AQUATIC PLANT MANAGEMENT PLAN

FISH, CRYSTAL and INDIAN LAKES

LOWER WISCONSIN BASIN
DANE COUNTY

SCUBA cut channels through EWM in Fish Lake, 1990

November 2006

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Summary

Aquatic plant surveys were performed during the summer of 2006 on Fish, Crystal and Indian lakes. The three lakes share common features including location within the Lower Wisconsin Drainage Basin, are seepage lakes and have displayed rising water levels in recent decades. Six hundred-ninety-three sites were sampled in the three lakes. Results of the point intercept surveys indicated that coontail and Eurasian watermilfoil dominated in both Fish and Indian lakes. Dense concentrations of these weedy plants coincided with low numbers of native species (low species richness). In Fish Lake, a higher diversity of native plants went undetected since the sampling points did not capture the narrow band of nearshore plants. In Crystal Lake, Eurasian watermilfoil was a minor component in an aquatic plant community already limited by heavy bluegreen algal blooms and poor water clarity. Plant density measures were lower in Crystal Lake compared to the other two lakes. Survey results indicated that Fish and Indian lakes warrant management of coontail and Eurasian watermilfoil while modest rooted plant densities in Crystal Lake were not posing water use problems. Higher water levels in both Indian and Crystal lakes had played an important role in restoring sportfish populations due to fewer winterkills and improved habitat.

Fish Lake Recommendations

1. Conduct a more complete inventory of native aquatic plants near shore to better assess their status and condition following the first year of pumping and lake drawdown.
2. Conduct mechanical harvesting at important access points to improve navigation and fish habitat. Mechanical and chemical removal of aquatic plants within Department of Natural Resources designated Sensitive Areas will be prohibited to protect critical habitat for fish spawning and early life stages.
3. Consider longer term efforts to sustain boating lanes and improved fish habitat using methods such as deep cutting - harvesting. Methods could include modified large scale harvesting or manual cutting involving SCUBA.
4. Protect important habitat features including floating-leaf plant beds and coarse woody habitat. Residents should be discouraged from manually removing high values species such as watershield, floating-leaf pondweed and water lilies.

5. Recommend Sensitive Areas Designations to WDNR based on criteria established in Wisconsin Administrative Code NR 107 and other important ecological features. Sensitive Areas would encompass plant beds with high value native species including watershield, floating-leaf pondweed and water lilies. Use of herbicides and large-scale mechanical harvesting is prohibited in these areas.
6. Encourage local land use planning and management to reduce nutrient runoff into the lake. (Watershed runoff had contributed to littoral zone sediments rich in nutrients, a factor contributing to high EWM growth in the lake. Potential sources of polluted runoff should be re-evaluated given reductions linked to surrounding park land acquisitions.)
7. Consider sampling nearshore fish populations, including blackchin shiner, blacknose shiner and banded killifish. These species may be affected by rapid habitat changes including rising water levels.
8. Consider updating the comprehensive lake management plan at some point in the near future.

Crystal Lake Recommendations

1. Mechanical harvesting should be conducted during periods when EWM densities are high to improve boating access.
2. Modest levels of native macrophytes provide important fish habitat and should not be the focus of eradication efforts. These conditions may change and Eurasian watermilfoil could expand under different water level conditions, warranting management.
3. Recommend Sensitive Area designations to WDNR including bays supporting white water lily beds.
4. Protect coarse woody habitat around the lake for fish and herptile populations.
5. Encourage local land use planning and management to reduce nutrient loading into the lake. (Reducing bluegreen algal blooms could ultimately improve native plant growth in the lake.)

6. Consider coordinating the preparation of a comprehensive lake management plan with Columbia County.

Indian Lake Recommendations

1. Continue harvesting channels when coontail or EWM impede navigation within the lake.
2. Avoid management activities that would shift productivity from submersed macrophytes to bluegreen algal blooms. Massive primary productivity shift from rooted plants to bluegreen algal blooms would likely result from whole-lake herbicide(s) treatment.
3. Consider planting floating leaf plants such as white water lily, yellow water lily or American lotus to improve fish habitat and aesthetics.
4. Sensitive Areas designation is not a high priority for Indian Lake at this time given the lake is entirely encompassed by park land, proposed management activities do not alter nearshore habitat and high value aquatic plant species are very scarce in the lake.

Introduction

As required in Wisconsin Administrative Code NR 109.04(d), the purpose of this plan is to guide mechanical harvesting activities and the effective management of aquatic plants in Fish, Crystal and Indian lakes. Dane County periodically operates mechanical harvesters in all three lakes, managing densely growing exotic Eurasian watermilfoil (*Myriophyllum spicatum*), exotic curly-leaf pondweed (*Potamogeton crispus*) and native coontail beds (*Ceratophyllum demersum*). Dense stands of the "weedy" plants have undermined the ecological balance and recreational uses in these lakes. Harvesting efforts have been designed to enhance both of these important lake management functions.

Significant ecological and hydrological changes have occurred in all three lakes over the last several decades, altering aquatic plant distributions and species compositions. Long term rising water levels have resulted in emergent, floating-leaf and submersed plant redistributions while effects of polluted runoff have benefited Eurasian watermilfoil and curly-leaf pondweed. In recent years submersed aquatic plant growths have expanded in the shallow hyper-eutrophic Indian and Crystal lakes, although species richness remains low. In contrast, native plant beds have declined significantly in Fish Lake, a deep water seepage lake with a maximum depth of 62 feet. Native plant declines in Fish Lake coincided with eutrophication, Eurasian watermilfoil invasion and water level changes.

The primary goals of this plan were to establish long term realistic objectives for managing nuisance exotic plant species while protecting valuable native species and their important habitat functions. While the goal was not to create a comprehensive lake management plan, we recognize that aquatic plant communities are linked to other aspects of lake and watershed management, and these links are identified.   A comprehensive lake management plan already exists for Fish Lake and this report updates and expands the aquatic plant management element of that plan.

Fish Lake Goals

Recognizing that Eurasian watermilfoil has dominated the littoral zone for over two decades, the goals for managing Fish Lake aquatic plants are to (1) improve recreational access in the lake, (2) improve bluegill (*Lepomis macrochirus*) – largemouth bass (*Micropterus salmoides*) interactions within monotypic stands of Eurasian watermilfoil, (3) identify and protect Sensitive Areas defined under Wisconsin Administration NR 107.05(3-i) and (4) reverse the documented declines of high value species [NR 107.08(4)] in Fish Lake including large-leaf pondweed (*Potamogeton amplifolius*) clasping-leaf pondweed (*P. richardsonii*), sago pondweed (*Struckenia pectinatus*) and watershield (*Brasenia schreberi*). Other important native plants that declined in Fish Lake and also require protection include floating-leaf pondweed (*P. natans*), variable pondweed (*P. gramineus*), flat-stem pondweed (*P. zosteriformis*) smartweed (*Polygonium amphibian*), water marigold (*Bidens beckii*), yellow water lily (*Nuphar variegatum*), white water lily (*Nymphaea tuberosa*) and American lotus (*Nelumbo lutea*).

Background Information

Fish Lake (252 acres) is a moderately eutrophic lake located in the Town of Roxbury. The lake is relatively undeveloped with significant parklands adjoining the east and west shorelines. Recreational uses include swimming, fishing and boating. There is a town ordinance prohibiting gasoline motors on the lake.

The Fish Lake watershed is approximately 1680 acres including lake surface areas. The primary land use is agriculture. Top soils are fine silty loam and are nutrient rich from manure and fertilizer applications. Most of the watershed is rolling farmland with steep wooded hills. Just northwest of Fish Lake is Mud Lake (74 acres), historically a northwest bay of Fish Lake that was partly disconnected when Fish Lake road was constructed. The bay is currently connected via a culvert.

Major changes have occurred within Fish Lake over the last several decades including declining water quality and reduced native aquatic plant beds. Detailed information on Fish Lake can be found in a comprehensive lake management plan (Marshall et al. 1996) and in numerous research articles focusing on ecology of macrophytes and fish. The comprehensive lake management plan was based on a U.S. Environmental Protection Agency (USEPA) Clean Lakes Phase I Diagnostic and Feasibility Study and incorporated significant findings of the cooperative research effort known as the “Integrated Management of Macrophytes and Fish”.

