**The Diversity, Density and Distribution of Aquatic Plants**

**in Glen Lake, St. Croix County, Wisconsin**

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**Introduction**

A survey of the aquatic plants (macrophytes) in Glen Lake was conducted during August, 1994 by Water Resources staff from the Western District DNR office. This was the first aquatic plant survey conducted on Glen Lake by the WDNR and the findings will provide needed information for decisions about fish habitat improvements, sensitive wildlife areas, water resource regulations and aquatic plant management options. The survey will also serve as a baseline for comparison with future plant inventories, offering insight into changes that may be occurring in the lake ecosystem.

**Background**

Glen Lake is an 84-acre drainage lake with a maximum depth of 38 feet. The lake is located in Glen Hills County Park which has a public access boat landing and swimming beach. The primary recreational use of the lake is fishing with large mouth bass the dominant game fish.

There are many factors that affect the distribution of aquatic plants in Glen Lake. Among the most important are: **1) water quality 2) sediment type 3) water level and 4) lake morphometry.**

**I. Water Quality** - The presence and abundance of aquatic plants is directly related to water quality. Particularly important are the **water clarity, available nutrients, pH and hardness.** The value ranges used in this discussion are drawn from Shaw et. al. 1993.

**Water clarity** - Light is the most critical factor restricting the growth of aquatic plants. When the plants receive less than 1 to 2% of the surface illumination, they can not survive. Water clarity is determined by a combination of *true color* (dissolved organic chemicals) and turbidity (suspended materials such as algae and silt). The water in Glen Lake has limited staining: water samples collected during 1994 had 30 color units (0 - 40 is considered low in color). The turbidity ratings for Glen Lake were in the moderate range varying from 4.1 NTU in the spring to 0.9 NTU in the fall.

Water clarity can be measured with Secchi disc readings that show the combined effect of color and turbidity. These Secchi disc values can then be

used to calculate the maximum rooting depth for plants (Dunst, 1982).

Maximum rooting depth in feet = 2.73 + 1.22(mean summer Secchi value in feet). The 1994 mean summer Secchi reading for Glen Lake was 1.9M (6.2 feet). This provides a maximum rooting depth of 10.3 feet.

**Available Nutrients** - Nutrient levels in the water are important in determining the trophic state of a lake. Oligotrophic lakes are low in nutrients while eutrophic lakes are high in nutrients and often experience excessive algae growth. Prolonged algal blooms can inhibit the growth of submersed vegetation through shading. The following table is a summary of trophic classification of Wisconsin lakes (Shaw et. al. 1993).

Trophic Class Total Phosphorus (ug/l) Chlorophyll a (ug/l) Secchi Disc (ft)

Oligotrophic 3 2 12

10 5 8

Mesotrophic 18 8 6

27 10 6

Eutrophic 30 11 5

50 15 4

During 1994, Glen Lake had a summer mean total phosphorus (32 ug/l) and summer mean chlorophyll a (24.8 ug/l) in the eutrophic range. The summer mean secchi reading was in the mesotrophic range (6.2 ft.).

**pH** - The pH of lake water is an index of the relative acidity of the water. The 1994 summer mean pH for Glen Lake was 9.4. This would favor aquatic plants that are adapted to alkaline conditions and discourage growth of low-pH adapted plants.

**Hardness** - The hardness or mineral content of lake water can also influence the success of aquatic plant growth. The 1994 hardness value was 99 mg/l. This is in the moderately hard category for Wisconsin lakes. Hard water lakes tend to have more abundant plant growth than soft water lakes, so this is a beneficial water quality parameter for aquatic plants in Glen Lake.

**II. Sediment Composition** - One of the most important factors influencing aquatic plants is the substrate in which they are rooted. Many aquatic plants depend on the sediment for required nutrients, so the richness or sterility of the lake sediment will determine which species of plants can survive there.

The sediment at the majority of sampling sites in Glen Lake was silt, although there were limited areas of muck, sand or rubble. The availability of mineral nutrients essential for plant growth is highest in sediments of intermediate density (Barko & Smart 1986). Highly organic sediments (organic content >20%) have low density, while sand and gravel have high density. The silt substrate common in Glen Lake is a favorable density for most aquatic plant growth.

**III. Water Level** - Fluctuating water levels place stress on aquatic plants. The shallow zone becomes exposed beach when the water level drops and this is too harsh an environment for macrophytes. The deep end of the littoral zone becomes shallower with a drop in water level, but the plants cannot usually spread quickly enough to take advantage of this area before it is re-flooded to a level they can not tolerate (Nichols 1975). Glen Lake has experienced fluctuating water levels in recent years related to seasons of high rainfall followed by seasons of drought. These changing water levels could be a factor in macrophyte distribution.

**IV. Lake Morphometry** - The morphometry of a lake is an important factor that is often overlooked in analyzing the distribution of aquatic plants. A study conducted by Duarte and Kalff found that the slope of the littoral zone accounted for 72% of the observed variability in maximum growth of submergent vegetation (Duarte & Kalff 1986).

The important role of morphometry can be seen along most of the shoreline in Glen Lake where there is a steeply sloped littoral zone. The only exception is the southwest bay that offers more extensive macrophyte habitat.

**Methods**

The objectives of this aquatic plant survey were to gather information about the species present, the distribution of aquatic vegetation and the frequency and abundance of these plants. The survey design was based primarily on the rake-sampling methodology developed by Jessen and Lound (1962).

