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

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

**Introduction**

A survey of the aquatic plants (macrophytes) in Pine Lake (T29N, R17W) was conducted during August, 1993 by Water Resources staff from the Western District DNR office. This was the first aquatic plant survey conducted on Pine Lake by the WDNR and the findings will provide needed information for decisions about fish habitat improvements, sensitive wildlife areas, water quality improvement needs 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**

Pine Lake is a 106.8 acre seepage lake with several intermittent streams that flow into it. It has a maximum depth of 21 feet and 99% of the lake is less than 20 feet deep. There is one public access boat landing at the northwest end of the lake. Recreational use of the lake is primarily fishing with northern pike as the dominant game fish.

There are many factors that affect the distribution of aquatic plants in Pine 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 Pine Lake has low staining and water samples collected during 1993 had only 30 to 40 color units (0 - 40 is considered low in color). The turbidity ratings, however, were high (3.9 - 9.7 NTU) primarily due to suspended algae.

 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 1993 mean summer Secchi reading for Pine Lake was 2.5 feet. This provides a maximum rooting depth of 5.8 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

 The total phosphorus, chlorophyll a and secchi disc values for Pine Lake all were at the high end of the eutrophic range. The 1993 summer mean total phosphorus was 121 ug/l, the summer mean chlorophyll a value was 58 ug/l and the summer mean secchi reading was 2.5 ft.

 **pH** - The pH of lake water is an index of the relative acidity of the water. The 1993 summer mean pH for Pine Lake was 9.2. 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 1993 hardness value was 41 mg/l. This is in the soft water category for Wisconsin lakes. Hard water lakes tend to have more abundant plant growth than soft water lakes, so this is a limiting water quality parameter for aquatic plants in Pine 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 sampling sites in Pine lake was sand, rubble or gravel. 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 high density sediments in Pine Lake are not favorable 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 reflooded to a level they can not tolerate (Nichols 1975). Pine Lake has experienced fluctuating water levels in recent years related to seasons of high rainfall followed by seasons of drought. The lake has a small watershed and is primarily dependent on groundwater seepage for its water supply.

**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 (1986) found that the slope of the littoral zone accounted for 72% of the observed variability in maximum growth of submergent vegetation. The important role of morphometry can be seen along most of the shoreline in Pine Lake where there is a steeply sloped littoral zone.

**Results**

**I. Species Present -**  A total of 6 species of aquatic plants were inventoried. No endangered or threatened species were found and no exotic species were present. There were 3 emergent, 1 floating-leaf and 2 submergent species.

 **Emergent Species**

 *Iris versicolor* - blueflag iris

 *Phalaris arundinacea* - reed canary grass

 *Polygonum pensylvanicum* var. *laevigatum -* smartweed

 **Floating-leaf Species**

 *Lemna minor -* small duckweed

 **Submergent Species**

 *Ceratophyllum demersum* - coontail

 *Elodea canadensis* - elodea

**II. Frequency of Occurrence** - Aquatic plants were found growing at 41.3% of all sampling points. Only one species was was found at more than 10% of the sampling sites: elodea (26.1%).

 **III. Density -** Mean density averaged over all sampling sites gives a good overview of the impact of each species within the plant community. Only elodea had a notable density (.67) averaged over all sites.

**IV. Distribution -** The distribution of aquatic plants in Pine Lake was limited to a shallow band along the shoreline.

 **Percentage of Sites with Plants in Each Depth Zone**

 Depth Zone % Sites with Macrophytes

 0 - 1.5 ft. 58.3%

 1.5 - 5 ft. 58.3%

 5 - 10 ft. 41.7%

 10 - 20 ft. 0.0%

The predicted maximum rooting depth was 5.8 feet. The deepest plant growth found during the survey was elodea at 7 feet.

V. Influence of sediment type - Hard sediments dominate the littoral zone in Pine Lake. There was sand at 63.0% of the samping sites, rubble at 30.4% and gravel at 6.5%.

**Sediment Type Occurrence of**

**at Sampling Sites Macrophytes**

sand 44.8%

gravel 100.0%

rubble 21.4%

**Discussion**

The plant community in Pine Lake is limited by the prolonged algal blooms that shade submersed plants. This shading starts in June and continues throughout the growing season. The only plant that is doing well in Pine Lake is elodea.

Elodea is well-adapted to low light conditions. It has chloroplasts concentrated on the periphery of leaves to capture available light. Elodea also remains green under the ice during the winter, so it has an advantage in the spring when it is already actively growing. Because it does not die back in the winter, it tends to form a dense mat that accumulates over a period of years and can inhibit the growth of other submersed aquatic plants.

There are some fish and wildlife values offered by elodea. It provides shelter for both adult and juvenile fish as well as supporting a variety of invertebrates for fish grazing.

The emergents that are present in the shallow water offer important shoreline stabilization and help buffer both wave action and upland runoff. These emergent beds are also important fish spawning sites for northern pike, and are the primary habitat for many waterfowl and shorebirds. However, emergents were present at only 13% of the sampling sites and had a low diversity: only reed canary grass, smartweed and blueflag iris were found.

**Conclusions**

The water quality problems in Pine Lake are evident in the plant population. Only disturbance tolerant species are present, and even these have low frequencies and densities. The hard sediments and sloped littoral zone create some limitations, but improved water clarity would open a window of opportunity for new species. Even the addition of a few species that do well in firm sediments, such as wild celery (*Vallisneria americana*) and slender naiad (*Najas flexilis*), would vastly improve both the fish and wildlife habitat of Pine Lake.