Historically, Fish Lake had been classified mesotrophic based on chlorophyll-a, phosphorus, and Secchi (DCRPC 1979). During the 1970’s, the lake was considered to have the best water quality in the county however other indicators suggested gradual water quality decline. Hypolimnetic dissolved oxygen levels had been declining since the late 1950’s while poor survival of stocked rainbow trout (*Oncorhynchus mykiss*) ended any efforts to manage a two story fisheries by 1969 Dane County Regional Planning Commission (DCRPC 1979). Cisco (*Coregonus artedii*) populations are native to the lake, and like trout also require deep cool water habitat with sufficient dissolved oxygen. Over the past several decades, periodic cisco kills have been documented and coincided with low dissolved oxygen levels in the upper hypolimnion and thermocline.

Fish Lake historically supported diverse floating-leaf and submersed aquatic plant beds (Table 1) but significant declines in abundance have occurred. Native plant declines coincided with three long term changes in the lake: eutrophication, Eurasian water milfoil (EWM) invasion and rising water levels.

Approximately 60% of the Fish Lake watershed was agricultural and primarily in the form of cropland. Even though the watershed to lake ratio is relatively low at 4.4:1, high phosphorus loading was documented during the 1990's. The annual estimated phosphorus loading to the lake was 1690 lbs/year. Winter manure spreading and feedlots were identified as principal watershed sources of phosphorus and nitrogen at that time. More recently, the predicted phosphorus loading to the lake has declined and reflects a feedlot closure near Mud Lake and expanded parkland around both Fish and Mud lakes.

Within the last few decades, rising Trophic State Index (TSI) values indicated that Fish Lake had shifted from mesotrophic to moderate eutrophic condition. The long term water quality decline in the lake had been linked to watershed nutrient sources (Marshall et al. 1996). Evidence of declining water quality included reduced Secchi measurements, higher chlorophyll and higher hypolimnetic phosphorus and ammonia levels. In addition to increasing (TSI) values, littoral zone sediments also reflected nutrient enrichment. Shallow water sediment core sampling revealed very high levels of both phosphorus (1142 mg/kg) and ammonia (128 mg/l). Sediment testing indicated that polluted runoff was deposited within littoral areas of the lake, particularly along the west shorelines adjacent to most of the agricultural runoff. Sediment fertility has been linked with EWM growth and phosphorus transport from the littoral zone (Smith and Barko 1990). Deep water sediment core sampling was also conducted and revealed significant water quality decline in recent years. Analyzing sediment cores is a way of determining a history of nutrient input into a lake. Upper portions of sediments reflect recent deposition. As you go deeper into the sediment you can determine what was added in the past.

While detailed lake and watershed monitoring studies were initiated in 1988 to address the declining water quality, lake users were generally more aware of the "dense weed beds" in the lake. Eurasian watermilfoil was first identified in 1967 and rapidly expanded throughout the 1980s. By 1991 dense growths of EWM covered 99 acres of the lake bottom area (Lillie 1996). During the EWM expansion period, numerous native species declined substantially as EWM established monotypic stands beyond one meter depth - a typical pattern of EWM invasions (Madsen et al. 1991). With the exception of coontail, the remaining native macrophytes occupied near-shore areas (Lillie 1996). The near-shore native plant beds can be more vulnerable to shoreline development and rapid water level decline.

In 1994, EWM declined by approximately 40% across the lake. The decline coincided with weevil damage (Lillie 2000, Creed 1998). Native weevils can reduce the viability of EWM by boring into the stems (Mazzei et al. 1999). Boring into the stem results in loss of plant buoyancy and the plant basically "falls down". This either kills the plant directly or severely weakens the plant due to reduced photosynthesis. Coinciding with reduced macrophyte density that year, Secchi depths declined and chlorophyll-a concentrations increased. Higher chlorophyll levels may have reflected nutrient release from decaying EWM, reduced alleopathy or both. These conditions were temporary since EWM rebounded in 1996. The temporary EWM decline did not expand the distribution or abundance of native plants and may reflect sediment nutrient effects. The EWM decline and resurgence suggested that a lake-wide chemical eradication may not expand native plants and could result in severe Cyanobacteria blooms.

In addition to eutrophication and EWM expansion in Fish Lake, long-term rising water levels (Krohelski et al. 2002) had been a third factor contributing to redistribution of native plants. As the water level rose, emergent and floating-leaf plants moved to newly submersed shoreline while EWM also migrated toward shore. The result had been a gradual shift of all plants, emergent, floating-leaf and submersed, toward the perimeter of the lake. In 2006, the management district began pumping water from the lake to reduce water levels and damage to several properties along the west shore. Many of the relatively scarce native species became desiccated as water levels dropped.

The EWM invasion had altered the habitat chemically in Fish Lake (Unmuth et al. 2000). Very low dissolved oxygen levels were found near the bottom of the beds. The effects of dense plant beds on predator-prey interactions had been reported as well (Engel 1987, Savino et al. 1992). Local efforts to develop new methods for improving habitat within dense EWM beds began in 1989 (Marshall 1990). Scuba divers used manual cutting tools in Fish Lake to cut deeper growths of EWM at the sediment surface. The deep cutting technique held promise since the channels created by the SCUBA divers persisted for four years. Aerial photographs of the lake during this period clearly show where the channels were cut (cover photo). Modest growths of curly-leaf pondweed and coontail had replaced EWM within the channels. Deep cutting to stress deeper EWM stands was ultimately tested by teams of researchers seeking management tools for improving EWM habitat and predator-prey interactions (Unmuth et al. 1999, Unmuth et al 1998, Olson et al. 1998, Trebitz et al 1997). The Dane County Public Works Department modified one of the county harvesters in order to conduct a series of deep cutting experiments in Fish Lake and other lakes around the state. While the mechanical channels did not persist as long as the manual cut channels, the results demonstrated increased growth rates for particular year classes of both bluegill and largemouth bass populations. "Cruising lanes" became available to largemouth bass. Predation on stunted bluegills occurred, followed with increased growth rates of specific year classes for both species.

Bluegill and largemouth bass comprise the dominant fisheries in the lake. Other species found in Fish Lake are listed in Table 2. Environmentally sensitive nongame species have been identified in Fish Lake including banded killifish (*Fundulus diaphanous*), blackchin shiner (*Notropis heterodon*) and blacknose shiner (*Notropis heterolepis*) and Iowa darter (*Etheostoma exile*). These species can typically be found in dense aquatic plant communities near shore (Becker 1983). The banded killifish is classified as State Special Concern and the other three species are classified as environmentally sensitive to degraded habitat (Lyons 1992). Abundant overhanging trees ring the lake and create another important habitat feature for fish populations and herptiles. In 2002, WDNR and Dane County Parks cooperated in a habitat improvement project along the Lussier Park shore. Large dead trees were pushed into the water and American lotus seed and nursery seedlings from Mud Lake were planted as well. The goal was to improve habitat for game fishes and intolerant nongame species that can be vulnerable to near-shore habitat loss. The current status of nongame fishes in the lake is unknown.

Table 1: Fish Lake floating-leaf and submersed macrophytes (Lillie 1996)

Scientific Name	Common Name
Bidens beckii	Water marigold
Brasenia schreberi	Water Shield*
Ceratophyllum demersum	Coontail*
Chara	Stonewort or Muskgrass
Eleocharis acicularis	Spike Rush
Elodea canadensis	Elodea
Lemna minor	Lesser Duckweed
Myriophyllum sibiricum	Northern Watermilfoil
Myriophyllum spicatum	Eurasian Watermilfoil (EWM – exotic)*
Najas flexilis	Bushy Pondweed
Nuphar variegata	Yellow Water Lily
Nymphaea odorata	White Water Lily*
Polygonum natans	Smartweed*
Potamogetan amplifolius	Large-leaf Pondweed
Potamogetan crispus	Curly-leaf Pondweed (CLP-exotic)*
Potamogetan gramineus	Variable-leaf Pondweed
Potamogetan natans	Floating-leaf Pondweed*
Potamogetan richardsonii	Clasping-leaf Pondweed*
Potamogetan zosteriformes	Flat-stem Pondweed
Struckenia pectinatus	Sago Pondweed*
Utricularia vulgaris	Bladderwort

* Herbarium specimens collected in 2006.

Table 2: Fish Taxa sampled from Fish Lake in 1991

Scientific Name	Common Name
Esox lucius	Northern pike
Cyprinus carpio	Common carp
Notemigonus crysoleucas	Golden shiner
Notropis heterodon	Blackchin shiner
Notropis heterolepis	Blacknose shiner
Catostomus commersoni	White sucker
Ameiurus natalis	Yellow bullhead
Fundulus diaphanus	Banded killifish
Lepomis cyanellus	Green sunfish
Lepomis gibbosus	Pumpkinseed sunfish
Lepomis macrochirus	Bluegill sunfish
L. gibbosus x *L. cyanellus*	Hybrid sunfish
L. gibbosus x *L. macrochirus*	Hybrid sunfish
Micropterus salmoides	Smallmouth bass
Pomoxis nigromaculatus	Black crappie
Etheostoma exile	Iowa darter
Perca flavescens	Yellow perch
Stizostedion vitreum	Walleye

Recent Aquatic Plant Management and Harvesting Records

The primary focus of mechanical harvesting in Fish Lake has been to improve boating access from the Fish Lake Park launch and along developments around the lake. Harvesting records from 1999 through 2004 indicate that plant tonnages removed from the lake ranged from 13 to 104 tons of plants (40 tons – 1999, 104 tons – 2000, 13 tons – 2001, 18 tons - 2004).