Transect lines running perpendicular to the shoreline were established at 500 to 700 foot intervals, with the first transect randomly placed. A total of 16 transects lines were used. The location of the transect lines was marked on a lake map and a geolocator was used to confirm these points in the field.

A long-handled steel thatching rake was used to sample vegetation in four depth zones along the transect lines: 0-1.5 ft., 1.5-5 ft., 5-10 ft. and 10-20 ft. A 6-foot diameter quadrat was sampled in each depth zone with a rake sample taken from each quarter of the quadrat. The species present on each rake sample were listed. Then each species was given a 1-5 rating depending upon whether it was present or absent on each of the rake samples taken at a depth zone. A rating of 4 would mean a species was present on all four rake samples. A rating of 5 means it was present abundantly on all four rake samples. A modified grappling hook was used for deeper samples taken to establish the maximum rooting depth.

The sediment type was also recorded at each sampling point so observations could be made about the influence of sediments on diversity and distribution of species. In addition to the information gathered on the transect lines, a visual inspection and periodic samples were collected between the transect lines. Vegetation found in these areas was noted for inclusion on the species list and the map of macrophyte distribution. Samples of all species were collected for preservation as voucher specimens. Nomenclature was according to Fassett (1957).

A number of calculations were done to evaluate the transect data (Appendix I,II)

1) species frequency of occurrence: number of sampling sites where it occurred /

total number of sampling sites

2) relative frequency: no. of occurrences of a species / all species occurrences

3) mean density: sum of a species density ratings / total no. of sampling sites

4) relative density: sum of a species density ratings / sum of all density ratings

5) mean density where present: sum of a species density ratings /

number of sites at which it occurred

6) importance value: relative frequency + relative density

**Results**

**I. Species Present -**  A total of 19 species of aquatic plants were inventoried. No endangered or threatened species were found and no exotic species were present. The macrophyte population was composed of 7 emergent, 3 floating-leaf and 9 sub- mergent species.

**Emergent Species**

*Eleocharis sp.* - spikerush

*Phalaris arundinacea* - reed canary grass

*Sagittaria latifolia -* common arrowhead

*Scirpus cyperinus -* wool grass

*Scirpus fluviatilis -* river bulrush

*Scirpus validus -* softstem bulrush

*Typha latifolia -* broadleaf cattail

**Floating-leaf Species**

*Lemna minor -* small duckweed

*Spirodela polyrhiza -* great duckweed

*Wolffia columbiana -* common watermeal

**Submergent Species**

*Ceratophyllum demersum* - coontail

*Chara sp*. - muskgrass

*Elodea canadensis* - waterweed

*Heteranthera dubia* - water stargrass

*Najas flexilis* - slender naiad

*Potamogeton nodosus -* long-leaf pondweed

*Potamogeton pectinatus -* sago pondweed

*Potamogeton pusillus -*  small pondweed

*Potamogeton zosteriformis -* flat-stem pondweed

**II. Frequency of Occurrence -** Aquatic plants were found growing at 76.3% of all sampling points. That means about a quarter (23.7%) of the sampling sites had no vegetation present. Eighteen of the 19 species present in the lake were found on transect lines. (*Potamogeton zosteriformis* was found between transect lines).

Figure 1 shows the frequency of occurrence for these plants at all sampling sites. Six species were found at more than 25% of the sampling points: *Ceratophyllum demersum* 64.4%, *Heteranthera dubia* 40.7%, *Potamogeton pusillus* 30.5%, *Najas flexilis 28.8*%, *Elodea canadensis* 27.1%, and *Potamogeton nodosus* 27.1%.

Figure 2 shows a comparison of the frequency of plant species within each depth zone. In the shallowest depth zone *Ceratophyllum demersum* and *Potamogeton nodosus* had the highest frequency of occurrence. In both the 0-1.5 ft. and 1.5-5 ft. depth zones *Ceratophyllum demersum*, *Heteranthera dubia* and *Potamogeton pusillus* were most frequent. In the deepest zone (10 to 20 ft.) the only macrophyte present was *Ceratophyllum demersum*.

**III. Density** - Mean density values for each species could range from 0 to 5 based on rake sampling (see Methods). Several species had high density growth when they were present at a site: *Typha latifolia* (4.0), *Najas flexilis* (3.0), *Scirpus cyperinus* (3.0) and *Wolffia columbiana* (3.0).

Mean density averaged over all sampling sites gives a good overview of the impact of each species within the plant community. The two species with the highest mean density throughout the littoral zone were *Ceratophyllum demersum* (1.66) and *Heteranthera dubia* (1.07). Figure 3 shows the density where present and overall mean density for each of the species.

There are also density differences by depth zone. Figure 4 compares the densities of the most frequently occurring species by depth zones. In the shallowest depth zone*, Ceratophyllum demersum* (2.31) and *Potamogeton nodosus* (2.38) had the highest mean densities. In the 1.5-5 ft. depth zone, *Ceratophyllum demersum* (2.00), *Heteranthera dubia* (1.81) an*d Potamogeton pusillus* (1.69) had the highest mean densities. In the 5-10 ft. zone, *Ceratophyllum* again had the highest density and in the deepest zone (10-20 ft.) only *Ceratophyllum* was present.