition of the lake is good. Phosphorus levels are relatively low for a small shallow lake such as Little Bearskin Lake. Algal blooms, if they occur, are infrequent and low intensity. Macrophytes are relatively dense in some areas of the lake and the presence of *Ceratophyllum* is sometimes annoying. This macrophyte historically has been present in the lake but in recent years has increased. This is likely the result of an increase in nutrients entering the lake as a result of lakeshore cottages. If the macrophytes had not increased there would be increased levels of algae in the water resulting in a reduction in water clarity.

It appears that the major source of nutrients to the lake is from lakeshore homes as there are few other nutrient sources in the watershed. The best plan to reduce nutrient runoff from these homes is to reduce erosion during construction (especially on steep slopes) and limit lawn fertilization. In fact lawns generally do not need phosphorus so applying fertilizer that does not contain any phosphorus would be advantageous for the lake. Maintaining a buffer strip of natural vegetation along the lakeshore will intercept some nutrients that otherwise would runoff from the lawns. Another measure that would reduce nutrients entering the lake is to properly maintain home septic systems. Well designed and maintained systems contribute less nutrients to the lake.

Overall Little Bearskin Lake is in good condition. Efforts should be directed in maintaining this condition. It is much easier to protect the current condition than to restore a lake after it has been seriously degraded.

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