2006 Aquatic Plant Survey Update

Methods

The sampling protocol was developed by Jen Hauxwell, a research scientist with Wisconsin Department of Natural Resources, Bureau of Integrated Science Services. The point intercept method was used where a large number of sampling sites are distributed equidistantly across a lake. GPS units were used to locate the sites and double-headed rakes were used to collect macrophytes. The rakes are constructed in two forms. The pole rake is used for sampling macrophytes up to 15 ft (4.6 m) and rope rake can be used to sample deeper areas. Density ratings from 1-3 are determined by the amount of plant material in the two-headed rake. Plants that were observed near the boat but were not collected in the rake were also noted. Samples of each species found in a lake are collected, pressed and submitted as voucher specimens to the UW Madison Herbarium.

Statistical analysis included the following:

- Frequency of occurrence within vegetated sites or number of times a species was found divided by the total number of vegetated sites.
- Relative frequency of plant species collected (describes each species contributing a certain percentage of the whole aquatic plant community).
- The Simpson Diversity Index is a nonparametric estimator of community heterogeneity. The Simpson Diversity Index range is from 0 to 1 with lower diversity reflected in scores closer to 1.

Detailed statistical results appear in the appendix.

Wisconsin Department of Natural Resources provided the sampling grids and spreadsheet software for data entry and analysis. A more detailed sampling description can be found in Baseline Monitoring of Aquatic Macrophytes (Hauxwell 2006).

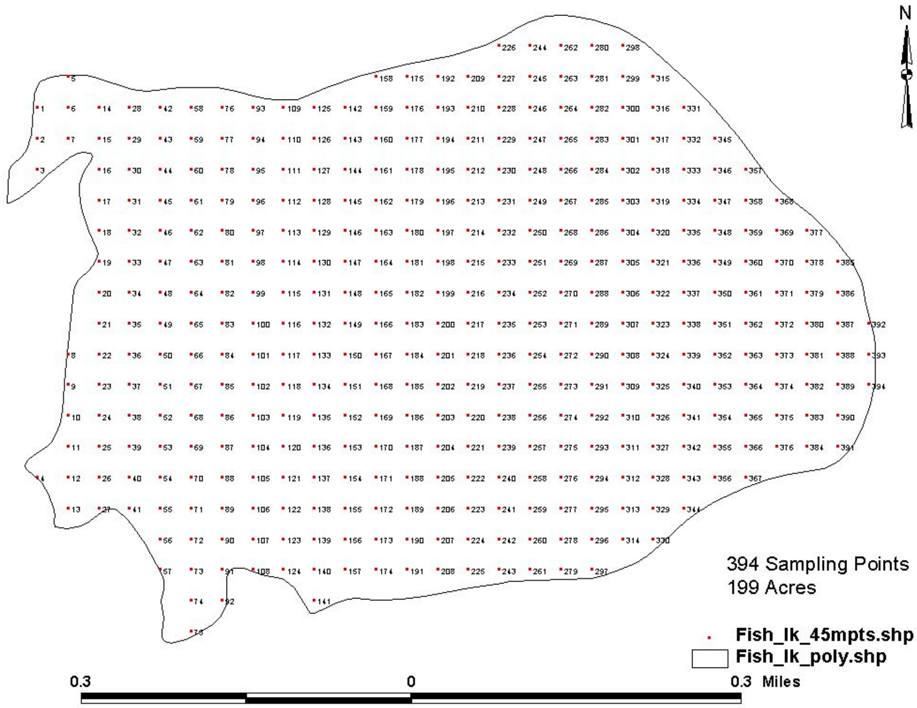
Results and Discussion

The aquatic plant survey was conducted on August 1 and 4, 2006. Secchi measurements were six feet on both survey days, generating a TSI score of 52 (moderately eutrophic).

A 394 point grid was established across the lake containing potential sampling sites (Figure 1). After eliminating sites within depths well beyond the littoral zone, a total of 226 points were sampled.

Aquatic plant sampling depths ranged from 5 feet to 36 feet with a mean depth of 14.4 feet. The grid system was created from an older map and did not capture shallow nearshore areas around the lake. The sampling depths in Fish Lake were generally greater than other Dane County lakes sampled for macrophytes in 2006 due to the lack of nearshore sites and presence of moss beyond the littoral zone. Mosses were found to grow within the depth range (17 – 31 feet) typically defined as littoriprofundal (Wetzel 1983). Implications for the range of sampling depths were twofold. First, the minimum depth of 5 feet resulted in under sampling native plants that were located close to shore. Second, sampling moss beyond the typical littoral zone resulted in lower relative and vegetated site frequencies for both EWM and coontail (Figure 2A). The results were adjusted in Figure 2B by removing the moss data. Regardless of these sampling issues, EWM and coontail dominated most of the littoral zone and reflected low species richness beyond 5 feet water depth. Only one other species was found during the point intercept sampling effort. Actual plant distributions across Fish Lake are located on the maps in Figure 4. A single watershield specimen was collected along the west shoreline. The low species richness within the sampling grid was reflected in a Simpson Diversity Index of 0.86. The Simpson Diversity Index range is from 0 to 1 with lower diversity reflected in scores closer to 1. The average rake fullness rating was 2 for both EWM and coontail.

Figure 1: Point intercept grid map of Fish Lake



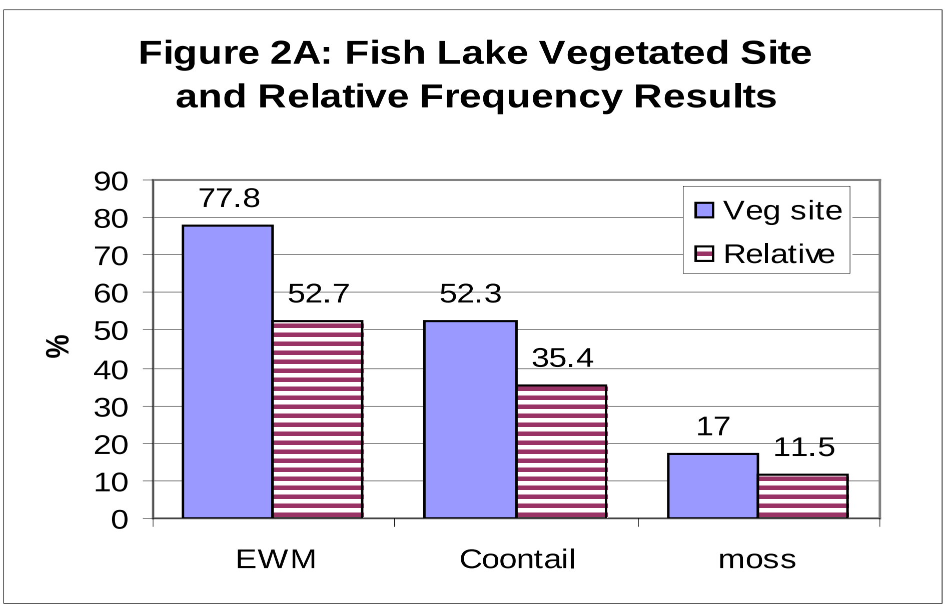
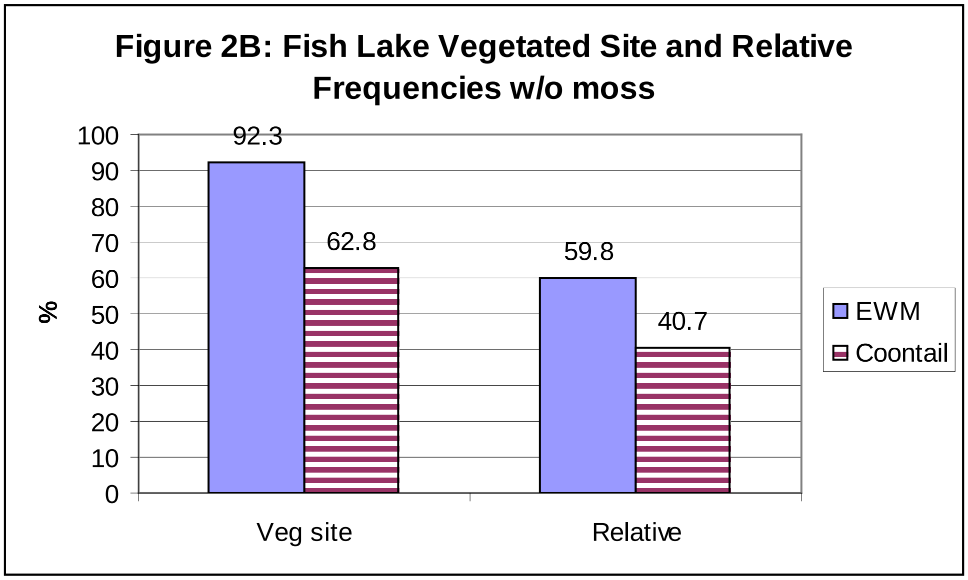
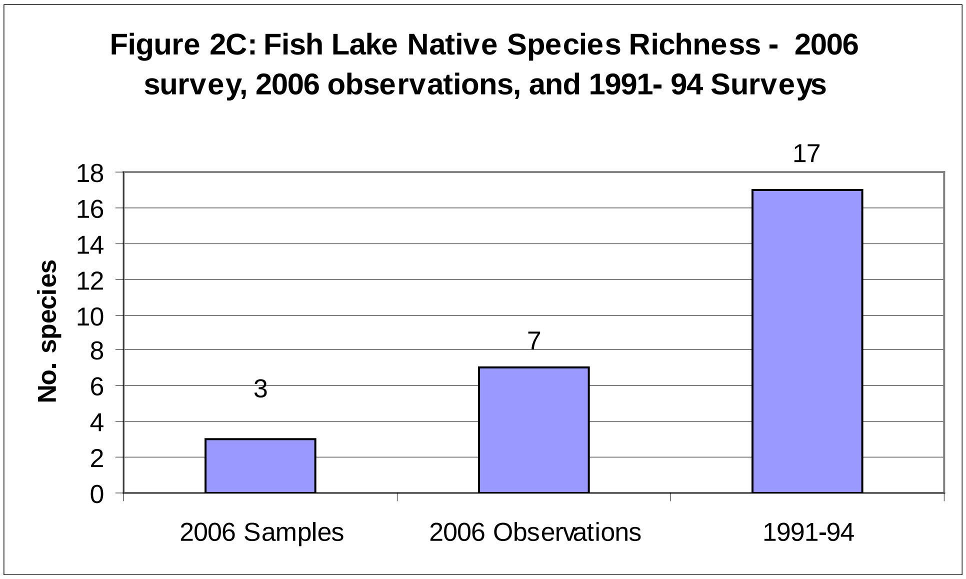


Figure 2A: Fish Lake Vegetated Site and Relative Frequency Results



The map with sampling area (Figure 1) did not include the southwest bay but observations confirmed dominance of EWM and coontail in that area as well. Both species were also dominant in that area when the lake was sampled from 1991-94. Recognizing that the sampling grid did not include nearshore areas during the 2006 survey, we periodically moved closer to shore to identify native plants and collect herbarium specimens. While the additional specimen collections did not constitute a complete nearshore sampling effort, the presence of white water lily, smartweed, clasping-leaf pondweed, floating-leaf pondweed, and sago pondweed were identified at various locations around the lake. Future sampling could both expand the point intercept sampling sites within the southwest bay and elsewhere and include a more thorough survey of nearshore plants.



American lotus was observed growing in abundance around adjoining Mud Lake. We found no evidence of American lotus in Fish Lake including the Lussier Park area where it was planted in 2002 as part of a habitat restoration effort. Several species including American lotus, white water lily, smartweed, clasping-leaf pondweed, sago pondweed were found desiccated within the drawdown zone of both Fish and Mud Lakes. In addition to the nearshore native plant observations, a few Curly leaf pondweed (CLP) turions were observed floating, an indication that the plant was in the over-wintering stage during the survey.

Species richness was greater during the more intensive macrophyte surveys from 1991-94, perhaps reflecting different sampling methodologies and more intensive nearshore sampling at that time. Figure 2C compares species richness data for the 2006 point intercept sampling effort, 2006 combined sampling with observations, and 1991-94 surveys results. Additional nearshore sampling is required to determine if a decline in species richness had occurred. Aside from these differences, the general pattern of EWM dominating throughout the deeper portion of the littoral zone did not change. Coontail was the second most abundant plant during all of the surveys.

Sensitive Areas (NR 107.05(3)(i) had been described in the 1996 comprehensive management plan. Areas supporting watershield, floating-leaf pondweed, white water lily, and yellow water lily included the west shore, southwest bay, northwest area and east shoreline.   Based on the 2006 aquatic plant survey, these areas continue to provide critical habitat for fisheries, including the environmentally sensitive nongame fishes and early life stages of sportfish in the lake. The floating-leaf plant communities should not be chemically treated or mechanically harvested. Small manual aquatic plant removal should be limited to Eurasian watermilfoil, curly-leaf pondweed and coontail.   The proposed Sensitive Areas are identified in the Figure 4 map.

Figure 3: 2006 aquatic plant distributions

Aquatic Plant Management Alternatives

While the primary emphasis of this plan is to protect important aquatic plant habitats and control nuisance EWM growths with mechanical harvesting equipment, additional management tools are available to individual property owners. Chemical treatments are regulated under Wisconsin Administrative Code NR 107. WDNR had generally discouraged chemical treatments in the past due to the vulnerability of nearshore native plant communities. Instead, riparian property owners have been encouraged to manually remove vegetation to enhance private access in front of their properties. Under NR 109.06 (a-1), a riparian owner is not required to obtain a permit from WDNR if the removal involves invasive species or removal of native species is limited to a single area with a maximum width of no more than 30 feet measured along the shoreline. In general, chemical treatments may not provide long term EWM control in Fish Lake due to high littoral zone sediment nutrients.

Creating long term access channels in Fish Lake could involve either deep cutting and harvesting or hydraulic dredging. Due to high costs, dredging may not be a practical option. This form of aquatic plant management would also require a Chapter 30 permit from WDNR. As prior research has demonstrated, deep cutting and harvesting can sustain relatively long term access channels. This effort may involve modification of existing mechanical harvesters or labor intensive efforts such as manual cutters or participation of SCUBA divers.

Another alternative is the use of aquatic weevils. Weevils have been demonstrated to control EWM in laboratory and enclosure studies (Mazzei et al. 1999, Sheldon and Creed 1995). The EWM decline in 1994 coincided with evidence of weevil damage (Lillie 2000), however EWM rebounded a few years later and high densities continue in the presence of the insect. More detailed discussions on aquatic plant management alternatives can be found in Cooke et al. (2005) and Petty (2005).

Specific Alternatives

1) **No treatment**: Rejecting all types of aquatic plant management does not appear realistic, given the extent of EWM coverage. Severe ecological unbalance already exists as well as significant loss of recreational uses over approximately 40% of the surface area.
2) **Biological control**: This method does not appear realistic at this time. Weevil (*Euhrychiopsis lecontei*) populations have already been well documented in the Fish Lake yet the density of EWM declined significantly only once over the past two decades. The findings are not clear if weevils were the cause for the temporary decline in 1994. High panfish populations can also reduce weevil densities below levels needed for effective EWM control.
3) **Chemical control:** Herbicide use should be restricted to small riparian areas using agents selective at controlling EWM. 2, 4-D is the likely agent given the partial selectivity for controlling EWM. However, several valuable native plants including water lilies can be damaged from 2, 4-D so WDNR permit applications should be carefully screened to avoid loss of already declining native plants.

Whole-lake applications do not appear realistic given the past EWM decline and resurgence that may reflect sediment nutrients and other factors.

4) **Manual - hand removal**: Manually removing plants around piers and swimming areas is a viable option. However, property owners should be educated about the importance of high value native species so that their efforts should focus on weedy exotics such as EWM. Sensitive Areas can not be harvested. SCUBA divers can be used for larger areas such as creating long term boat channels within the manual removal zone. All plants that are cut should be removed. In the case of SCUBA divers, barges or pontoon boats can be used to transport harvested plants from the lake.
5) **Mechanical harvesting**: Given the extent of EWM over 40% of the lake surface area, mechanical harvesting provides effective temporary access through the dense monotypic beds as well as habitat improvements. Deep cutting and harvesting offers potential for relatively long term effectiveness but modifications to existing harvesters would be required.
6) **Physical control**: Hydraulic dredging can be an option for removing the nutrient rich sediments within designated navigation channels. This method has the greatest potential for long term control but can be initially expensive. Whole lake dredging is unrealistic given the vast littoral areas affected by EWM. Fabrics are another physical control method but rarely used by property owners because of the labor of installation and maintenance. During local demonstrations, problems arose due to gas collection under the fabric. Drawdown is also rarely used in Wisconsin for aquatic plant management however drawdown is currently underway in Fish Lake with the goal of water level control and not aquatic plant management. So far negative effects on valuable native plants have been observed.

Crystal Lake Goals

The goals for managing Crystal Lake macrophytes are to (1) control dense EWM and other weedy plant growths in areas where recreational uses are undermined (2) identify and protect Sensitive Areas defined under Wisconsin Administration NR 107.05(3-i), particularly floating-leaf plant beds, (3) sustain native aquatic plant beds for fish habitat and inhibit potentially toxic concentrations of Cyanobacteria blooms that frequently occur within the hypereutrophic lake.

Background Information

Crystal Lake is a 525 acre shallow seepage lake located just 1,950 feet east of Fish Lake. Recreational uses include gasoline motorized boating, fishing, water skiing and swimming. In recent years, Crystal Lake has been a popular attraction for anglers due to the fast growing bluegill, crappie and largemouth bass populations. Additional recreational opportunities are located at a large commercial park located on the Columbia County side of the lake.

Unlike the relatively deep Fish Lake, Crystal Lake is shallow and it does not thermally stratify. Crystal Lake is classified as hypereutrophic due to high concentrations of Cyanobacteria. The WDNR lake database indicated that Secchi depth measurements have ranged from 1.5 (TSI = 72) to 2.8 feet (TSI = 63). The surrounding watershed is very similar to the Fish Lake watershed with agriculture the dominant land use. Likely sources of phosphorus to Crystal Lake include feedlots, crop fields and internal loading as the lake mixes throughout the summer. During the 1980s, WDNR conducted animal waste management (NR 243) investigations on several shoreline feedlots located on the Columbia County side of the lake.

Crystal Lake is hydraulically connected to Fish Lake by groundwater and rising water levels have coincided in both lakes for decades (Krohelski et al. 2002). Maximum water depths were only 6 feet in the 1940s and increased to 9 feet by 1960. Frequent winter fish kills had been documented from the 1940s through the 1960s (DCRPC 1979). Aeration and frequent stocking were necessary to create recreational fishing during that period. When fish kills had occurred, bullheads were often the only survivors.

In recent years the trend of increasing water levels continued and the maximum water depth has increased to 14 feet. Consistent with the Fish Lake shoreline, trees had become inundated in past years and dead trees now line the perimeter of Crystal Lake. The dead trees are an important habitat feature for fish and herptile populations. Coinciding with the rising water levels, sustainable largemouth bass and panfish populations in the lake indicate that winterkills have diminished. In spite of continued hypereutrophic conditions, greater water volume has apparently increased the total oxygen mass within the lake. Water level declines in the future, perhaps linked to pumping, may potentially reverse the trend of sustainable winter dissolved oxygen levels in the lake.

Dense growths of macrophytes had been reported decades ago including common waterweed (*Elodea canadensis*), sago pondweed (*Struckenia pectinatus*), duckweed (*Lemna*) and white water lily (*Nymphaea odorata*) (DCRPC 1970). There are no historical quantitative records on Cyanobacteria blooms or how the blooms might have affected the maximum rooting depths and distribution of macrophytes in Crystal Lake.

In recent years, EWM had become established in the lake and the formation of dense monotypic stands created recreational use problems. Management had included private herbicides applications around the two commercial mobile home parks in Columbia County while Dane County operated mechanical harvesters to provide boating access from the public boat ramp and elsewhere.

Fish populations have fluctuated over the years due to previous winterkills and also reflect restocking efforts. Bluegills (*Lepomis macrochirus*), largemouth bass (*Micropterus salmoides*) and black bullhead (*Ameirus melas*) had been the most common species reported (DCRPC 1979). Other species reported from the lake include golden shiner (*Notemigonus crysoleucas*), fathead minnow (*Pimephales promelas*), pumpkinseed (*Lepomis gibbosus*) and orangespotted sunfish (*Lepomis humilis*). No environmentally intolerant fish species have been reported from the lake. Since about 1980, higher water levels have coincided with sustainable populations of largemouth bass, bluegill, black crappie (*Pomoxis nigromaculatus*), and to a lesser extent yellow perch (*Perca flavescens*)

(Larson – personal communication). In addition to high water levels, native macrophytes enhance fisheries habitat. Dissolved oxygen deficits, associated with low water level induced winterkills or heavy summer Cyanobacteria blooms, and outbreaks of *Columnaris* bacteria are factors that can have negative impacts on the fisheries.

2006 Aquatic Plant Survey Update

Methods (Refer to page 8)

Results and Discussion

The aquatic plant survey was conducted on July 28 and 29, 2006. Secchi measurements reflected very poor water clarity with depths ranging from 1.8’ to 2.5’ during the survey. The equivalent Secchi TSI scores were 70 and 63 respectively, clearly indicating eutrophic conditions. The original sampling grid contained 495 points (Figure 4) however the total number was reduced. There were more sampling points created than were needed to conduct the survey, given the typically low species richness found in hypereutrophic lakes such as Crystal Lake. A total of 263 points were ultimately sampled but total sampling area was maintained since every other point was sampled along a given transect.

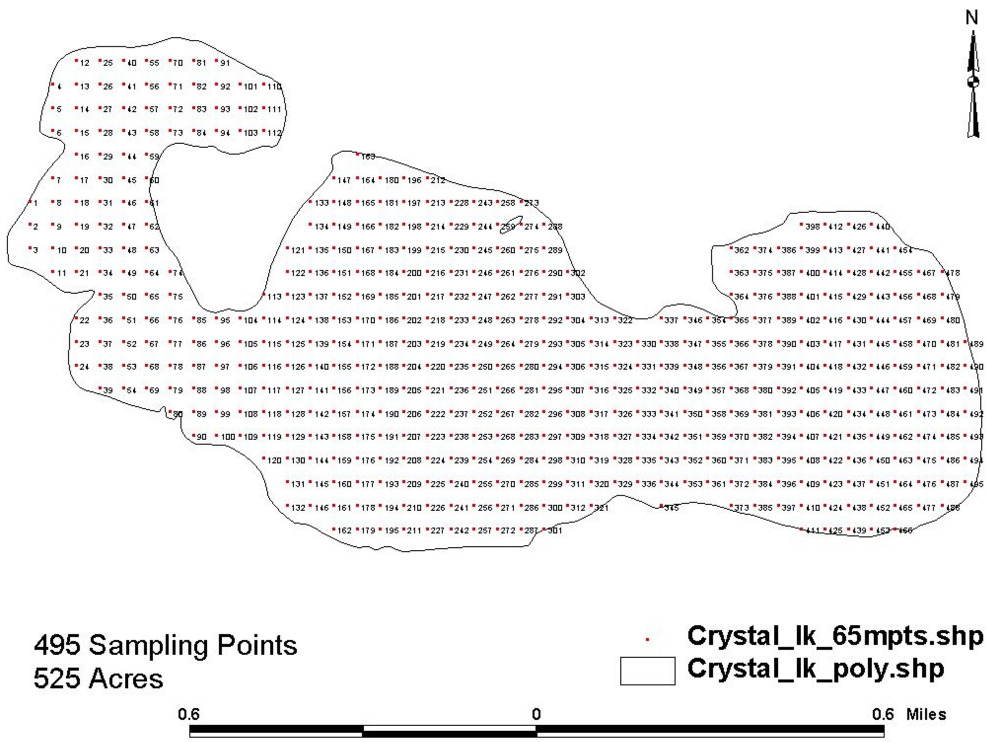
Consistent with the Fish Lake sampling grid, most of the sampling points were not very close to shore since the maps did not reflect the current lake volumes. For instance, in the Figure 5 grid map a portion of the northeast bay was excluded. Historically, that area was partly a cattail marsh. We attempted to collect specimens closer to shore, however nearshore species richness did not appear to differ from deeper locations and the only additional plants observed were white water lily and cattail (*Typha*). Overall, the sampling grid did not significantly affect the plant species richness score.

Unlike Fish Lake where EWM was clearly the dominant macrophyte, native species were dominant in Crystal Lake. Common waterweed (*Elodea canadensis*) was the most abundant plant followed by leafy pondweed (*Potamogeton foliosus*). Filamentous algal growths were also relatively abundant in the lake and were often attached to the aquatic plants. Both the vegetated sites frequency and relative frequency results reflect the dominance of common waterweed in Crystal Lake (Figure 6). Results also indicate that EWM was infrequently found in 2006 and it did not pose recreational or ecological problems. The Simpson Diversity Index was 0.65 and the average rake fullness was 1 for EWM and 2 for common waterweed, coontail and sago pondweed. Crystal Lake had a higher Simpson Diversity Index than Fish Lake based on point intercept sampling results. However species richness was actually higher in Fish Lake if the nearshore plants that were not part of the point intercept sampling effort are included. Distributions of the plants found in Crystal Lake are displayed in Figure 7.

Curly-leaf pondweed (*Potamogeton crispus*) was the other exotic plant found in the lake but at a very low frequency. Curly-leaf pondweed (CLP) typically becomes dormant when water temperatures increase and most late summer aquatic plant surveys either underestimate typical densities or miss the plant entirely. Curiously, we observed windrows of CLP turions floating across the lake during the Crystal Lake survey. High numbers of the over-wintering turions that we observed indicated potentially high densities of the plant earlier in the growing season. Frequency and distribution of CLP could be assessed more effectively if an early season survey was performed.

Sensitive Areas had not been designated on Crystal Lake. Based on the 2006 survey results, Sensitive Areas should include portions of the northeast bay and west shoreline (Figure 8) that support white water lilies. Chemical treatments and large-scale mechanical harvesting should be avoided in these areas.

Figure 5: Point intercept sampling grid for Crystal Lake



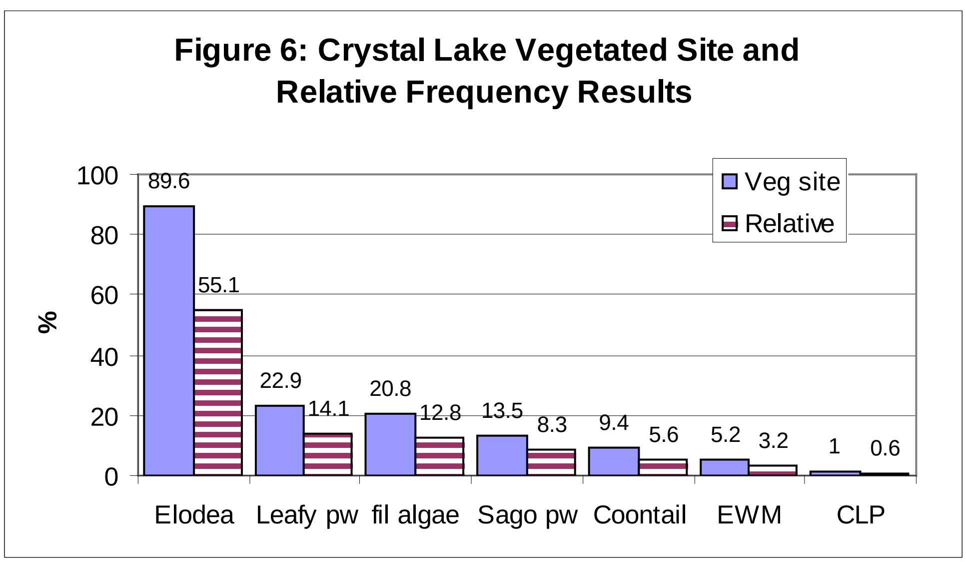


Figure 6: Crystal Lake Vegetated Site and Relative Frequency Results

Recent Aquatic Plant Management

Dane County records indicate that mechanical harvesting had not been performed on the lake since 1999. The combination of relatively low densities of rooted plants and dense of bluegreen algal blooms have eliminated the need for harvesting in recent years. Chemical herbicide applications have been conducted within the vicinity of the mobile home parks on the northwest side of the lake.

Figure 7: (Plant distribution maps)

Figure 8: Crystal Lake Sensitive Areas

Aquatic Plant Management Alternatives

Results of the 2006 aquatic plant survey indicated that overall macrophyte densities were low in Crystal Lake. Macrophyte densities were notably low within the northwest bay area that had received chemical treatment in 2006 and previous years. The overall low densities suggest that major macrophyte control efforts were not warranted in the lake. Rather, the macrophytes densities generally provided desirable habitat functions for fish. If a resurgence of EWM is detected in the lake, then a combination of selective chemical applications and mechanical harvesting beyond the nearshore areas may improve habitat and recreational uses. Given the hypereutrophic condition of the lake, continued Cyanobacteria blooms will likely continue in the lake. The long term challenge is to reduce nuisance growths of exotic CLP and EWM while enhancing native populations that may compete with Cyanobacteria and provide habitat for fish.

Specific Alternatives

1) **No treatment**: Rejecting all types of aquatic plant control may be reasonable given the modest densities of both native aquatic plants and EWM.
2) **Biological control**: This method does not appear realistic at this time. Weevil (*Euhrychiopsis lecontei*) populations had been well documented in the Fish Lake yet the density of EWM declined significantly only once over the past two decades. The findings are not clear if weevils were indeed responsible for the temporary decline in 1994. EWM densities currently are not causing ecological or habitat problems in the lake.
3) **Chemical control:** Herbicide use should be restricted to small riparian areas and commercial campgrounds using agents selective at controlling EWM. 2,4-D is the likely agent given the partial selectivity for controlling EWM. However, several valuable native plants including water lilies can be damaged from 2,4-D so permit applications should be carefully screened to avoid loss of already declining native plants. Whole-lake applications do not appear feasible given the low density of EWM and frequent Cyanobacteria blooms.
4) **Manual - hand removal**: Manually removing plants around piers and swimming areas is a viable option. However, property owners should be educated about the importance of high value native species so that their efforts should focus on weedy exotics such as EWM. Sensitive Areas can not be harvested.
5) **Mechanical harvesting**: In 2006, mechanical harvesting was not needed due to the low densities of aquatic plants. However, this option should remain available if a resurgence of EWM undermines lake access.
6) **Physical control**: Hydraulic dredging is an unlikely option in Crystal Lake. The heavy Cyanobacteria blooms will likely replenish sediment nutrients within a short period following excavation. Watershed nutrient sources are likely an issue as well. Fabrics are rarely used by property owners because of the labor of installation and maintenance. In local demonstrations, problems arose due to gas collection under the fabric. Drawdown is currently underway in Fish Lake and Crystal Lake water levels are predicted to decline due to the hydraulic connection.

While the goal is not aquatic plant management but rather flood control, valuable nearshore native plants can be negatively affected.

Indian Lake Goals

The goals for managing Indian Lake macrophytes are to (1) improve non-motorized boat access within dense coontail, Eurasian watermilfoil and curly-leaf pondweed beds, (2) sustain lake-wide aquatic plant beds in desirable densities to prevent bluegreen algal blooms that had historically occurred (3) manage aquatic plants to enhance the largemouth bass and bluegill fisheries and (4) enhance native floating-leaf plant populations.

Background Information

Indian Lake is a 27 ha (66 acres) shallow kettle lake that is maintained by groundwater and surface runoff. The entire lake is surrounded by the county park and recreational uses include fishing, bird watching, canoeing and other types of boating that do not involve gas engines. The lake is primarily managed for largemouth bass and panfish. An aeration system is frequently used during late winter months to avoid anoxia and fish winterkill conditions.

The small lake had a long history of severe bluegreen algal blooms. During the early 1980's, WDNR Bureau of Research conducted an experiment to determine if adding nitrogen to the lake would trigger a shift from nitrogen fixing Cyanobacteria species to non-bloom species (Lathrop 1988). The findings indicated that nitrogen applications were not effective due to short-term responses and other complicating factors. Since then, bluegreen algal blooms in the lake have declined as a response to sustained dense aquatic plant growths and other factors.

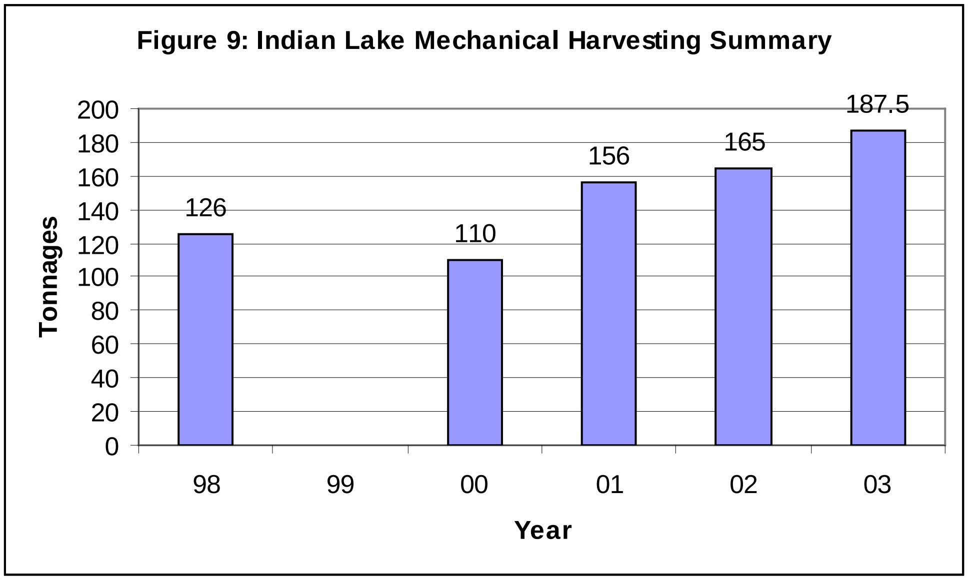
Consistent with the hydrology of Fish and Crystal lakes, Indian Lake water levels have increased over time. The maximum recorded depth during the 1970s was 6 feet (Day et al. 1985). In 2006, the maximum water depth had increased to 8.5 feet. The water levels in all three lakes may reflect increased regional groundwater recharge associated with agricultural conservation land use practices (Gebert and Krug 1996).

More recently, EWM and coontail had become established in the lake and apparently suppress phytoplankton blooms. Harvesting the dense beds had become the primary management focus in the shallow lake. Dane County has been operating mechanical harvesters to create navigation channels for non-motorized boating access in the lake. These efforts also have potential to improve predator prey interactions.

Fish species richness has been limited by periodic past winterkills in the past. Species identified in the past surveys include fathead minnows (*Pimephales promelas*), bluntnose minnow (*Pimephales notatus*), white suckers (*Catostomus commersoni*), black bullhead (*Ameiurus melas*), green sunfish (*Lepomis cyanellus*), bluegill (*Lepomis macrochirus*), black crappie (*Pomoxis nigromaculatus*), largemouth bass (*Micropterus salmoides*) and yellow perch (*Perca flavescens*) (Lathrop 1988, Day et al. 1985). Following winterkills, bullhead populations periodically exploded and exacerbated turbidity and internal phosphorus loading in the lake. This occurred with dense bullhead populations disturbed bottom sediments when feeding. Currently, bluegill and largemouth bass populations are sustained by late winter aeration and harvesting improves the habitat.

Recent Mechanical Harvesting Records

Dane County records indicate that Indian Lake had been harvested since 1998. The primary goal has been to create navigation channels within dense plant beds from the public boat ramp to various access points across the lake. Figure 9 displays annual tonnages of harvested aquatic plants removed from Indian Lake from 1998 to 2003.



2006 Aquatic Plant Survey Update

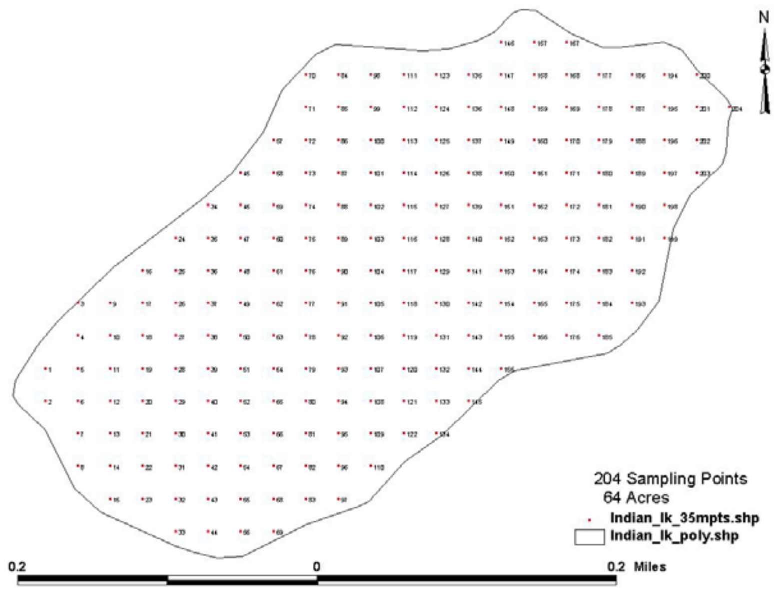
Methods (Refer to page 8)

Results and Discussion

The aquatic plant survey was conducted on June 19, 2006. Secchi depth was measured at 4 feet with an equivalent Secchi TSI score of 54. The sampling grid contained 204 points (Figure 10) however the survey did not include a bay on the southeast side of the lake. Consistent with the Fish and Crystal lake surveys, the Indian Lake map did not reflect the higher water level and expanded lake area.

Very dense beds of coontail, CLP and EWM had topped out of the water during the survey and rowing was difficult. CLP was beginning to decompose but still rigid enough to form dense beds. Coontail followed by EWM were the dominant two species yielding very high vegetated site and relative frequencies. Also abundant throughout the marshy lake were small floating plants, *Lemna and Wolffia*. Relative frequency data for both submersed and floating plants are displayed in Figure 11. The average rake fullness was 2 for EWM and 3 for coontail. The Simpson Diversity Index reflected low species richness with a score of 0.83. Beyond the sampling points, the entire lake was bordered by emergent vegetation, mostly cattails and to lesser extent bur reeds. Aquatic plant distributions are displayed in the Figure 12 maps for the individual species.

Figure 10: Point intercept sampling grid for Indian Lake



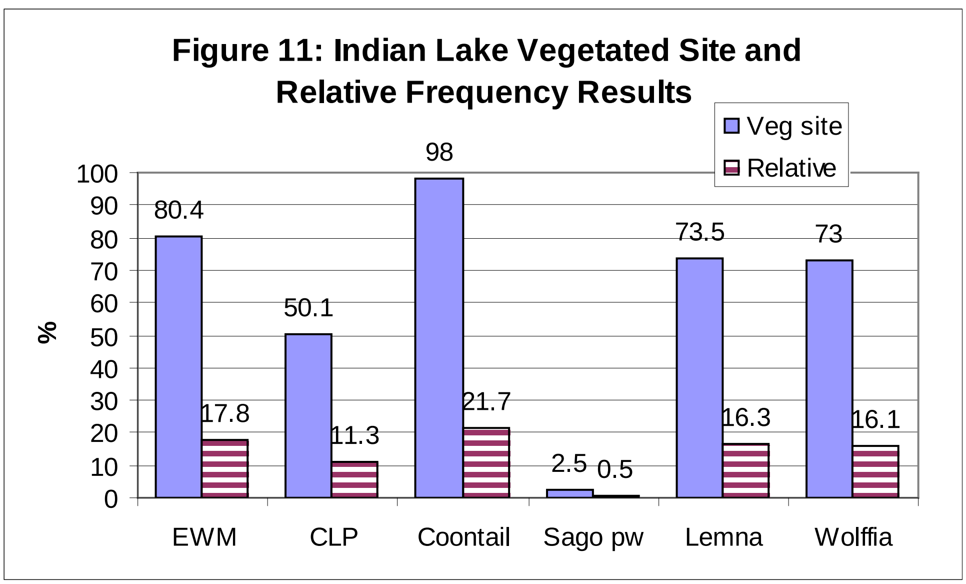


Figure 11: Indian Lake Vegetated Site and Relative Frequency Results

Figure 12: Indian Lake aquatic plant distribution maps

Aquatic Plant Management Alternatives

Indian Lake offers outdoor enthusiasts a relatively rare opportunity to enjoy an undeveloped lake in southern Wisconsin. However, the dense aquatic plant communities have created nuisance conditions that impede navigation and detract somewhat from the experience. In the past, harvesting channels has improved boating access and benefited fish populations as well. Indian Lake has been suggested as a site for experimental whole-lake chemical treatment of EWM. This effort could tip the balance toward bluegreen algal blooms. In 2006, EWM was not the dominant plant causing navigational problems. Rather, native coontail was more abundant. The existing conditions reflect decades of runoff pollution and sedimentation. Very high productivity, typical of hypereuthrophic conditions, will likely persist in the lake. These conditions will continue unless a major rehabilitation project is launched, such as drawdown and dredging.

Specific Options

1) **No treatment**: Rejecting all types of aquatic plant management is unreasonable given the high densities of EWM, CLP and coontail that undermine public access.
2) **Biological control**: This method does not appear realistic at this time. Weevil (*Euhrychiopsis lecontei*) populations had been well documented in the Fish Lake yet the density of EWM declined significantly only once over the past two decades. The findings are not clear if weevils were indeed responsible for the temporary decline in 1994. In Indian Lake, coontail and CLP currently combine for greater ecological and nuisance problems than EWM.
3) **Chemical control:** Herbicides are an unlikely management tool given the entire lake is encompassed within a park. An experimental whole-lake treatment may create severe Cyanobacteria blooms given the hypereuthrophic status of the lake.
4) **Manual - hand removal**: Manually removing plants around piers and swimming areas is a viable option. Volunteers could be encouraged to remove dense weedy plants to create small fishing or swimming areas.

5) **Mechanical harvesting**: In 2006, mechanical harvesting is needed due to the high densities of coontail, EWM and CLP. Figure 13 demonstrates the areas typically harvested in Indian Lake most years.
6) **Physical control**: Hydraulic dredging is an unlikely option for Indian Lake. Fabrics are rarely used because of the labor of installation and maintenance. In local demonstrations, problems arose due to gas collection under the fabric. Drawdown combined with dredging could be evaluated but the option would be very costly and have dramatic affects on the ecosystem. Watershed sources of nutrients would also have to be controlled for an effective lake restoration effort.

Figure 13: (Areas typically harvested in Indian Lake)

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GLOSSARY

Alleopathy	harmful effect of one plant on another caused by the release of chemical compounds produced by the first plant.
Chlorophyll a	The green pigment present in all plant life and needed for photosynthesis. The amount present in lake water is related to the amount of algae found there and is used as an indicator of water quality.
Columnaris	Bacterial infection of fish which especially occurs when they are stressed. The disease is highly contagious to fish and typically enters through gills, mouth or small skin wounds.
Cyanobacteria	Another name for blue-green algae. A group of algae that are often associated with "problem" lake blooms. Certain species can produce toxins which can cause illness and even death in animals and humans. Blue-green algae can "fix" nitrogen from the atmosphere and thus are often found when phosphorus levels in water are high.
Desiccated	To thoroughly dry something.
Emergent plants	Species with leaves that extend above the water surface and are usually found in shallow water.
Eutrophication	The process by which lakes are enriched with nutrients thereby increasing the amount of rooted plants and algae. The extent to which this process has occurred is reflected in a trophic classification system.
Eutrophic	Using the lake trophic classification system this is a lake that is rated as being very productive and fertile.

Floating-leaf plants Rooted plants with leaves that float on the water surface such as water lilies.

Filamentous algae Algae that forms filaments or mats which attach to the bottom sediments, rooted plants, piers, etc.

Hectare A unit of measure which is equivalent to about 2.47 acres.

Herptiles A broad group of cold blooded animals including turtles and amphibians.

Hypereutrophic A very nutrient enriched lake characterized by severe and dominant algal blooms are very poor water quality.

Hypolimnion Lakes deeper than 20 feet stratify, or layer, based on temperature differences. This is the layer of the lake closest to the bottom and immediately below the metalimnion or thermocline.

Hypolimnetic See hypolimnion.

Intolerant Aquatic species that are impacted by changing conditions. For example, if water quality worsens certain species may disappear because of lowered oxygen levels or a loss of their habitat.

Littoral Zone Is the shallow part of a lake where most of the rooted aquatic plants are found.

Littoriprofundal Transition zone base of aquatic vascular plants to gradient of benthic algae, photosynthetic bacteria and cyanobacteria and is **o**ften adjacent to the metalimnion of stratified lakes.

Macrophytes The higher (multi-celled) plants found growing in or near the water. They produce oxygen and provide food and cover for lake organisms.

Mesotrophic Lakes that are in-between Eutrophic (very fertile) and Oligotrophic (infertile) waters. They exhibit fairly good water quality and rooted aquatic plant growth.

Oligotrophic Are very clear lakes having lower amounts of rooted aquatic plant growth and productivity but are rich in oxygen throughout their depth.

Planktonic Algae Small free-floating algae including green algae, blue-green algae, and diatoms.

Secchi disc An 8 inch diameter disc with four alternating quadrants of black and white. It is lowered into a lake on a rope and used to measure light penetration. Lakes are infertile (oligotrophic) if the depth you can see the disc are great. Lakes are fertile (eutrophic) if the disc disappears quickly.

Species Richness A way to measure a condition by sampling and identifying the number of different species present.

Thermocline Another name for the metalimnion. It is the narrow transition zone between the epilimnion (upper part) and the hypolimnion (bottom). This portion of a lake is where the temperature changes most rapidly and in most waters is found around 20 feet or deeper.

Trophic State Index A way to measure, rate and classify the quality of a water body. See Eutrophic, Mesotrophic, Oligotrophic and Hypereutrophic.

Turions The over-wintering bud produced by aquatic plants.

Two story fisheries Management of trout and warm water sport fishes in lakes that typically sustain adequate dissolved oxygen in the hypolimnion.

Appendix A

Fish Lake Summary Statistics

Total number of points sampled	**226**
Total number of sites with vegetation	**153**
Total number of sites shallower than maximum depth of plants	**210**
Frequency of occurrence at sites shallower than maximum depth of plants	**72.86**
Simpson Diversity Index	**0.86**
Maximum depth of plants (ft)	**31.00**
Number of sites sampled using rake on Rope (R)	**65**
Number of sites sampled using rake on Pole (P)	**160**
Average number of all species per site (shallower than max depth)	**1.08**
Average number of all species per site (veg. sites only)	**1.48**
Average number of native species per site (shallower than max depth)	**0.51**
Average number of native species per site (veg. sites only)	**1.01**
Species Richness	**4**
Species Richness (including visuals)	**4**

Crystal Lake Summary Statistics

Total number of points sampled	**263**
Total number of sites with vegetation	**96**
Total number of sites shallower than maximum depth of plants	**258**
Frequency of occurrence at sites shallower than maximum depth of plants	**37.21**
Simpson Diversity Index	**0.65**

Maximum depth of plants (ft)	13.00
Number of sites sampled using rake on Rope (R)	0
Number of sites sampled using rake on Pole (P)	263
Average number of all species per site (shallower than max depth)	
Average number of all species per site (veg. sites only)	1.63
Average number of native species per site (shallower than max depth)	0.50
Average number of native species per site (veg. sites only)	1.58
Species Richness	7
Species Richness (including visuals)	7

Indian Lake Summary Statistics

Total number of points sampled	204
Total number of sites with vegetation	204
Total number of sites shallower than maximum depth of plants	204
Frequency of occurrence at sites shallower than maximum depth of plants	100.00
Simpson Diversity Index	0.83
Maximum depth of plants (ft)	8.50
Number of sites sampled using rake on Rope (R)	0
Number of sites sampled using rake on Pole (P)	204
Average number of all species per site (shallower than max depth)	4.50
Average number of all species per site (veg. sites only)	4.50
Average number of native species per site (shallower than max depth)	2.48
Average number of native species per site (veg. sites only)	3.23
Species Richness	8
Species Richness (including visuals)	8

Appendix B

Fish and Waterfowl Values of Desirable Native Plants in Fish, Crystal and Indian Lakes

Scientific Name	Common Name	Fish	Wildlife
Bidens beckii	Water marigold	Food and cover	Food
Brasenia schreberi	Water Shield*	Cover	Food
Ceratophyllum demersum	Coontail*	Food and cover	Food
Chara	Stonewort or	Food and cover	Food

	Muskgrass		
Eleocharis acicularis	Spike Rush	Cover	Food
Elodea canadensis	Elodea	Food and cover	Food
Lemna minor	Lesser Duckweed	Food and cover	Food
Myriophyllum sibiricum	Northern Watermilfoil	Food and cover	Food
Najas flexilis	Bushy Pondweed	Food and cover	Food
Nelumbo lutea	American lotus	Food and cover	Food
Nuphar variegata	Yellow Water Lily	Food and cover	Food
Nymphaea odorata	White Water Lily	Food and cover	Food
Polygonum natans	Smartweed	Food and cover	Food
Potamogetan amplifolius	Large-leaf Pondweed	Food and cover	Food
Potamogetan foliosus	Leafy Pondweed	Food and cover	Food
Potamogetan gramineus	Variable-leaf Pondweed	Food and cover	Food
Potamogetan natans	Floating-leaf Pondweed	Food and cover	Food
Potamogetan richardsonii	Clasping-leaf Pondweed*	Food and cover	Food
Potamogetan zosteriformes	Flat-stem Pondweed	Food and cover	Food
Struckenia pectinatus	Sago Pondweed*	Food and cover	Food
Utricularia vulgaris	Bladderwort	Food and cover	

Fish and Wildlife Values based on Borman et al. 1997, Nichols and Vennie 1991 and Janecek 1988.